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Special Interlaboratory Quality Control Study: Evaluation of Total Alkalinity Methods of Fixed-End Point Titration, IR/CO_2 Evolution, Alkalinity/Acidity in Precipitation Samples, and Gran Analysis - IRQC 74 A

V. Cheam

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IWD-HQ Water Quality Branch Regional
Managers

Contents

ABSTRACT

Non-comparability of WQB data were observed in the inter-regional quality control studies for total alkalinity in water. This special interlaboratory study was designed and conducted in order to shed light to this problem area.

Since alkalinity/acidity is very important in the acid rain program, precipitation samples and groundwaters are included in this study, in addition to artificial and natural waters from various locations.

The submitted data, obtained from four WQB methods, are commented on. The limitation and application of these four methods are also discussed.

INTRODUCTION

The inter-regional quality control studies No. 60-61 identified a problem area in the determination of total alkalinity. We contacted all the chemists and analysts who reported alkalinity data in order to verify the results and procedures.
Mr. Merl Korchinski (Calgary) expressed concerns about their observed non-compatibility of the two analytical methos used by Water Quality Branch laboratories — the IR/CO_2 evolution, and the traditional fixed-end point titration method (NAQUADAT CODED 10106 and 10101, respectively). Subsequently, Korchinski expressed interest in a round-robin study which addresses the subject matter and offered to send some samples for the study (IR60-61 report). It was thought most appropriate to carry out a detailed study as the alkalinity intimately relates to the acidity and acid rain pollution, which is now one of the most serious threats to the environment and probably heads the list of priority pollutants in many countries.

The purpose of the study is to shed light on the non-compatibility of data and methods for total alkalinity. We took the multi-sample and multi-method approach. The samples, natural and standards, covered a very wide range of analyte concentration and background composition and thus put to test the analytical methods under possibly the toughest challenge ever encountered by WQB laboratories on a one shot basis.

Several preliminary data summaries were sent to laboratories after we received data from them in October 1980, December 1980, January 1981, March 1981, and May 1981. After the study went out in August 1980, the regions were contacted on many occasions in order to recheck reported data, verify method codes, accommodate request for additional samples, and to request to reanalyze some samples.

EXPERIMENTAL

Samples

We considered several natural samples for the study. The criterion for selection was to use the waters from the various regions as much as possible and that they represent waters with quite a variety of composition and concentrations. Waters from very low to very high conductivity were considered so that samples related to acid rain as well as those with complex background matrices are altogether investigated under the same study.

In-House Stability Monitoring and Confirmatory Analyses

We monitored samples alkalinity for about one month to determine their stability and chose the most stable ones. Sub sampling was then made into 250 mL polyethylene bottles and confirmatory analyses made using mostly methods of fixed end point and Gran analysis; occasionally, CO_2 and a special inflextion point methods were utilized.

Distribution

The following samples were distributed to each of the six Water Quality Branch laboratories across Canada: Beaver Skin Lake water (sample 1), Lake Superior water plus borax (sample 2), Lake Superior water (sample 3), Qu'Appelle River water (sample 4), Hamilton Harbour water (sample 5), Wascana Creek water (sample 6), Pebbleloggitch Lake water (sample 7), composite rain water (sample 8), and a solid sample of ultrapure Na_2CO_3 (exactly 0.265 g). We requested storage of water samples at 4°C until analysis. Instructions were given for dissolution of solid sample.

RESULTS AND DISCUSSION

The analytical methods used to determine total alkalinity by WQB laboratories were: fixed end-point titration (Code 10101), infra-red or CO_2 evolution method (Code 10106), method for precipitation samples (Code 10107) and Gran titration analysis (Code 10110). The method for determining acidity in rain smaples was also used (Code 10210).

As the samples in this study substantially differ from one another in types and concentration levels, it would be advantageous to group similar samples and discuss comparison of results and methods group by group. There may be four groups - natural samples with low concentration levels, natural samples with medium levels, natural samples with high levels, and standards with low and high levels.

Natural samples with low levels - Beaver Skin Lake, Pebbleloggitch Lake, and Composite Rain

The waters from Beaver Skin Lake (sample 1) and Pebbleloggitch Lake (sample 7) were supplied to us by Moncton Laboratory (Dr. Tom Pollock), whereas the composite rain sample (sample 8) by the Monitoring and Surveillance Section of Water Quality Branch, Burlington, Ontario (Mr. Lorne Perkins).

When dealing with low levels of alkalinity, or most anything else for that matter, one should expect to encounter more data scattering than with mediums or high levels. Take Beaver Skin Lake sample results as a first example. Three laboratories using the fixed-end point mehod reported 2.10, 2.60, 0.05, <0.5, <0.5, giving an average of 1.58 with a percent CV of 85.3%. Combining all the results from methods of fixed-end point, CO_2 evolution and precipitation samples, one has an average of 1.39 with 67% CV. All results, however, seem to indicate that beaver Skin Lake water, with an average pH of 5.2, and SO_4 of 3.24 ppm (all SO_4 results are comparable), is slightly alkaline.

Consider now the Pebbleloggitch Lake water (sample 7). It is a very interesting sample because of its low pH, 4.5, and its border-line classification as acidic or alkaline. Our in-house analysis, before sample distribution, indicated that the sample behaved more like distilled water as far as titration results were concerned. The Gran and fixed-end point methods indicated acidity, whereas the CO_2 and "inflection" methods indicated alkalinity.

This interlaboratory study seems to show that Pebbleloggitch Lake water is acidic. Both Calgary and Moncton reported negative values for total alkalinity by fixed-end point method and Gran analysis, respectively (data summary printout). In addition, CCIW ships reported an acidity value of 2.2 by acidity method for precipitation samples (Code 10210).

Vancouver analysed the Pebbleloggitch sample for alkalinity and acidity by the mehtods for precipitation samples (Codes 10107 and 10210), and respectively reported 11.9 and 12.1 mg/L. These results contradict each other and, therefore, cannot be used to disprove or support the implications made above.

Three laboratories analyzed Pebbleloggitch Lake sample by the CO_2 method and reported an average of 4.56 ±23% which is a fair precision at this level. But this method never sees a negative value even if the test sample were acidic; also, at low analyte levels it tends to give larger responses than they actually are. Recognizing these facts, CCIW ships now use titration methods to determine low alkalinity of ≈5 ppm or less (Yusuf Sheik, personal communication). Another example of high result by the method is seen in the composite rain sample (see below).

Sulfate results agree fairly well with each other, giving an average of 5.43 ±18%.

Turning now to the composite rain sample (pH 5.9, sample 8), the methods for precipitation samples and the fixed-end point produced positive alkalinity results with an average of 1.66 pm ±32%. These reuslts are in fair agreement with each other and indicate that the water is slightly alkaline.

