

**UPPER GREAT LAKES CONNECTING CHANNELS
INTERLABORATORY PERFORMANCE EVALUATION STUDY
QM-4: MAJOR IONS IN SURFACE WATER
FINAL REPORT**

by
W.A. Horn, R. Szawiola, D. Takeuchi
and P.D. Leishman

Research and Applications Branch
National Water Research Institute
Canada Centre for Inland Waters
Burlington, Ontario, Canada, L7R 4A6

and the Quality Management Work Group

May 1987
Revised August 1987

MANAGEMENT PERSPECTIVE

The Upper Great Lakes Connecting Channels (UGLCC) have been designated as "Areas of Concern" by the International Joint Commission. A Canada-U.S. binational study, involving the identification and assessment of the environmental impacts of toxic substances, in those areas, was initiated in 1984. In order to assist analytical laboratories, who are contributing data for the UGLCC study, to generate reliable and accurate data during the study, a Quality Management Work Group was formed and thirteen interlaboratory performance evaluation studies were implemented. This report describes the results from the fourth interlaboratory performance evaluation study, QM-4, which consisted of the analysis of 23 major ions and nutrients in surface water. Results were received from ten out of 13 participating laboratories (seven Canadian, three U.S.). Overall, most of the data received from the participants were satisfactory and comparable, except for some parameters. All participating laboratories have been provided with the appropriate feed-back.

Dr. J. Lawrence
Director, Research and Applications Branch
National Water Research Institute

PERSPECTIVE - GESTION

La Commission mixte internationale a désigné les voies d'eau reliant les Grands Lacs d'amont "Secteurs de préoccupation". En 1984, le Canada et les Etats-Unis ont entrepris une étude conjointe sur la détermination et l'évaluation des effets des substances toxiques sur l'environnement de ces régions. Afin d'aider les laboratoires qui participent à cette étude à fournir des données fiables et précises, on a créé un Groupe de travail sur la gestion de la qualité et procédé à 13 études interlaboratoires. Le présent rapport décrit les résultats de la quatrième évaluation comparative de la performance des laboratoires, QM-4, qui portait sur l'analyse des 23 principaux ions et éléments nutritifs dans les eaux de surface. 10 laboratoires participants sur 13 ont fait parvenir leurs résultats (sept laboratoires canadiens et trois américains). En général, presque toutes les données revues étaient valables et comparables, sauf dans certains cas. On a envoyé à tous les laboratoires participants les commentaires appropriés.

ABSTRACT

The Upper Great Lakes Connecting Channels (UGLCC) study recognizes Quality Assurance/Quality Control (QA/QC) aspects as crucial elements to the overall utility of study results. As part of the QA/QC program, 13 interlaboratory performance evaluation studies were designed and conducted by the Quality Management Work Group.

This report describes the results from the fourth interlaboratory performance evaluation study, QM-4, which consisted of the analysis of 23 major ions and nutrients in surface water. Results were received from ten out of 13 participating laboratories (seven Canadian, three U.S.). Ten of the parameters were evaluated for bias by Youden's ranking technique and results which deviated significantly from the median were flagged. The rest of the parameters were evaluated for outliers by the Grubbs and Dixon tests. The interlaboratory comparability of major ion data was satisfactory for most of the parameters. Included in this report is a summary of each laboratory's performance.

RÉSUMÉ

L'assurance et le contrôle de la qualité (AQ/CQ) sont des éléments essentiels à l'utilité générale des résultats de l'étude sur les voies d'eau reliant les Grands Lacs d'amont. Dans le cadre du programme AQ/CQ, le groupe de travail sur la gestion de la qualité a conçu et réalisé treize évaluations comparatives de la performance des laboratoires participant à l'étude.

Le présent rapport décrit les résultats de la quatrième évaluation de performance, QM-4, soit l'analyse des 23 principaux ions et éléments nutritifs dans les eaux de surface. 10 laboratoires participants sur 13 ont fait parvenir leurs résultats (sept laboratoires canadiens et trois américains). Certains paramètres ont fait l'objet d'une évaluation des biais possibles dans les données grâce à la technique de Youden et on n'a pas tenu compte des résultats qui s'écartaient de façon significative de la médiane. De plus, tous les résultats ont été calculés en pourcentage de récupération par rapport aux valeurs théoriques. Dans certains cas, les données sur les principaux ions étaient comparables d'un laboratoire à l'autre. En général, la comptabilité entre les valeurs théoriques et les médianes des laboratoires était bonne, sauf exception. On a annexé au présent rapport un résumé de la performance de chaque laboratoire.

INTRODUCTION

The Upper Great Lakes Connecting Channels (UGLCC) have been designated as "Areas of Concern" by the International Joint Commission (IJC). To identify and deal with the environmental problems, a three year, binational study was initiated in 1984, involving Canadian and U.S. environmental and resource agencies, to study the St. Marys, St. Clair and Detroit Rivers and Lake St. Clair. The study involves identifying, quantifying and determining the environmental impacts of conventional and toxic substances from various sources.

The UGLCC Study recognizes Quality Assurance/Quality Control (QA/QC) aspects as crucial elements to the overall utility of study results. As part of the QA/QC program, 13 interlaboratory performance evaluation (QC) studies were designed and conducted by the Quality Management Work Group. The goal of these QC studies is to assist analytical laboratories, which are producing data for the UGLCC study, to generate reliable, accurate data and to assess their overall performance during this study. A total of some 100 parameters (organic, inorganic and physical properties) in three types of matrices (water, sediment and biota), will be assessed.

This fourth interlaboratory study, QM-4, was initiated on January 31, 1986. It involved the analysis of 23 major ions and nutrients in surface water. The original deadline for reporting results was set for April 30, 1986. However, several laboratories were late in reporting, so the study was not closed until August 8, 1986.

STUDY PROFILE

From the returned questionnaires, the following 13 laboratories affirmed that they would participate in this study: U001, U010, U014, U049, U057, U075, U077, U089, U091, U013, U063, U078, U090. By the time the study closed, the last three laboratories had not sent back any results. See the list of participants at the end of this report.

Each laboratory was provided with four naturally occurring surface water samples as described in Table 1. All samples were reference waters developed by the Quality Assurance and Methods Section (QAMS) of the National Water Research Institute (NWRI). The design values of some of the parameters and the interlaboratory medians are given in Table 2. The design values are based on in-house and external analyses. The same water samples are used twice yearly in the Federal Provincial Interlaboratory Program. The design values of most of the parameters in these samples were confirmed by the interlaboratory medians of these studies (1). Some of the parameters do not have confirmed design values.

Participants were asked to analyze samples 401-404 for 23 major ions and nutrients (colour, conductivity, turbidity, boron(B), dissolved organic carbon (DOC), dissolved inorganic carbon (DIC), total Kjeldahl nitrogen (TKN), nitrite + nitrate N ($\text{NO}_2 + \text{NO}_3$), ammonia N (NH_3), total nitrogen (TN), fluoride (F), alkalinity - CaCO_3 , acidity - CaCO_3 , pH, hardness, sodium (Na), magnesium (Mg), silica - SiO_2 (Si), total phosphorus (P), sulphate (SO_4), chloride (Cl), potassium (K) and calcium (Ca)). In order to provide some indication of the precision of such analyses, these samples were sent out in blind duplicate pairs, as shown in Table 1.

RESULTS AND DISCUSSION

Analytical Methodology

All samples could be analyzed directly without dilution, using appropriate methods and standards.

For colour, four out of six laboratories used the visual comparison method with cobalt-platinum standards, while laboratories U089 and U091 analyzed apparent colour spectrophotometrically.

All laboratories analyzed conductivity with a conductivity meter, except laboratory U057 which used the conductivity cell in their Dionex Ion Chromatograph.

Turbidity was analyzed by all seven laboratories, by the nephelometric method.

Boron was analyzed by three laboratories, laboratories U010 and U057 used an inductively coupled plasma atomic emission spectrometer (ICP-AES) and laboratory U077 used a direct current plasma atomic emission spectrometer (DCP-AES).

Dissolved organic carbon (DOC) was analyzed by four laboratories and laboratory U014 analyzed total organic carbon (TOC). All laboratories used a total carbon analyzer. The procedure included catalytic combustion of the sample followed by detection by a non-dispersive infrared analyzer.

Dissolved inorganic carbon (DIC) was analyzed by four laboratories. Laboratories U075 and U077 determined DIC by difference (total dissolved carbon (TDC) - DOC). U001 and U049 analyzed for DIC directly using the inorganic channel of the carbon analyzer with a non-dispersive infrared detector.

Total Kjeldahl nitrogen (TKN) was analyzed by eight laboratories. Two different methods were used, either digestion, distillation and titration by laboratories U001 and U049, or digestion and colorimetry by the rest of the laboratories.

For $(\text{NO}_3 + \text{NO}_2)\text{N}$ laboratory U057 used ion chromatography (IC) while the remaining laboratories used colorimetry azodye (five out of the seven used Cadmium reduction and the other two used hydrazine reduction).

All eight laboratories used colorimetry (automated phenate) for ammonia nitrogen (NH_3). Only U057 reported results for total nitrogen, which were calculated by summing TKN, $(\text{NO}_3$ and $\text{NO}_2)\text{N}$ results.

Three methods were used for fluoride. Four laboratories used a potentiometric method (specific ion electrode), two laboratories used ion chromatography and one laboratory used a colorimetric method (complexone).

For alkalinity, five laboratories used fixed end point titration and one laboratory used dual end point/inflection point titration. Only laboratory U014 used a colorimetric end point (methyl orange).

Only laboratories U001 and U077 analyzed the samples for acidity (CaCO_3) and both used electrometric titration.

All seven laboratories which reported pH results used a pH meter.

There were two different methods used to analyze hardness. Two laboratories calculated hardness from their calcium and magnesium data and the other three laboratories used an EDTA titrimetric method.

Of seven laboratories analyzing for sodium (Na), one used automated flame photometry, two used D.C.P.-A.E.S., four used Atomic Absorption Spectrophotometry (A.A.S.)-flame.

Eight laboratories analyzed for magnesium (Mg). One used I.C.P.-A.E.S., two used D.C.P.-A.E.S. and five used A.A.S.-flame. All six laboratories analyzing for silica (SiO_2) used colorimetry (heteropoly blue).

Total phosphorus was analyzed by six laboratories, all of which used some form of acid digestion followed by various colorimetric methods.

Sulphate was analyzed by eight laboratories of which three used colorimetry (methylthymol blue), four used ion chromatography, and one used turbidimetry (barium sulfate).

Chloride was analyzed by five laboratories colorimetrically (ferric thiocyanate), and three laboratories used ion chromatography.

Seven laboratories analyzed for potassium, one used flame photometry, four used A.A.S.-flame and two used D.C.P.-A.E.S.

Calcium was analyzed by eight laboratories. Five used A.A.S.-flame, two used D.C.P.-A.E.S. and one used I.C.P.-A.E.S.

Data Evaluation

All raw data submitted by the participants are listed by parameter in the data summary (Appendix II). Individual laboratory results for only ten parameters (conductivity, $(\text{NO}_2 + \text{NO}_3)\text{N}$, pH, hardness, Na, Mg, SO_4 , Cl, K and Ca) were evaluated by the Youden ranking technique

(2) for the detection of bias, as well as a computerized flagging procedure (3). A laboratory's results are judged biased high or low, when its total rank is outside of a statistically allowable range. Results are flagged very low, low, high or very high, when they deviate significantly from the interlaboratory median. For a further explanation of the ranking and flagging procedure, see Appendix I. This statistical procedure, which semi-quantitatively evaluates data accuracy is widely used in other interlaboratory QC studies. A summary of the ranking and flagging of the data is given in Appendix II. The accuracy of results has been summarized in Table 5. In this table, the number of results reported, the sum of results flagged VH, H, L and VL, the percentages of results flagged and a statement of biased results are presented for each laboratory.

