INVESTIGATION OF PREDICTION TECHNIQUES FOR ACID MINE DRAINAGE

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INVESTIGATION OF PREDICTION TECHNIQUES FOR ACID MINE DRAINAGE

Final Report
by

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SUMMARY

A laboratory test program has been carried out to evaluate and compare methods to predict the formation of acid mine drainage (AMD) in mine wastes, to evaluate the reliability of the methods in predicting actual field behaviour at minesites, and to recommend prediction methods most suitable for laboratory and field use. Methods evaluated included static tests and kinetic tests. The following documented prediction procedures were studied:

B.C. Research Initial Test
Acid Base Accounting
Alkaline Production Potential : Sulphur Ratio Test
Hydrogen Peroxide Test for Pyrite Estimation
B.C Research Confirmation Test
Humidity Cell Test
Shake Flask Weathering Test
Soxhlet Extraction Test
Manometric Carbonate Pressure Analysis

In addition, three other tests, modified from the original procedure or developed during the study were evaluated :

Modified Acid Base Accounting
Net Acid Production Test
Modified Biological Confirmation Test

Evaluation of the above tests was carried out by performing each procedure on each of eight tailing samples and four waste rock samples from Canadian mines. This report presents all of the data produced in the evaluations and provides discussion on each method and its performance relative to the other tests of similar procedure and objective.

From the results of the study it is concluded that confident prediction of acid mine drainage is not likely to be achieved in a single test. Static tests are recommended for use for initial screening of samples, followed by some form of kinetic weathering test to confirm the initial prediction and to provide drainage quality and kinetic data. Several static and kinetic tests were shown to provide credible prediction of field AMD behaviour. Choice of method can be made on the basis of the comparison of simplicity, time required, equipment

required, cost, ease of interpretation and correlation with the field data. Results indicate that the mode of waste deposition in the field can also affect the choice of test used. Some tests were shown to be unrealistic in their methodology. In other cases, data obtained was believed to be unreliable or difficult to interpret.

Changes to established procedures have been suggested and recommended to facilitate performance and interpretation of certain existing test methods, and/or to improve the accuracy of AMD prediction. In addition, recommendations have been made for further research, development, and evaluation of existing and new methods to provide more reliable procedures and equipment for confident AMD prediction in the future.

RÉSUMÉ

Un programme d'essais a été exécuté en laboratoire afin d'évaluer et de comparer les méthodes de prévision du drainage minier acide (DMA) dans les déchets miniers, d'évaluer la fiabilité des méthodes de prévision de l'effet réel sur le terrain, dans des sites miniers, et de recommander les méthodes de prévision les plus pertinentes pour des applications en laboratoire et sur le terrain. Les méthodes évaluées comprennent les essais statiques et cinétiques. L'étude a porté sur les méthodes suivantes de prévision, lesquelles méthodes étaient étayées de documents :

- Essai initial de B.C. Research
- Détermination des acides-bases
- Essai d'établisement du ratio Soufre:Potentiel de production alcaline
- Essai au peroxyde d'hydrogène afin de déterminer la présence de pyrite
- Essai de confirmation de B.C. Research
- Essai de cellules humides
- Essai de désagrégation par agitation dans un récipient
- Essai d'extraction à l'aide d'un appareil Soxhlet
- Analyse de la pression manométrique des carbonates

De plus, trois autres essais modifiés par rapport à la méthode originale ou élaborée au cours de l'étude ont été évalués, notamment :

- La détermination modifiée des acides-bases
- L'essai de production nette d'acides
- L'essai modifié de confirmation biologique

L'évaluation des assais susmentionnés a été faite par l'application de chaque méthode à chacun des huit échantillons de stériles et des quatre échantillons de déchets de roche provenant de mines canadiennes. Ce rapport présente toutes les donnés obtenues des évaluations et examine chaque méthode et son efficacité en regard des autres essais de méthodes semblables et d'objectifs similaires.

Les résultats de l'etude permettent de conclure qu'il n'est guère probable p'obtenir d'un seul essai des prévisions fiables du drainage minier acide. Il est recommandé d'effecteur des essais statiques pour faire une première sélection des

énchantillons puis de réaliser une certaine forme d'essai cinétique de désegrégation afin de confirmer les premières prévisions et de produire des données qualitatives et cinétiques sur le drainage. L'expérience a montré que plusieurs essais cinétiques et statiques permettaient d'obtenir des prévision crédibles du comportement du DMA sur le terrain. La méthode à utiliser peut être choisie par comparaison de la simplicité, des délais nécessaires, de l'équipment exigé, des coûts à supporter, de la facilité d'interprétation et de la corrélation avec les données obtenues sur le terrain. Les résultats montrent que la méthode d'élimation des déchets sur le terrain peut également influer sur le choix de la méthode de prévision. Certains essais se sont révélés irréalistes quant à leur méthodologie. Dans d'autres cas, on était d'avis que les données obtenues n'étaient pas fiables ou qu'elles posaient des difficultés d'interprétation.

Des changements aux procédures établies ont été proposé ou recommandés afin d'améliorer l'efficacité de certaines méthodes existantes d'essais, de faciliter l'interprétation des données et d'améliorer la précision des prévisions du DMA ou les deux. De plus, des recommendations ont été formulées en vue de poursuivre la researche, le développement et l'évaluation des méthodes existantes ou nouvelles afin de fournir des méthodes et de l'équipement plus fiables permettant de faire des prévisions sûres du DMA au cours des années à venir.

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The authors of this report wish to acknowledge the assistance, advice and support of Keith Ferguson, Environment Canada, and Gordon Ritcey, CANMET, throughout the conception and performance of the study. We also wish to thank Frank Carrucio for useful discussions during the study, and those laboratories that participated in the work. Thanks are also due to Shelley Jaffe, Environmental Technician, Coastech Research, for her excellent technical support in carrying out many of the test procedures. Finally, the financial support of Energy, Mines and Resources, Canada, through Supply and Services, Canada, is also gratefully acknowledged.

INVESTIGATION OF PREDICTION TECHNIQUES FOR ACID MINE DRAINAGE

1.0 INTRODUCTION

1.1 Terms of Reference

Coastech Research Inc, North Vancouver, B.C., has been awarded a contract by the Supply and Services Canada to carry out an investigation to evaluate and compare the laboratory methods used to predict acid mine drainage. This report has been completed in accordance with the terms of DSS Contract Serial No. 23440-7-9178/01-SQ.

1.2 Background

The disposal of mining and mineral processing wastes can have a significant environmental impact. Acidity and associated heavy metal contamination in run-off and seepage water from waste rock and tailings containing the sulphide minerals pyrite and/or pyrrhotite is a common problem to mining operations throughout the world. Millions of dollars are spent annually in Canada alone for acid mine drainage (AMD) remediation. As yet, there are no means to provide certainty for the long term effectiveness in the reduction of contaminant levels so that mines can be safely abandoned after production ceases. Considerable research is ongoing nationally and internationally to find techniques to prevent or control acid generation.

For new mines and new developments in existing operations, it is necessary to characterize tailings and waste rock materials prior to production to predict if AMD will be generated. Accurate prediction would reduce environmental damage and costs to the industry by allowing the implementation of sound waste management practices to both prevent acid generation and to maximize containment and treatment if AMD cannot be avoided. Regulatory agencies are now requiring verification that waste materials have been characterized and that AMD control measures will be implemented before permits are issued.

Several AMD prediction techniques have been developed and are used in Canada and the United States by commercial laboratories, research organizations and regulatory authorities. In general, predictive techniques include static tests which examine the balance between acid producing and acid consuming materials, and kinetic tests which attempt to predict drainage quality over time. However, the relative effectiveness of the various techniques is unclear. Moreover, some techniques were developed for coal mines in the United States and might not be suitable for characterizing base metal mine wastes produced in Canada.

1.3 Scope of Project

The objectives of this project were as follows:

1) to investigate the advantages and disadvantages of current acid mine drainage prediction techniques on the basis of simplicity, resources required, ease of interpretation, value of data, cost, and time required,

2) to evaluate the reliability of prediction techniques in forecasting actual field behaviour by correlating the laboratory data obtained from the prediction technique evaluation with minesite drainage quality data,

3) to recommend prediction methods most suitable for particular wastes and tailings for both laboratory and field use.

The project involved the assessment of 11 prediction techniques, each technique being used on 4 waste rock and 8 tailings samples from Canadian metalliferous/base metal mines. The prediction techniques were evaluated in the Coastech laboratories and at other laboratories recognized for their expertise at carrying out a specific procedure. In addition, each mine supplying samples for the test program were asked to supply data on the samples and on the AMD status at the minesite.

2.0 EVALUATION OF AMD PREDICTION TECHNIQUES : METHODOLOGY

2.1 Prediction Procedures

Eleven AMD prediction techniques were evaluated. The literature reference and brief description of each technique follows. Further descriptions of each procedure as required to supplement or clarify the published method are given in Section 3.

Direct comparison of the published methods can sometimes be confusing as different units and definitions of terms are used. In presenting the results of each procedure evaluated in this study, the calculation and presentation of data has generally been done in accordance with the published or recommended method. Where considered necessary, data have also been calculated and presented using standard units so that comparison between methods is facilitated.

A standard convention adopted for comparison in this report is to express the potential for a sample to generate or consume acid in terms of **kg $CaCO_3$ equivalent per tonne** of waste or tailing. The difference between the acid production potential and the acid consumption (or neutralization) potential is expressed as the Net Neutralization Potential (Net NP) so that :

Net NP = Neutralization Potential - Acid Production Potential

In the standard convention, a positive value for the Net NP indicates that a sample is a net consumer of acid.

The neutralization potential (NP) is usually determined by determining the amount of standard acid consumed by a known weight of the sample and by calculating this amount on the basis of $CaCO_3$ equivalent.

The acid producing potential (AP) of a sample is usually calculated from the sulphur (or sulphide sulphur) content of the waste or tailing and expressed on the basis of calcium carbonate equivalent as follows :

$$AP = S\% \times 31.25 \text{ kg } CaCO_3 \text{ equiv./t}$$

2.1.1 B.C. Research Initial Test

Ref : Duncan and Bruynesteyn, 1979.

This test is static test which aims to provide a quantitative measure of the net acid production potential of a sample by comparing the maximum acid potential based on the stoichiometry of complete sulphur oxidation with the capacity of the sample to consume acid. The test uses direct sulphuric acid titration from the natural pH of a slurry containing the finely ground sample of waste rock or tailing at room temperature to an endpoint of pH 3.5 to determine the acid consumption for calculation of the neutralization potential. The pH of 3.5 is chosen as it is considered that this value represents the limit to biological oxidative activity. The NP value obtained by acid titration is compared with the theoretical AP, expressed in kg H_2SO_4/t, calculated from the total sulphur analysis to provide an "yes/no" assessment of the acid generating potential of the sample. The method usually reports only the final acid consumption to the endpoint pH. In this study, titration curves showing acid consumption as a function of time were also prepared.

2.1.2. Acid - Base Accounting

Ref: Sobek et al., 1978.

This is a static test similar in objective to the above procedure but which is based on the addition of excess hydrochloric acid, heating to ensure complete reaction, and titrating the unconsumed acid with sodium hydroxide to pH 7.0. Determination of the volume and normality of acid to be used in the digestion is based on a so-called fizz test in which the carbonate content of a sample is estimated by observing the intensity of the reaction between a small quantity of the sample and strong hydrochloric acid. Determination of the paste pH of each sample is also carried out.

The calculation of the acid producing potential in the referenced method is based on the total sulphur analysis. In this project, the net NP calculated using both total sulphur and sulphidic sulphur analyses were determined.

A modification of the Sobek et al method used routinely at Coastech was also evaluated for comparison. In this method, the hydrochloric acid digestion procedure is conducted for 24 hours at ambient temperature. AP is determined from the sulphide sulphur analysis.

2.1.3 Alkaline Production Potential : Sulphur Ratio

Ref: Caruccio et al., 1981.

The alkaline production potential (APP) value of a sample is determined by measuring the hydrochloric acid (20 mL of 0.1N) consumed by 500 mg of the finely ground sample (-23 um) in 2 hours at room temperature and comparing the consumption value with the acid consumption obtained for calcium carbonate standards. Acid consumption is determined by back titration of the excess acid to an endpoint of pH 5.0. APP is expressed as mg $CaCO_3$ per 500 mg of sample.

The originators of this technique use the APP values obtained for a number of samples from related geologic units and plot values against total sulphur contents to provide an APP : S ratio plot. By comparing the plot with simulated weathering tests such as humidity cells, a series of weathering charts can be generated which relate the chemical weathering characteristics of the samples to the APP:S ratios. For subsequent assessments, the APP:S ratio can be used to provide a rapid indication of the potential of a sample for acid production without the need for a more time-consuming weathering test. Since only one sample from each mine location was tested in this program, the APP:S ratios obtained do not provide a value of any particular significance.

2.1.4 Hydrogen Peroxide Test

Ref: Finkelman and Giffin, 1986.

The purpose of the hydrogen peroxide test is to determine the amount of pyrite in a sample by comparing the rate of the chemical oxidation reaction of the sample with hydrogen peroxide, by measuring the rate of change of pH of the samples in contact with the reagent, to a standard curve prepared by observing the rates of reaction of standards of known pyrite content.

In this study, the change of temperature during the reaction was also monitored and the results compared with the temperature profiles obtained for the pyrite standards.