The CO_2 evolution method, again, gives high results with an average of 5.44 ppm, as in Pebbleloggitch Lake water, and the explanation given there may be applied here as well. All sulfate results are fairly comparable with a mean of 3.59 ±16%.

Natural Samples, Medium-Normal Levels = Lake Superior, Lake Superior Spiked with Borax, and Hamilton Harbour Waters

The waters used were Lake Superior water (sample 3), Lake Superior water spiked with some borax (sample 2), and Hamilton Harbour water (sample 5). These types of waters are often tested by Water Quality Branch laboratories and expected to cause no difficulty.

The analytical results were obtained by three methods: fixed-end point titration (Code 10101), CO_2 evolution method (Code 10106), and the titration method for precipitation samples (Code 10107). Even though the results seem to be comparable and indicate that the three methods are compatible, a few points of interest should be made here. Firstly, in sample 2, a small amount of borax, equivalent to 4 ppm boron, was intentionally added to the Lake Superior sample. This caused the pH to increase from 7.6 to 8.2. As boron contributes to alkalinity determination, one expects the alkalinity in sample 2 to be greater than that of sample 3 (Lake Superior waer). This was observed (45.2 ppm vs 41.9 ppm average values). Secondly, both the fixed-end point titration and the titration for precpitation samples give a difference of 4.2 ppm, whereas the CO_2 method a difference of 1.3 ppm. It is surprising that the latter difference was observed at all. Nevertheless, this small difference of 1.3 ppm indicates that the CO_2 method is not as adequate as the other methods in picking up the contribution from boron. What if boron were present in a large quantity? This is certainly another weakness in the IR/CO_2 method, and will be amply illustrated later.

Sulfate results by CCIW ships are consistently lower than others.

Natural Samples, High-Levels = Qu'Appelle River and Wascana Creek

The waters from Qu'Appelle River - at Highway 11 (sample 4) and Wascana Creek - near the mouth (sample 6), were kindly sent to us from Regina, Saskatchewan through Mr. Merl Korchinski of Calgary laboratory. These waters are known to contain high concentration levels of alkalinity, sulfate, and other constituents and known to give some analytical problems to the Calgary laboratory (Korchinski, personal communication).

At this high alkalinity level and at pH ≈8, the three analytical methods (fixed-end point, CO_2, and precipitation) produced comaprable results in both samples. It appears that CALGARY laboratory does not have any difficulty with these samples and that their two methods (fixed-end point and CO_2) are compatible.

Vancouver's SO_4 results are high in both samples relative to others and are circled. CCIW ship's results on SO_4, again, tend to be low.

Standards, Low and High Levels = Solid Na_2CO_3 with Instruction for Dilution

A carefully weighted solid sample of Na_2CO_3 (0.265 g, ultra high purity, Ultrex) was sent to each participant with instructions to:

a) dissolve the whole soid content in a 1 L volumetric flask using deionized distilled water, and call it sample 9;

b) to pipette 40 mL of sample 9 into another flask and make up to the 1 L mark with the same deionized distilled water; and

c) analyze the background d.D.W. as sample 11.

The average background alkalinity in d.D.W. is -0.01 ppm with a C.V. of -3200% and is equated to zero in subsequent calculations.

Four methods were used - fixed-end point, CO_2, precipitation samples method, and Gran analysis. Using known added values of 250 and 10 ppm $CaCO_3$ of alkalinity, the precision and recoveries by the method of fixed-end point, and that for precipitation samples, are excellent. The Gran analysis, used by the Moncton laboratory only, appears to give satisfactory results (this method is believed to give dependable results at all levels). On the other hand, the CO_2 evolution method is imprecise and unaccuate giving a recovery of 59% at both levels of 250 and 10 ppm (data summary printout).

The IR method converts the sample inorganic content to total alkalinity by using the conversion factor of 4.166. As sodium carbonate, Na_2CO_3, was used, the total alkalinity conversion factor is 8.333. Thus, in principle, the present IR method should show a recovery of 50% only (rather than 59%). If one applies the latter factor to the present IR data, one would obtain 293 mg $CaCO_3$/L and 11.8 mg $CaCO_3$/L in samples 9 and 10, respectively. Now the recoveries are 118%, which is an improvement, but is high. This is due, in part, to high results by Calgary (data summary printout).

Let us now return to the IR60-61 study, where a 50/50 mixture of HCO_3-C and CO_3-C was used to ensure stability in test samples 12, 13, and 14. There, we observed non-compatibility between the fixed-end point and IR methods, and the IR data did not agree with each other (IR60-61 report). We propose that the TIC values from the IR method (CCIW ships and Calgary) and spikes be converted to total alkalinity by the following equation:

$$\frac{TIC}{2}(4.166) + \frac{TIC}{2}(8.333) \qquad (1)$$

The calculated results are shown in Table 1. It can be seen that the three results are now much more comparable than before.

In the above calculation of IR data, we intentionally omitted CCIW INORG results, which, for all practical purposes, agree with those in Table 1 without being subjected to recalculation by equation 1 (IR60-61, Appendix 3). This accuracy of IR data by CCIW INORG is puzzling in the light of the following points:

a) In this special study, IR74A, their results are approximately half of theoretical values, basically agree with other IR data of ships and Calgary, and, therefore, produce low results as expected.

b) In IR60-61, their results basically agree with theoretical values, disagree with other IR data of SHIPS and CALGARY, and unexpectedly produce accurate results.

c) Mr. Doug Sturtevant and Mr. Rick Wells (personal communication) insist that no deviations from CO_2 evolution procedures were followed in the IR60-61 study.

In sample 9 of this study, the average pH of 10.5 indicates the titration region of CO_3's. As each $CO_3^=$ species requires two hydrogen ions in total alkalinity determination, the fixed-end point method, the Gran analysis, and the method for precipitation samples, should provide accurate determinations as they are directly relevant to the volume of acid used. On the other hand, the CO_2 evolution method mainly concerns with the amount of CO_2 measured following the addition of acid. Thus, in samples where there are significant amounts of $CO_3^=$, the CO_2 method is bound to give low results unless proper accounts are made such as those suggested above. Furthermore, as we saw earlier, the method does not pick up other alkalinity contributing consitutents such as borax (in sample 2). As it mainly reflects the sample bicarbonate content, perhaps the method should be identified as determining bicarbonate alkalinity rather than total alkalinity.

As bad as it may sound, the CO_2 evolution method is useful in determining the inorganic content. Furthermore, as most natural samples encountered by WQB laboratories have pH $<$8.3, and do not, in general, contain significant amounts of other species such as boron, the CO_2 method should be adequate in these instances. In samples where the pH is high and where it is known that alkalinity contributing species are present in a significant quantity, titration methods should be the preferred methods to use. In the $CO_3^{=}$ - HCO_3^- - H_2CO_3 titration system, a pH of 8.3 indicates predominance of HCO_3^- species, and that one now enters the HCO_3^- - H_2CO_3 equilibrium system , and therefore, may be used as a qualitative signal for the applicability of the IR method.