For the rest of the parameters, since the number of reporting laboratories was small, and some of the data reported were unuseable, (less than values or w codes), neither the Youden ranking technique nor the computerized flagging procedure were used to evaluate the data. This data was evaluated for outliers, by the Grubbs (4) and Dixon (5) tests. Less than values and "W" coded values were not included in these tests. Five percent significance level was used. In order to be an outlier, both of these tests had to be positive.

General Comments

Laboratories U010, U014, U089 and U091 reported their data by the originally set deadline (April 30, 1986). All laboratories, except U013, submitted their results by the second closing date (August 8, 1986). Since laboratory U013 submitted their results extremely late (October 17, 1986), well after the final data summary had been sent out, their results were not included in this report, but can be found in Appendix IV and in the lab specific comments section.

Computer printouts of the raw data were sent to all reporting laboratories for verification in July 1986. All laboratories returned their results verified, except laboratory U001, whose results were

verified by telephone. The only changes made were from laboratory U089, for fluoride results, which they changed from <1.0 mg/L to <0.01 mg/L.

A final data summary was sent to the participating laboratories, the Quality Management Work Group, the Work Group Chairmen, and the MC and AIC Chairmen on September 15, 1986.

The overall interlaboratory performance of major ion and nutrient analysis was satisfactory for some parameters and samples. The interlaboratory relative standard deviation was less than 30% for colour (401, 402), conductivity, DOC (401), DIC (401, 402) TKN (401), (NO₃ + NO₂)N (401, 402, 404), alkalinity, pH, hardness, Na (403, 404), Mg, SO₄, Cl, K and Ca. The rest of the parameters and samples had an interlaboratory relative standard deviation greater than 30%. In most cases, the difference between the interlaboratory mean and median was less than 15%. There was a greater than 15% difference between the mean and median for turbidity, DOC (402), TKN (403, 404), NH₃ (404), Si (401, 402) and P (401, 402). For the parameters with design values, the agreement between the design values and the interlaboratory medians was within 15%.

In most cases the precision of within laboratory analysis was within a relative standard deviation (RSD) of 15%. All laboratories reported detection limits for most parameters. Table 4 contains the reported detection limits.

General Comments by Parameter

Only laboratory U057 reported data for total nitrogen. Two laboratories (U001 and U077) reported data for acidity, and for the rest of the parameters the number of reporting laboratories varied from three to eight. Laboratory U010 reported results for boron only. Laboratory U014 analyzed for total organic carbon (TOC) instead of dissolved organic carbon (DOC). Laboratory U089 did not have enough sample to

analyze DOC and acidity and laboratory U091 did not have enough of sample 401 to analyze turbidity.

The following ten parameters were analyzed by the Youden ranking technique and the computerized flagging procedures: conductivity, $(\text{NO}_2 + \text{NO}_3)\text{N}$, pH, hardness, Na, Mg, SO_4 , Cl, K and Ca.

For conductivity, laboratory U001 was biased high, laboratory U057 had two very low flags and was biased low and laboratory U075 had two low flags. Thirteen percent of the results submitted for conductivity were flagged.

No laboratories had biased results for $(\text{NO}_2 + \text{NO}_3)\text{N}$. Laboratory U001 had one very high flag, laboratory U057 had two very high flags and laboratories U049 and U075 had two very low flags. Overall, 22% of the results submitted for $(\text{NO}_2 + \text{NO}_3)\text{N}$ were flagged.

For pH, no laboratories had biased results. Laboratories U001 and U014 had one low flag each. Overall, only 7% of the results submitted were flagged.

For hardness, laboratory U001 had one high flag, laboratory U014 had one very high flag and was biased high, and laboratory U089 had a very low flag. Overall 15% of the results reported were flagged.

Twenty-five percent of the results reported for Na were flagged. Laboratory U014 had one high flag, laboratory U049 had two low flags, laboratory U089 had two very low flags and laboratory U077 had two very high flags and results were biased high.

For Mg, 22% of the results reported were flagged. Laboratory U049 had two high flags and results were biased high. Laboratory U075 had one low and very low flag and results were biased low, laboratory U077 had two very high flags and laboratory U089 had one low flag.

For SO_4 , both laboratories U014 and U049 had one low flag each, laboratory U075 had two high flags, and laboratory U077 had a very low and a low flag. Overall 19% of the results reported were flagged.

Twenty-two percent of the results reported for Cl were flagged. Laboratories U014 and U089 had two low flags each. Laboratory U075 had two very high flags and laboratory U077 had one high flag.

For K, 25% of the results reported were flagged. Laboratory U014 had three low flags, laboratory U075 had two very low flags, and laboratories U089 and U049 had one high flag each. Results for U049 were also biased high.

For Ca, 13% of the results reported were flagged. Laboratory U075 had three very low flags, one low flag and results were biased low.

The following parameters: colour (401, 402), turbidity, DOC, DIC (401, 402), TKN, NH_3 (404), F(401, 402), alkalinity, Si(401, 402) and total P (401, 402, 403) were all tested for outliers by the Grubbs and Dixon tests. Most of the data were comparable except for the following outliers which were confirmed by both of these tests: DIC (401 and 402) for laboratory U075; TKN (403 and 404) for laboratory U014 and total P (401 and 402) for laboratory U077.

For the following parameters: colour (403, 404), B, DIC (403, 404), NH_3 (401 - 403), total N, F (403, 404), acidity, Si (403, 404) and total P (404), there was no basis for comparison as there was less than three sets of useable results for each parameter. Some of these parameters were at low levels which were close to the laboratories detection limits and difficult to analyze.

Lab Specific Comments (see Appendix III for each laboratory's appraisal)

U001

This laboratory's results were overall satisfactory for the ten parameters analyzed by the flagging and Youden's ranking procedure, as only only five percent of the results were flagged. Na, Mg, SO_4 , Cl, K and Ca were all satisfactory with no flags or biases. Hardness and pH were both satisfactory, except for one H flag and one L flag respectively. Although no results were flagged for conductivity, ranking indicated the results were biased high. $(\text{NO}_2 + \text{NO}_3)\text{N}$ was flagged VH on one sample.

No results were reported for B, Total N, alkalinity (403, 404) and acidity (401, 402). Less than values were reported for colour, NH_3 , DIC (403, 404), F (403, 404) and Si (403, 404).

There was no basis for comparison for colour, DIC (403, 404), NH_3 , F (403, 404), acidity (403, 404), Si (403, 404), and total P (404). Turbidity, DOC, DIC (401, 402), TKN, F (401, 402), alkalinity (401, 402), Si (401, 402) and total P (401-403) were all comparable with the data set.

The precision between duplicate results was in most cases within a RSD of 15%, except for turbidity, DOC (401, 402), TKN (403, 404), $(\text{NO}_2 + \text{NO}_3)\text{N}$ (403, 404), and total P.

U010

This laboratory agreed to participate in QM-4 for B and Ca only, but results were submitted only for B. The results submitted were less than values.

U014

For the ten parameters evaluated by the flagging and Youden procedures, conductivity, $(\text{NO}_2 + \text{NO}_3)\text{N}$, Mg and Ca results were all satisfactory. SO_4 and pH were satisfactory except for one low flag each and Na was satisfactory except for one high flag. Hardness was flagged very high on one sample and ranking indicated the results were biased high. Cl was flagged low on two samples and K was flagged low on three samples. Thirteen percent of the reported results were flagged.

Colour, B, DIC, total N and acidity were not analyzed. Less than values were reported for NH_3 (402-404), alkalinity (403, 404), Si (403, 404), F, and total P (401, 404). Total organic carbon (TOC) was reported instead of DOC.

There was no basis for comparison for alkalinity (403, 404), NH_3 , F, Si (403, 404) and total P (401, 404). The following parameters

were comparable with the data set: turbidity, TKN (401, 402), alkalinity (401, 402), Si (401, 402) and total P (402, 403). According to the Grubbs and Dixon tests, TKN results for samples 403 and 404 were outliers in this data set.

Precision between duplicate samples was in most cases within a RSD of 15%, except for TKN (401, 402), total P, Cl (401, 402), K (401, 402) and NH_3 (401, 402).

U049

For the ten parameters evaluated by the flagging and Youden procedures, conductivity, pH, hardness, Cl and Ca were all satisfactory with no flags or biases. SO_4 was satisfactory with one low flag. Results for $(\text{NO}_2 + \text{NO}_3)\text{N}$ (403, 404) were unuseable (" $<$ " values) and were flagged very low. Na had two low flags. Ranking indicated that both Mg and K results were biased high, Mg had two high flags and K had one high flag. Thirteen percent of the results submitted for these ten parameters were flagged.

No results were submitted for turbidity, B, total N, alkalinity, acidity, Si and total P. Less than values were reported for colour, DOC (403, 404), DIC (403, 404) and $(\text{NO}_2 + \text{NO}_3)\text{N}$ (403, 404) and NH_3 (401).

There was no basis for comparison for colour, DOC (403, 404), DIC (403, 404), NH_3 (401, 402, 403) and F (403, 404). The following parameters were comparable with the data set: DOC (401, 402), DIC (401, 402), TKN, NH_3 (404) and F (401, 402).

The precision was within a RSD of 15%, except for DOC (401, 402), TKN and NH_3 .

U057

Six of the ten parameters evaluated by the flagging and ranking procedures were reported. Seventeen percent of these results

were flagged. Mg, SO₄, Cl, and Ca were all satisfactory. Conductivity had two very low flags and ranking indicated the results were biased low. (NO₂ + NO₃)N had two very high flags.

No results were reported for pH, hardness, Na, K, total P, DOC, DIC and acidity. The latter three are not routinely analyzed by this laboratory. "W" codes were reported for colour, turbidity, B (403, 404), NH₃ (401 - 403) and Si (403, 404).

There was no basis for comparison for colour, turbidity, B, NH₃ (401 - 403), total N, F (403, 404) and Si (403, 404). The following parameters were comparable with the data set NH₃ (404), F (401, 402), TKN, alkalinity and Si (401, 402).

Precision between duplicate samples was within a RSD of 13%.

U075

Of the ten parameters evaluated by the flagging and Youden procedures, this laboratory had the highest percent flagged with 34%. Only pH, hardness and Na were satisfactory. Conductivity was flagged low on two samples; (NO₂ + NO₃)N was flagged very low on two samples and results for samples 403 and 404 were unuseable (less than values). Mg was flagged low on one sample, very low on one sample and ranking indicated results were biased low. SO₄ was flagged high on two samples, Cl was flagged very high on two samples and K was flagged very low on two samples. Ca was flagged very low on three samples, low on one sample and ranking indicated results were biased low.

No results were reported for colour, B, total N, F, acidity and Si. Less than values were reported for TKN, (NO₂ + NO₃)N (403, 404), NH₃ and total P.

There was no basis for comparison for DIC (403, 404), TKN, NH₃, and total P. The following parameters were comparable with the data set, turbidity, DOC and alkalinity. According to the Grubbs and Dixon tests, DIC results for sample 401 and 402 were outliers in this data set.

Precision was within a RSD of 15%, except for DOC and DIC (403, 404).

U077

For the ten parameters analyzed by the flagging and Youden procedures, 17% of the results were flagged. Conductivity, $(\text{NO}_2 + \text{NO}_3)\text{N}$, pH, K, Ca were all satisfactory, and Cl was satisfactory, except for one high flag. Na had two very high flags and ranking indicated the results were biased high. Mg was flagged very high on two samples, SO_4 was flagged very low on one sample and low on one sample.

No results were reported for hardness, total N and total P (sample 403 had been spilled). Less than values were reported for B, TKN, NH_3 , F, alkalinity (403, 404), acidity and Si (403, 404).

There was no basis for comparison for colour (403, 404), B, DIC (403, 404), NH_3 , F, alkalinity (403, 404), acidity, Si (403, 404) and total P (404). The following parameters were comparable with the data set: colour (401, 402), turbidity, DOC, DIC (401, 402), alkalinity (401, 402), and Si (401, 402). According to the Grubbs and Dixon tests, total P data for samples 401 and 402 were outliers in this data set.

Precision between duplicate samples was within a RSD of 10%, except for turbidity (403, 404).