2.1.5 Net Acid Production Test

Ref: Albright, 1987
Lutwick, 1988
Lawrence et al, 1988

This test was developed at Coastech for the program and was based on a concept referred to in the Albright reference and following discussions with G.D. Lutwick.

The method uses the addition of hydrogen peroxide to oxidize sulphides contained in the test sample. All or part of the acid generated by the oxidation is consumed by the alkaline constituents in the sample. The net acid remaining after reaction is determined by titration to pH 7.0 to provide a direct assessment of the net acid production potential of the sample expressed as kg $CaCO_3$ equivalent per tonne of sample. This value can be compared with the Net NP value from acid-base accounting.

2.1.6 B.C. Research Confirmation Test

Ref: Duncan and Bruynesteyn, 1979.

This test is a kinetic, biological oxidation test designed to determine if sulphide oxidizing bacteria can produce more acid from oxidation of pyrite in the sample than can be consumed by an equal quantity of the sample.

The test involves inoculating a pre-acidified (pH 2.0-2.4) pulp containing the test sample with an active culture of bacteria such as T. ferrooxidans. The pulp pH is monitored and the test is terminated when oxidation ceases as indicated by the attainment of a stable pH. An equivalent weight to the original sample is then added in two increments after 24 and 48 hours and the pH is measured 24 hours after each addition. If the pH is above 3.5 at either point, the sample is classified as a non-acid producer. If the final pH remains below 3.5 a potential for the generation of AMD is indicated. Typically, the test requires 3 to 4 weeks for completion.

2.1.7 Modified Confirmation Test

Ref : Lawrence and Sadeghnobari, 1986.

In addition to the tests carried out at B.C. Research, a similar procedure used routinely at Coastech was run on selected samples for comparison. This procedure differs from the B.C. Research test in that the weight of sample used is generally smaller and is dependent on the sulphide sulphur content. In addition, once reaction is complete and the additional sample has been added, if the pH is still below 3.5, then sodium hydroxide is added equivalent to the acid which was added initially to provide a suitable starting pH. This is done to remove the bias towards an acid generating classification that the initial acidification procedure provides. The classification of the sample is then made on the usual criteria of final pH. The sodium hydroxide addition is practiced since the initial acidification procedure can provide a bias towards an acid-generating classification. For some samples, the initial amount of acid to be added can be substantial and has been found to significantly affect the final predictive result.

2.1.8 Humidity Cell Test

Ref: Sobek et al., 1978.

The humidity cell test is a kinetic test which aims to model the processes of geochemical weathering of a mining waste material. A special apparatus is used to provide simple control over air, temperature and moisture, while allowing for the removal of oxidation products which are collected and monitored.

The test procedure comprises subjecting a bed of the sample in a humidity cell to alternating cycles of dry air (3 days), moist air (3 days), and leaching (1 day). The leachates are then analyzed for a number of parameters including pH, redox (mV), acidity, alkalinity, sulphate, conductivity, and dissolved metals by ICP. The test generally is run for 10 weeks although a longer time period might be required to establish the weathering characteristics of some samples.

The humidity cells used in this study provided dry and moist air flows across the top of the bed of sample, and during the leach step. The solution was poured onto the top of the bed and allowed to stand for 1 hour and then decanted off for analysis.

2.1.9 Shake Flasks Test

Ref: Halbert et al., 1983.

The shake flask test as referenced is a kinetic test with the same objectives as the humidity cell test. The tests are carried out by leaching the waste samples in water in Erlenmeyer flasks placed on a reciprocating shaker. In this project, 10 identically prepared flasks were set up for each sample and one flask was removed for analysis of the total leachate for each week of the test. Monitoring of the flasks and analysis of products was carried out in a similar manner to the humidity cell test.

In the original referenced procedure, a 3 factor x 2 level factorial design was used to determine the effect of temperature, initial pH, and the presence of bacteria on sulphate generation. In this study, only one test at room temperature was performed using 250 g sample (tailing as received, waste rock at -200 mesh) in 500 mL distilled water with no bacteria added.

2.1.10 Soxhlet Extraction Test

Ref: Singleton and Lavkulich, 1978
Sullivan and Sobek, 1982.

This kinetic test is designed to simulate geochemical weathering using Soxhlet apparatus. Two procedures were evaluated as referenced: one with the calibrated Singleton and Lavkulich soxhlet, using both acetic acid and distilled water as leachate, and one with a modification described by Sullivan and Sobek using distilled water. In the former method, the test sample is leached with hot acetic acid or water (70 ^{o}C). The modified method uses a different soxhlet arrangement so that the temperature of the leachate is reduced (25 ^{o}C).

2.1.11 Manometric Carbonate Pressure Analysis

Ref: Evangelou et al, 1895.

The presence of carbonates in a pyritic mine waste does not necessarily mean that these carbonates will be totally available to neutralize acidity generated from pyrite oxidation. The manometric carbonate technique attempts to determine the rates of reaction of carbonates present in a sample including calcite, dolomite and siderite. The technique measures the rates of dissolution of the carbonates in hydrochloric acid by measuring the pressure of CO_2 evolved and claims to be able to differentiate and quantify the three carbonate species. This allows the prediction of the effectiveness of the waste in neutralizing or controlling AMD.

2.2 Participating Laboratories

The test procedures described in Section 2.1 were carried out in the laboratories listed below.

B.C. Research Initial Test
B.C. Research Confirmation Test

Lab: B.C. Research, Vancouver, B.C.

Contact: Dr. R.O. McElroy

Soxhlet Extraction

Lab: Department of Soil Science, University of British Columbia, Vancouver, B.C.

Contact: Dr. L.M. Lavkulich

Manometric Carbonate Pressure Analysis

Lab: Department of Agronomy, University of Kentucky, Lexington, KY.

Contact: Dr. V.P. Evangelou

Acid-Base Account
Alkaline Production Potential : S Ratio
Hydrogen Peroxide
Net Acid Production
Modified Confirmation Test
Humidity Cells
Shake Flasks

Lab: Coastech Research, North Vancouver, B.C.

Contact: Dr. R.W. Lawrence

2.3 Samples and Sample Preparation

2 barrels containing samples of tailing and waste rock, and 1 bucket of tailings, shipped by CANMET, Ottawa, were received at Coastech on 28 January, 1988. Table 1 gives details of the individual samples received.

Tailing samples were air dried, thoroughly mixed, and riffle split into appropriate sized sub-samples for assay, mineralogical analysis, screen analysis, and provision of test material to participating laboratories.

Waste rock samples were cone crushed to minus 6 mm and riffle split to provide approximately 2 kg sub-samples. One sub-sample of each waste rock was wet ground for a short time in a laboratory rod mill to approximately 2 mm. The ground material was air dried and further riffle split to provide samples for humidity cell testing. A further sub-sample was rod milled to approximately 80 percent 200 mesh (Tyler), air dried and riffle split to provide samples for assay, screen analysis, and for the remaining prediction procedures at participating laboratories. A representative sub-sample of minus 6 mm material was submitted for mineralogical analysis.

The results of screen analyses for each tailing and waste rock sample are given in Table 2.

2.4 Sample and Test Product Analyses

Each tailing and waste rock sample was analyzed for sulphur species, multi-element, and mineralogy as follows:

Table 1. Tailing and Waste Rock Samples Received for AMD Prediction Tests

COMPANY / MINE	CODE	CANMET Date Rcvd.	CANMET Moisture (%)	COASTECH Weight (kg)
TAILING :		(1987)		
Curragh - Yukon	CUT	late Jun	2.4	30.0
Elliot Lake Quirke - Ont.	ELT	22 Jul	23.4	30.0
Equity Silver - B.C.	EST	18 Nov	22.1	30.0
Heath Steele - N.B.	HST	15 Dec	16.1	31.0
Key Lake - Sask.	KLT	21 Aug	44.5	36.0
Noranda Bell - B.C.	NBT	02 Nov	25.9	29.5
Waite Amulet -	WAT	20 Jul	9.5	27.0
Westmin - B.C.	WMT	02 Dec	25.8	31.0
WASTE ROCK :				
Curragh - Yukon	CUWR	late Jun	0.0	24.0
Equity Silver - B.C.	ESWR	18 Nov	0.0	24.0
Heath Steele - N.B.	HSWR	15 Dec	0.0	24.0
INCO - Ont.	INWR	10 Aug	0.0	24.0

Table 2. Screen Analyses for Tailing and Crushed Waste Rock Samples

SAMPLE	% MINUS 200 MESH	% MINUS 16 MESH *	% MINUS 16 MESH **
Tailing :			
WAT	40.5		
CUT	85.9		
HST	92.1		
WMT	98.5		
EST	65.3		
ELT	22.5		
NBT	61.0		
KLT	58.0		
Waste Rock :			
INWR		72.0	90.4
ESWR		51.0	76.0
CUWR		65.0	87.6
HSWR		55.0	72.8

* Waste rock samples for humidity cells
** Waste rock samples for remaining procedures

Total sulphur by Leco, sulphate sulphur by hydrochloric acid digestion/gravimetry, and sulphate + sulphide sulphur by nitric acid digestion were done in duplicate at Chemex Laboratories, North Vancouver, B.C.

Multi element analyses by inductively coupled argon plasma spectroscopy (ICP) of tailing and waste rock samples were carried out at Chemex Laboratories.

Microscopic examination of the test sample to provide approximate mineralogical composition by modal analysis, and a description of mineral occurrences and relationships, was performed by Vancouver Petrographics Ltd. (Dr. J.F. Harris), Fort Langley, B.C.

Leachates produced from humidity cell, shake flask and soxhlet extraction tests were analyzed for pH, redox (mV), conductivity, acidity/alkalinity, sulphate, and multi-element by ICP as follows:

For humidity cell and shake flask tests, pH, redox (mV SCE), conductivity, acidity/alkalinity, and sulphate were determined at Coastech Research using standard procedures (Standard Methods, 1981).

For soxhlet extraction tests, pH and conductivity were determined in the Department of Soil Science , University of British Columbia, Vancouver, B.C.

Multi-element analyses by ICP for leachates from humidity cells, shake flasks, and soxhlets were carried out by Analytical Services Laboratories Ltd. (ASL), Vancouver, B.C. Detection limits for the ICP analyses are shown in Appendix 1.

2.5 Head Assays and Mineralogy : Results

The results of the sulphur species analyses (mean of duplicate analyses) for the tailing and waste rock samples are given in Table 3. Assay certificates are provided in Appendix 1.

Multi-element ICP analysis certificates are also provided in Appendix 1.

Table 3. Sulphur Analyses for Tailing and Waste Rock Samples

SAMPLE	S(Total) (%)	S(Sulphate) (%)	S(Sulphide) (%)	S(other)* (%)
Tailing :				
CUT	24.95	0.14	24.21	0.60
ELT	3.79	0.22	3.28	0.29
EST	3.40	0.06	3.11	0.24
HST	39.90	1.04	38.05	0.81
KLT	4.68	4.21	0.39	0.08
NBT	2.99	0.04	2.59	0.36
WAT	13.00	0.24	12.74	0.03
WMT	22.90	0.36	22.13	0.41
Waste Rock :				
CUWR	8.66	0.03	8.19	0.44
ESWR	19.10	0.04	19.73	-0.67
HSWR	6.12	0.03	5.89	0.20
INWR	0.69	0.02	0.20	0.48

* S (other) may be baritic or elemental sulphur and is calculated from S(T) - S(SO4) - S(S=)

The mineralogical report by Vancouver Petrographics Ltd is provided in Appendix 2. The report includes a Summary and individual descriptions of each tailing and waste rock sample.

2.6 Field Data

Each mining company supplying tailing and waste rock samples for the test program were requested to supply information on the sample, its origin, AMD characteristics at site, and other pertinent information, for comparison with the prediction technique data obtained in the laboratory.

A copy of the letter and questionnaire sent to each participating company is provided in Appendix 12.

3.0 EVALUATION OF AMD PREDICTION TECHNIQUES : RESULTS

3.1 B.C. Research Initial Test

The results of the B.C. Research Initial Test acid titrations are provided in Appendix 3. A summary of the results, showing the acid consumption and theoretical acid-producing potentials calculated from the total sulphur analyses, is given in Table 4. Titration curves for the tailing and waste rock samples showing acid consumption (kg H_2SO_4/tonne) vs time are presented in Figures 1 and 2 respectively. Some of these graphs show that, for some samples, there was more than one stage of reaction, indicated by changes in the rate of acid consumption. This could suggest that some samples contain different types of alkaline components which consume acid at different rates.

All samples, with the exception of tailing sample NBT, were classified as potential acid producers by this test procedure. Samples NBT (acid producer) and INWR (acid consumer) were marginal in their classification, having net acid potential values very close to zero.