SUMMARY AND CONCLUSIONS

1. The six participating laboratories used four analytical methods for alkalinity, and one method for acidity in this special study:

CCIW INORG - IR method (11 samples)

MONCTON - Fixed-end point (11 samples)
- Gran analysis (3 samples)

CCIW SHIPS - IR and precipitation sample methods (11 samples)
- acidity method 10210 (1 sample)

CALGARY - IR and fixed-end point (11 samples)

VANCOUVER - Fixed-end point (10 samples)
Precipitation samples method (one sample)

LONGUEUIL - Fixed-end point (seven samples)

2. It is difficult to draw definitive conclusions about the four methods since they were not uniformly used by the laboratories for all 11 samples. In fact, none of the methods were commonly used by all six laboratories, and some methods was used for a few samples only (see 1). Therefore, it is not meaningful to have detailed statistical treatments of the data.

3. Some useful conclusions may, nevertheless, be made:

- The IR method should be used with reservation when dealing with low levels of alkalinity, ≈5 ppm $CaCO_3$ or less, as it tends to give high results. The titration methods — fixed-end point, Gran, or precipitation samples — would provide better accuracy. CCIW ships (Omar Elkei, personal communication) do away with the CO_2 method for rain samples, but titrate them using a Metrohm Titroprocesor.

- The IR method will be biased low when alkalinity contributing species such as boron and carbonate ($CO_3^{=}$) are significantly present in test samples.

- A a general rule of thumb, it is not advisable to use the IR method for alkalinity determination in samples with pH <8.3. (Note: This does not imply that for test samples with pH <8.3, the IR method is always adequate. Results on alkalinity and pH in sample 2 illustrate this point).

- In spite of the above weaknesses, the CO_2 evolution method is still applicable to most inland waters encountered by WQB laboratories.

- CALGARY, Lab does not seem to have any difficulty analysing alkalinity in complex water samples such as Wascana Creek and Qu'Appelle River waters

- Sulfate results:
  - CCIW ships tend to be biased low.
  - CCIW INORG's are somewhat erratic.

APPENDIX 1

REFERENCES

Analytical Methods Manual, 1979. Inland Waters Directorate, Water Quality Branch, Ottawa, Ontario, Canada.

Cheam, V., May 1980. Summary report on IRQC studies Nos. 60 & 61 - Specification studies on anions, nutrients, alkalinity and mercury methods. Confidential distribution to Headquarter, Ottawa and managers and analysts of all six regional Water Quality Branch laboratories.

Freiser, H. and Q. Fernando, 1963. "Ionic equilibria in analytical chemistry", John Wiley & Sons, New York.

Laitinen, H.A. 1960. "Chemical Analysis", McGraw-Hill, Toronto.

Appendix 2

Government of Canada Gouvernement du Canada

MEMORANDUM **NOTE DE SERVICE**

V.CHEAM/NWRI/4645 jb

TO / A: Distribution

SECURITY - CLASSIFICATION - DE SÉCURITÉ

OUR FILE/NOTRE RÉFÉRENCE

YOUR FILE/VOTRE RÉFÉRENCE

FROM / DE:
V. Cheam
Quality Assurance and Methods Section
AMD, NWRI

DATE 18 August 1980

SUBJECT / OBJET: Special Study on alkalinity

Enclosed are eight (8) water samples and one (1) solid sample for the above study. Please send results in by the week of September 15, 1980.

The water samples are in 250 ML polyethylene bottles, unpreserved, and should be stored in a 4°C room before analysis. They represent a good variety of waters with a wide range of alkalinity from the various regions.

The solid sample in the small Pyrex container should be dissolved in one (1) litre volumetric flask using deionized distilled water. Label this 1 L solution as sample 9.

Pipette an aliquot of 40 ML of sample 9 and transfer it into another one (1) litre volumetric flask and make up to the mark with deionized distilled water. Now call this solution sample 10. Sample 11 is the distilled water.

Please analyse samples 9 and 10 in duplicate. Samples 4, 6 and 9 may take more titration time than the others to reach the end points as their alkalinity values are high, around 200-400 PPM. On the other hand, samples 1, 7, and 8, having low buffer capacity, should require shorter titration time. We caution, however, that these latter samples could be the most difficult ones with respect to accurate and precise determination of alkalinity or acidity. We therefore request that samples 1, 7 and 8 be analyzed in duplicate as 9 and 10.

We are suggesting also that the analysts use as many methods as they can to determine alkalinity. Reporting negative values of alkalinity by titration method is welcome. As can be seen in the enclosed data sheet, we are also requesting analyses of SO_4, B, pH and Alkalinity/acidity, whose analytical results could shed some light on problem samples which might be encountered.

V. Cheam
Enclosure

DISTRIBUTION:

Head, Analytical Services Section
Pacific Region Water Quality Branch

Head, Analytical Services Section
Ontario Region Water Quality Branch

Head, Analytical Services Section
Quebec Region Water Quality Laboratory

Head, Analytical Services Section
Atlantic Region Water Quality Branch

Head, Analytical Services Section
Western Region Water Quality Laboratory

c.c: Chief, Laboratory Operations Division
Water Quality Branch, Ottawa

Head, Quality Assurance and Methods Section
Analytical Methods Division, NWRI
CCIW, Burlington

DATA SHEET

for Special Study on ALKALINITY

CONSTITUENT, PPM	NAQUADAT CODE	SAMPLES										
		1+	2	3	4	5	6	7+	8+	9+	10+	11
T. ALKALINITY (as $CaCO_3$)	10101 10106 *- - -											
SULFATE												
BORON												
Initial pH (pH units)												
ALKALINITY/ ACIDITY	10107 10210											

+Duplicate determintions.

*Any new method used for determination of T. Alkalinity is welcome, including the new semi-automated titration system. Please briefly describe the principle of the method if it is new.