U089

For the ten parameters evaluated by the flagging and Youden's ranking procedure, conductivity, $(\text{NO}_2 + \text{NO}_3)\text{N}$, pH, SO_4 and Ca were all satisfactory. Mg and K were satisfactory except for one low and high flag respectively. Hardness had one very low flag, Na had two very low flags and Cl had two low flags. Thirteen percent of the results submitted for these ten parameters were flagged and no parameters were biased.

DOC and acidity were not analyzed as the laboratory ran out of sample. DIC, B and total N were not routinely analyzed by this laboratory. Less than values were reported for colour (403, 404) and F. W codes were reported for NH_3 , Si (403, 404), TKN (403) and total P (404). (See appendix I for an explanation of these codes).

There was no basis for comparison for colour (403, 404), TKN (403), NH_3 , F, Si (403, 404) and total P (404). The following parameters were comparable with the data set: colour (401, 402), turbidity, TKN (401, 402, 404), alkalinity, Si (401, 402) and total P (401 - 403).

The precision between duplicate samples was within a RSD of 15% except for turbidity, TKN (403, 404), and total P (401, 402).

U091

For the nine parameters evaluated by the flagging and Youden's procedures all were satisfactory with no flags or biases.

Hardness, B, DOC, DIC, total N and acidity were not analyzed. There was insufficient sample to analyze turbidity (401). Less than values were reported for colour (403, 404), F, Si (403, 404), and total P (402, 403, 404).

There was no basis for comparison for colour (403, 404), NH_3 (401-403), F, Si (403, 404) and total P (402-404). The following parameters were comparable with the data set, colour (401, 402), turbidity (402 - 404), TKN, NH_3 (404), alkalinity, Si (401, 402) and total P (401).

The precision between duplicate samples was within a RSD of 10%, except for turbidity (403, 404) and total P (401, 402).

U013 - see Appendix IV

This laboratory submitted results well after the closing deadline (October 17, 1986). Results were submitted for only six parameters. Less than values were reported for NH_3 , Si (401, 402) and total P (402).

There was no basis for comparison for NH_3 , Si and total P (402). The following parameters were comparable with the data set hardness, Cl (403, 404), and $(\text{NO}_2 + \text{NO}_3)\text{N}$. According to the Grubbs and Dixon tests, data for samples 401, 403, 404 for total P and samples 401 and 402 for Cl were outliers.

The precision between duplicate samples was within a RSD of 5% except for $(\text{NO}_2 + \text{NO}_3)\text{N}$ (401, 402) and total P (401, 402). The data for this laboratory can be found in Appendix IV along with corrections to data submitted in December 1986.

COMMENTS

Overall, for the ten parameters evaluated by the Youden and flagging procedures (conductivity, $(\text{NO}_2 + \text{NO}_3)\text{N}$, pH, hardness, Na, Mg, SO_4 , Cl, K and Ca, most of the data was satisfactory. There was no basis for comparison for B, total N, acidity, colour (403, 404), DIC (403, 404), NH_3 (401 - 403), F (403, 404), Si (403, 404) and total P (404). Most of the results for turbidity, DOC, TKN, alkalinity, color (401, 402), DIC (401, 402), NH_3 (404), F (401, 402), Si (401, 402) and total P (401 - 403) were comparable with some outliers by the Grubbs and Dixon tests.

ACKNOWLEDGEMENTS

The authors sincerely thank all participants for their cooperation, Dr. H.B. Lee, W. Li and E. Kokotich for their assistance.

LIST OF PARTICIPANTS

Barringer Magenta Limited, Rexdale, Ontario

Beak Analytical Services, Mississauga, Ontario

Michigan Department of Natural Resources, Lansing, Michigan

National Water Quality Laboratory, Burlington, Ontario

Ontario Ministry of Environment, London, Ontario

Ontario Ministry of Environment, Inorganic Trace Contaminants, Waters Unit, Rexdale, Ontario

Ontario Ministry of Environment, Thunder Bay, Ontario

Raytheon Service Corporation (U.S. Environmental Protection Agency - Large Lakes Research Station) Grosse Ile, Michigan

US Geological Survey - National Water Quality Laboratory, Arvada, Colorado

Waste Water Technology Centre (Conservation and Protection), Burlington, Ontario

The following laboratories were sent samples but did not submit any results:

Mann Testing Laboratories Ltd., Mississauga, Ontario - Volunteer Laboratory

US Army Corps of Engineers - Environmental Analysis Branch, Detroit, Michigan

Zenon Environmental Inc., Burlington, Ontario

REFERENCES

1. Alkema, H. Federal Provincial Interlaboratory Quality Assurance Program. NWRI Contributions.
2. Youden, W.J. and Steiner, E.H. Statistical Manual of AOAC, Published by AOAC, P.O. Box 540, Benjamin Franklin Station, Washington, D.C. 20044 (1975).
3. Clark, J.L. Evaluation of Performance of Laboratories Determining Water Quality Constituents through Natural Water Samples whose True Values are Unknown. In summary of Conference Presentations. Envirometrics 81, p. 54-55, 1981. Alexandria, Virginia, April 8-10, 1981.
4. Grubbs, F.E. Procedures for Detecting Outlying Observations in Samples. Technometrics, Vol. 11, 1969, p. 1-21.
5. Dixon, W.J. Processing Data for Outliers. Biometrics, Vol. 9, 1953, p. 74-89.
6. Aspila, K.I. and Leishman, P. LRTAP (Long Range Transport of Atmospheric Pollutants) Intercomparison Study L-12: Major Ions, Nutrients and Physical Properties in Water. January 1987.

TABLE 1

Samples Distributed for Analysis in QM-4

Sample	Description
401	CM-ION-91 (LAKE SUPERIOR)
402	Same as 401
403	CM-ION-92 (Synthetic)
404	Same as 403

TABLE 2

Design Values and Interlaboratory Medians for Major Ions
 (All values are in mg/L unless stated)

Parameter	Design Value	Interlab. Median		Design Value	Interlab. Median	
		401	402		403	404
Colour (Hazen Unit)		4.5	4.5		5.0	5.0
Conductivity (μ Siemens/cm)	93.9	93.8	94.2	443	443	442
Turbidity (JTU/NTU)		0.17	0.14		0.14	0.13
Boron		0.006	0.005		0	0
DOC		2.05	1.80		0.47	0.40
DIC	9.77	9.80	9.90		0.25	0.29
TKN		0.115	0.095		0.060	0.058
(NO ₂ + NO ₃) N	0.30	0.30	0.30	0.032	0.035	0.032
Ammonia N		0.006	0.015		0.020	0.010
Total N		0.460	0.450		0.100	0.110
Fluoride		0.040	0.040		0.085	0.085
Alkalinity (CaCO ₃)	41.1	42.4	42.0		2.00	2.00
Acidity (CaCO ₃)		0	0		1.60	1.40
pH	7.69	7.66	7.66	5.48	5.60	5.50
Hardness	44.4	42.0	44.0	148	142	143
Sodium	1.29	1.30	1.30	19.1	19.1	19.2
Magnesium	2.74	2.77	2.75	9.38	9.23	9.23
Silica (SiO ₂)	2.38	2.40	2.40		0	0
Total P		0.003	0.003		0.001	0.010
Sulphate	3.32	3.20	3.24	37.1	36.8	37.4
Chloride	1.25	1.29	1.29	105	103	106
Potassium	0.488	0.500	0.500	0.884	0.900	0.900
Calcium	12.5	13.2	13.1	42.4	42.1	42.0

TABLE 3
Analytical Methodology for Major Ions

Lab No. Parameter	U001	U010	U014	U049	U057	U075	U077	U089	U091
Colour	Visual Comparison			Visual Comparison	Visual Comparison Co/Pt. stds.		Visual Comparison Co/Pt. stds.	Apparent colour Spectrophotometric	Apparent colour Spectrophotometric
Conductivity	Conductivity Meter (Wheatstone Bridge)		Conductivity Meter (Wheatstone Bridge)	Conductivity Meter (Wheatstone Bridge)	Flow through Conductivity Cell from Dionex I.C.	Conductivity Meter	Conductivity Meter (Wheatstone Bridge)	Conductivity Meter	Conductivity Meter
Turbidity	Nephelometric (turbidimeter)		Nephelometric (turbidimeter)		Nephelometric	Nephelometric (Hach turbidimeter)	Nephelometric (Hach turbidimeter)	Nephelometric	Nephelometric
Boron		I.C.P.-A.E.S (direct aspiration)			I.C.P.- A.E.S. (direct aspiration)		D.C.P.- A.E.S.		
DOC	Carbon analyzer - catalytic oxidation - IR		Total organic carbon - catalytic combustion - IR	Total organic carbon auto analyzer - catalytic combustion - IR		Autoanalyzer - total combustion - nondispersive IR	Carbon analyzer - oxidation - nondispersive IR		
DIC	Carbon analyzer - IR			Carbon auto analyzer - IR		by difference TDC - DOC	- no acidification - by difference TDC-DOC		
TKN	- acid steam distillation - titration		- semi automated block digester (acid) - colorimetric	- acid digestion (Nessler) - distillation - titration	- acid digestion - colorimetric (automated phenate)	- digestion - colorimetric (automated phenate)	- acid digestion - colorimetric	- block digestion - colorimetric (automated phenate-hypochlorite)	- block digestion - colorimetric (automated phenate-hypochlorite)

TABLE 3 (continued)

Lab No. Parameter	U001	U010	U014	U049	U057	U075	U077	U089	U091
(NO ₂ + NO ₃)N	Automated cadmium reduction - colorimetric (azo dye)		Automated cadmium reduction - colorimetric (azo dye)	- cadmium reduction - colorimetric	Ion Chromatography	Automated cadmium reduction - colorimetric	Automated cadmium reduction - colorimetric (diazot)	Automated hydrazine reduction - colorimetric (azo dye)	Automated hydrazine reduction - colorimetric (azo dye)
Ammonia N	Automated phenate - colorimetric		Automated phenate - colorimetric	Automated phenate - colorimetric	Automated phenate - colorimetric	Automated phenate - colorimetric	Automated phenate - colorimetric	Automated phenate-hypochlorite - colorimetric	Automated phenate-hypochlorite - colorimetric
Total N					Calculated by TKN + NO ₃ + NO ₂				
Fluoride	Automated Specific Ion electrode		Automated Complexone, colorimetric	Ion Chromatography	Ion Chromatography		Automated Ion Selective electrode	Specific Ion Electrode	Specific Ion Electrode
Alkalinity (CaCO ₃)	Potentiometric titration-two end points		Automated colorimetric (methyl orange)		Titration (fixed end pt.)	Titration (manual) (fixed end pt.)	Automated titration (fixed end pt.)	Potentiometric titration (fixed end pt.)	Potentiometric manual titration (fixed end pt.)
Acidity (CaCO ₃)	Electrometric titration - end point 8.3						Electrometric titration-end pt. 8.3		
pH	Electrometric (pH meter)		Electrometric (pH meter)	Electrometric (pH meter)		Electrometric (pH meter)	Electrometric (pH meter)	Electrometric (pH meter)	Electrometric (pH meter)
Hardness	Calculation from Ca and Mg data		Titrimetric - EDTA	Titrimetric EDTA		Titrimetric - EDTA (manual)		Calculation from Ca and Mg data	
Sodium	Automated Flame Photometry		A.A.S.- flame (direct)	D.C.P.- A.E.S.		D.C.P.- A.E.S.	A.A.S.- flame (direct)	Automated A.A.S.- flame	Automated A.A.S.- flame
Magnesium	Automated A.A.S.- flame		A.A.S.- flame (direct)	D.C.P.- A.E.S.	I.C.P.- A.E.S. (direct)	D.C.P.- A.E.S.	A.A.S.- flame (direct)	Automated A.A.S.- flame	Automated A.A.S.- flame

TABLE 3 (continued)