Table 4. B.C. Research Initial Test results

SAMPLE	INITIAL pH	PERCENT SULPHUR	ACID * POTENTIAL	ACID * CONSUMPTION	NET ACID * POTENTIAL	ACID PRODUCER ?
TAILING :						
CUT	4.5	24.95	763.5	26.4	737.1	YES
ELT	7.2	3.79	116.0	21.6	94.4	YES
EST	8.2	3.40	104.0	27.7	76.3	YES
HST	3.8	39.90	1220.9	3.4	1217.5	YES
KLT	8.8	4.68	143.2	98.5	44.7	YES
NBT	8.4	2.99	91.5	96.5	-5.0	NO
WAT	3.1	13.00	397.8	1.0	396.8	YES
WMT	5.8	22.90	700.7	22.3	678.4	YES
WASTE ROCK :						
CUWR	7.8	8.66	265.0	38.5	226.5	YES
ESWR	4.9	19.10	584.5	10.8	573.7	YES
HSWR	6.6	6.12	187.3	29.4	157.9	YES
INWR	7.3	0.69	21.1	13.9	7.2	YES

* Potentials and consumptions expressed in kg H_2SO_4 /tonne
Positive values indicate the potential for AMD

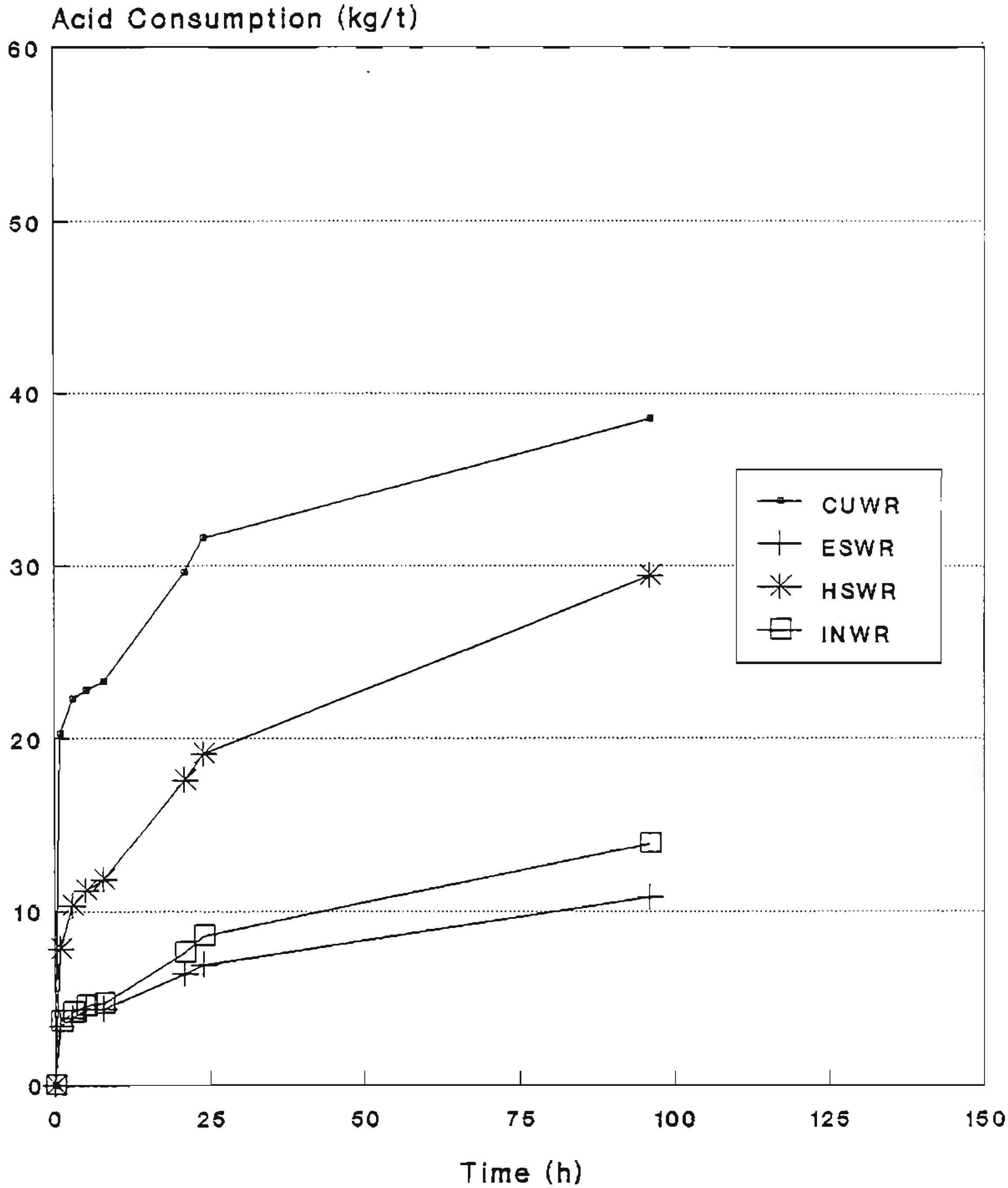


Fig.2 BC Research Initial Test
Acid Titration : Waste Rock Samples

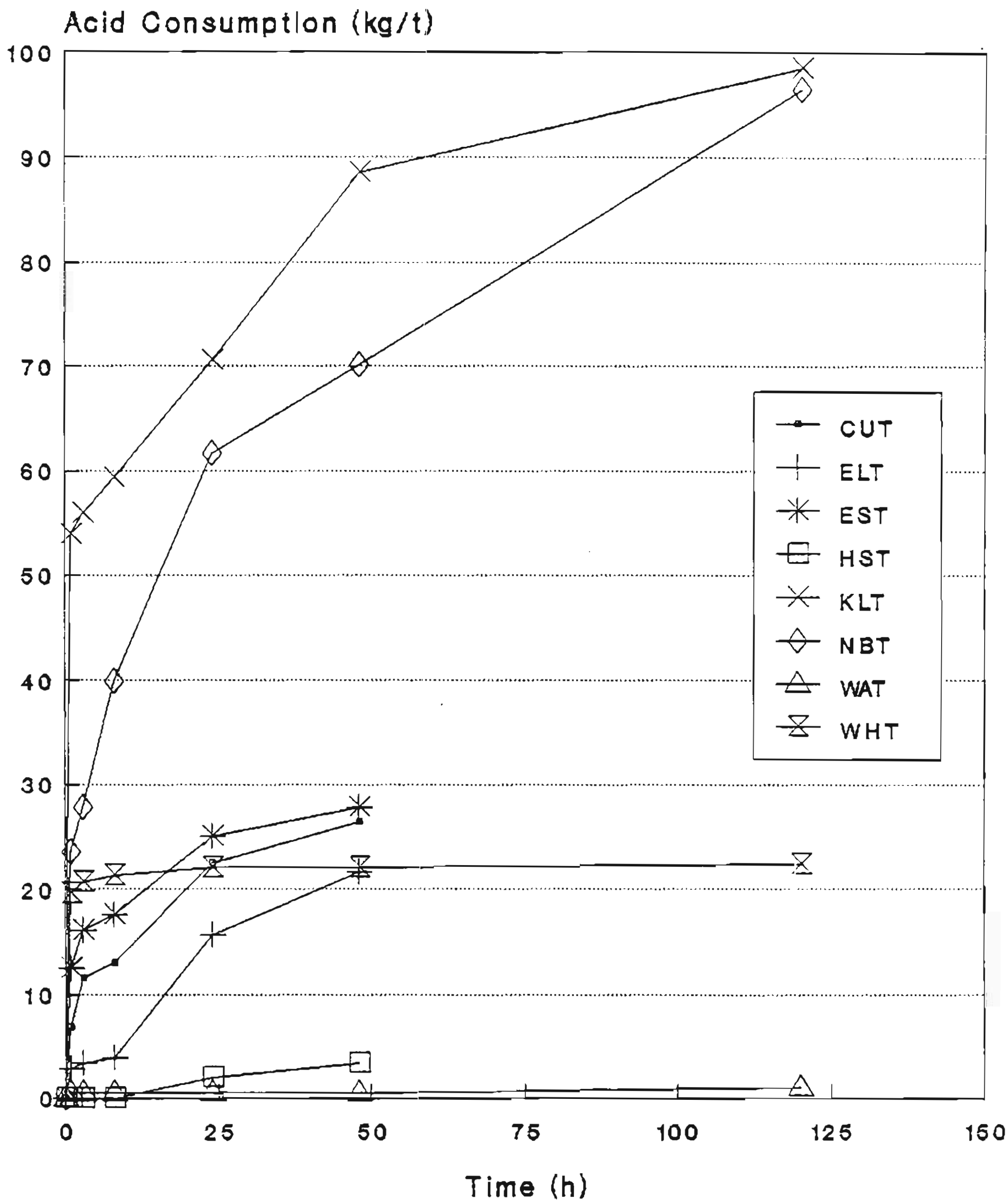


Fig. 1 BC Research Initial Test
Acid Titration : Tailing Samples

3.2 Acid - Base Accounting

Acid-Base Account testing was carried out in duplicate on all tailing and waste rock samples according to the standard procedure (hot digestion; total sulphur analysis). The results of these tests are given in Table 5.

Results of the neutralization potential and net NP values obtained for the standard procedure (Method A) are compared with values calculated using sulphide sulphur instead of total sulphur analyses (Method B) and with values obtained with modified procedures (Methods C and D) in Table 6.

In the modified procedures, the acid digestion was carried out at ambient temperatures for 24 hours on a reciprocating shaker on selected (3 tailing and 1 waste rock) samples. For Method C, the volume and strength of hydrochloric acid used was chosen on the same basis of the fizz test observation as in the standard procedure. In Method D, different volumes and strengths of acid were chosen.

The acid-base accounting test data for the four methods are provided in Appendix 4. This includes the back-titration data for which curves plotting neutralization potential values (calculated from the acid consumption data) as a function of pH are shown in Figures 3 - 5 for the standard procedure.

The standard procedure classified all samples of tailing and waste rock as potential acid producers. Samples NBT and INWR were marginal in their classification, having Net NP values close to zero. Using the standard procedure but calculating AP on the basis of sulphide sulphur analyses changed the classification of samples KLT, NBT and INWR to net acid consumers. For KLT, the change in Net NP was large due to the high sulphate sulphur content of the tailing.

The modified procedures, using an ambient temperature digestion, produced a tendency towards more positive Net NP values (more acid-consuming). This was unexpected as it shows a greater reactivity of the alkaline components at the lower temperature. It could be expected that the hot digestion can lead to the overestimation of NP by the measuring and equating poorly-neutralizing carbonates such as siderite or other rock types, marginally reactive with acid at ambient temperatures, with effective alkalinity-producers such as limestone or dolomite.

Table 5. Acid-Base Account test : standard procedure (in duplicate, A and B))

SAMPLE	PASTE pH	TOTAL SULPHUR (%)	ACID POTENTIAL (*)	NEUTRALIZATION POTENTIAL A (*)	NEUTRALIZATION POTENTIAL B (*)	NET NEUTRALIZATION POTENTIAL A (*)	NET NEUTRALIZATION POTENTIAL B (*)
TAILING :							
CUT	4.76	24.95	785.9	12.5	12.4	-773.4	-773.5
ELT	6.79	3.79	119.4	0.3	0.1	-119.1	-119.3
EST	7.68	3.40	107.1	53.2	24.5	-53.9	-82.6
HST	2.68	39.90	1256.9	-18.4	-18.8	-1275.3	-1275.7
KLT	8.50	4.68	147.4	51.5	50	-95.9	-97.4
NBT	7.34	2.99	94.2	87.4	87.9	-6.8	-6.3
WAT	2.92	13.00	409.5	1.1	-0.5	-408.4	-410.0
WMT	5.35	22.90	721.4	43.5	-3.9	-677.9	-725.2
WASTE ROCK :							
CUWR	7.16	8.66	272.8	100.9	93.4	-171.9	-179.4
ESWR	4.33	19.10	601.7	4.6	5.5	-597.1	-596.2
HSWR	5.85	6.12	192.8	13.5	14.3	-179.3	-178.5
INWR	7.05	0.69	21.7	14.0	12.8	-7.7	-8.9

* Potentials expressed in kg calcium carbonate equivalent per tonne of sample

Table 6. Acid-Base Accounting : comparison of neutralization potential (NP) and Net NP obtained by different methods

SAMPLE	STANDARD METHOD (A)		METHOD (B)		METHOD (C)		METHOD (D)	
	NP	NET NP	NP	NET NP	NP	NET NP	NP	NET NP
TAILING :								
CUT	12.5	-773.5	12.5	-750.2				
ELT	0.2	-119.0	0.2	-103.1	5.4	-97.9	7.4	-95.9
EST	38.9	-68.3	38.9	-59.0	75.0	-22.8	33.8	-64.0
HST	-18.6	-1275.5	-18.6	-1217.0				
KLT	50.8	-96.7	50.8	38.5				
NBT	87.7	-6.4	87.7	6.1	129.8	48.2	99.4	17.8
WAT	0.3	-409.2	0.3	-400.9				
WMT	19.8	-701.6	19.8	-677.3				
WASTE ROCK :								
CUWR	97.2	-175.6	97.2	-160.7	149.9	-107.9	117.0	-140.8
ESWR	5.1	-596.6	5.1	-616.4				
HSWR	13.9	-178.7	13.9	-171.6				
INWR	13.4	-8.5	13.4	7.3				

Note: NP and Net NP expressed in kg calcium carbonate equivalent per tonne of sample

Methods: A. Standard procedure (mean values of duplicates). Method uses total sulphur analyses
B. Standard procedure using sulphide sulphur to determine acid potential
C. Ambient temperature / 24 h acid digestion procedure (sulphide sulphur for acid potential)
D. As for method C, using different volumes of acid in digestion procedure

(volume and strengths of acid used in all methods given in Appendix 4)