APPENDIX 3

SUMMARY

INTER REGIONAL QUALITY CONTROL PROGRAM

STUDY NO. 60-61 DATE: 01/07/79 DATE DISTRIBUTED 50779
SOURCE OF SAMPLE SPIKED-NATURAL WATER SAMPLES,DW,LSW,AND RAIN WATERS

MAJOR ANIONS NUTRIENTS(UNPRES) HG(PRES)		CCIW INORG	MONCTON	CCIW SHIPS	CALGARY	VANCOUVER	LONGEUIL	MEAN	STDEV	RELAT STDEV	SPIKE	BGC	%REC
SAMPLE12=SPK DW													
06051 CARBON TOTAL INO	MG/L	N/A	8.500	N/A	N/A	2.000	N/A						
06051 CARBON TOTAL INO	MG/L	N/A	N/A	N/A	N/A	1.600	N/A	4.033	3.073	96.0	2.010	0.000	200.7
06101 CARBON DIS ORG.	MG/L	N/A	N/A	N/A	N/A	13.000	N/A						
06101 CARBON DIS ORG.	MG/L	N/A	N/A	N/A	N/A	21.000	N/A	17.000	5.657	33.3	2.010	0.000	845.8
06104 DISS ORG CARBON	MG/L	N/A	N/A	1.9	2.0	N/A	N/A						
06104 DISS ORG CARBON	MG/L	N/A	N/A	N/A	N/A	N/A	N/A	2.0	.1	3.6	2.0	0.0	97.0
06151 DIC/COMBUST CO2	MG/L	N/A	N/A	N/A	N/A	2.000	N/A						
06151 DIC/COMBUST CO2	MG/L	N/A	N/A	N/A	N/A	1.600	N/A	1.800	.283	15.7	2.010	0.000	89.6
06152 DIC/IR DETCT CO2	MG/L	N/A	N/A	2.000	3.000	N/A	N/A						
06152 DIC/IR DETCT CO2	MG/L	N/A	N/A	N/A	N/A	N/A	N/A	2.500	.707	28.3	2.010	0.000	124.4
10101 TOT ALKLTY TITN	MG/L	N/A	13.60	N/A	N/A	13.70	11.50						
10101 TOT ALKLTY TITN	MG/L	N/A	N/A	N/A	N/A	12.70	10.80	12.46	1.28	10.3	12.56	1.73	87.2
10106 TOT ALKLTY CO2	MG/L	11.00	N/A	9.00	7.00	N/A	N/A						
10106 TOT ALKLTY CO2	MG/L	12.00	N/A	N/A	N/A	N/A	N/A	9.75	2.22	22.7	12.56	1.00	71.9
10151 P ALKALINITY	MG/L	N/A	N/A	N/A	N/A	.20	0.00						
10151 P ALKALINITY	MG/L	N/A	N/A	N/A	N/A	2.40	0.00	.65	1.17	180.1	N/A	N/A	0.0
SAMPLE13=SPK DW													
06051 CARBON TOTAL INO	MG/L	N/A	32.500	N/A	N/A	26.000	N/A						
06051 CARBON TOTAL INO	MG/L	N/A	N/A	N/A	N/A	24.000	N/A	27.500	4.444	16.2	23.970	0.000	114.7
06101 CARBON DIS ORG.	MG/L	N/A	N/A	N/A	N/A	98.000	N/A						
06101 CARBON DIS ORG.	MG/L	N/A	N/A	N/A	N/A	37.000	N/A	67.500	43.134	63.9	23.960	0.000	281.7
06104 DISS ORG CARBON	MG/L	N/A	N/A	22.0	19.0	N/A	N/A						
06104 DISS ORG CARBON	MG/L	N/A	N/A	N/A	N/A	N/A	N/A	20.5	2.1	10.3	24.0	0.0	89.8
06151 DIC/COMBUST CO2	MG/L	N/A	N/A	N/A	N/A	26.000	N/A						
06151 DIC/COMBUST CO2	MG/L	N/A	N/A	N/A	N/A	29.000	N/A	27.500	2.121	7.7	23.970	0.000	114.7
06152 DIC/IR DETCT CO2	MG/L	N/A	N/A	25.000	23.000	N/A	N/A						
06152 DIC/IR DETCT CO2	MG/L	N/A	N/A	N/A	N/A	N/A	N/A	24.000	1.414	5.9	23.970	0.000	100.1
10101 TOT ALKLTY TITN	MG/L	N/A	148.00	N/A	N/A	146.00	153.00						
10101 TOT ALKLTY TITN	MG/L	N/A	N/A	N/A	N/A	148.00	152.00	149.40	2.97	2.0	149.82	1.73	98.6
10106 TOT ALKLTY CO2	MG/L	145.00	N/A	108.00	99.00	N/A	N/A						
10106 TOT ALKLTY CO2	MG/L	144.00	N/A	N/A	N/A	N/A	N/A	124.00	23.98	19.3	149.82	1.00	82.2
10151 P ALKALINITY	MG/L	N/A	N/A	N/A	N/A	31.30	41.50						
10151 P ALKALINITY	MG/L	N/A	N/A	N/A	N/A	27.90	38.90	34.90	6.36	18.2	N/A	N/A	0.0
SAMPLE 14=SPK DW													
06051 CARBON TOTAL INO	MG/L	N/A	120.000	N/A	N/A	58.000	N/A						
06051 CARBON TOTAL INO	MG/L	N/A	N/A	N/A	N/A	60.000	N/A	79.333	35.233	44.4	47.930	0.000	165.5
06101 CARBON DIS ORG.	MG/L	N/A	N/A	N/A	N/A	113.000	N/A						
06101 CARBON DIS ORG.	MG/L	N/A	N/A	N/A	N/A	58.000	N/A	85.500	38.891	45.5	47.920	0.000	178.4
06104 DISS ORG CARBON	MG/L	N/A	N/A	40.0	48.0	N/A	N/A						
06104 DISS ORG CARBON	MG/L	N/A	N/A	N/A	N/A	N/A	N/A	44.0	5.7	12.9	47.9	0.0	91.8
06151 DIC/COMBUST CO2	MG/L	N/A	N/A	N/A	N/A	68.000	N/A						
06151 DIC/COMBUST CO2	MG/L	N/A	N/A	N/A	N/A	49.000	N/A	58.500	13.435	23.0	47.930	0.000	122.1
06152 DIC/IR DETCT CO2	MG/L	N/A	N/A	50.000	48.000	N/A	N/A						
06152 DIC/IR DETCT CO2	MG/L	N/A	N/A	N/A	N/A	N/A	N/A	49.000	1.414	2.9	47.930	0.000	102.2
10101 TOT ALKLTY TITN	MG/L	N/A	292.00	N/A	N/A	289.00	298.00						
10101 TOT ALKLTY TITN	MG/L	N/A	N/A	N/A	N/A	292.00	292.00	292.60	3.29	1.1	299.60	1.73	97.1
10106 TOT ALKLTY CO2	MG/L	282.00	N/A	185.00	N/A	N/A	N/A						
10106 TOT ALKLTY CO2	MG/L	290.00	N/A	N/A	N/A	N/A	N/A	252.33	58.45	23.2	299.60	1.00	83.9
10151 P ALKALINITY	MG/L	N/A	N/A	N/A	N/A	45.30	9.80						
10151 P ALKALINITY	MG/L	N/A	N/A	N/A	N/A	69.70	10.80	33.90	29.02	85.6	N/A	N/A	0.0

TABLE 1. COMPARISON OF TOTAL ALKALINITY RESULTS, ppm (IR60-61)

	Sample 12	Sample 13	Sample 14
Theoretical, ppm	12.56*	149.82*	299.6*
IR method (average of SHIPS and CALGARY)	15.63	150.012	306.2
Fixed-end point titration	12.46	149.40	292.6

* An average background value of 1.55 ppm is not included.