Lab No. Parameter	U001	U010	U014	U049	U057	U075	U077	U089	U091
Silica (SiO ₂)	Automated Colorimetric (Heteropoly Blue-ammonium molybdate)		Colorimetric (Heteropoly Blue molybdosillic acid)		Colorimetric (molybdosillic acid)		Automated Colorimetric (molybdate blue)	Automated Colorimetric (Heteropoly Blue molybdate)	Automated Colorimetric (Heteropoly molybdate)
Total Phosphorus	- acid diges- - color- - metric (Stannous chloride)		automated block digestor (acid) - colorimetric			- automated digestion - colorimetric	- acid digestion - automated colorimetric (phosphomolyb- date)	- acid digestion - automated colorimetry	- acid diges- - tion - automated colorimetry
Sulphate	Automated Colorimetric (methylthymol blue)		Automated Colorimetric (methylthymol blue)	Ion chromato- graphy	Ion chromato- graphy	Ion chromato- graphy	Automated Turbidimetric (Barium Sulfate)	Automated Colorimetric (methylthymol blue)	Automated Ion Chromatography
Chloride	Colorimetric (Ferric thiocyanate)		Colorimetric Automated (Ferric thiocyanate)	Ion Chromatography	Ion Chromatography	Ion Chromatography	Colorimetric Automated (Ferric thiocyanate)	Colorimetric Automated (Ferric thiocyanate)	Colorimetric Automated (Ferric thiocyanate)
Potassium	Automated Flame Photometry		A.A.S. - flame (direct)	D.C.P.-A.E.S.		D.C.P.-A.E.S.	A.A.S. - flame (direct)	A.A.S.- flame (direct)	Automated A.A.S. - flame
Calcium	Automated A.A.S.- flame		A.A.S. - flame (direct)	D.C.P.-A.E.S.	I.C.P.-A.E.S. (direct)	D.C.P.-A.E.S.	A.A.S.- flame (direct)	A.A.S.- flame (direct)	A.A.S.- flame

TABLE 4
Reported Detection Limits (All values are in mg/L unless stated)

Parameter	U001	U010	U014	U049	U057	U075	U077	U089	U091
Turbidity (JTU/NTU)	0.01		0.4		0.2	0.15	0.1	NVR	0.02
Colour (Hazen Unit)	5			5	5		0	NVR	0.3
Conductivity (μ Siemens/cm)	0.2		1	5	0.1	10	0.5	NVR	NVR
Acidity (CaCO_3)	0.1					± 0.02	5.0		
pH	NVR		0.1	0.05			NVR	NVR	NVR
Hardness	NVR		5	0.1		1		NVR	
Boron		0.02			0.005		0.01		
DOC	0.1			0.05		0.1	0.10		
Alkalinity (CaCO_3)	0.1		5		0.2	1	1.0	2.6	0.3
DIC	0.1			0.05		0.1	0.10		
Total N					0.03				
($\text{NO}_2 + \text{NO}_3$)N	0.005		0.005	0.01	0.01	0.1	0.01	0.01	0.01
NH_3	0.001		0.005	0.01	0.005	0.1	0.01	0.008	0.005
TKN	0.01		0.05	0.002	0.02	0.1	0.20	0.02	0.01
F	0.01		0.1	0.01	0.005		0.1	NVR	NVR
Na	0.02		1	0.2		0.1	0.01	0.20	0.10
Mg	0.01		1	0.02	0.01	0.1	0.01	0.3	0.03
Si (SiO_2)	0.02		0.05		0.1		0.1	0.05	0.01
Total P	0.0002		0.003			0.1	0.01	0.002	0.001
SO_4	0.2		1	0.05	0.05	0.05	0.20	1.7	0.05
Cl	0.05		1	0.02	0.005	0.05	0.20	0.95	0.02
K	0.02		0.1	0.05		0.1	0.01	0.06	0.03
Ca	0.05		1	0.05	0.01	0.1	0.01	0.74	0.1

NVR - no value reported

TABLE 5

Summary of Results by Laboratory Based on
the Flagging and Youden Procedures

(for conductivity, NO₂ + NO₃, pH, Hardness, Na, Mg, SO₄, Cl₂, K, Ca)

(see Appendix III)

Lab Code	No. of Results Reported	Elements not Analyzed	No. of Results Flagged				% Flagged*	Comments
			VH	H	L	VL		
U001	40	-	1	1	1	0	5%	Conductivity - biased high
U010	0	Ca	-	-	-	-	-	-
U014	40	-	1	1	7	0	13%	Hardness - biased high
U049	40 (2 "<") both flagged	-	0	3	3	2	13%	Mg & K - biased high
U057	24	pH, Hardness Na, K	2	0	0	2	17%	Conductivity - biased low
U075	40 (2 "<")	-	2	2	4	8	34%	Mg, Ca - biased low
U077	36	Hardness	4	1	1	1	17%	Na - biased high
U089	40	-	0	1	3	3	13%	No bias
U091	36	Hardness	0	0	0	0	0%	All satisfactory

* H and L flags are counted as half of a VH and VL flag. Less than values that were flagged are included in the calculation of the % flagged.

APPENDIX I

Glossary of Terms(1) Ranking

Ranking is a non-parametric statistical technique used for the detection of pronounced systematic error (bias) in interlaboratory studies. According to Youden's procedure, rank 1 is given to the laboratory that provided the lowest result, rank 2 to the next lowest. In case of a tie, the average rank is given to the tied laboratories. Results with a < sign are not ranked. For each parameter, the total rank of each laboratory is the sum of individual ranks on each sample. In the case of six test samples and ten laboratories, the 5% probability limits for ranking scores are 14 and 52. A laboratory with a score lower than 14 is identified as biased low. Similarly, a laboratory with a total rank higher than 52 is biased high. In both cases, their results are classified as outliers. In cases where a laboratory did not provide all the results, or some of the results were not ranked, the average rank instead of total rank was used for the determination of biased statements.

The more comparable, i.e., better, laboratories should have ranks in the middle rather than at the extreme ends. However, laboratories with middle ranks do not necessarily mean that they provide more consistent results since very high results (high ranks) and very low results (low ranks) would average out to yield a total rank close to the median. Therefore, ranking alone is not sufficient to determine the performance of a laboratory.

(2) Flagging

When the true values of constituents in test samples are unknown, individual results can be evaluated in terms of their absolute differences from the interlaboratory medians. Medians are chosen rather than means since they are not influenced by a moderate number of extreme values. By this flagging technique, all results are graded into the

following three groups in the order of decreasing accuracy: (1) results with no flags, (2) results with H or L flags, and (3) results with VH or VL flags. Before evaluation is performed, three parameters, namely, Lower Limit for use of Basic Acceptable Error (LLBAE), Basic Acceptable Error (BAE), and Concentration Error Increment (CEI) are to be set. LLBAE is usually set at the lower end of the medians in the test samples. A 5-20% error at LLBAE is considered reasonable and thus this is used as BAE. For samples whose medians are at or below LLBAE, the results are evaluated according to the following formulae:

Absolute difference between sample and median results		\leq BAE	:	acceptable
BAE <	Absolute difference between sample and median results	$\leq 1.5 \times$ BAE:	H or L	
	Absolute difference between sample and median results	$> 1.5 \times$ BAE:	VH or VL	

For samples whose medians are above the LLBAE, the allowable BAE is augmented by adding an increment to the BAE. This increment is calculated by multiplying the CEI by the difference between the sample median and LLBAE values. Sample results are again evaluated by the above three formulae except that the augmented BAE is used instead of BAE.

For further discussion on this evaluation technique, please refer to the original paper by Clark.

Bias: A set of results is said to be biased when the set exhibits a tendency to be either higher or lower than some standard - the standard which has been used in the analysis of our studies thus far has been the performance of all other participating laboratories. The ranking procedure employed in testing for bias is described in W.J. Youden's paper, "Ranking Laboratories by

Round-Robin Tests from Precision Measurement and Calibration, H.H. Ku, Editor, NBS Special Publication 300 - Volume 1, U.S. Government Printing Office, Washington, D.C., 1969. In this paper, Youden establishes the rationale for evaluating 'laboratories' performance by ranking results. In our use of the procedure there is about one chance in twenty of deeming a set of results biased when in fact it is not, that is, $t = 0.05$.

Codes

W: A "W" code is used with a reported result when no measurement was possible due to no response of the instrument to the sample. The "W" is preceded by the smallest determinative division that can be used in the units used in reporting.

T: The "T" code is used with values between the Criterion of Detection and the "W" value. The Criterion of Detection is commonly thought of by many as the limit of detection.

NA:	not analyzed
NRA:	not routinely analyzed
N or ND:	not detected
NAPP:	not applicable
H:	high
VH:	very high
L:	low
VL:	very low
LTV:	less than value (<)

APPENDIX II

UGLCC INTERLABORATORY PERFORMANCE EVALUATION STUDY

QM-4 Major Ions in Surface Water

Data Summaries

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: COLOUR

HAZEN UNIT

SAMPLE RESULTS

	401	402	403	404
LAB				
U001	<	<	<	<
U049	<	<	<	<
U057	W	W	W	W
U077	5.	5.	5.	5.
U089	5.	5.	5.	5.
U091	4.5	4.5	1.0	1.0
	3.3	3.5	.3	.3
TOTAL LABS REPORTING	6	6	6	6
TOTAL LABS USED	3	3	1	1
MEAN	4.26667	4.33333	5.00000	5.00000
STD DEV	.87369	.76376	0.00000	0.00000
MEDIAN	4.50000	4.50000	5.00000	5.00000

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: CONDUCTIVITY

MMSIEMEN/CM

SAMPLE RESULTS

	401	402	403	404
LAB				
U001	95.9	96.1	454.3	453.
U014	95.	96.	448.	448.
U049	90.	90.	425.	415.
U057	79.7	79.7	405.	405.
U075	84.00	83.00	400.	405.
U077	95.4	95.9	458.	448.
U089	92.5	92.5	438.	437.
U091	96.	96.	447.	447.
TOTAL LABS REPORTING	8	8	8	8
TOTAL LABS USED	8	8	8	8
MEAN	91.06250	91.15000	433.41250	432.25000
STD DEV	6.14444	6.48933	21.12659	20.52699
MEDIAN	93.75000	94.20000	442.50000	442.00000
DESIGN VALUE	93.9	93.9	443	443

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: TURBIDITY

JTU/NTU

SAMPLE RESULTS

LAB	401	402	403	404
U001	.11	.06	.08	.05
U014	.4	.4	.3	.3
U057	.2	.2	.2	.2
U075	.17	.14	.16	.14
U077	.3	.3	.4	.5
U089	.10	.13	.12	.08
U091		.08	.08	.11
TOTAL LABS REPORTING	7	7	7	7
TOTAL LABS USED	5	6	6	6
MEAN	.21600	.18500	.19000	.19667
STD DEV	.13012	.13502	.13130	.17236
MEDIAN	.17000	.13500	.14000	.12500

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: BORON

MG/L

SAMPLE RESULTS

	401	402	403	404
LAB				
U010	< .02	< .02	< .02	< .02
U057	< .006	< .005	< .005	< .005
U077	< .01	< .01	< .01	< .01
TOTAL LABS REPORTING	3	3	3	3
TOTAL LABS USED	1	1	0	0
MEAN	.00600	.00500	0.00000	0.00000
STD DEV	0.00000	0.00000	0.00000	0.00000
MEDIAN	.00600	.00500	0.00000	0.00000

QW4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: DISSOLVED ORGANIC CARBON

MG/L

LAB	SAMPLE RESULTS			
	401	402	403	404
U001	1.8	1.3	.2	.2
U049	2.5	2.0	.05	.05
U075	2.3	3.7	.9	.4
U077	1.49	1.60	.47	.43
TOTAL LABS REPORTING	4	4	4	4
TOTAL LABS USED	4	4	3	3
MEAN	2.02250	2.15000	.52333	.34333
STD DEV	.46119	1.07238	.35303	.12503
MEDIAN	2.05000	1.80000	.47000	.40000
U014 (TOC)	1.41	1.47	0.19	0.21