Fig.3 Acid -Base Account Titrations
Tailing Samples CUT ELT HST WAT

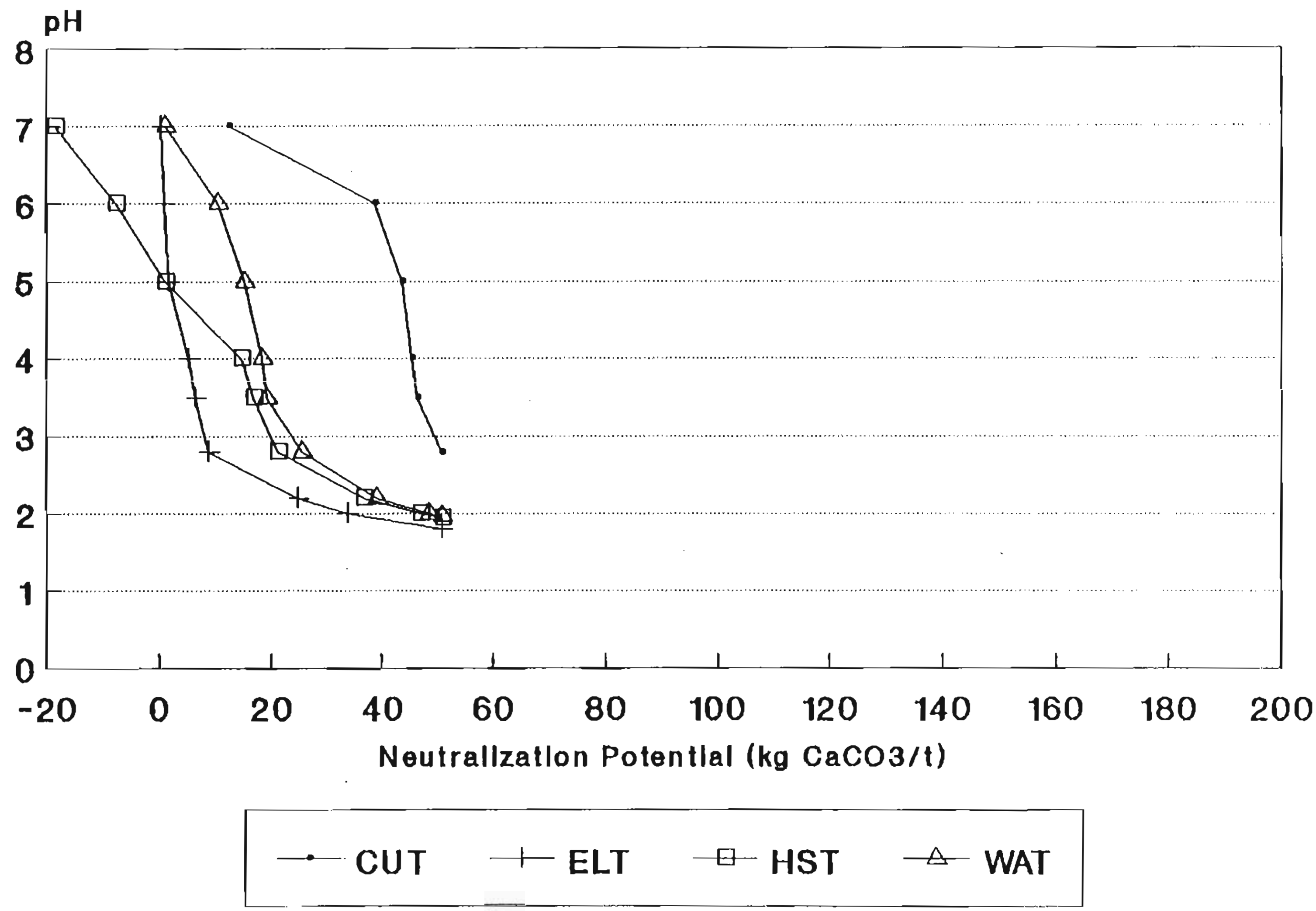


Fig 4. Acid -Base Account Titrations
Tailing Samples EST KLT NBT WMT

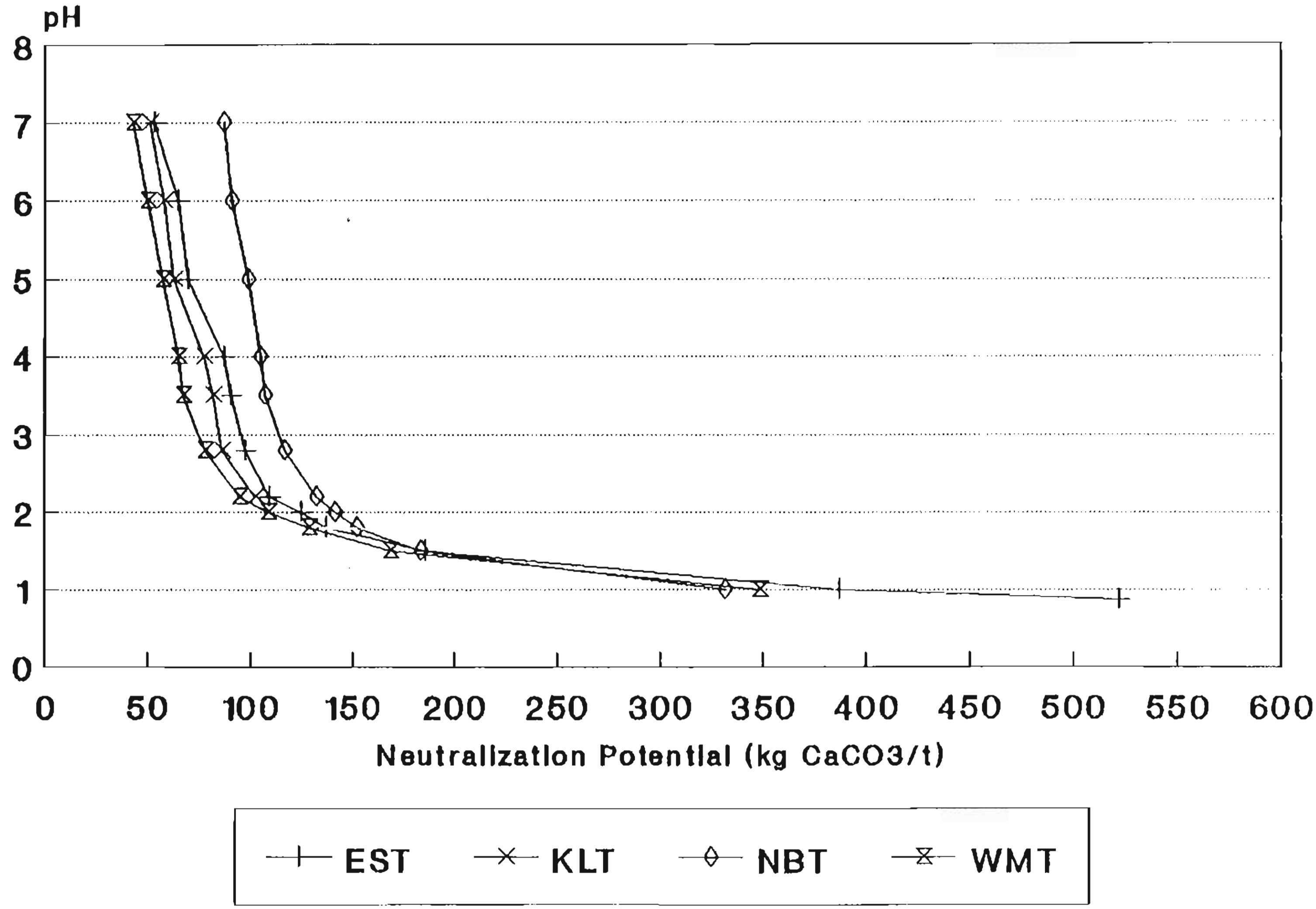
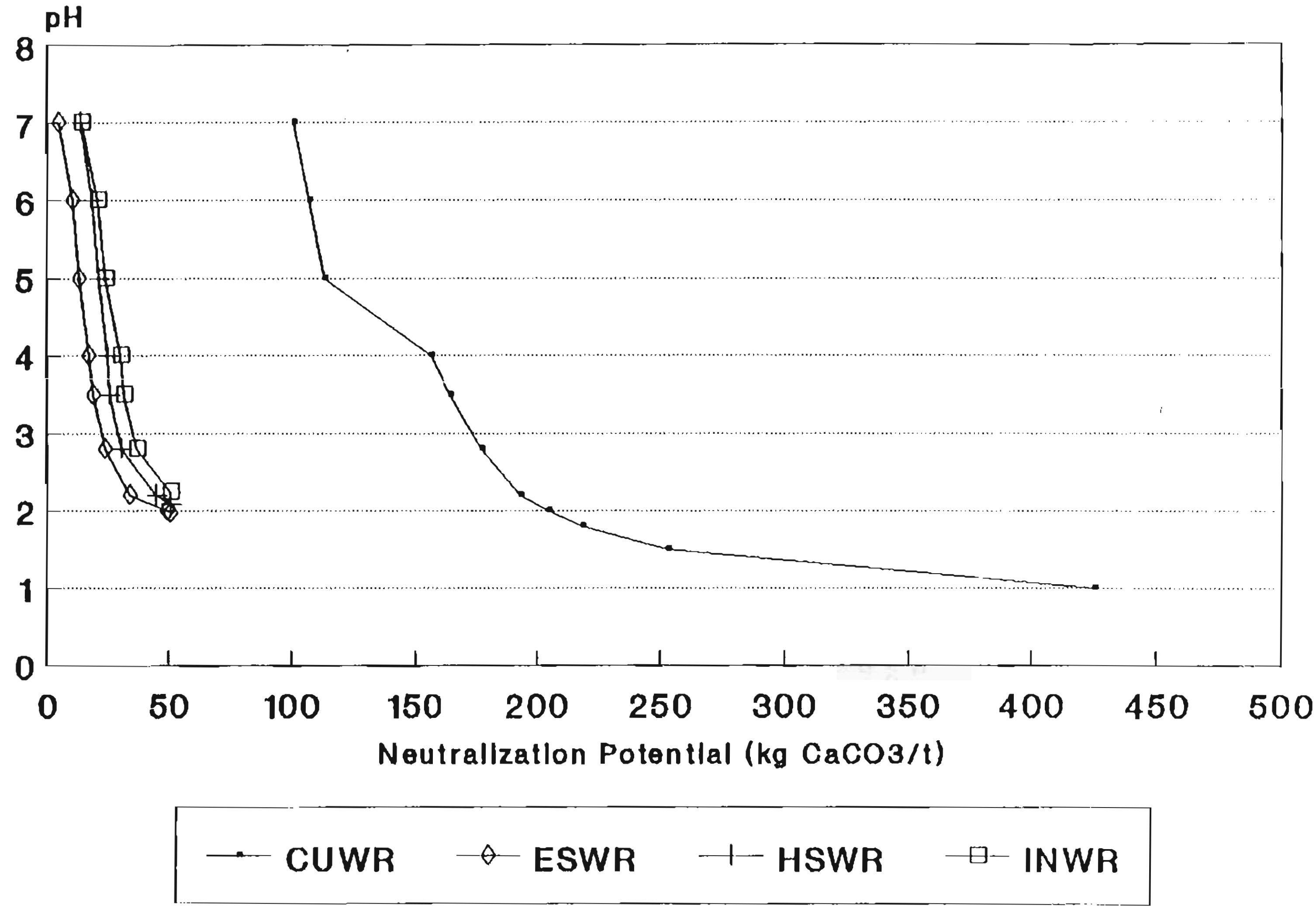


Fig 5. Acid -Base Account Titrations
Waste Rock Samples



3.3 Alkaline Production Potential : Sulphur Ratio

The results of the titrations to determine the amounts of hydrochloric acid consumed by known amounts of calcium carbonate standards and the calibration curve constructed from the data are provided in Appendix 5. The results of the acid consumption titrations for the tailing and waste rock samples are also provided in Appendix 5.

Using the calibration curve, the alkaline production potential (APP) of each sample was determined as mg $CaCO_3$ per 500 mg of sample. These values and the APP:S ratio values are shown in Table 7.

For comparison with the acid-base accounting data, the APP data is also shown on a kg $CaCO_3$ equivalent per tonne basis in Table 7, calculated from the titration data as in the acid-base accounting method. In general, NP values obtained from this digestion/titration procedure correlate well with the values obtained from the acid-base account method. Samples with higher NP values from acid base accounting tend to give lower values in the APP method due to the shorter retention time and the more dilute acid used. This would reduce reaction rates with the less reactive carbonate species.

Table 7. Alkaline Production Potential results

SAMPLE	APP (mg CaCO3 per 500 g)	APP : S RATIO *	NEUT. ** POTENTIAL (kg CaCO3/t)	NP FROM ACID BASE ACCOUNT
TAILING :				
CUT	3.4	0.14	10.1	12.5
ELT	0.4	0.11	2.5	0.2
EST	11.4	3.35	27.9	38.9
HST	<0.0	-	-4.5	-18.6
KLT	>25.0	>5.34	63.4	50.8
NBT	25.4	8.49	50.9	87.7
WAT	1.7	0.13	-0.1	0.3
WMT	7.9	0.34	22.7	19.8
WASTE ROCK :				
CUWR	10.0	1.15	26.8	97.2
ESWR	2.8	0.15	6.7	5.1
HSWR	4.9	0.80	15.7	13.9
INWR	4.0	5.80	12.6	13.4

* APP/S(T)%

** NP calculated from APP titration results for comparison with acid base accounting data

3.4 Hydrogen Peroxide Test

The results of the Hydrogen Peroxide Test are given in Appendix 6 which provides the data and calibration curves showing changes in temperature and pH for the reaction of 5 g pyrite standards (0 - 15 % by weight FeS_2) with 100 mL 30 % hydrogen peroxide, and corresponding data and reaction curves for the tailing and waste rock samples.

