WATER QUALITY-
YUKON RIVER BASIN

WATER QUALITY WORK GROUP
REPORT #1

BY

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DECEMBER 1983

WHITEHORSE, YUKON

This report was funded by the Yukon River Basin Committee (jointly with Department of Indian Affairs and Northern Development) under the terms of "An Agreement Respecting Studies and Planning of Water Resources in the Yukon River Basin" between Canada, British Columbia and Yukon. The views, conclusions and recommendations are those of the authors and not necessarily those of the Yukon River Basin Committee or the Governments of Canada, British Columbia and Yukon.

4 DISCUSSION OF RESULTS

4.1 Reconnaissance Data

The results for the reconnaissance sampling are located in Appendix 1 and Appendix 2. In Appendix 1, each page represents one set of the replicate samples. The notation in the upper left hand corner indicates the number of meters the sample was collected from the left hand bank. The variable code is illustrated on Page A-5. The columns X(1) are the results for each of the replicates, XBAR is arithmetic mean, S.D. is standard deviation, G.E. is geometric mean and G.F. is geometric function. The data for all non-replicate parameters are in Appendix 2 coded 5 under column L.

At each station the parameters sampled across the transect were basically the same with the exception of White River at Mouth, 00YT09CC0001. The left hand bank had two to three times lower non-filterable residue values than the other two sites on the transect. This is reflected in some of the dissolved parameters being much lower also. Other than that, the sites on each of the transects were so similar that it made no difference where on the transect samples were collected during regular monitoring, although every effort was made to take mid-stream samples. The White River was sampled at mid channel where the highest residue values had occurred. It was felt that the sample locations were representative at each of the stations.

After reviewing the reconnaissance data, several of the parameters were dropped for the regular monitoring part of the study. These included ammonia nitrogen, dissolved organic carbon, dissolved metals, replicate total metals, total dissolved phosphorus and three of the replicate total phosphorus. The dissolved parameters were deleted because it was not practical to have lay samplers filter in the field.

The data showed that there was very little variation in the replicate total metal concentrations, although zinc had the greatest fluctuations of the five metals. Relatively high single values of total phosphorus and nitrate plus nitrite were encountered and replicates for these parameters were continued although the number of phosphorus replicates was reduced. Three parameters, extractable arsenic, extractable selenium and total magnesium were added for regular monitoring. Another change was that regular monitoring included total cadmium at Eagle, Carmacks and Marsh Lake stations.

4.2 Monitoring Network Data

4.2.1 General Water Quality In the Yukon River Basin. All waters tested in the Yukon River Basin were slightly alkaline with pH's from 7.0 to 8.3. This is probably caused by the thin layer of volcanic ash which was deposited over the Yukon 1500 years ago (Lerbekmo, 1969).

Most waters tested were soft, less than 95 mg/l as $CaCO_3$ (Demayo, 1980) to medium hard.

In winter, rivers with major groundwater sources had higher conductivity, alkalinity and hardness values in contrast to lake outlets whose values stayed relatively the same all year round. The Yukon River showed a slight increase in these parameters in the winter months. It was also observed that the values for conductivity, alkalinity and hardness increased as one went downstream on the Yukon River. The Marsh Lake Control Structure, station 00YT09AB0006, had the lowest values; values increased at Carmacks, station 00YT09AH0001; and were highest at Eagle, Alaska, station 00AK09ED0001.

During freshet and rainstorms higher nonfilterable residues occurred and these were linked to high total iron and total phosphorus concentrations on some occasions. Thus, the nonfilterable residues contained iron and phosphorus which were measured in the analysis of these elements.

The parameters measured in this study that had drinking water guidelines as listed in Health and Welfare, 1979 or aquatic life objectives as listed in Environment Canada 1979-1983 were checked for each station. The parameters which were exceeded at least 20% of the time that they were measured are listed in Table 6. The only drinking water limits exceeded were turbidity, colour, iron and manganese. Since these limits are set for aesthetic reasons only their exceedence of the limit presents no danger to health.