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: DISSOLVED INORG. CARBON MG/L

SAMPLE RESULTS

	401	402	403	404
LAB				
U001	9.5	9.8	<	.5
U049	10.0	10.0	<	.05
U075	12.1	11.2	.1	.2
U077	9.59	9.69	.40	.37
TOTAL LABS REPORTING	4	4	4	4
TOTAL LABS USED	4	4	2	2
MEAN	10.29750	10.17250	.25000	.28500
STD DEV	1.22121	.69692	.21213	.12021
MEDIAN	9.79500	9.90000	.25000	.28500
DESIGN VALUE	9.77	9.77		

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: TOTAL KJELDAHL NITROGEN

MG/L

SAMPLE RESULTS

LAB	401	402	403	404
U001	.136	.159	.035	.045
U014	.13	.10	.29	.29
U049	.16	.11	.063	.082
U057	.08	.07	.06	.07
U075	< .1	< .1	< .1	< .1
U077	< .2	< .20	< .20	< .2
U089	.09	.08	.01	.02
U091	.10	.09	.01	.01
TOTAL LABS REPORTING	8	8	8	8
TOTAL LABS USED	6	6	5	6
MEAN	.11600	.10150	.09160	.08617
STD DEV	.03085	.03152	.11296	.10363
MEDIAN	.11500	.09500	.06000	.05750

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: (NITRATE + NITRITE) N

MG/L

SAMPLE RESULTS

LAB	401	402	403	404
U001	.306	.313	.047	.033
U014	.30	.30	.024	.027
U049	.31	.32	.01	.01
U057	.38	.38	.04	.04
U075	.2	.2	.1	.1
U077	.30	.30	.03	.03
U089	.28	.28	.02	.02
U091	.30	.30	.04	.04
TOTAL LABS REPORTING	8	8	8	8
TOTAL LABS USED	8	8	6	6
MEAN	.29700	.29913	.03350	.03167
STD DEV	.04908	.04980	.01050	.00776
MEDIAN	.30000	.30000	.03500	.03150
DESIGN VALUE	0.30	0.30	0.032	0.032

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: AMMONIA N

MG/L

SAMPLE RESULTS

LAB		401		402		403		404
U001	<	.001	<	.001	<	.001	<	.001
U014		.001	<	.001	<	.001	<	.001
U049	<	.01		.02		.03		.04
U057	W	.005	W	.005	W	.005		.006
U075	<	.1	<	.1	<	.1	<	.1
U077	<	.01	<	.01	<	.01	<	.01
U089	W	.005	W	.005	W	.005	W	.005
U091		.01		.01		.01		.01
TOTAL LABS REPORTING		8		8		8		8
TOTAL LABS USED		2		2		2		3
MEAN		.00550		.01500		.02000		.01867
STD DEV		.00636		.00707		.01414		.01858
MEDIAN		.00550		.01500		.02000		.01000

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: TOTAL NITROGEN

MG/L

	SAMPLE RESULTS			
	401	402	403	404
LAB				
U057	.46	.45	.10	.11
TOTAL LABS REPORTING	1	1	1	1
TOTAL LABS USED	1	1	1	1
MEAN	.46000	.45000	.10000	.11000
STD DEV	0.00000	0.00000	0.00000	0.00000
MEDIAN	.46000	.45000	.10000	.11000

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: FLUORIDE

MG/L

SAMPLE RESULTS

		401		402		403		404
LAB								
U001		.03		.03	<	.01	<	.01
U014	<	.1	<	.1	<	.1	<	.1
U049		.04		.04		.01		.01
U057		.065		.060		.160		.160
U077	<	.1	<	.1	<	.1	<	.1
U089	<	.10	<	.10	<	.10	<	.10
U091	<	.1	<	.1	<	.1	<	.1
TOTAL LABS REPORTING		7		7		7		7
TOTAL LABS USED		3		3		2		2
MEAN		.04500		.04333		.08500		.08500
STD DEV		.01803		.01528		.10607		.10607
MEDIAN		.04000		.04000		.08500		.08500

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: ALKALINITY (CAC03)

MG/L

SAMPLE RESULTS

LAB	401	402	403	404
U001	42.4	43.7		
U014	47.	42.	< 5.	< 5.
U057	43.5	43.7	2.1	2.2
U075	41.	39.	2.	2.
U077	44.	43.	1.	1.
U089	41.4	40.8	T 1.2	T 1.4
U091	41.8	41.6	1.8	1.8
TOTAL LABS REPORTING	7	7	7	7
TOTAL LABS USED	7	7	3	3
MEAN	43.01429	41.97143	1.96667	2.00000
STD DEV	2.06594	1.70168	.15275	.20000
MEDIAN	42.40000	42.00000	2.00000	2.00000
DESIGN VALUE	41.1	41.1		

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: ACIDITY (CAC03)

MG/L

SAMPLE RESULTS

	401	402	403	404
LAB				
U001				
U077	< 5.	< 5.	< 1.6 5.	< 1.4 5.
TOTAL LABS REPORTING	2	2	2	2
TOTAL LABS USED	0	0	1	1
MEAN	0.00000	0.00000	1.60000	1.40000
STD DEV	0.00000	0.00000	0.00000	0.00000
MEDIAN	0.00000	0.00000	1.60000	1.40000

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: PH

PH UNITS

SAMPLE RESULTS

401 402 403 404

LAB

U001	7.39	7.66	5.28	5.41
U014	7.8	7.1	5.6	5.6
U049	7.90	7.75	5.6	5.50
U075	7.59	7.60	5.68	5.46
U077	7.86	7.90	5.6	5.64
U089	7.66	7.71	5.50	5.58
U091	7.65	7.65	5.47	5.49

TOTAL LABS REPORTING	7	7	7	7
TOTAL LABS USED	7	7	7	7
MEAN	7.69286	7.62429	5.52143	5.51429
STD DEV	.17680	.25052	.11978	.07955
MEDIAN	7.66000	7.66000	5.60000	5.50000
DESIGN VALUE	7.69	7.69	5.48	5.48

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: HARDNESS

MG/L

SAMPLE RESULTS

	401	402	403	404
LAB				
U001	44.3	44.2	141.8	142.8
U014	47.	46.	146.	143.
U049	41.2	43.2	144.	146.
U075	42.0	44.0	142.	140.
U089	41.	40.	142.	142.
TOTAL LABS REPORTING	5	5	5	5
TOTAL LABS USED	5	5	5	5
MEAN	43.10000	43.48000	143.16000	142.70000
STD DEV	2.54362	2.19818	1.82428	2.16518
MEDIAN	42.00000	44.00000	142.00000	142.80000
DESIGN VALUE	44.4	44.4	148	148

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: SODIUM

MG/L

SAMPLE RESULTS

LAB	401	402	403	404
U001	1.3	1.3	19.2	19.3
U014	1.6	1.4	19.1	19.2
U049	1.0	1.1	17.8	16.9
U075	1.24	1.19	18.3	18.3
U077	3.03	3.03	20.	20.
U089	.7	.7	18.6	18.5
U091	1.3	1.3	19.2	19.3
TOTAL LABS REPORTING	7	7	7	7
TOTAL LABS USED	7	7	7	7
MEAN	1.45286	1.43143	18.88571	18.78571
STD DEV	.74977	.74095	.71747	1.00404
MEDIAN	1.30000	1.30000	19.10000	19.20000
DESIGN VALUE	1.29	1.29	19.1	19.1

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: MAGNESIUM

MG/L

SAMPLE RESULTS

	401	402	403	404
LAB				
U001	2.7	2.6	9.2	9.2
U014	2.9	2.8	9.6	9.5
U049	2.91	2.97	10.3	10.2
U057	2.84	2.83	9.46	9.75
U075	2.44	2.33	8.65	8.45
U077	4.0	4.0	9.0	9.0
U089	2.6	2.4	9.2	9.0
U091	2.70	2.70	9.26	9.26
TOTAL LABS REPORTING	8	8	8	8
TOTAL LABS USED	8	8	8	8
MEAN	2.88625	2.82875	9.33375	9.29500
STD DEV	.47716	.52018	.48412	.53001
MEDIAN	2.77000	2.75000	9.23000	9.23000
DESIGN VALUE	2.74	2.74	9.38	9.38

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: SILICA (SI02)

MG/L

SAMPLE RESULTS

LAB	401	402		403		404
U001	2.4	2.4	<	.02	<	.02
U014	2.4	2.4	<	.02	<	.02
U057	2.4	2.4	W	.1	W	.1
U077	2.5	2.5	<	.1	<	.1
U089	1.16	1.16	W	.02	W	.02
U091	1.14	1.14	<	.01	<	.01
TOTAL LABS REPORTING	6	6		6		6
TOTAL LABS USED	6	6		0		0
MEAN	2.00000	2.00000		0.00000		0.00000
STD DEV	.65958	.65958		0.00000		0.00000
MEDIAN	2.40000	2.40000		0.00000		0.00000
DESIGN VALUE	2.38	2.38				

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: TOTAL PHOSPHORUS

MG/L

SAMPLE RESULTS

LAB	401	402	403	404
U001	.0035	.0028	.0009	.0006
U014	<.001	.002	.001	.001
U075	<.1	<.1	<.1	.1
U077	.014	.015		.019
U089	.002	.001	.001	.001
U091	.003	.001	.001	.001
TOTAL LABS REPORTING	6	6	6	6
TOTAL LABS USED	4	3	2	2
MEAN	.00563	.00660	.00095	.00980
STD DEV	.00562	.00729	.00007	.01301
MEDIAN	.00325	.00280	.00095	.00980

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/28.

PARAMETER: SULPHATE

MG/L

SAMPLE RESULTS

LAB	401	402	403	404
U001	3.1	3.3	35.3	37.6
U014	3.2	2.7	37.9	37.2
U049	3.1	3.0	36.	32.
U057	3.34	3.17	40.1	41.2
U075	3.2	3.3	42.	42.
U077	3.3	3.4	31.	32.
U089	3.5	3.5	36.0	36.5
U091	2.95	3.05	37.55	37.70
TOTAL LABS REPORTING	8	8	8	8
TOTAL LABS USED	8	8	8	8
MEAN	3.21125	3.17750	36.98125	37.02500
STD DEV	.16949	.25617	3.30821	3.66011
MEDIAN	3.20000	3.23500	36.77500	37.40000
DESIGN VALUE	3.32	3.32	37.1	37.1

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: CHLORIDE

MG/L

SAMPLE RESULTS

LAB	401	402	403	404
U001	1.27	1.28	103.1	103.4
U014	1.4	1.0	94.	91.
U049	1.23	1.21	94.	105.
U057	1.33	1.32	103.	106.
U075	1.3	1.4	163.	161.
U077	1.4	1.3	114.	115.
U089	1.0	1.0	105.	105.
U091	1.2	1.3	100.	110.
TOTAL LABS REPORTING	8	8	8	8
TOTAL LABS USED	8	8	8	8
MEAN	1.26625	1.22625	109.51250	112.05000
STD DEV	.12961	.14899	22.54110	20.91800
MEDIAN	1.28500	1.29000	103.05000	105.50000
DESIGN VALUE	1.25	1.25	105	105

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: POTASSIUM

MG/L

SAMPLE RESULTS

	401	402	403	404
LAB				
U001	.49	.50	.91	.91
U014	.5	.4	.8	.8
U049	.56	.57	.99	.97
U075	.34	.37	.90	.88
U077	.5	.5	.9	.9
U089	.60	.50	.85	.85
U091	.51	.51	.94	.93
TOTAL LABS REPORTING	7	7	7	7
TOTAL LABS USED	7	7	7	7
MEAN	.50000	.47857	.89857	.89143
STD DEV	.08103	.06914	.06094	.05521
MEDIAN	.50000	.50000	.90000	.90000
DESIGN VALUE	0.488	0.488	0.884	0.884

QM4 MAJOR IONS IN SURFACE WATER

PRINTOUT PREPARED: 86/11/20.