The rates of reaction of the tailing and waste rock samples and the calibration curves have been used to estimate the pyrite contents of the samples. These estimates are shown in Table 8, with comments, where necessary, qualifying the estimations. Also shown in Table 8 are the pyrite contents of the samples calculated from the sulphide assays (Table 3) assuming all sulphide sulphur is as pyrite, and NP data (from Table 5). Figure 6 shows an example of the pH and temperature curves obtained for the hydrogen peroxide reaction (for sample ESWR).

In general, the method appears to produce results too inaccurate and erratic to be of real use. The sensitivity of the estimations of pyrite content is very low, particularly because the time scale of the reaction of the unknown samples was often very different to that of the standards. The method also fails to take consideration of the alkaline component of the material (NP value) the reaction of which with products of oxidation will have a marked effect on the apparent rate of oxidation as evidenced by temperature rise or pH drop. The waste rock CUWR provides a good example of this shortcoming.

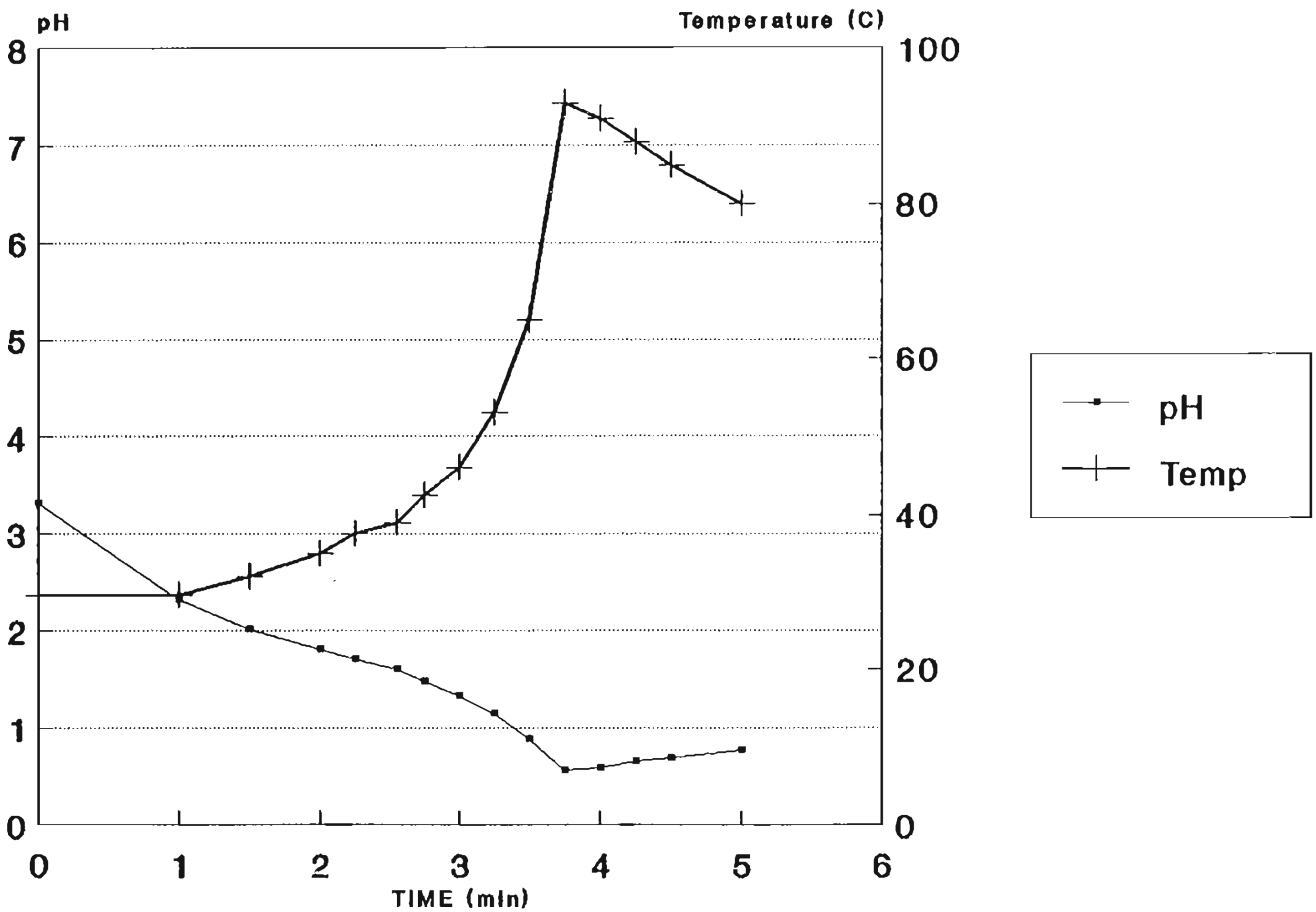
Table 8. Estimation of pyrite contents by Hydrogen Peroxide Test

SAMPLE	PYRITE CONTENT ESTIMATE TEMP.BASIS (%)	pH BASIS (%)	COMMENTS	PYRITE * (%)	NP ** (kg CaCO3/t)
TAILING :					
CUT	>15	>15	Reaction time much shorter than standard	48	12.5
ELT	0	0	pH rise	6	0.2
EST	1	0	pH rise	6	38.9
HST	>15	>15	Reaction time much shorter than standard	76	-18.6
KLT	0	1	pH rise	1	50.8
NBT	0	0	pH rise	5	87.7
WAT	>15	>15	Reaction time much shorter than standard	25	0.3
WMT	>15	>15	Reaction time much shorter than standard	44	19.8
WASTE ROCK :					
CUWR	?	?	Very slow reaction	16	97.2
ESWR	>15	>15		39	5.1
HSWR	10	10		12	13.9
INWR	?	?	Very slow reaction	1	13.4

* Pyrite content estimated from sulphide sulphur analyses

** NP from acid base account data

Fig 6. Example of reaction curves
for Hydrogen Peroxide Test (ESWR)



3.5 Net Acid Production

The Net Acid Production method developed for this study involved the addition of 100 mL of hydrogen peroxide (15%) to 5 g of each of the tailing and waste rock samples. After 1 hour following the apparent completion of the reaction, the pH of the pulp for each test material were measured and then titrated to pH 7.0 with standardized sodium hydroxide to determine the amount of excess acidity generated by the reaction. The method was repeated on selected samples, with the titration being carried out after only 5 minutes following the apparent completion of reaction.

The results of the titrations for both methods (A and B) are provided in Appendix 7. From the titration data, the net acid production was calculated for each sample as follows:

$$\text{NET AP} = \frac{50ab}{c}$$

where: NET AP = acid production potential, kg $CaCO_3$ equivalent per tonne
a = normality of base
b = volume of base, mL
c = weight sample

The net acid production values for each sample by Methods A and B are given in Table 9. There was good agreement between the results of both methods. For comparison with the net acid production values, the Net NP values obtained from acid-base accounting using sulphide sulphur analyses to calculate NET NP are also shown in Table 9. In general, the Net AP values provide a much lower indication of the potential for the production of AMD than the acid base account test, although the ratios between the corresponding values of the two tests show good correlation. The two tailing samples, KLT and NBT, which have positive NET NP values in acid base accounting, are shown to have zero NET AP values in the test in question.

Table 9. Net Acid Production Test results

SAMPLE	METHOD A * pH AFTER REACTION	METHOD A * NET ACID ** PRODUCTION	METHOD B * pH AFTER REACTION	METHOD B * NET ACID ** PRODUCTION	NET NP ***
TAILING :					
CUT	2.19	82.3	1.98	87.7	-750.2
ELT	2.16	20.6			-103.1
EST	4.54	7.2			-59.0
HST	2.08	69.2	2.03	67.4	-1217.0
KLT	7.56	0.0			38.5
NBT	7.13	0.0			6.1
WAT	2.14	41.2			-400.9
WMT	2.05	48.4			-677.3
WASTE ROCK :					
CUWR	2.76	9.6	2.79	9.6	-160.7
ESWR	1.87	84.9	1.89	84.6	-616.4
HSWR	2.45	7.3	2.41	17.0	-171.6
INWR	2.71	6.8	2.74	6.9	7.3

* Method A : titration performed 1 hour after reaction stops
Method B : titration performed 5 mins after reaction stops

** Net acid production expreseed in kg $CaCO_3$ equiv. per tonne

*** Net NP from Acid-Base Accounting (Table 6) using sulphide sulphur assays

Note : A positive NET AP value indicates potential for AMD, whereas for NET NP, a negative value is indicative of AMD potential

3.6 B.C. Research Confirmation Test

The results of the B.C. Research Confirmation Tests performed on the tailing and waste rock samples at B.C. Research are given in Table 10.

Samples ELT, KLT, and NBT were classified as non-acid producers, with final pH values higher than 3.5, although sample ELT was marginal with a final pH of 3.57. The B.C. Research Initial Test predicted only sample NBT to be a non-acid producer.

All other samples were classified as acid producers. With the exception of waste rock sample INWR, which had a final pH of 3.2, the samples giving a positive test result were strongly acid producing.

Table 10. B.C. Research Biological Confirmation Test results

SAMPLE	SAMPLE WEIGHT (g)	ACID ADDED (kg/t)	pH AFTER REACTION	pH 24 h *	pH 48 h **	ACID PRODUCER (?)
TAILING :						
CUT	8	32.3	1.05	1.18	1.28	YES
ELT	16	8.8	3.03	3.47	3.65	NO
EST	8	29.4	1.61	1.73	1.97	YES
HST	8	11.7	0.83	0.91	1.00	YES
KLT	16	76.4	2.69	4.35	-	NO
NBT	8	62.4	1.66	2.00	4.20	NO
WAT	8	7.3	1.30	1.35	1.50	YES
WMT	8	45.5	0.97	1.00	1.00	YES
WASTE ROCK :						
CUWR	8	38.9	1.41	1.53	1.64	YES
ESWR	8	13.2	1.14	1.23	1.18	YES
HSWR	8	44.8	1.37	1.66	1.47	YES
INWR	8	13.9	2.57	3.11	3.20	YES

* pH value after addition of 0.5 x original sample weight

** pH value after addition of 1.0 x original sample weight

3.7 Modified Confirmation Test

The results of the modified confirmation/biological oxidation tests (Coastech) performed on samples EST, KLT, NBT, WMT, and CUWR are shown in Table 11. The sample classifications derived from these tests were the same as for the B.C. Research tests, although the final pH values were generally higher due to the addition of the sodium hydroxide at the end of the test. For more marginal samples, a higher end pH could result in a change of classification from acid producing to non-acid producing.

The major criticism of this and the previous procedure is that the initial acidification procedure is not realistic, particularly for samples with moderate to high NP values. The buffering capacity of such samples is possibly sufficient to effectively inhibit any oxidative activity from starting or to prevent pH from falling to ranges where biological oxidative activity is really effective. Any sample shown by static tests such as acid-base accounting to be potential sources of AMD are almost certain to be confirmed as such by the B.C Research or the modified Confirmation Test method.

Table 11. Coastech Research Biological Oxidation Test results

SAMPLE	SAMPLE WEIGHT (g)	pH AFTER REACTION	pH AFTER SAMPLE*	pH AFTER NaOH **	ACID PRODUCER (?)
TAILING :					
EST	7	1.59	1.90	2.41	YES
KLT	7	1.85	4.41	-	NO
NBT	7	1.54	2.12	3.78	NO
WMT	4	0.95	1.17	1.29	YES
WASTE ROCK :					
CUWR	5	1.51	1.77	2.09	YES

* Original sample weight added in 2 increments over 48 h

** NaOH added equivalent to acid added to initiate biological oxidation

3.8 Humidity Cell Tests

The results of the Humidity Cell Tests are provided in Appendix 8 and comprise leachate analysis tables (pH, redox (mV), conductivity, sulphate, cumulative sulphate, acidity, and cumulative acidity); ICP metal analyses and cumulative metal extraction tables; and graphs of pH and redox, and cumulative sulphate and cumulative acidity, versus time).

A summary of the final values for pH, conductivity, cumulative sulphate, and cumulative acidity are shown in Table 12. Also shown are the sulphur assay and NP for each sample.

In general terms, the trends of pH and acidity, and of conductivity and sulphate, show close correlation. Similarly, there are generally good correlations between increase in acidity and increases in soluble metals (ICP data). For samples showing an increase in acidity, there is generally a rise in redox potential, although in no case do very high values (>450 mV) occur which would be indicative of strong microbiological activity (Fe-oxidizing bacteria).

The four samples showing zero acidity at the termination of the tests after 19 cycles (EST, KLT, NBT, and CUWR), are the samples with the highest NP values. For sample KLT, zero acidity is accompanied by high sulphate and conductivity values indicating that pyrite oxidation is taking place but that the acidity produced is neutralized by the calcareous content of the tailing sample. Minor oxidation is also indicated for sample NBT and to a lesser extent for samples EST and CUWR.

Four samples, ELT, WMT, HSWR, and INWR, indicate that oxidative activity was producing increasing acidity in the later stages of the tests, particularly for sample WMT. The four remaining samples, CUT, HST, WAT and ESWR produced acidity throughout the tests, albeit at varying rates.