TABLE 2 MMARY

INTER REGIONAL QUALITY CONTROL PROGRAM

STUDY NO. 74A DATE: 15/09/80 DATE DISTRIBUTED 200880
SOURCE OF SAMPLE VARIOUS SOURCES AND SOLID SAMPLES-SYNTHETIC SAMPLES

SPECIAL STUDY/ALKALINITY (UNPRSD SMPLES)		*	CCIW INORG	MONCTON	CCIW SHIPS	CALGARY	VANCOUVER	LONGEUIL	*	MEAN	STDEV	RELAT STDEV	SPIKE	BGD	%REC
SAMPLE1=BEAVER SKIN LAKE WATER															
05105 B DISVD COLRMTY	MG/L	*	N/A	.100L	N/A	N/A	N/A	N/A	*	0.000	0.000	0.0	N/A	N/A	0.0
10101 TOT ALKLTY TITN	MG/L	*	N/A	2.10	N/A	.05	.50L	N/A	*						
10101 TOT ALKLTY TITN	MG/L	*	N/A	2.60	N/A	N/A	.50L	N/A	*	1.58	1.35	85.3	N/A	N/A	0.0
10106 TOT ALKLTY CO2	MG/L	*	1.20	N/A	2.00	N/A	N/A	N/A	*						
10106 TOT ALKLTY CO2	MG/L	*	1.00	N/A	2.00	N/A	N/A	N/A	*	1.55	.53	33.9	N/A	N/A	0.0
10107 ALKLTY PPTN TITN	MG/L	*	N/A	N/A	.20	N/A	N/A	N/A	*	.20	0.00	0.0	N/A	N/A	0.0
10190 T ALKLTY MIX MET	MG/L	*	1.20	2.10	2.00	.05	.50L	N/A	*						
10190 T ALKLTY MIX MET	MG/L	*	1.00	2.60	2.00	N/A	.50L	N/A	*						
10190 T ALKLTY MIX MET	MG/L	*	N/A	N/A	.20	N/A	N/A	N/A	*	1.39	.93	67.0	N/A	N/A	0.0
10301 PH	UNITS	*	5.3000	5.2000	5.2000	N/A	5.2500	4.8000	*	5.1500	.2000	3.9	N/A	N/A	0.0
16304 SULPHATE DISS	MG/L	*	N/A	3.30	N/A	N/A	N/A	N/A	*	3.30	0.00	0.0	N/A	N/A	0.0
16306 SULPHATE FILT	MG/L	*	3.10	N/A	N/A	N/A	3.00	N/A	*	3.05	.07	2.3	N/A	N/A	0.0
16390 SULPHATE SO4 M4T	MG/L	*	3.10	3.30	3.55N	N/A	3.00	N/A	*	3.24	.24	7.5	N/A	N/A	0.0
SAMPLE2=L SUPERIOR WATER + BORAX															
05105 B DISVD COLRMTY	MG/L	*	N/A	N/A	N/A	1.600	N/A	N/A	*	1.600	0.000	0.0	4.000	.030	39.7
10101 TOT ALKLTY TITN	MG/L	*	N/A	44.40	N/A	47.00	45.50	43.10	*						
10101 TOT ALKLTY TITN	MG/L	*	N/A	48.20	N/A	46.00	N/A	N/A	*	45.70	1.82	4.0	N/A	N/A	0.0
10106 TOT ALKLTY CO2	MG/L	*	43.00	N/A	46.00	43.00	N/A	N/A	*	44.00	1.73	3.9	N/A	N/A	0.0
10107 ALKLTY PPTN TITN	MG/L	*	N/A	N/A	46.00	N/A	N/A	N/A	*	46.00	0.00	0.0	N/A	N/A	0.0
10190 T ALKLTY MIX MET	MG/L	*	43.00	44.40	46.00	47.00	45.50	43.10	*						
10190 T ALKLTY MIX MET	MG/L	*	N/A	48.20	46.00	46.00	N/A	N/A	*						
10190 T ALKLTY MIX MET	MG/L	*	N/A	N/A	N/A	43.00	N/A	N/A	*	45.22	1.79	4.0	N/A	N/A	0.0
10301 PH	UNITS	*	8.2000	N/A	8.2000	N/A	8.4000	8.1000	*	8.2250	.1258	1.5	N/A	N/A	0.0
16304 SULPHATE DISS	MG/L	*	N/A	3.50	N/A	N/A	N/A	N/A	*	3.50	0.00	0.0	N/A	N/A	0.0
16306 SULPHATE FILT	MG/L	*	5.30	N/A	N/A	4.00	3.00	N/A	*	4.10	1.15	28.1	N/A	N/A	0.0
16390 SULPHATE SO4 M4T	MG/L	*	5.30	3.50	2.90N	4.00	3.00	N/A	*	3.74	.98	26.1	N/A	N/A	0.0
SAMPLE3=L SUPERIOR WATER															
05105 B DISVD COLRMTY	MG/L	*	N/A	.100L	N/A	.030	N/A	N/A	*	.030	0.000	0.0	N/A	N/A	0.0
10101 TOT ALKLTY TITN	MG/L	*	N/A	44.50	N/A	41.00	41.20	37.60	*						
10101 TOT ALKLTY TITN	MG/L	*	N/A	43.60	N/A	41.00	N/A	N/A	*	41.48	2.42	5.8	N/A	N/A	0.0
10106 TOT ALKLTY CO2	MG/L	*	42.00	N/A	45.00	41.00	N/A	N/A	*	42.67	2.08	4.9	N/A	N/A	0.0
10107 ALKLTY PPTN TITN	MG/L	*	N/A	N/A	42.00	N/A	N/A	N/A	*	42.00	0.00	0.0	N/A	N/A	0.0
10190 T ALKLTY MIX MET	MG/L	*	42.00	44.50	45.00	41.00	41.20	37.60	*						
10190 T ALKLTY MIX MET	MG/L	*	N/A	43.60	42.00	41.00	N/A	N/A	*						
10190 T ALKLTY MIX MET	MG/L	*	N/A	N/A	N/A	41.00	N/A	N/A	*	41.89	2.13	5.1	N/A	N/A	0.0
10301 PH	UNITS	*	7.7000	7.6000	7.6000	N/A	7.6000	7.6000	*	7.6200	.0447	.6	N/A	N/A	0.0
16304 SULPHATE DISS	MG/L	*	N/A	4.00	N/A	N/A	N/A	N/A	*	4.00	0.00	0.0	N/A	N/A	0.0
16306 SULPHATE FILT	MG/L	*	4.30	N/A	N/A	3.00	3.00	N/A	*	3.43	.75	21.9	N/A	N/A	0.0
16390 SULPHATE SO4 M4T	MG/L	*	4.30	4.00	2.90N	3.00	3.00	N/A	*	3.44	.66	19.1	N/A	N/A	0.0
SAMPLE4=QUAPPELLE RIVER WATER															
05105 B DISVD COLRMTY	MG/L	*	N/A	.300	N/A	.220	N/A	N/A	*	.260	.057	21.8	N/A	N/A	0.0
10101 TOT ALKLTY TITN	MG/L	*	N/A	177.00	N/A	176.00	177.00	178.40	*						
10101 TOT ALKLTY TITN	MG/L	*	N/A	184.00	N/A	N/A	N/A	N/A	*	178.48	3.20	1.8	N/A	N/A	0.0
10106 TOT ALKLTY CO2	MG/L	*	193.00	N/A	190.00	180.00	N/A	N/A	*	187.67	6.81	3.6	N/A	N/A	0.0
10107 ALKLTY PPTN TITN	MG/L	*	N/A	N/A	177.00	N/A	N/A	N/A	*	177.00	0.00	0.0	N/A	N/A	0.0
10190 T ALKLTY MIX MET	MG/L	*	193.00	177.00	190.00	176.00	177.00	178.40	*						
10190 T ALKLTY MIX MET	MG/L	*	N/A	184.00	177.00	180.00	N/A	N/A	*	181.38	6.26	3.5	N/A	N/A	0.0
10301 PH	UNITS	*	7.7000	N/A	7.9000	N/A	7.9000	8.1000	*	7.9000	.1633	2.1	N/A	N/A	0.0
16304 SULPHATE DISS	MG/L	*	N/A	265.00	N/A	N/A	N/A	N/A	*	265.00	0.00	0.0	N/A	N/A	0.0
16306 SULPHATE FILT	MG/L	*	220.00	N/A	224.00	246.00	280.00	N/A	*	242.50	27.49	11.3	N/A	N/A	0.0
16390 SULPHATE SO4 M4T	MG/L	*	220.00	265.00	224.00	246.00	280.00	N/A	*	247.00	25.85	10.5	N/A	N/A	0.0