PARAMETER: CALCIUM

MG/L

SAMPLE RESULTS

	401	402	403	404
LAB				
U001	13.3	13.4	41.6	42.0
U014	14.3	13.8	42.5	41.6
U049	12.7	12.9	43.6	43.4
U057	13.4	13.2	43.1	44.5
U075	10.2	10.0	35.0	36.3
U077	14.	13.	40.	40.
U089	12.0	12.0	41.5	42.0
U091	13.1	13.2	42.5	42.2
TOTAL LABS REPORTING	8	8	8	8
TOTAL LABS USED	8	8	8	8
MEAN	12.87500	12.68750	41.22500	41.50000
STD DEV	1.29587	1.20171	2.74838	2.47560
MEDIAN	13.20000	13.10000	42.05000	42.00000
DESIGN VALUE	12.5	12.5	42.4	42.4

QM-4

Flagging and Youden's Ranking Procedures

for

**Conductivity, $(\text{NO}_3 + \text{NO}_2)\text{N}$, pH, Hardness, Na, Mg,
SO₄, Cl, K and Ca**

USIEMEN/CM

PARAMETER 00492 CONDUCTIVITY

QMS MAJOR IONS IN SURFACE WATER

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR=90.00 BASIC ACCEPTABLE ERROR= 4.50 CONCENTRATION ERROR INCREMENT=1.00
LABORATORIES YET TO REPORT: U063, U078, U030
LABORATORY RESULTS OMITTED ARE NONE

401			402			403			404		
SAMPLE	REPORTED	RANK	REPORTED	RANK		REPORTED	RANK		REPORTED	RANK	
LAB NO	VALUE		VALUE			VALUE			VALUE		
U001	95.9	7.00	95.1	8.00		424.3	8.00		453.	8.00	
U014	95.	6.00	90.	6.50		448.	6.00		448.	6.50	
U049	90.	3.00	90.	3.00		425.	3.00		415.	3.00	
U057	79.7 VL	1.00	73.7 VL	1.00		405.	2.00		405.	1.50	
U075	84.00 VL	2.00	83.00 VL	2.00		400.	1.00		405.	1.50	
U077	95.4	6.00	95.9	5.00		450.	4.00		448.	6.50	
U089	92.3	4.00	92.3	4.00		438.	4.00		437.	4.00	
U091	96.	8.00	96.	6.50		447.	5.00		447.	5.00	
MEDIAN	93.750		90.200								
CONC.						442.500			442.000		

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	BIASED HIGH	BIASED LOW	DETECTION LIMIT
U001	31.00	7.750	4				0.2
U014	21.00	5.250	4				1
U049	12.00	3.000	4				0.1
U057	5.50	1.375	4	VLVL			10
U075	6.50	1.625	4	LL			5
U077	26.50	6.625	4				10
U089	16.00	4.000	4				5
U091	24.50	6.125	4				0.2
OVERALL AVERAGE RANK IS		4.500					

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	BIASED LOW	BIASED HIGH	DETECTION LIMIT
U057	5.50	1.375	4				0.1
U075	6.50	1.625	4	VLVL			10
U049	12.00	3.000	4	LL			5
U089	16.00	4.000	4				1
U077	24.50	6.125	4				5
U091	24.50	6.125	4				0.2
U001	31.00	7.750	4				0.2
OVERALL AVERAGE RANK IS		4.500					

CONDUCTIVITY

PARAMETER: 92 NITRATE + NITRITE N MG/L

Q04 MAJOR IONS IN SURFACE WATER

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR= .05 BASIC ACCEPTABLE ERROR= .01 CONCENTRATION ERROR INCREMENT= .10
LABORATORIES YET TO REPORT: U063, U078, U090
LABORATORY RESULTS OMITTED ARE NONE

SAMPLE LAB NO	401	402	403	404
	REPORTED VALUE	REPORTED VALUE	REPORTED VALUE	REPORTED VALUE
U001	306	113	0.47 VH	0.33
U016	30	30	0.24 VL	0.27
U049	31	32	0.01 VL	0.01 VL
U057	38 VH	38 VH	0.4	0.4
U075	38 VL	38 VL	0.1	0.1
U077	30	30	0.03	0.03
U089	28	28	0.02	0.02
U091	30	30	0.04	0.04
MEDIAN				
CONC.	300	300	0.030	0.030

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U001	24.00	6.000	4	VH	0.005
U016	14.00	4.000	4	VL VH	0.005
U049	16.00	4.000	4	VH VH	0.01
U057	20.00	7.000	4	VL VL	0.01
U075	2.000	1.000	2		0.01
U077	16.00	4.000	4		0.01
U089	18.00	4.500	4		0.01
U091	20.00	5.000	4		0.01
OVERALL RANK IS		4.267			

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U075	2.00	1.000	2	VL VL	0.01
U089	8.00	2.000	4		0.005
U016	14.00	3.500	4		0.01
U077	16.00	4.000	4	VL VL	0.01
U049	16.00	4.000	4		0.01
U091	20.00	5.000	4	VH	0.005
U001	24.00	6.000	4	VH VH	0.01
U057	28.00	7.000	4		
OVERALL RANK IS		4.267			

NITRATE + NITRITE N

PH UNITS

PARAMETER 92 PH

QM4 MAJOR IONS IN SURFACE WATER

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR= 5.50 BASIC ACCEPTABLE ERROR= .27 CONCENTRATION ERROR INCREMENT= .10
LABORATORIES YET TO REPORT: U063, U078, U090
LABORATORY RESULTS OMITTED ARE NONE

SAMPLE LAB NO	401 REPORTED VALUE	401 RANK	402 REPORTED VALUE	402 RANK	403 REPORTED VALUE	403 RANK	404 REPORTED VALUE	404 RANK
U001	7.39	1.00	7.66	4.00	5.28	1.00	5.41	1.00
U014	7.8	5.00	7.1	1.00	5.6	5.50	5.60	6.00
U049	7.99	7.00	7.75	6.00	5.6	5.50	5.60	4.50
U075	7.59	2.00	7.80	2.00	5.60	2.50	5.46	2.00
U077	7.86	6.00	7.71	5.00	5.50	3.00	5.84	7.00
U089	7.66	3.00	7.65	3.00	5.47	2.00	5.50	4.50
U091	7.65						5.49	3.00
MEDIAN								
CONC.	7.660		7.660		5.600		5.500	

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U001	7.00	1.750	4	L	0.1
U014	17.50	4.375	4		0.05
U049	23.00	5.750	4		0.02
U075	11.50	2.875	4		
U077	25.50	6.375	4		
U089	16.50	4.125	4		
U091	11.00	2.750	4		
OVERALL AVERAGE RANK IS		4.000			

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U001	7.00	1.750	4	L	0.02
U091	11.00	2.750	4		
U075	16.50	4.125	4		
U049	17.50	4.375	4	L	0.1
U014	23.00	5.750	4		0.05
U077	25.50	6.375	4		
OVERALL AVERAGE RANK IS		4.000			

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR=40.00 BASIC ACCEPTABLE ERROR= 2.00 CONCENTRATION ERROR INCREMENT= .10
LABORATORIES YET TO REPORT: U063, U078, U090
LABORATORY RESULTS OMITTED ARE NONE

SAMPLE LAB NO	401		402		403		404	
	REPORTED VALUE	RANK	REPORTED VALUE	RANK	REPORTED VALUE	RANK	REPORTED VALUE	RANK
U001	44.3	H	44.2	4.00	141.8	1.00	143.8	3.00
U014	41.2	VH	43.2	5.00	146.	5.00	143.	4.00
U049	41.2	3.00	43.2	2.00	144.	4.00	146.	5.00
U075	42.0	3.00	44.0	3.00	142.	2.50	140.	1.00
U089	41.	1.00	40. VL	1.00	142.	2.50	142.	2.00
MEDIAN								
CONC.	42.000		44.000		142.000		142.800	

LAB NO.	TOTAL PANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U001	12.00	3.000	4	H	5
U014	19.00	4.750	4	VH	0.1
U049	13.00	3.250	4		1
U075	9.50	2.375	4	VL	
U089	6.50	1.625	4		
OVERALL AVERAGE		3.000			
RANK IS					

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U089	6.50	1.625	4	VL	1
U075	9.50	2.375	4		0.1
U001	13.00	3.250	4	H	5
U049	13.00	3.250	4	VH	
U014	19.00	4.750	4		
OVERALL AVERAGE		3.000			
RANK IS					

HARDNESS

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR= 1.30 BASIC ACCEPTABLE ERROR= .26 CONCENTRATION ERROR INCREMENT= .10
LABORATORIES YET TO REPORT: U063, U078, U090
LABORATORY RESULTS OMITTED ARE NONE

SAMPLE LAB NO	401			402			403			404		
	REPORTED VALUE	RANK		REPORTED VALUE	RANK		REPORTED VALUE	RANK		REPORTED VALUE	RANK	
U001	1.3	4.50		1.3	4.50		19.2	5.50		19.3	5.50	
U014	1.6 H	6.00		1.4	6.00		17.8	4.00		16.9 L	1.00	
U049	1.0 L	2.00		1.1	3.00		18.3	1.00		20.0	2.00	
U075	1.24 L	3.00		1.3	3.00		18.6	3.00		18.5	3.00	
U077	3.03 VH	1.00		3.7 VL	4.50		19.2	5.50				
U086	1.7 VL	4.50		1.3								
U091	1.3			1.300			19.100					
MEDIAN												
CONC.	1.300									19.200		

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U001	20.00	5.000	4		0.02
U014	20.00	5.000	4	HL	1
U049	6.00	1.500	4		0.2
U075	10.00	2.500	4	VH VH	0.1
U077	28.00	7.000	4	VL VL	0.01
U089	8.00	2.000	4		0.20
U091	20.00	5.000	4		0.10
OVERALL AVERAGE RANK IS		4.000			

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U049	6.00	1.500	4	LL	0.20
U089	8.00	2.000	4	VL VL	0.1
U075	10.00	2.500	4	H	1
U014	20.00	5.000	4		0.02
U001	20.00	5.000	4		0.10
U091	20.00	5.000	4		0.01
U077	28.00	7.000	4		
OVERALL AVERAGE RANK IS		4.000			

SODIUM

MG/L

PARAMETER: 12091 MAGNESIUM

QM4 MAGNESIUM IN SURFACE WATER

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR= 2.70 BASIC ACCEPTABLE ERROR= .27 CONCENTRATION ERROR INCREMENT= .10
LABORATORIES YET TO REPORT: U063, U078, U090
LABORATORY RESULTS OMITTED ARE NONE

SAMPLE LAB NO.	401			402			403			404		
	REPORTED VALUE	RANK		REPORTED VALUE	RANK		REPORTED VALUE	RANK		REPORTED VALUE	RANK	
U001	2.7	3.50		2.8	3.00		9.2	3.50		9.2	4.00	
U014	2.91	6.00		2.97	5.00		9.6	7.00		9.5	6.00	
U049	2.84	7.00		2.83	6.00		10.3	8.00	H	10.2	9.00	
U075	2.84	5.00		2.83	5.00	VL	9.45	9.00		9.75	7.00	
U077	4.0	1.00	L	3.0	1.00		9.0	9.00		9.45	1.00	
U089	2.6	2.00	VH	2.7	2.00	VH	9.26	2.00		9.0	2.50	
U091	2.70	3.50	L	2.78	4.00	L	9.26	3.50		9.26	5.00	
MEDIAN	2.770			2.750			9.230	5.00		9.230		
CONC.												