Table 12. Humidity Cell Tests : final cycle leachate analyses

SAMPLE	HUMIDITY CELL ANALYSES (Final Cycle) pH	CONDUCTIVITY (mS/cm3)	CUM. SULPHATE ----(mg/100g)----	CUM. ACIDITY	(from Acid-Base Acc.) S(T) (%)	NP * (kg CaCO3/t)	COMMENTS
TAILING :							
CUT	3.1	1960	2043	1178	25.0	12.5	Moderate acidity produced throughout test
ELT	4.8	443	851	75	3.8	0.2	Minor acidity starting to appear during last cycles
EST	7.4	170	424	0	3.4	38.9	Sample able to neutralize very minor acid production
HST	2.7	2890	4785	17293	39.9	-18.6	Sample strongly acid producing from start of test
KLT	7.7	1395	3191	0	4.7	50.8	Sample able to neutralize strong acid production
NBT	7.4	426	414	0	3.0	87.7	Sample able to neutralize minor acid production
WAT	3.0	2200	2761	6127	13.0	0.3	Steadily acid producing throughout test
WMT	3.2	1334	1112	1892	22.9	19.8	Strong acidity starting to increase during last cycles
WASTE ROCK :							
CUWR	7.1	134	216	0	8.7	97.2	No acid production
ESWR	3.6	353	342	262	19.1	5.1	Low acidity produced throughout test
HSWR	5.8	468	391	8	6.1	13.9	Very minor acidity starting to increase during last cycles
INWR	5.2	233	289	18	0.7	13.4	Very minor acidity starting to increase during last cycles

* NP values from Table 6

3.9 Shake Flask Tests

The results of the Shake Flask Tests are presented in a similar format as for the humidity cell tests in Appendix 9 . The data comprise leachate analysis tables (pH, redox (mV), conductivity, sulphate, cumulative sulphate, acidity, and cumulative acidity); ICP metal analysis tables; and plots of pH, redox, and cumulative sulphate, cumulative acidity, versus time).

A summary of the final values for pH, conductivity, cumulative sulphate, and cumulative acidity are shown in Table 13. Also shown are the sulphur assay and NP for each sample.

In general terms, the values of the leachate parameters show very similar trends to those obtained in the humidity cell tests, although the data obtained from week to week often exhibits considerable deviation from the general trend for several of the parameters. This can be seen by comparing the graphs in Appendices 8 and 9. In most cases, values of cumulative acidity are lower than for the humidity cell tests, although cumulative sulphate values are similar or higher.

Table 13. Shake Flask Tests : final leachate analyses

SAMPLE	SHAKE FLASK ANALYSES (Final Leachates) pH	CONDUCTIVITY (mS/cm3)	CUM. SULPHATE -----(mg/100g)----	CUM. ACIDITY	(from Acid-Base Acc.) S(T) (%)	NP * (kg CaCO3/t)	COMMENTS
TAILING :							
CUT	2.5	12020	4950	1313	25.0	12.5	Acid producing, particularly towards end of test
ELT	4.9	2200	555	3	3.8	0.2	Very little acid production activity
EST	7.5	1828	420	0	3.4	38.9	Sample able to neutralize very minor acid production
HST	2.1	19430	7800	4126	39.9	-18.6	Sample strongly acid producing
KLT	7.1	2370	600	0	4.7	50.8	Sample able to neutralize very minor acid production
NBT	7.5	1505	315	0	3.0	87.7	No acid production
WAT	2.8	8080	2700	1094	13.0	0.3	Moderately acid producing throughout test
WMT	2.5	8760	3750	1200	22.9	19.8	Moderately acid producing throughout test
WASTE ROCK :							
CUWR	7.0	1417	375	0	8.7	97.2	Sample able to neutralize very minor acid production
ESWR	3.2	3140	750	540	19.1	5.1	Low acidity produced throughout test
HSWR	5.8	2940	600	2	6.1	13.9	Sample able to neutralize very minor acid production
INWR	6.4	1187	330	1	0.7	13.4	Sample able to neutralize very minor acid production

* NP values from Table 6

3.10 Soxhlet Extraction Tests

The report by L.M. Lavkulich and W. Price, Dept. of Soil Science, UBC, is provided in Appendix 10 and gives the results of the Soxhlet Extraction Tests. The results are summarized in Tables 14 (tailings) and 15 (waste rock) which show leachate analyses (pH and conductivity) for the three methods evaluated.

In general terms, the results of the tests using distilled water correlate reasonably well with the humidity cell and shake flask tests. For tailings, the three samples showing zero acidity in humidity cell tests (EST, KLT, NBT) are the only samples for which pH values did not fall in the soxhlet tests. For the other tailing samples, the drop in pH was not so rapid in the Singleton and Sobek method (lower temperature). The tests on waste rock show similar correlations with the other kinetic methods.

Tests using acetic acid all produced low pH endpoints. The interpretation of this test procedure is less certain.

Table 14. Soxhlet Extraction Tests : Summary of Results for Tailing

Method :		SINGLETON AND LAVKULICH 1978		SINGLETON AND LAVKULICH 1978		SULLIVAN AND SOBEK 1982	
Leachate :		ACETIC ACID		DISTILLED WATER		DISTILLED WATER	
SAMPLE	WEEK	pH	CONDUCTIVITY (mS/cm3)	pH	CONDUCTIVITY (mS/cm3)	pH	CONDUCTIVITY (mS/cm3)
CUT	1	4.7	-	3.1	4000	2.4	1800
	2	3.4	4800	2.2	3300	2.3	2500
	3	2.8	4200	1.7	4600	2.4	2900
ELT	1	3.0	2700	8.5	1900	8.7	1500
	2	2.5	1200	3.2	300	8.5	100
	3	2.2	1300	2.3	800	4.3	100
EST	1	4.0	7800	9.3	2300	9.5	1600
	2	3.2	2000	9.4	900	9.3	600
	3	3.0	2700	8.7	1000	9.3	500
HST	1	2.9	4000	1.8	12800	2.0	13500
	2	2.4	3300	1.8	7000	1.9	5800
	3	1.9	5000	1.6	7600	1.9	6600
KLT	1	4.3	13400	9.2	3000	9.3	3000
	2	3.0	3200	9.2	800	9.2	1800
	3	2.7	2800	9.4	600	9.4	500
NBT	1	4.4	12700	9.3	2000	8.8	2100
	2	2.9	1800	9.4	900	9.4	600
	3	2.5	1900	9.2	900	9.0	600
WAT	1	3.9	8000	3.2	4400	2.1	7200
	2	3.6	5500	3.2	1600	2.1	3000
	3	3.3	5200	2.5	2100	2.3	3000
WMT	1	3.7	6400	4.0	2800	6.6	3000
	2	2.4	2600	2.0	4200	3.9	1300
	3	2.1	3500	1.6	5000	2.5	1800

Table 15. Soxhlet Extraction Tests : Summary of Results for Waste Rock

Method :		SINGLETON AND LAVKULICH 1978		SINGLETON AND LAVKULICH 1978		SULLIVAN AND SOBEK 1982	
Leachate :		ACETIC ACID		DISTILLED WATER		DISTILLED WATER	
SAMPLE	WEEK	pH	CONDUCTIVITY (mS/cm3)	pH	CONDUCTIVITY (mS/cm3)	pH	CONDUCTIVITY (mS/cm3)
CUWR	1	4.4	11800	9.2	1700	9.4	2000
	2	3.4	3500	9.3	800	9.4	800
	3	3.2	4200	9.3	900	9.1	900
ESWR	1	3.7	6100	2.5	3200	2.5	3400
	2	3.2	2900	2.5	3100	2.4	1800
	3	2.9	3400	2.0	3200	2.3	2400
HSWR	1	4.0	7200	9.2	2600	9.2	600
	2	3.4	3000	7.2	1000	8.9	700
	3	3.2	3400	4.0	2100	8.6	600
INWR	1	4.0	7900	9.1	1400	9.1	1100
	2	3.4	3300	5.5	1700	8.4	300
	3	3.3	4700	4.5	500	6.2	500

3.11 Carbonate Pressure Analysis

The report giving the results of the Carbonate Pressure Analysis tests conducted by Dr. V.P. Evangelou, University of Kentucky, are provided in Appendix 11.

A summary of the results, showing the proportions of the calcareous material in the tailing and waste rock samples which are identified as having reactivities approximately equivalent to calcite, dolomite, and siderite, is given in Table 16. The NP values for the samples are also given for comparison.

Results are inconclusive in establishing the reliability of this technique. Correlation of the totals of $CaCO_3$ equivalent for each sample with NP values are only marginal. Similarly, there does not seem to be much correlation between the test data and other test data such as the acid consumption curves for the B.C. Research Initial Test.

Table 16. Carbonate Pressure Analysis : summary of results

SAMPLE	COMPOSITION IN kg/t CaCO3 EQUIVALENTS			NP *
	CALCITE	DOLOMITE	SIDERITE	
TAILING :				
CUT	0.0	25.9	82.0	12.5
ELT	0.0	0.0	0.0	0.2
EST	20.1	0.0	0.0	38.9
HST	0.0	2.3	0.0	-18.6
KLT	3.9	0.0	0.0	50.8
NBT	43.5	26.0	0.0	87.7
WAT	0.0	0.0	0.0	0.3
WMT	15.5	0.0	0.0	19.8
WASTE ROCK :				
CUWR	17.5	0.0	35.0	97.2
ESWR	2.1	0.0	1.6	5.1
HSWR	0.0	32.0	0.0	13.9
INWR	3.6	0.0	0.0	13.4

* NP values (kg CaCO3/t) from Table 6

4.0 FIELD DATA

In order to obtain information on the field behaviour of the tailing and waste rock samples used in the laboratory test programs, a questionnaire was sent to each of the nine operating mines which had supplied the samples. A copy of the questionnaire and details on individual replies received are provided in Appendix 12.

Table 17 summarizes the more important aspects of the replies received. Although more than half of the tailing or waste rock samples were generating significant AMD in the field, some only did so after significant lag times as indicated.

Table 17. Summary of Field Behaviours of Tailing and Waste Rock Samples Selected for AMD Prediction Tests

SAMPLE	CODE	SAMPLE DESCRIPTION	LIME ADDED	FRESH/ OLD	PRODUCING AMD
TAILING :					
Curragh	CUT	Tail discharge line	No	Fresh	Yes - after 15 years
Elliot Lake Quirke	ELT				
Equity Silver	EST	Pond-beach surface	No	Fresh	No
Heath Steele	HST	Pond-beach surface	Yes	Old	Yes
Key Lake	KLT	Tail discharge line	No	Fresh	No
Noranda Bell	NBT	Tail discharge line	No	Fresh	No
Waite Amulet	WAT	Pond-above water	Yes	Old	Yes
Westmin	WMT	Pond-beach surface	No	Fresh	Yes - after > 1 year
WASTE ROCK :					
Curragh	CUWR	Waste pile surface	No	1 year	Yes - high Zn, SO4. neut. pH
Equity Silver	ESWR	Main zone pit	No	Fresh	Yes - after 6 months
Heath Steele	HSWR	Waste pile surface	No	Old	?
INCO	INWR	Waste pile surface	Yes	Fresh	Yes

5.0 COMPARISON OF PREDICTION TECHNIQUES

5.1 Static Methods

A summary of the results of the static test procedures for the prediction of AMD is given in Table 18. For each static test procedure, a simple yes AMD/no AMD classification is given based on whether the value of the Net NP value derived from the test data is positive or negative. These classifications can be compared with the data obtained from the field survey which are also simply given in Table 18 as "yes or no". The principal observations for each method are as follows:

Acid Base Accounting : all tailing and waste rock samples were predicted to be potential sources of AMD. Three of the tailing samples, EST, KLT, and NBT, were not generating acid in the field. Both EST and KLT gave large negative NET NP values in the test. Samples NBT and INWR were barely acidic with NET NP values of -6.3 and -8.9 kg $CaCO_3$/t respectively. The Sobek et al method recommends that acid generation is indicated if the NET NP is < -5 kg $CaCO_3$/t. The end point of pH 7.0 as specified is not very stable. An endpoint of pH 8.3 is recommended for this and other tests using back titration of excess acid.

Modified Acid Base Accounting : this test, in which AP is calculated based on sulphide sulphur analysis, predicted tailing samples KLT and NBT as non - acid producing, as is the case in the field. One waste rock sample (INWR) was predicted to be non-acid generating (marginal) although AMD in the field was noted. For sample KLT, the value of using sulphide sulphur analysis is very evident since 90% of the total sulphur is present as gypsum formed in the acid leach process at Key Lake. Thus the assessment made by the standard procedure is clearly unrealistic. However, in other cases, the presence of sulphate in a sample is the result of oxidative processes, often in very reactive tailing or waste rock. In such cases, use of the modified procedure calculation could lead to an error and a bias towards a non-acid generating classification. Differentiation between the sulphur species in a sample should be carried out. For some samples, particularly coal, non AMD forming organic sulphur can exist and should be differentiated.