L = LESS THAN

N/A = NOT ANALYSED

N = NO CODE GIVEN

SUMMARY

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STUDY NO. 74A DATE: 15/09/80 DATE DISTRIBUTED 200880
SOURCE OF SAMPLE VARIOUS SOURCES AND SOLID SAMPLES-SYNTHETIC SAMPLES

SPECIAL STUDY/ALKALINITY (UNPFSD SMPLES)		*	CCIW INORG	MONCTON	CCIW SHIPS	CALGARY	VANCOUVER	LONGEUIL	*	MEAN	STDEV	RELAT STDEV	SPIKE	BGD	%REC
SAMPLE5=HAMILTON HARBOR WATER															
~~05105 B DISVD COLRMTY~~	~~MG/L~~	~~*~~	~~N/A~~	~~N/A~~	~~N/A~~	~~.100~~	~~N/A~~	~~N/A~~	~~*~~	~~.100~~	~~0.000~~	~~0.0~~	~~N/A~~	~~N/A~~	~~0.0~~
10101 TOT ALKLTY TITN	MG/L	*	N/A	97.00	N/A	96.00	96.20	95.50	*						
10101 TOT ALKLTY TITN	MG/L	*	N/A	102.00	N/A	N/A	N/A	N/A	*	97.34	2.66	2.7	N/A	N/A	0.0
10106 TOT ALKLTY CO2	MG/L	*	94.00	N/A	103.00	96.00	N/A	N/A	*	97.67	4.73	4.8	N/A	N/A	0.0
~~10107 ALKLTY PPTN TITN~~	~~MG/L~~	~~*~~	~~N/A~~	~~N/A~~	~~98.10~~	~~N/A~~	~~N/A~~	~~N/A~~	~~*~~	~~98.10~~	~~0.00~~	~~0.0~~	~~N/A~~	~~N/A~~	~~0.0~~
10190 T ALKLTY MIX MET	MG/L	*	94.00	97.00	103.00	96.00	96.20	95.50	*						
10190 T ALKLTY MIX MET	MG/L	*	N/A	102.00	98.10	96.00	N/A	N/A	*	97.53	3.03	3.1	N/A	N/A	0.0
10301 PH	UNITS	*	8.0000	N/A	7.9000	N/A	8.0000	8.1000	*	8.0000	.0816	1.0	N/A	N/A	0.0
~~16304 SULPHATE DISS~~	~~MG/L~~	~~*~~	~~N/A~~	~~70.00~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~*~~	~~70.00~~	~~0.00~~	~~0.0~~	~~N/A~~	~~N/A~~	~~0.0~~
16306 SULPHATE FILT	MG/L	*	67.00	N/A	52.00	63.00	62.00	N/A	*	61.00	6.38	10.5	N/A	N/A	0.0
16390 SULPHATE SO4 MMT	MG/L	*	67.00	70.00	52.00	63.00	62.00	N/A	*	62.80	6.83	10.9	N/A	N/A	0.0
SAMPLE6=WASCANA CREEK WATER															
05105 B DISVD COLRMTY	MG/L	*	N/A	.600	N/A	.380	N/A	N/A	*	.490	.156	31.7	N/A	N/A	0.0
10101 TOT ALKLTY TITN	MG/L	*	N/A	207.00	N/A	201.00	203.00	201.70	*						
~~10101 TOT ALKLTY TITN~~	~~MG/L~~	~~*~~	~~N/A~~	~~208.00~~	~~N/A~~	~~N/A~~	~~N/A~~	~~N/A~~	~~*~~	~~204.14~~	~~3.17~~	~~1.6~~	~~N/A~~	~~N/A~~	~~0.0~~
10106 TOT ALKLTY CO2	MG/L	*	200.00	N/A	210.00	205.00	N/A	N/A	*	205.00	5.00	2.4	N/A	N/A	0.0
10107 ALKLTY PPTN TITN	MG/L	*	N/A	N/A	205.00	N/A	N/A	N/A	*	205.00	0.00	0.0	N/A	N/A	0.0
10190 T ALKLTY MIX MET	MG/L	*	200.00	207.00	210.00	201.00	203.00	201.70	*						
~~10190 T ALKLTY MIX MET~~	~~MG/L~~	~~*~~	~~N/A~~	~~208.00~~	~~209.00~~	~~205.00~~	~~N/A~~	~~N/A~~	~~*~~	~~204.92~~	~~3.59~~	~~1.7~~	~~N/A~~	~~N/A~~	~~0.0~~
10301 PH	UNITS	*	7.9000	8.1000	8.0000	N/A	8.1000	8.2000	*	8.0600	.1140	1.4	N/A	N/A	0.0
16304 SULPHATE DISS	MG/L	*	N/A	400.00	N/A	N/A	N/A	N/A	*	400.00	0.00	0.0	N/A	N/A	0.0
16306 SULPHATE FILT	MG/L	*	395.00	N/A	372.00	413.00	445.00	N/A	*	406.25	30.80	7.5	N/A	N/A	0.0
~~16390 SULPHATE SO4 MMT~~	~~MG/L~~	~~*~~	~~395.00~~	~~400.00~~	~~372.00~~	~~413.00~~	~~445.00~~	~~N/A~~	~~*~~	~~405.00~~	~~26.82~~	~~6.6~~	~~N/A~~	~~N/A~~	~~0.0~~