The parameters which were checked to see if they exceeded aquatic life objectives were; cadmium, copper, lead, mercury, selenium, and zinc. The aquatic life objectives were all for total metal concentrations. Only selenium was measured as extractable rather than total selenium in this study. It is the only parameter which might be higher if measured as a total concentration. The only aquatic life objectives exceeded were copper and lead. The presence of these metals and the softness of the waters in the Yukon River Basin mean that caution must be used in considering the addition of these and other metals from man-made sources in the future.

TABLE 6 PARAMETERS THAT EXCEEDED DRINKING WATER AND AQUATIC LIFE OBJECTIVES[1]

STATION	HARDNESS RANGE mg/l as $CaCO_3$	DRINKING WATER[2] LIMIT EXCEEDED	AQUATIC LIFE[3] OBJECTIVES EXCEEDED
Yukon R. at Eagle, Alaska 00AK09ED0001	84-222	Turb Colour Fe	Cu
Yukon R. at Carmacks 00YT09AH0001	45-89		
Yukon R. at Marsh Lake Control Str. 00YT09AB0006	32-52		
Klondike R. at Dawson 00YT09EA0001	75-232	Fe	Cu
Stewart R. at Stewart Crossing 00YT09DD0001	67-332	Turb Colour Fe Mn	Cu Pb
Pelly R. at Pelly Crossing 00YT09BC0002	70-235	Turb Colour Fe Mn	Cu Pb
Pelly R. at Faro 00YT09BC0008	72-186	Turb Colour Fe	Pb
Nordenskiold R. at mouth 00YT09AH0012	60-178	Colour Fe	Cu
Takhini R. at mouth 00YT09AC0001	20-62	Turb Fe	Cu Pb
Yukon R. u/s from Takhini R. 00YT09AB0008	41-53		Cu
Lake Laberge Outlet 00YT09AB0011	42-51		Cu
Tagish R. at bridge 00YT09AA0008	38-42		

TABLE 6 (cont'd)

STATION	HARDNESS RANGE mg/l as $CaCO_3$	DRINKING WATER[2] LIMIT EXCEEDED	AQUATIC LIFE[3] OBJECTIVES EXCEEDED
Bennett Lake outlet 00YT09AA0009	26-30		Cu
Teslin Lake outlet at Johnsons Crossing 00YT09AE0001	56-66		Cu
Atlin Lake outlet 00BC09AA0004	49-52		Cu
Kluane Lake outlet 00YT09CA0005	110-145	Fe	Cu
Yukon R. u/s from White R. 00YT09CD0001	70-95	Fe Turb	
White R. at mouth 00YT09CC0001	94-189	Turb Colour Fe Mn	Cu
McQuesten R. at bridge 00YT09DD0011	53-164	Colour	Cu
Teslin R. at mouth 00YT09AF0001	63-79	Colour Fe	Cu
Jennings R. at mouth 00BC09AE0010	24-58		Cu Pb

1. Only parameters that exceeded drinking water and aquatic life limits more than 20% of the time are shown.

2. Ref: Health and Welfare Canada, 1979.

3. Ref: Environment Canada, 1979 - 1983.

4.2.2 Sampling Frequency. Ten sites out of twenty-one were collected at one and two week intervals. The data from these stations was evaluated by compute analysis to determine optimum sampling frequency with the aim of optimizing future monitoring efforts in the basin. The methods and results are reported in Whitfield, 1983. The results and their implications will be discussed in this section.

In the analysis, each parameter at each station was assessed for optinum frequency. The objective was to make a frequency recommendation for long term monitoring that would detect trends or changes over time in water quality. Results of the analysis are shown in Table 7.

For practical reasons it is necessary to analyse all parameters at the sam frequency. The site must be visited in any case. It is easier to design a shipping container for the same number of bottles each time. It is easier to be consistent if the same procedure is followed each time, especially if more than one sample person is involved.