BC Research Initial Test : two tailing samples, EST and KLT, were given AMD classifications opposite to that observed in the field. The erroneous classification of sample KLT as a potential source of AMD was again the result of using total

Table 18. Summary of the Results of Static Prediction Procedures

SAMPLE	ACID BASE ACCOUNT		MODIFIED * ACID BASE ACCOUNT		BC RESEARCH INITIAL TEST		ALKALINE PRODUCTION POTENTIAL **		NET ACID PRODUCTION		FIELD
	NET NP	AMD ?	NET NP	AMD ?	NET NP	AMD ?	NET NP	AMD ?	NET NP	AMD ?	AMD ?
Tailing:											
CUT	-773.5	Yes	-750.2	Yes	-737.1	Yes	-775.8	Yes	-82.3	Yes	Yes
ELT	-119.0	Yes	-103.1	Yes	-94.4	Yes	-94.4	Yes	-20.6	Yes	Yes
EST	-68.3	Yes	-59.0	Yes	-76.3	Yes	-79.2	Yes	-7.2	Yes	No
HST	-1275.5	Yes	-1217.0	Yes	-1217.5	Yes	-1261.4	Yes	-69.2	Yes	Yes
KLT	-96.7	Yes	38.5	No	-44.7	Yes	-84.0	Yes	0.0	No	No
NBT	-6.4	Yes	6.1	No	5.0	No	-43.3	Yes	0.0	No	No
WAT	-409.2	Yes	-400.9	Yes	-396.8	Yes	-409.6	Yes	-41.2	Yes	Yes
WMT	-701.6	Yes	-677.3	Yes	-678.4	Yes	-698.6	Yes	-48.4	Yes	Yes
Waste Rock:											
CUWR	-175.6	Yes	-160.7	Yes	-226.5	Yes	-246.0	Yes	-9.6	Yes	Yes
ESWR	-596.6	Yes	-616.4	Yes	-573.7	Yes	-595.0	Yes	-84.9	Yes	Yes
HSWR	-178.7	Yes	-171.6	Yes	-157.9	Yes	-177.1	Yes	-7.3	Yes	Yes
INWR	-8.5	Yes	7.3	No	-7.2	Yes	-9.1	Yes	-6.8	Yes	Yes

Note: NET NP values all expressed as positive to designate an acid consuming material or negative to indicate the potential for acid generation

* Modified procedure uses ambient temperature/24 h digestion and sulphide sulphur analysis

** Net NP values for the APP test calculated as for the standard Acid Base Account test using titration data and total sulphur assays sulphur analysis for the calculation of AP. Net NP values obtained using this sulphuric acid titration were very similar to those obtained using the hydrochloric acid digestion method of the Acid Base Account. The BC Research method is more time consuming and requires slightly more sophisticated equipment than the latter method. On the other hand, the method might not titrate carbonates such as siderite which should not be counted in the acid-base balance since it is not an effective neutralizer.

Alkaline Production Potential : values of NET NP derived from this less severe and shorter acid digestion procedure were similar to those obtained by Acid Base Accounting, although in some cases, NP values were significantly lower indicating only partial reaction of the contained carbonates. All samples were classified as potential sources of AMD. The APP : S ratio values are of little use in this study without the comparison with kinetic weathering charts on multiple samples from the same geologic units. Such a comparison might only really be viable for lower sulphur values, such as found in the wastes of coal mines for which the test was originally developed.

Net Acid Production Test : This test correctly predicted all tailing and waste rock relative to the current field data with the exception of one tailing sample (EST) which all other static tests also incorrectly assessed. For this sample, only weak NET AP was predicted unlike the high values obtained in the other tests. In the field, no AMD was reported. An advantage of this procedure is that sulphur assays are not required. This reduces the cost and time required for the test and makes it suitable for field use. Further development of this method to increase the data base should be carried out on a wider selection of waste materials.

Other Static Tests : The Hydrogen Peroxide Test did not provide a realistic assessment of the pyrite contents of the test samples. The determination lacks sensitivity, mainly due to the difficulty in using the calibration/standard curves with the test data. The effect of the alkaline components of the samples on the direction and rates of reaction is also neglected. The results appear to be too inaccurate to be of real use.

The Carbonate Pressure Analysis method used to characterize the potential rate of reactions of the alkaline components of a sample did not provide conclusive evidence of reliability in predicting the effectiveness of alkalinity production from a sample. The test procedure is considered to have potential as a supplemental test to be used with other static tests or to aid in the interpretation of kinetic test data.

5.2 Kinetic Methods

A summary of the results of the kinetic test procedures for the prediction of AMD is given in Table 19. Field observations are also included in the table. The principal observations for each method are as follows:

BC Research Confirmation Test : with the exception of tailing samples ELT and EST, the method identified all field AMD. It is believed that the initial acidification of samples makes some results unrealistic. The modified procedure which compensates for the initial acid addition is seen to provide a moderate improvement, although the opportunity to study the potential for the development of AMD in the higher pH ranges is still not possible. For some samples, the reactions taking place in the approximate pH range 7 down to 2 might be critical in determining the formation of AMD.

Humidity Cells Test : The humidity cell correctly predicted field results on all 8 tailing samples and 3 out of 4 waste rock samples. The one incorrectly classified waste rock sample was shown not to generate AMD when it did (rarely) in the field. The test seems particularly well suited to the evaluation of waste materials, particularly waste rock, which are deposited on a land site where they would be alternately subjected to infiltration of water, drying and flushing sequences.

Shake Flask Test : The shake flask test correctly predicted the behaviour of all 8 tailing samples, but was incorrect for 3 out of 4 waste rock samples which were shown not to generate AMD when they did in the field. The good prediction for tailing could be expected from this test which has a constant leaching action and might better model the behaviour of tailings which are often saturated and have low oxygen permeability. For the same reason, the test might not be well suited for waste rock which would be more likely to be

Table 19. Summary of the Results of Kinetic Prediction Procedures

SAMPLE	BC RESEARCH CONFIRMATION TEST AMD ?	HUMIDITY CELLS AMD ?	SHAKE FLASKS AMD ?	SOXHLET EXTRACTION * AMD ?	FIELD AMD ?
Tailing:					
CUT	Yes, strong	Yes, moderate	Yes, at end of test	Yes, strong	Yes, after 15 years
ELT	No, v. marginal	Minor at end of test	Very low activity	Yes	Yes
EST	Yes, strong	No	No	No	No
HST	Yes, strong	Yes, strong	Yes, strong	Yes, strong	Yes
KLT	No	No	No	No	No
NBT	No	No	No	No	No
WAT	Yes, strong	Yes	Yes, moderate	Yes, strong	Yes
WMT	Yes, strong	Strong at end of test	Yes, moderate	Yes	Yes, after 1 year
Waste Rock:					
CUWR	Yes, strong	No	No	No	Yes, high Zn, SO4
ESWR	Yes, strong	Very low production	Low production	Yes, strong	Yes, after 6 months
HSWR	Yes, strong	V.minor at end of test	Extremely low activity	Yes, low production	Yes
INWR	Yes, marginal	V.minor at end of test	Extremely low activity	Yes, low production	Yes

* Soxhlet extraction tests using water

subjected to alternate wetting, drying and flushing cycles as modelled by humidity cells.

Soxhlet Extraction Tests : although this test procedure is seen to be less realistic than some other weathering tests such as humidity cells, the method (using water) was successful in predicting the field behaviour of all 8 tailing samples and 3 out of 4 of the waste rock samples. The method using acetic acid predicted all samples to be sources of AMD and it is believed that the results of this procedure is unrealistic.
The method has the disadvantage of being more complex than the humidity cell or shake flask tests and requires more sophistication in equipment. However, the test is of shorter duration and might be able to simulate a long weathering sequence in a relatively rapid time.

5.3 Overall Comparison

Table 20 provides an overview of the various static and kinetic test procedures for the prediction of AMD evaluated in this study on the basis of simplicity, time required, special equipment, cost, ease of interpretation, and correlation with the field data.

Table 20. Comparison of AMD Prediction Procedures

PREDICTION PROCEDURE	SIMPLICITY OF TEST	TIME REQUIRED	SPECIAL EQUIPMENT	$ COST PER SAMPLE	EASE OF INTERPRETATION	CORRELATION WITH FIELD DATA
STATIC TESTS :						
BC Research Initial Test	Yes	2 days *	No	75 - 200	Easy	1 tailing sample in error
Acid - Base Accounting	Yes	4 h *	No	50 - 130	Easy	3 tailing samples in error
Mod. Acid-Base Account	Yes	1 day *	No	50 - 130	Easy	1 tailing and 1 waste rock in error
APP : S Ratio Test	Yes	4 h *	No	50 - 130	Moderate	3 tailing samples in error
Net Acid Production Test	Yes	4 h	No	40 - 80	Easy	1 tailing sample in error
KINETIC TESTS :						
BC Research Confirmation	Moderate	3-4 weeks	Moderate	200 - 400	Moderate	2 tailing samples in error
Humidity Cell Test	Moderate	10+ weeks	Moderate	500 -1000	Moderate	1 waste rock sample in error
Shake Flask Test	Moderate	10+ weeks	Moderate	500 -1000	Moderate	Poor prediction for waste rock
Soxhlet Extraction Test	Moderate	3+ weeks	Yes	250 - 500	Moderate	1 waste rock sample in error
OTHER TESTS						
Hydrogen Peroxide Test	Yes	4 h *	No	80 - 120	Moderate	Poor estimate of pyrite content
Carbonate Pressure	No	4 h	Specialized	?	Specialized	Estimates of carbonate species inconclusive

Notes to Table :

1. In the Simplicity catagory, rating assumes test carried out by a trained laboratory technician or technologist

2. In the Time Required catagory, for tests marked with *, time should be allowed for sulphur assay turnaround

3. In the Special Equipment catagory, rating assumes test carried out in a normally equipped chemical laboratory

4. In the Cost category, costs will vary from lab to lab, will depend on number of samples tested at same time, and on the number and cost of the sulphur species assays required. For kinetic tests, costs are based on a weekly sampling regime. Actual costs will depend on the number of and frequency leachate analyses performed including ICP multi-element analyses. Costs are estimates in $ Cdn as of March 1989.

6.0 CONCLUSIONS AND RECOMMENDATIONS

The results of this study support the following conclusions and recommendations:

1. This study shows that several of the static and/or kinetic procedures evaluated provided a good prediction of the field behaviour of many of the tailing and waste rock samples. However, the choice of one particular test procedure alone is not likely to provide a definitive assessment of whether a particular sample is going to produce AMD. It is more likely that a combination of two or more tests will provide a more confident assessment but even then, for some samples, prediction might be uncertain. The prediction of long term weathering characteristics of a tailing or waste rock will always have some uncertainty factor if the prediction test is carried out on a practical time scale in the laboratory.

2. Static methods of prediction have merit in providing a simple, rapid and low cost screening test to give a "first pass" indication of wastes that have the potential for AMD generation. In this study, the prediction of field behaviour on a yes/no basis was good for most of the methods, with approximately 80% accuracy. However, the predictions assume complete reaction of the sulphide and alkaline components of the rock and do not take into account the kinetics or equilibria of the acid generating and consuming reactions. The rate of release of alkalinity from a particular sample might not match the rate of acid production.

3. The use of sulphide sulphur analyses to calculate AP values in static tests is recommended over the use of total sulphur to avoid error in assessment by neglecting the presence of sulphates such as gypsum. However, the presence of sulphates resulting from the oxidation of sulphides in a sample prior to testing should be included in the assessment as these readily hydrolyzable oxidation products can contribute to AMD. Analyses of such sulphur species should be carried out to make these distinctions. Use of this procedure in combination with Acid Base Accounting, BC Research Initial Test, Alkaline Production Potential, or modifications thereof, should provide a more realistic static prediction.

4. The use of hot acid digestion in the standard Acid Base Accounting procedure is believed by some to overestimate the NP of a sample. In this study, use of a 24 hour/room

temperature digestion did not confirm this. The latter method is, however, easier to perform.

5. In static tests using a back titration of excess acid to calculate NP, the use of an endpoint of pH 8.3 is suggested as this provides greater stability of endpoint than the usual pH 7.0 endpoint.

6. The Net Acid Production method provided prediction accuracy equal to the other static tests, but did not require sulphur species analyses for the assessment. The method could therefore be carried out at a lower cost and would be suitable for field use. Further development of this method is recommended.

7. The APP : S ratio method provided results of limited use in this study due to only one sample of each waste material being tested. Its use in assessing wastes from coal mines has been shown by others to be effective and further assessment of the method for application to base metal mines could be carried out. It is thought that the method might not be applicable to high-sulphur wastes.

8. The so-called Hydrogen Peroxide method for pyrite estimation is not recommended.

9. The Carbonate Pressure Analysis method for characterizing the nature of alkaline producing carbonate in a sample provided inconclusive data in this study. The reliability of the method has not been established.

10. The kinetic tests, Humidity Cells and Shake Flasks, appeared to be capable of accurately predicting AMD. The alternate wetting, drying and flushing cycles of the Humidity Cells appears to be preferable for the assessment of waste rock stored in an unsaturated condition on land, although the method also successfully predicted the field behaviour of all 8 tailing samples. Shake Flasks might be more suited for evaluating underwater storage of tailing and waste rock but not above-ground permeable wastes. This method was successful in predicting only 1 out of 4 waste samples of this type. Further investigation of the suitability of one method over another for the prediction of land-based or sub-aqueous waste deposition is recommended.

11. The Soxhlet Extraction Test using distilled water provided accurate prediction of all samples except one waste rock sample. Its advantage appears to be that it provides a more rapid assessment but it requires more sophisticated

equipment than the other methods. The use of acetic acid as leachate appears to be unrealistic.

12. The prediction of AMD in a humidity cell type kinetic test will be a function of the degree and frequency of the flushing cycle. In this study, the operation of the humidity cells was according to the standard procedure only. Investigation of the type of weathering apparatus and its operation using different wetting, drying, flushing cycles is recommended. The objective of such a study would be to produce a definitive method(s) to provide rapid assessment of weathering characteristics of waste materials so that prediction of the long term behaviour of the material can be confidently assessed and modelled.

13. The BC Research Confirmation Test also provided good prediction in this study although, in general, it is believed that the initial acidification procedure used in the method provides an unrealistic condition. The method does not address the weathering characteristics in the approximate pH range of 7 down to 2, nor does it provide leachate quality trend data.