SAMPLE7=PEBBLELOGGITCH LAKE WATER															
~~05105 B DISVD COLRMTY~~	~~MG/L~~	~~*~~	~~N/A~~	~~N/A~~	~~N/A~~	~~.140~~	~~N/A~~	~~N/A~~	~~*~~	~~.140~~	~~0.000~~	~~0.0~~	~~N/A~~	~~N/A~~	~~0.0~~
10101 TOT ALKLTY TITN	MG/L	*	N/A	.50L	N/A	-.20	N/A	N/A	*						
10101 TOT ALKLTY TITN	MG/L	*	N/A	N/A	N/A	-.60	N/A	N/A	*	-.40	.28	-70.7	N/A	N/A	0.0
10106 TOT ALKLTY CO2	MG/L	*	4.50	N/A	5.50	3.00	N/A	N/A	*						
~~10106 TOT ALKLTY CO2~~	~~MG/L~~	~~*~~	~~4.30~~	~~N/A~~	~~5.50~~	~~N/A~~	~~N/A~~	~~N/A~~	~~*~~	~~4.56~~	~~1.03~~	~~22.7~~	~~0.00~~	~~0.00~~	~~0.0~~
10107 ALKLTY PPTN TITN	MG/L	*	N/A	N/A	N/A	N/A	11.90	N/A	*	11.90	0.00	0.0	N/A	N/A	0.0
10110 T ALKLTY GRAN TN	MG/L	*	N/A	-.60	N/A	N/A	N/A	N/A	*						
10110 T ALKLTY GRAN TN	MG/L	*	N/A	-.60	N/A	N/A	~~N/A~~	N/A	*	-.60	0.00	0.0	N/A	N/A	0.0
~~10190 T ALKLTY MIX MET~~	~~MG/L~~	~~*~~	~~4.50~~	~~.50L~~	~~5.50~~	~~-.20~~	11.90	~~N/A~~	~~*~~						
10190 T ALKLTY MIX MET	MG/L	*	4.30	-.60	5.50	-.60	~~N/A~~	N/A	*						
10190 T ALKLTY MIX MET	MG/L	*	N/A	-.60	N/A	3.00	~~N/A~~	N/A	*	3.27	4.00	122.3	N/A	N/A	0.0
10210 ACIDITY PPTN TTN	MG/L	*	N/A	N/A	2.200	N/A	12.100	N/A	*	7.150	7.000	97.9	N/A	N/A	0.0
~~10301 PH~~	~~UNITS~~	~~*~~	~~4.6000~~	~~4.5000~~	~~4.5000~~	~~N/A~~	~~4.4000~~	~~4.2000~~	~~*~~	~~4.4400~~	~~.1517~~	~~3.4~~	~~N/A~~	~~N/A~~	~~0.0~~
16304 SULPHATE DISS	MG/L	*	N/A	4.50	N/A	N/A	N/A	N/A	*	4.50	0.00	0.0	N/A	N/A	0.0
16306 SULPHATE FILT	MG/L	*	6.80	N/A	N/A	5.00	5.40	N/A	*	5.73	.95	16.5	N/A	N/A	0.0
16390 SULPHATE SO4 MMT	MG/L	*	6.80	4.50	N/A	5.00	5.40	N/A	*	5.43	.99	18.2	N/A	N/A	0.0
SAMPLE8=RAIN WATER															
05105 B DISVD COLRMTY	MG/L	*	N/A	.100L	N/A	.020L	N/A	N/A	*	0.000	0.000	0.0	N/A	N/A	0.0
~~10101 TOT ALKLTY TITN~~	~~MG/L~~	~~*~~	~~N/A~~	~~1.70~~	~~N/A~~	~~1.00~~	~~1.50~~	~~N/A~~	~~*~~						
10101 TOT ALKLTY TITN	MG/L	*	N/A	2.40	N/A	1.80	1.00	N/A	*	1.57	.53	33.9	N/A	N/A	0.0
10106 TOT ALKLTY CO2	MG/L	*	5.20	N/A	7.00	3.00	N/A	N/A	*						
10106 TOT ALKLTY CO2	MG/L	*	5.00	N/A	7.00	N/A	N/A	N/A	*	5.44	1.66	30.6	0.00	0.00	0.0
~~10107 ALKLTY PPTN TITN~~	~~MG/L~~	~~*~~	~~N/A~~	~~N/A~~	~~2.20~~	~~N/A~~	~~N/A~~	~~N/A~~	~~*~~	~~2.20~~	~~0.00~~	~~0.0~~	~~N/A~~	~~N/A~~	~~0.0~~
10190 T ALKLTY MIX MET	MG/L	*	5.20	1.70	7.00	1.00	1.50	N/A	*						
10190 T ALKLTY MIX MET	MG/L	*	5.00	2.40	7.00	1.80	1.00	N/A	*						
10190 T ALKLTY MIX MET	MG/L	*	N/A	N/A	2.20	3.00	N/A	N/A	*	3.23	2.23	68.9	N/A	N/A	0.0
~~10301 PH~~	~~UNITS~~	~~*~~	~~5.9000~~	~~5.9000~~	~~5.9000~~	~~N/A~~	~~6.1000~~	~~5.5000~~	~~*~~	~~5.8600~~	~~.2191~~	~~3.7~~	~~N/A~~	~~N/A~~	~~0.0~~
16304 SULPHATE DISS	MG/L	*	N/A	3.30	N/A	N/A	N/A	N/A	*	3.30	0.00	0.0	N/A	N/A	0.0
16306 SULPHATE FILT	MG/L	*	3.70	N/A	N/A	3.00	4.35	N/A	*	3.68	.68	18.3	N/A	N/A	0.0
16390 SULPHATE SO4 MMT	MG/L	*	3.70	3.30	N/A	3.00	4.35	N/A	*	3.59	.58	16.3	N/A	N/A	0.0