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U001	16.00	3.500	4		0.01
U014	24.00	6.000	4	HH	1
U049	24.00	6.000	4		0.02
U057	24.00	6.000	4		0.01
U075	4.00	1.000	4	LVL	0.1
U077	20.50	5.125	4	VHVL	0.03
U089	10.00	2.500	4	L	
U091	17.50	4.375	4		
OVERALL AVERAGE RANK IS		4.500			

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U075	4.00	1.000	4		0.1
U089	10.00	2.500	4	LVL	0.01
U091	17.50	4.375	4	L	0.01
U077	20.50	5.125	4	VHVL	0.03
U014	24.00	6.000	4		1
U057	24.00	6.000	4		0.01
U049	30.00	7.500	4	HH	0.02
OVERALL AVERAGE RANK IS		4.500			

MAGNESIUM

MG/L

PARAMETER 16009 SULPHATE

Q04 MAJ IONS IN SURFACE WATER

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR= 3.20 BASIC ACCEPTABLE ERROR= .48 CONCENTRATION ERROR INCREMENT= .10
LABORATORIES YET TO REPORT: U063, U078, U090
LABORATORY RESULTS OMITTED ARE NONE

SAMPLE LAB NO.	401			402			403			404		
	REPORTED VALUE	RANK		REPORTED VALUE	RANK		REPORTED VALUE	RANK		REPORTED VALUE	RANK	
U001	3.1	2.50		3.3	5.50		35.3	2.00		37.6	5.00	
U014	3.2	2.50		3.7	1.00		37.9	6.00		37.2	4.00	
U049	3.1	2.50		3.0	2.00		36.1	3.50		32.2	1.50	
U052	3.14	7.00		3.17	4.00		40.1	7.00		41.2	7.00	
U077	3.3	6.00		3.3	7.00		42.1	1.00		42.1	8.00	
U089	3.5	6.00		3.5	8.00		31.0	3.50		32.0	1.50	
U091	2.95	1.00		3.8	3.00		36.0	5.00		36.5	3.00	
MEDIAN				3.235			37.55			37.70	6.00	
CONC.	3.200			3.235			36.775			37.400		

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U001	15.00	3.750	4		0.2
U014	15.50	3.875	4	L	1
U049	25.00	6.250	4		0.05
U057	25.00	6.250	4		0.05
U077	26.00	6.500	4	HH	0.05
U089	22.50	5.625	4	VLL	0.20
U091	15.00	3.750	4		1.7
OVERALL AVERAGE		4.500			0.05

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U049	9.50	3.750	4		0.05
U001	15.00	3.750	4	L	0.2
U091	15.00	3.750	4		0.05
U077	15.50	3.875	4	VLL	0.05
U014	15.50	3.875	4	L	0.20
U089	22.50	5.625	4		1.7
U057	25.00	6.250	4		0.05
U075	26.00	6.500	4	HH	0.05
OVERALL AVERAGE		4.500			

SULPHATE

MG/L

PARAMETER: 17003 CHLORIDE

Q14 MAJOR IONS IN SURFACE WATER

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR= 1.25 BASIC ACCEPTABLE ERROR= .19 CONCENTRATION ERROR INCREMENT= .10
LABORATORIES YET TO REPORT: U063, U078, U090
LABORATORY RESULTS OMITTED ARE NONE

SAMPLE LAB NO	401 REPORTED VALUE	401 RANK	402 REPORTED VALUE	402 RANK	403 REPORTED VALUE	403 RANK	404 REPORTED VALUE	404 RANK
U001	1.27	4.00	1.28	4.00	103.1	5.00	103.4	2.00
U014	1.4	7.50	1.0 L	1.50	94.	1.50	91. L	1.00
U049	1.23	3.00	1.21	3.00	94.	1.50	105.	3.50
U057	1.33	8.00	1.32	7.00	103.	4.00	106.	5.00
U075	1.3	5.00	1.3	8.00	103.	4.00	151. VH	8.00
U077	1.4	7.50	1.4	5.50	114. H	7.00	115.	7.00
U089	1.0 L	1.00	1.0 L	1.50	105.	6.00	105.	3.50
U091	1.2	2.00	1.2	5.50	100.	3.00	110.	6.00
MEDIAN	1.285		1.290		103.050		105.500	
CONC.								

LAR NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING
U001	15.00	3.750	4	LL
U014	11.00	2.750	4	
U049	11.00	2.750	4	
U057	22.00	5.500	4	VH VH
U075	29.00	7.250	4	H
U077	27.00	6.750	4	LL
U089	12.00	3.000	4	
U091	16.50	4.125	4	
OVERALL AVERAGE RANK IS		4.500		

DETECTION LIMIT
0.05
1
0.02
0.005
0.05
0.20
0.95
0.02

LAR NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING
U049	11.00	2.750	4	LL
U014	11.00	2.750	4	LL
U089	12.00	3.000	4	
U001	15.00	3.750	4	
U057	22.00	5.500	4	
U075	29.00	7.250	4	H
U077	27.00	6.750	4	VH VH
OVERALL AVERAGE RANK IS		4.500		

DETECTION LIMIT
0.02
1
0.95
0.05
0.02
0.005
0.20
0.05

CHLORIDE

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR= .50 BASIC ACCEPTABLE ERROR= .07 CONCENTRATION ERROR INCREMENT= .01
LABORATORIES YET TO REPORT: U063, U078, U090
LABORATORY RESULTS OMITTED ARE NONE

401				402				403				404			
SAMPLE	LAB NO	REPORTED VALUE	RANK	REPORTED VALUE	RANK	REPORTED VALUE	RANK	REPORTED VALUE	RANK	REPORTED VALUE	RANK	REPORTED VALUE	RANK	REPORTED VALUE	RANK
U001		.49	3.00	.50	4.00	.91	5.00	.81	5.00	.81	5.00	.81	5.00	.81	5.00
U014		.56	3.50	.47	2.00	.99	1.00	.97	1.00	.97	1.00	.97	1.00	.97	1.00
U049		.34	6.00	.57	7.00	.90	3.50	.88	3.50	.88	3.50	.88	3.50	.88	3.50
U075		.20	1.00	.37	1.00	.90	3.50	.90	3.50	.90	3.50	.90	3.50	.90	3.50
U077		.20	1.00	.37	1.00	.90	3.50	.90	3.50	.90	3.50	.90	3.50	.90	3.50
U089		.51	7.00	.50	4.00	.85	2.00	.85	2.00	.85	2.00	.85	2.00	.85	2.00
U091		.51	5.00	.51	6.00	.94	6.00	.94	6.00	.94	6.00	.94	6.00	.94	6.00
MEDIAN															
CONC.		.500		.508		.900		.900		.900		.900		.900	

SUMMARY OF FLAGGING				BIASED HIGH				DETECTION LIMIT			
LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED
U001	16.00	4.000	4	U001	16.00	4.000	4	U001	16.00	4.000	4
U014	17.50	4.375	4	U014	17.50	4.375	4	U014	17.50	4.375	4
U049	27.00	6.750	4	U049	27.00	6.750	4	U049	27.00	6.750	4
U075	8.50	2.125	4	U075	8.50	2.125	4	U075	8.50	2.125	4
U077	15.00	3.750	4	U077	15.00	3.750	4	U077	15.00	3.750	4
U089	13.00	3.250	4	U089	13.00	3.250	4	U089	13.00	3.250	4
U091	23.00	5.750	4	U091	23.00	5.750	4	U091	23.00	5.750	4
OVERALL AVERAGE RANK IS		4.000		OVERALL AVERAGE RANK IS		4.000		OVERALL AVERAGE RANK IS		4.000	

SUMMARY OF FLAGGING				BIASED HIGH				DETECTION LIMIT			
LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED
U014	7.50	1.875	4	U014	7.50	1.875	4	U014	7.50	1.875	4
U075	8.50	2.125	4	U075	8.50	2.125	4	U075	8.50	2.125	4
U089	15.00	3.750	4	U089	15.00	3.750	4	U089	15.00	3.750	4
U001	16.00	4.000	4	U001	16.00	4.000	4	U001	16.00	4.000	4
U091	23.00	5.750	4	U091	23.00	5.750	4	U091	23.00	5.750	4
U049	27.00	6.750	4	U049	27.00	6.750	4	U049	27.00	6.750	4
OVERALL AVERAGE RANK IS		4.000		OVERALL AVERAGE RANK IS		4.000		OVERALL AVERAGE RANK IS		4.000	

POTASSIUM

LOWER LIMIT FOR USE OF BASIC ACCEPTABLE ERROR=13.00 BASIC ACCEPTABLE ERROR= 1.30 CONCENTRATION ERROR INCREMENT= .10
LABORATORIES YET TO REPORT: U063, U078, U090
LABORATORY RESULTS OMITTED ARE NONE

SAMPLE LAB NO	401			402			403			404		
	REPORTED VALUE	RANK		REPORTED VALUE	RANK		REPORTED VALUE	RANK		REPORTED VALUE	RANK	
U001	13.3	5.00		13.4	7.00		41.6	4.00		42.0	3.50	
U014	14.3	3.00		13.8	6.00		42.5	5.50		41.6	3.00	
U049	12.7	3.00		12.9	3.00		43.6	8.00		43.4	7.00	
U057	13.4	6.00		13.2	5.50		43.6	7.00		43.4	6.00	
U077	10.2	1.00	VL	10.0	1.00		35.0	1.00	VL	36.3	1.00	
U089	12.0	2.00		13.0	4.00		40.5	2.00		40.0	2.00	
U091	13.1	4.00		13.2	5.50		41.5	3.00		42.0	4.50	
MEDIAN							42.5	5.50		42.2	6.00	
CONC.	13.200			13.100			42.050			42.000		

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U001	20.50	5.125	4		0.05
U014	24.50	6.125	4		1
U049	21.00	5.250	4		0.05
U057	26.50	6.625	4		0.01
U077	4.00	1.000	4	VLVLVL	0.1
U089	15.00	3.750	4		0.01
U091	21.00	5.250	4		0.074
OVERALL RANK IS	AVERAGE	4.500		BIASED LOW	0.1

LAB NO.	TOTAL RANK	AVERAGE RANK	NO. OF SAMPLES RANKED	SUMMARY OF FLAGGING	DETECTION LIMIT
U075	4.00	1.000	4		0.1
U089	15.00	3.750	4		0.074
U077	20.50	5.125	4		0.01
U081	21.00	5.250	4		0.05
U049	21.00	5.250	4		0.05
U091	24.50	6.125	4		0.1
U014	24.50	6.125	4		1
U057	26.50	6.625	4		0.01
OVERALL RANK IS	AVERAGE	4.500		BIASED LOW	0.01

APPENDIX III

UGLCC INTERLABORATORY PERFORMANCE EVALUATION STUDY

QM-4 Major Ions in Surface Water

Laboratory Appraisals

CRITERIA USED TO PREPARE STATEMENTS FOR THE LABORATORY APPRAISALS

Note: Please refer to the "Glossary of Terms" and associated references for an explanation of

- a) How the non-parametric process of ranking is able to discern bias in a laboratory data set and
- b) The calculation and conditions that warrants a reported result to be flagged L, H, VL or VH.