The results obtained, suggest that a frequency of weekly is required. The once every two weeks samples at three sites were less adequate than the weekly sampling at the other sites. It is possible that an analysis of multiyear data, which was not done, might find once every two weeks was an adequate frequency but it is unlikely that any sampling less frequent than that would b adequate.

4.3 Quality Control Study

The Quality Control Study was done to evaluate sampling methods in the field and thus establish the validity of the data collected.

Field measurements made by lay samplers were also evaluated. Air and wate temperatures were reliable and useful. These measurements can only be done in the field. Field conductivity and pH measurements were less reliable especially when done by lay samplers. This may be the result of lack of calibration with standards and the use of inexpensive and thus less accurate equipment. It must be questioned whether or not these measurements should be done by lay samplers since the results may not be reliable.

4.3.1 Distilled Water Blanks. Distilled water blanks were done at four sites. The influence of sampling techniques, field conditions, sample bottle cleanliness and preservative purity were thus tested for.

TABLE 7 MINIMUM SAMPLING FREQUENCIES FOR YUKON RIVER BASIN SITES IN WEEK INTERVALS (From Whitfield 1983)

VARIABLE	AH0001 80-81	AH0001 81-82	AH0001 82-83	AB0006 80-81	AB0006 81-82	AB0006 82-83
Air Temperature	1	1	8	1	1	5
Water Temperature	1	1	6	1	1	3
Field pH	1	1	1	*	-	*
Field Conductance	*	*	-	1	-	-
Lab Temperature	1	1	1	*	*	*
Lab pH	1	1	*	1	*	2
Lab Conductance	1	1	3	1	*	1
Turbidity	1	2	2	1	1	3
Colour	1	1	2	1	1	1
Alkalinity Phenolphthalein	any	any	any	any	any	any
Alkalinity Total	1	1	3	1	*	2
Hardness	1	1	3	1	*	1
Ca	1	1	3	1	*	1
Mg	*	*	1	*	1	*
K	1	*	*	*	*	*
Na	3	1	*	1	*	*
Cl	1	1	1	*	*	*
F	*	2	1	8	1	4
Silicate	1	1	3	*	1	*
Sulphate	2	1	7	1	1	*
Nitrate & Nitrite	4	*	1	*	*	*
Nonfilterable Residue	1	-	-	*	-	-
Filterable Residue	*	-	-	1	-	*
Fixed Nonfilterable Residue	1	-	-	*	-	-
Fixed Filterable Residue	*	-	-	1	-	*
As	*	*	*	*	*	*
Se	*	*	*	any	2	*
Cd	-	-	-	-	*	*
Cu	-	-	*	-	*	*
Zn	-	-	*	-	*	1
Fe	-	-	2	-	1	-
Pb	-	-	*	-	*	*
Mn	-	-	2	-	1	*
Hg	-	-	*	-	*	*
Total Dissolved Nitrogen	-	-	*	-	*	*
Total Phosphorus	-	-	*	-	1	2
Total Organic Carbon	-	-	2	-	-	1
Total Inorganic Carbon	-	-	1	-	-	*

(*) more frequently than weekly.
(-) not analysed - less than 90% of values determined.

TABLE 7 (Cont'd)