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SPECIAL STUDY/ALKALI NITY (UNPRSO SMPLES)			CCIW INORG	MONCTON	CCIW SHIPS	CALGARY	VANCOUVER	LONGEUIL	MEAN	STDEV	RELAT STDEV	SPIKE	BGD	%REC
SAMPLE9=NA2CO3 STD														
05105	B DISVD COLRMTY	MG/L	N/A	.600	N/A	.020L	N/A	N/A	.600	0.000	0.0	N/A	N/A	0.0
10101	TOT ALKLTY TITN	MG/L	N/A	252.00	N/A	248.00	250.00	247.60						
10101	TOT ALKLTY TITN	MG/L	N/A	253.00	N/A	248.00	250.00	N/A	249.80	2.10	.8	250.00	0.00	99.9
10106	TOT ALKLTY CO2	MG/L	130.00	N/A	136.00	175.00	N/A	N/A						
10106	TOT ALKLTY CO2	MG/L	127.00	N/A	137.00	175.00	N/A	N/A	146.67	22.26	15.2	250.00	0.00	58.7
10107	ALKLTY PPTN TITN	MG/L	N/A	N/A	245.00	N/A	N/A	N/A	245.00	0.00	0.0	250.00	0.00	98.0
10110	T ALKLTY GRAN TN	MG/L	N/A	229.00	N/A	N/A	N/A	N/A						
10110	T ALKLTY GRAN TN	MG/L	N/A	233.00	N/A	N/A	N/A	N/A	231.00	2.83	1.2	250.00	0.00	92.4
10190	T ALKLTY MIX MET	MG/L	130.00	252.00	136.00	248.00	250.00	247.60						
10190	T ALKLTY MIX MET	MG/L	127.00	253.00	137.00	249.00	250.00	N/A						
10190	T ALKLTY MIX MET	MG/L	N/A	229.00	245.00	175.00	N/A	N/A						
10190	T ALKLTY MIX MET	MG/L	N/A	233.00	N/A	175.00	N/A	N/A	208.48	51.47	24.7	250.00	0.00	83.4
10301	PH	UNITS	10.6000	10.6000	10.3000	N/A	10.5000	10.3000	10.4600	.1517	1.4	N/A	N/A	0.0
16304	SULPHATE DISS	MG/L	N/A	1.00L	N/A	N/A	N/A	N/A	0.00	0.00	0.0	N/A	N/A	0.0
16306	SULPHATE FILT	MG/L	5.80	N/A	N/A	1.00L	N/A	N/A	5.80	0.00	0.0	N/A	N/A	0.0
16390	SULPHATE SO4 MMT	MG/L	5.80	1.00L	N/A	1.00L	N/A	N/A	5.80	0.00	0.0	N/A	N/A	0.0
SAMPLE10=NA2CO3 STD														
05105	B DISVD COLRMTY	MG/L	N/A	.100L	N/A	.020L	N/A	N/A	0.000	0.000	0.0	N/A	N/A	0.0
10101	TOT ALKLTY TITN	MG/L	N/A	12.50	N/A	10.00	9.00	9.10						
10101	TOT ALKLTY TITN	MG/L	N/A	11.20	N/A	10.00	9.30	N/A	10.16	1.28	12.6	10.00	0.00	101.6
10106	TOT ALKLTY CO2	MG/L	4.80	N/A	6.00	7.00	N/A	N/A						
10106	TOT ALKLTY CO2	MG/L	4.70	N/A	5.00	7.00	N/A	N/A	5.92	1.01	17.1	10.00	0.00	59.2
10107	ALKLTY PPTN TITN	MG/L	N/A	N/A	10.60	N/A	N/A	N/A	10.60	0.00	0.0	10.00	0.00	106.0
10110	T ALKLTY GRAN TN	MG/L	N/A	9.80	N/A	N/A	N/A	N/A						
10110	T ALKLTY GRAN TN	MG/L	N/A	9.90	N/A	N/A	N/A	N/A	9.85	.07	.7	10.00	0.00	98.5
10190	T ALKLTY MIX MET	MG/L	4.80	12.50	6.00	10.00	9.00	9.10						
10190	T ALKLTY MIX MET	MG/L	4.70	11.20	6.00	10.00	9.30	N/A						
10190	T ALKLTY MIX MET	MG/L	N/A	9.80	10.60	7.00	N/A	N/A						
10190	T ALKLTY MIX MET	MG/L	N/A	9.90	N/A	7.00	N/A	N/A	8.56	2.34	27.4	10.00	0.00	85.6
10301	PH	UNITS	7.6000	8.3000	7.2000	N/A	9.0500	8.7000	8.1700	.7645	9.4	N/A	N/A	0.0
16304	SULPHATE DISS	MG/L	N/A	1.00L	N/A	N/A	N/A	N/A	0.00	0.00	0.0	N/A	N/A	0.0
16306	SULPHATE FILT	MG/L	.50L	N/A	N/A	1.00L	N/A	N/A	0.00	0.00	0.0	N/A	N/A	0.0
16390	SULPHATE SO4 MMT	MG/L	.50L	1.00L	N/A	1.00L	N/A	N/A	0.00	0.00	0.0	N/A	N/A	0.0
SAMPLE11=DIST WTER														
05105	B DISVD COLRMTY	MG/L	N/A	.100L	N/A	N/A	N/A	N/A	0.000	0.000	0.0	N/A	N/A	0.0
10101	TOT ALKLTY TITN	MG/L	N/A	.50L	N/A	-.30	.50L	N/A						
10101	TOT ALKLTY TITN	MG/L	N/A	.50L	N/A	-.40	N/A	N/A	-.35	.07	-20.2	N/A	N/A	0.0
10106	TOT ALKLTY CO2	MG/L	1.00L	N/A	1.00L	.25	N/A	N/A	.25	0.00	0.0	N/A	N/A	0.0
10107	ALKLTY PPTN TITN	MG/L	N/A	N/A	.40	N/A	N/A	N/A	.40	0.00	0.0	N/A	N/A	0.0
10190	T ALKLTY MIX MET	MG/L	1.00L	.50L	1.00L	-.30	.50L	N/A						
10190	T ALKLTY MIX MET	MG/L	N/A	.50L	.40	-.40	N/A	N/A						
10190	T ALKLTY MIX MET	MG/L	N/A	N/A	N/A	.25	N/A	N/A	-.01	.40	****** -9200	N/A	N/A	0.0
10301	PH	UNITS	5.6500	5.9000	5.7000	N/A	5.3000	5.0000	5.5000	.3536	6.4	N/A	N/A	0.0
16304	SULPHATE DISS	MG/L	N/A	1.00L	N/A	N/A	N/A	N/A	0.00	0.00	0.0	N/A	N/A	0.0
16306	SULPHATE FILT	MG/L	.50L	N/A	N/A	1.00L	N/A	N/A	0.00	0.00	0.0	N/A	N/A	0.0
16390	SULPHATE SO4 MMT	MG/L	.50L	1.00L	.50L	1.00L	N/A	N/A	0.00	0.00	0.0	N/A	N/A	0.0
RESULTS RECVD		DYMOYR	*19/03/80	20/11/80	29/10/80	26/09/80			*					
RESULTS RECVD		DYMOYR	*19/03/80	20/11/80	29/10/80	09/01/81	18/03/81	01/05/81*						