Status of Data

(Refer to Appendix II - Date Files)

Statement Produced in Appraisal (Appendix III)

- | | |
|--|---|
| 1a) No flags, no bias in the data set. | 1a) Satisfactory |
| b) No bias, only 1 minor flag (H or L). | b) Satisfactory except for low/high flag on sample ____. |
| 2. No data or results reported by laboratory. | 2. No results reported. |
| 3. Data reported on less than half of the samples, no results flagged. | 3. Insufficient data to assess bias. |
| 4. Same as Item 3, but some results are flagged. | 4. Flagged ____ on sample ____ and flagged ____ on sample ____ Insufficient data to assess bias. |
| 5. No results are flagged but data set identified as biased high or low | 5. Although no results are flagged ranking indicates results are biased high/low. |
| 6. Some results are flagged, the data set is discerned as biased. | 6. Flagged ____ on sample ____; Flagged ____ on sample _____. Ranking indicates results are biased. |
| 7. Some results are flagged. | 7. Flagged ____ on sample ____ and flagged ____ on samples ____. |
| 8. No bias statement but two or three results are flagged. One is very high, the other is very low. | 8. Flagged very high on sample ____ and very low on sample _____. These results are slightly erratic. |
| 9. No bias statement but two or more results are flagged very high and two or more results are flagged very low. | 9. Flagged very high on samples ____ and flagged very low on samples _____. These results are erratic. |
| 10. Results are ranked, the data set is not biased but one result is flagged very high or very low. | 10. Flagged ____ on sample _____. This extreme result suggests the measurement process is out of control. |
| 11. Less than values | 11. Unuseable values. |

* Taken from LRTAP Intercomparison Study L-12 (6)

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4

Your Laboratory Code is: U001

Parameter	Comments
Conductivity	Although no results are flagged, ranking indicates results are biased high
(NO ₂ + NO ₃) N	Flagged VH on sample 403
pH	Satisfactory, except flagged L on sample 403
Hardness	Satisfactory, except flagged H on sample 401
Sodium	Satisfactory
Magnesium	Satisfactory
Sulphate	Satisfactory
Chloride	Satisfactory
Potassium	Satisfactory
Calcium	Satisfactory
Turbidity	Comparable with data set
DOC	Comparable with data set
TKN	Comparable with data set
Alkalinity	401,402-Comparable with data set; 403,404-no results reported
Colour	No basis for comparison (all "<" values).
DIC	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
Ammonia N	No basis for comparison (all "<" values)
Fluoride	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
Silica	401,402,-comparable with data set; 403,404-no basis for comparison (2 "<" values)
Total P	401,402,403-comparable with data set; 404-no basis for comparison
Boron	No results reported
Total N	No results reported
Acidity	403,404-no basis for comparison; 401,402-no results reported

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4Your Laboratory Code is: U010

Parameter	Comments
Conductivity	NAPP
(NO ₂ + NO ₃) N	NAPP
pH	NAPP
Hardness	NAPP
Sodium	NAPP
Magnesium	NAPP
Sulphate	NAPP
Chloride	NAPP
Potassium	NAPP
Calcium	No results submitted
Turbidity	NAPP
DOC	NAPP
TKN	NAPP
Alkalinity	NAPP
Colour	NAPP
DIC	NAPP
Ammonia N	NAPP
Fluoride	NAPP
Silica	NAPP
Total P	NAPP
Boron	No basis for comparison (all "<" values)
Total N	NAPP
Acidity	NAPP

NAPP - not applicable

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4

Your Laboratory Code is: U014

Parameter	Comments
Conductivity	Satisfactory
(NO ₂ + NO ₃) N	Satisfactory
pH	Satisfactory, except flagged L on sample 402
Hardness	Flagged VH on sample 401. Ranking indicates results are biased high
Sodium	Satisfactory, except flagged H on sample 401
Magnesium	Satisfactory
Sulphate	Satisfactory, except flagged L on sample 402
Chloride	Flagged L on samples 402 and 404
Potassium	Flagged L on samples 402, 403 and 404
Calcium	Satisfactory
Turbidity	Comparable with data set
DOC	No results reported. TOC was reported
TKN	401,402-comparable with data set; 403,404-outliers by Grubbs & Dixon
Alkalinity	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
Colour	No results reported
DIC	No results reported
Ammonia N	No basis for comparison (3 "<" values)
Fluoride	No basis for comparison (all "<" values)
Silica	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
Total P	401,404-no basis for comparison (2 "<" values), 402,403 comparable with data set
Boron	No results reported
Total N	No results reported
Acidity	No results reported

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4

Your Laboratory Code is: U049

Parameter	Comments
Conductivity	Satisfactory
(NO ₂ + NO ₃) N	Results for samples 403 and 404 are unuseable ("<" values) which were flagged VL
pH	Satisfactory
Hardness	Satisfactory
Sodium	Flagged L on samples 401 and 404
Magnesium	Flagged H on samples 403 and 404. Ranking indicates results are biased high
Sulphate	Satisfactory, except flagged L on sample 404
Chloride	Satisfactory
Potassium	Flagged H on samples 403. Ranking indicates results are biased high
Calcium	Satisfactory
Turbidity	No results reported
DOC	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values).
TKN	Comparable with data set
Alkalinity	No results reported
Colour	No basis for comparison (all "<" values)
DIC	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
Ammonia N	401,402,403-no basis for comparison (401-<" value); 404-comparable with data set
Fluoride	401,402-comparable with data set; 403,404-no basis for comparison
Silica	No results reported
Total P	No results reported
Boron	No results reported
Total N	No results reported
Acidity	No results reported

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4

Your Laboratory Code is: U057

Parameter	Comments
Conductivity	Flagged VL on samples 401 and 402. Ranking indicates results are biased low
(NO ₂ + NO ₃) N	Flagged VH on samples 401 and 402
pH	No results reported
Hardness	No results reported
Sodium	No results reported
Magnesium	Satisfactory
Sulphate	Satisfactory
Chloride	Satisfactory
Potassium	No results reported
Calcium	Satisfactory
Turbidity	No basis for comparison (all "W" values reported)
DOC	No results reported
TKN	Comparable with data set
Alkalinity	Comparable with data set
Colour	No basis for comparison (all "W" values reported)
DIC	No results reported
Ammonia N	404-comparable with data set; 401,402,403-no basis for comparison ("W" values reported)
Fluoride	401,402-comparable with data set; 403,404-no basis for comparison
Silica	401,402-comparable with data set; 403,404-no basis comparison ("W" values reported)
Total P	No results reported
Boron	No basis for comparison (403,404-"W" values)
Total N	No basis for comparison
Acidity	No results reported

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4

Your Laboratory Code is: U075

Parameter	Comments
Conductivity	Flagged L on samples 401 and 402
(NO ₂ + NO ₃) N	Flagged VL on samples 401 and 402. Results for samples 403 and 404 were unuseable ("<" values)
pH	Satisfactory
Hardness	Satisfactory
Sodium	Satisfactory
Magnesium	Flagged L on sample 401 and VL on sample 402. Ranking indicates results are biased low
Sulphate	Flagged H on samples 402 and 404
Chloride	Flagged VH on samples 403 and 404
Potassium	Flagged VL on samples 401 and 402
Calcium	Flagged VL on samples 401, 402, 403 and L on sample 404. Ranking indicates results are biased low
Turbidity	Comparable with data set
DOC	Comparable with data set
TKN	No basis for comparison (all "<" values)
Alkalinity	Comparable with data set
Colour	No results reported
DIC	401,402-outliers by Grubbs & Dixon; 403,404-no basis for comparison
Ammonia N	No basis for comparison (all "<" values)
Fluoride	No results reported
Silica	No results reported
Total P	No basis for comparison (all "<" values)
Boron	No results reported
Total N	No results reported
Acidity	No results reported

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4Your Laboratory Code is: U077

Parameter	Comments
Conductivity	Satisfactory
(NO ₂ + NO ₃) N	Satisfactory
pH	Satisfactory
Hardness	No results reported
Sodium	Flagged VH on samples 401 and 402. Ranking indicates results are biased high
Magnesium	Flagged VH on samples 401 and 402
Sulphate	Flagged VL on sample 403 and L on sample 404
Chloride	Satisfactory, except flagged H on sample 403
Potassium	Satisfactory
Calcium	Satisfactory
Turbidity	Comparable with data set
D _{OC}	Comparable with data set
TKN	No basis for comparison (all "<" values)
Alkalinity	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
Colour	401,402-comparable with data set; 403,404-no basis for comparison
DIC	401,402-comparable with data set; 403,404-no basis for comparison
Ammonia N	No basis for comparison (all "<" values)
Fluoride	No basis for comparison (all "<" values)
Silica	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
Total P	401,402-outliers by Grubbs & Dixon; 403-no results 404-no basis for comparison
Boron	No basis for comparison (all "<" values)
Total N	No results reported
Acidity	No basis for comparison (all "<" values)

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4

Your Laboratory Code is: U089

Parameter	Comments
Conductivity	Satisfactory
(NO ₂ + NO ₃) N	Satisfactory
pH	Satisfactory
Hardness	Flagged VL on sample 402
Sodium	Flagged VL on samples 401 and 402
Magnesium	Satisfactory, except flagged L on sample 402
Sulphate	Satisfactory
Chloride	Flagged L on samples 401 and 402
Potassium	Satisfactory, except flagged H on sample 401
Calcium	Satisfactory
Turbidity	Comparable with data set
DOC	No results reported
TKN	401,402,404-comparable with data set; 403-no basis for comparison ("W" value)
Alkalinity	Comparable with data set
Colour	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
DIC	No results reported
Ammonia N	No basis for comparison (all "W" values)
Fluoride	No basis for comparison (all "<" values)
Silica	401,402-comparable with data set; 403,404-no basis for comparison (2 "W" values)
Total P	401,402,403-comparable with data set; 404-no basis for comparison ("W" value)
Boron	No results reported
Total N	No results reported
Acidity	No results reported

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4

Your Laboratory Code is: U091

Parameter	Comments
Conductivity	Satisfactory
(NO ₂ + NO ₃) N	Satisfactory
pH	Satisfactory
Hardness	No results submitted
Sodium	Satisfactory
Magnesium	Satisfactory
Sulphate	Satisfactory
Chloride	Satisfactory
Potassium	Satisfactory
Calcium	Satisfactory
Turbidity	402,403,404-comparable with data set; 401-no result reported
DOC	No results reported
TKN	Comparable with data set
Alkalinity	Comparable with data set
Colour	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
DIC	No results reported
Ammonia N	401,402,403-no basis for comparison; 404-comparable with data set
Fluoride	No basis for comparison (all "<" values)
Silica	401,402-comparable with data set; 403,404-no basis for comparison (2 "<" values)
Total P	401-comparable with data set; 402,403,404-no basis for comparison (3 "<" values)
Boron	No results reported
Total N	No results reported
Acidity	No results reported

LABORATORY APPRAISAL FOR UGLCC STUDY QM-4

Your Laboratory Code is: U013

Parameter	Comments
Conductivity	N.A.
(NO ₂ + NO ₃) N	Comparable with data set
pH	N.A.
Hardness	Comparable with data set
Sodium	N.A.
Magnesium	N.A.
Sulphate	N.A.
Chloride	401,402-outliers by Grubbs & Dixon; 403,404-comparable with data set
Potassium	N.A.
Calcium	N.A.
Turbidity	N.A.
DOC	N.A.
TKN	N.A.
Alkalinity	N.A.
Colour	N.A.
DIC	N.A.
Ammonia N	No basis for comparison (all "<" values)
Fluoride	N.A.
Silica	401,402-<" values; 403,404-no basis for comparison
Total P	402-no basis for comparison (<" value); 401,403,404-outliers by Grubbs & Dixon
Boron	N.A.
Total N	N.A.
Acidity	N.A.

NA - not analyzed

APPENDIX IV

LATE DATA SUBMITTED FOR

UGLCC INTERLABORATORY STUDY

QM-4

LATE DATA SUBMITTED BY LABORATORY U013

(Received on October 17, 1986)

	Sample (mg/l)				Detection Limit
	401	402	403	404	
nitrite + nitrate N	0.3	0.21	.02	.02	.01
ammonia N	<.005	<.005	<.005	<.005	.005
hardness	42	43	148	148	2
silica (SiO ₂)	<.02	<.02	2.60	2.59	.02
total phosphorus	3	<1	1	1	.5
chloride	.4	.4	102	103	Nd*

* Nd - not determined (all other parameters were Nd*)

Methodology

(NO₂ + NO₃)N - colorimetry, Cu-Cd reduction (azo dye)

Ammonia N - colorimetry, phenate

Hardness - colorimetry, EDTA chelate

Silica - colorimetry, molybdenum blue

Total P - colorimetry, phosphomolybdate blue

Chloride - colorimetry, ferric thiocyanate

CHANGES TO DATA SUBMITTED BY LABORATORY U013

(Received on December 2, 1986)

	Sample (mg/l)				Criterion of Detection
	401	402	403	404	
nitrite + nitrate N	0.3	0.21	T.02	T.02	0.2
ammonia N	W	W	W	W	0.1
hardness	42	43	148	148	30
silica (SiO ₂)	W	W	2.60	2.59	0.5
total phosphorus	T.003	W	T.001	T.001	.005
chloride	T.4	T.4	102	103	6

(all other parameters were Nd* = Not Determined)