VARIABLE	EA0001	DD0001	BC0002	BC0008	AH0012	AC0001	AB0008
Air Temperature	3	8	3	4	4	2	3
Water Temperature	3	5	4	3	4	2	1
Field pH	-	*	-	1	*	*	*
Field Conductance	-	-	-	-	2	*	-
Lab Temperature	*	*	1	1	*	*	*
Lab pH	*	1	*	1	2	2	*
Lab Conductance	6	3	1	1	4	4	*
Turbidity	*	1	1	3	*	4	*
Colour	1	1	1	1	*	*	*
Alkalinity Phenolphthalein	any	any	any	any	any	any	any
Alkalinity Total	3	3	1	2	2	2	2
Hardness	6	3	1	1	2	2	2
Ca	3	3	1	1	2	2	2
Mg	5	2	1	3	2	*	*
K	1	1	2	2	4	*	*
Na	6	3	4	1	2	2	2
Cl	4	2	5	*	2	*	2
F	1	1	2	3	*	*	*
Silicate	6	1	2	2	2	6	*
Sulphate	6	2	3	1	2	4	*
Nitrate & Nitrite	6	1	1	*	*	*	*
Nonfilterable Residue	3	4	-	-	-	4	*
Filterable Residue	1	1	1	-	-	*	*
Fixed Nonfilterable Residue	3	4	-	-	-	4	*
Fixed Filterable Residue	1	1	*	-	-	*	*
As	*	1	2	*	*	2	*
Se	4	4	3	1	*	*	*
Cd	-	-	-	-	-	-	*
Cu	*	2	1	1	*	*	*
Zn	*	4	1	1	2	*	*
Fe	3	5	1	3	*	4	-
Pb	1	*	1	4	*	*	*
Mn	3	1	1	3	*	4	*
Hg	*	*	*	*	*	*	*
Total Dissolved Nitrogen	6	*	1	*	*	*	*
Total Phosphorus	3	1	1	3	*	*	*
Total Organic Carbon	2	2	2	1	*	2	*
Total Inorganic Carbon	1	2	1	1	2	4	*

The only parameters which had high values which were of the same concentration as normal Yukon River basin samples were; dissolved nitrite/nitrate nitrogen, total phosphorus, and total zinc. This limited sampling suggests that any samples might have contamination for these parameters so all data on these parameters should be viewed with caution.

4.3.2 Duplicates and Increased Frequency Sampling. Parameters which had concentration differences in duplicate samples were non-filterable residues, filterable residues, nitrite/nitrate nitrogen and total phosphorus.

Parameters which had concentration differences in samples taken three times a week were turbidity, non-filterable residues, nitrite/nitrate nitrogen and total phosphorus. The Pelly River at Faro also showed concentration differences for arsenic and iron.

The differences in parameter concentrations in duplicates were similiar to the differences in the more frequent sampling. The results of the Quality Control Study indicate that certain parameters vary greatly in samples taken a few minutes apart or one or two days apart. Some of these parameters (nitrite/nitrate nitrogen and total phosphorus) had measurable concentrations in distilled water blanks. This means that differences may be due to contamination and individual high results for these parameters should especially be viewed with caution

4.4 Results of Mercury Testing in the Pelly River Area

4.4.1 Water Quality. All water samples taken in this special project were below the laboratories' detection limit for mercury (Appendix 4.1). The June 14, 1983 drinking water sample was below the detection limit of 0.0001 mg/l whereas the remaining samples were below 0.00005 mg/l.

The acceptable concentration for drinking water standards for mercury is 0.001 mg/l (Health and Welfare, 1979).

On the five occasions when mercury was present during other monitoring the levels were still below this standard (Appendix 2.7). Pelly River at Pelly Crossing also had detectable levels of mercury on five occasions (Appendix 2.6). Some, but not all detectable mercury levels occurred on the same dates as those upstream at Faro. None of these values warrant a concern as they were well below the drinking standard.

During other monitoring mercury concentrations were above the detection limit five times each in the Pelly River at Faro and Pelly Crossing and in the Stewart River. Mercury concentrations were above the detection limit only a few times at seven of the remaining eighteen stations. Therefore it is unlikely that these infrequent occurences of detectable mercury are of any significance in the Yukon River Basin.

4.4.2 Sediment. The mercury concentrations in the sediments were very low, ranging from 0.07 to 0.17 mg/kg (Appendix 4.2). These values reflect similiar concentrations found in seven Yukon streams in a study done by Mathers et al, 1981.