14. It is recommended that this report be supplemented by the compilation of a Manual to provide detailed description of all of the prediction methods and modifications used in this study.

15. It is recommended that the work carried out in this study be extended to provide greater analysis of some of the data, and to evaluate more fully specific methods from the current list of prediction procedures. Such a study would use a greater number and wider range of samples both from selected sites used in this work and from other sites exhibiting a wider range of sulphur contents and NP values. Methods should include static methods, such as Acid Base Accounting and the Net Acid Production method, and a more detailed comparison of the kinetic methods Humidity Cells, Shake Flasks and the Soxhlet Extraction Test.

16. Comparison of the data obtained in this study with the field data provides evidence of the lack of field verification for currently used prediction techniques. It is recommended, therefore, that the recommended extension to this study include a more in-depth assessment of AMD at minesites supplying the tailing and waste rock samples. In this study, only one sample from each mine was supplied and it is believed that in some cases, the samples might not have been representative, or the simple yes/no assessment provided in response to the questionnaires

might not have provided the full details on AMD at the site.

17. An overall objective of further research into prediction techniques should be to combine the effects of waste type, mining plan, disposal method, and reclamation plans, into the predictive scheme.

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APPENDIX 1

SULPHUR SPECIES AND ICP ANALYSES FOR TAILING AND WASTE ROCK SAMPLES

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T OASTECH RESEARCH INC.

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Project : 87-5013
Comments: ATTN: LINDA BROUGHTON

Date :04-APR-88
Invoice # :I-8811561
P.O. # :88-2135

CERTIFICATE OF ANALYSIS A8811561

*CORRECTED COPY

SAMPLE DESCRIPTION	PREP CODE		Sulphide % ***	SO4 % **	S % (Leco)
INT HEAD A	214	--	0.10	0.80	0.854
WAT HEAD A	214	--	13.02	0.72	12.20
CUT HEAD A	214	--	24.02	0.41	25.1
HST HEAD A	214	--	38.05	3.14	39.7
WMT HEAD A	214	--	22.05	1.15	23.0
EST HEAD A	214	--	3.16	0.21	3.35
ELT HEAD A	214	--	3.30	0.70	3.67
NBT HEAD A	214	--	2.58	0.18	2.97
KLT HEAD A	214	--	0.38	12.43	4.68
INWR HEAD A	214	--	0.22	0.07	0.702
ESWR HEAD A	214	--	19.70	0.17	19.10
CUWR HEAD A	214	--	8.10	0.06	8.61
HSWR HEAD A	214	--	5.88	0.07	6.19
INT HEAD B	214	--	< 0.01	0.69	0.761
WAT HEAD B	214	--	12.45	0.69	*11.50
CUT HEAD B	214	--	24.40	0.45	24.8
HST HEAD B	214	--	38.04	3.11	40.1
WMT HEAD B	214	--	22.21	1.02	22.8
EST HEAD B	214	--	3.05	0.13	3.45
ELT HEAD B	214	--	3.26	0.59	3.90
NBT HEAD B	214	--	2.60	0.04	3.00
KLT HEAD B	214	--	0.40	12.84	4.68
INWR HEAD B	214	--	0.17	0.02	0.686
ESWR HEAD B	214	--	19.76	0.09	19.10
CIWR HEAD B	214	--	8.27	0.12	8.71
HSWR HEAD B	214	--	5.90	0.09	6.04

NOTE: ** HCL SOLUBLE SULPHATE
*** HNO3 SOLUBLE SULPHIDE

ALL ASSAY DETERMINATIONS ARE PERFORMED OR SUPERVISED BY BC CERTIFIED ASSAYERS

CERTIFICATION : W. Slen Bmaviai

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Comments: ATTN: LINDA BROUGHTON

Date : 19-FEB-88
Invoice # : I-8811562
P.O. # : 88-2135

CERTIFICATE OF ANALYSIS A8811562

SAMPLE DESCRIPTION	PREP CODE		Mo ppm (ICP)	W ppm (ICP)	Zn ppm (ICP)	P ppm (ICP)	Pb ppm (ICP)	Bi ppm (ICP)	Cd ppm (ICP)	Co ppm (ICP)	Ni ppm (ICP)	Ba ppm (ICP)	Fe % (ICP)	Mn ppm (ICP)	Cr ppm (ICP)	Mg % (ICP)
INT HEAD A	299	232	< 1	< 10	121	< 10	< 2	< 2	1.0	197	9104	30	>25.0	295	105	0.30
WAT HEAD A	299	232	< 1	< 10	2710	370	150	< 2	6.0	63	60	110	18.00	1245	71	2.24
CUT HEAD A	299	232	< 1	< 10	4780	850	3820	< 2	6.5	115	32	270	>25.0	1210	18	0.37
HST HEAD A	299	232	< 1	< 10	>10000	240	7710	314	43.5	647	12	50	>25.0	315	69	0.37
WMT HEAD A	299	232	47	< 10	4060	240	458	< 2	14.5	< 1	45	600	20.0	286	20	0.73
EST HEAD A	299	232	3	< 10	2540	1250	478	20	18.0	21	45	810	6.12	633	53	0.79
ELT HEAD A	299	232	2	< 10	34	410	206	2	1.5	68	32	690	3.51	20	2	0.04
NBT HEAD A	299	232	47	< 10	86	390	18	< 2	1.5	11	17	600	4.64	314	19	0.77
KLT HEAD A	299	232	9	< 10	447	380	1010	162	1.5	521	>9999	80	1.70	147	66	1.37
INWR HEAD A	299	232	16	< 10	218	780	24	< 2	2.0	87	1086	410	9.67	1175	508	3.26
ESWR HEAD A	299	232	20	< 10	454	1230	68	< 2	5.5	13	251	100	21.6	601	431	0.63
CUWR HEAD A	299	232	13	< 10	3620	410	1010	6	5.5	97	161	260	11.40	923	313	1.21
HSWR HEAD A	299	232	12	180	>10000	710	4610	56	22.5	161	137	460	11.65	1220	254	1.29

CERTIFICATION : Hart Bichler

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To:)ASTECH RESEARCH INC.

869 WEST THIRD ST.
NORTH VANCOUVER, B.C.
V7P 1E2
Project : 87-5013
Comments: ATTN: LINDA BROUGHTON

CERTIFICATE OF ANALYSIS A8811562

SAMPLE DESCRIPTION	PREP CODE		V ppm (ICP)	Al % (ICP)	Be ppm (ICP)	Ca % (ICP)	Cu ppm (ICP)	Ag ppm AAS	Ti % (ICP)	Sr ppm (ICP)	Na % (ICP)	K % (ICP)				
INT HEAD A	299	232	73	0.56	< 0.5	0.31	562	3.0	0.10	18	0.16	0.06				
WAT HEAD A	299	232	94	4.54	< 0.5	1.90	1675	12.0	0.32	55	0.88	0.45				
CUT HEAD A	299	232	87	2.54	< 0.5	0.45	1145	19.5	0.08	98	0.10	0.63				
HST HEAD A	299	232	13	1.43	< 0.5	0.46	>10000	37.5	0.02	12	0.08	0.44				
WMT HEAD A	299	232	121	5.20	< 0.5	1.10	1720	11.5	0.07	118	0.31	2.01				
EST HEAD A	299	232	110	8.94	< 0.5	1.01	885	31.5	0.28	307	1.09	3.06				
ELT HEAD A	299	232	7	2.23	< 0.5	0.25	51	2.0	0.10	19	0.11	1.71				
NBT HEAD A	299	232	45	6.33	< 0.5	1.56	1275	1.5	0.11	124	0.47	2.83				
KLT HEAD A	299	232	346	4.45	5.0	6.16	300	4.0	0.20	110	0.09	0.36				
INWR HEAD A	299	232	225	7.81	< 0.5	5.18	1465	2.0	0.64	266	2.00	1.12				
ESWR HEAD A	299	232	81	7.01	< 0.5	0.56	93	2.5	0.23	201	0.86	2.20				
CUWR HEAD A	299	232	61	8.29	< 0.5	2.56	1360	4.0	0.35	187	0.68	2.46				
HSWR HEAD A	299	232	80	7.13	< 0.5	0.58	1960	22.0	0.37	32	0.56	2.54				

CERTIFICATION : Hart Bichler

APPENDIX 2

MINERALOGICAL REPORT ON TAILING AND WASTE ROCK SAMPLES

Vancouver Petrographics Ltd.

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Report for: Linda M. Broughton,
Coastech Research Inc.,
869 West Third St.,
North Vancouver, B.C.
V7P 1E2

March 9th, 1988

Samples:

8 tailings samples and 4 waste rock samples for polished thin section preparation and mineralogical study.

Samples are numbered as follows:

Tailings: CUT, HST, EST, ELT, KLT, NBT, WAT, WMT.

Waste Rock: CUWR, HSWR, ESWR, INWR

Summary:

These materials - as might be expected from their disparate origin - show considerable variety in terms of grain size and overall sulfide content. They show less variation in actual sulfide mineralogy - pyrite, and sometimes pyrrhotite, being the only significant sulfide components in almost all cases.

Of the tailings samples, CUT, HST, WAT and WMT are sulfide-rich, whilst NBT, EST and ELT contain much less sulfides (estimated 4 - 7%). KLT contains very minor amounts of sulfides and arsenides.

Of the above samples, WAT and ELT are relatively coarse grained, whilst the others are finely to very finely comminuted, with sulfide particles extending down to the low micron size range.

Sulfides are largely as liberated particles in all the tailings samples.

Of the waste rock samples, ESWR is sulfide-rich, HSWR and CUWR have low to moderate sulfide contents, and INWR is very low in sulfides. These materials generally show a particle size range of about 0.05 - 3.0mm.

The presence of carbonate may be significant in acid-generation studies as an at-source neutralizer. Most of the samples appear to contain very little carbonate. Exceptions are CUT, WMT, CUWR and ESWR with 1 - 2%, and NBT with an estimated 5%. More precise measurements of carbonate contents could be obtained by chemical analyses for CO_2 .

A few of the samples contain minor amounts of iron oxides (magnetite and hematite) of primary origin. None contain secondary (limonitic) oxides which might be indicative of active oxidation of the particulate materials having started. In fact, the freshness of the pyrite particles, even at the bottom end of the size range, is a notable feature throughout the suite.

The partial alteration of pyrrhotite referred to in a number of the descriptions is a typical feature of this mineral in many primary ores. It is a late hydrothermal and/or near-surface modification and not the result of post-mining oxidation.

The slides have been retained for later comparison with the same material after subjection to simulated weathering.

Individual descriptions are attached.

J.F. Harris Ph.D.
(phone: 929-5867)

Sample CUT

Estimated mode

Gangue	
Quartz	30
Feldspar	5
Sericite	12
Chlorite	1
Carbonate	2
Opaques	
Pyrite	33
Secondary pyrite) Altered pyrrhotite)	14
Pyrrhotite	2
Chalcopyrite) Sphalerite) Galena)	1
Magnetite	trace

This is a sulfide-rich product consisting predominantly of pyrite grains in the size range 5 - 200 microns. Some of the accompanying gangue particles are considerably coarser, ranging up to 500 microns.

About 99% of the pyrite appears to be as free grains. It includes a notable proportion of the microgranular type which is commonly secondary after pyrrhotite. Observation of locking characteristics is impeded by the tendency for slimes-sized material to agglomerate as close-packed clumps, with optical superposition of grains.

Base metal sulfides are sparse. They occur partly as a few relatively coarse composites (sphalerite/pyrrhotite/gangue; galena/gangue, chalcopyrite/gangue, pyrite/ sphalerite/galena, etc). The remainder occurs as tiny free grains, and as disseminated specks, on the scale 5 - 50 microns, in gangue.

Sample HST

Estimated mode

Gangue	20
Pyrite	55
Pyrrhotite) Altered pyrrhotite)	24
Sphalerite) Magnetite)	1
Chalcopyrite	trace

This is a finely comminuted, sulfide-rich product, in which the majority of particles are in the size range 5 - 50 microns. Extensive flocculation of fines into tight packed aggregates impedes observations. Gangue particles include some coarser grains to 100 microns or more. They are not identifiable, as this sample had to be prepared as a polished mount rather than a polished thin section.

The principal sulfide is pyrite, but there is a significant proportion of pyrrhotite and brownish secondary-type pyrite, probably derived from pyrrhotite. Relative proportions are difficult to determine in such finely divided material.

Sulfides appear to be largely liberated. This is also true of the trace accessories, though a few grains show locking on a scale down to a few microns.

The slide includes noticeable amounts of a grey mineral which could be magnetite or sphalerite. The two cannot readily be distinguished optically at this size range.

The high Cu and Pb analyses for this product are at odds with the microscopic observations. Chalcopyrite is observed - but only in fractions of a percent - and no galena was seen.

Sample EST

Estimated mode

Gangue	
Sericite)	
Sericitized felsite)	82
Volcanic lithic fragments)	
Plagioclase	5
Quartz	1
Chlorite	1
Rutile	2
Carbonate	trace
Opaques	
Pyrite	7
Sphalerite	trace
Chalcopyrite	trace
Galena	trace
Tetrahedrite	trace
Magnetite)	2
Hematite)	

This is a sulfide-poor product whose true particle size is difficult to determine.

The slide includes numerous sub-rounded masses, 0.2 - 3.0mm in size, of what looks like a rather well-sorted wacke or tuff, made up of close-packed, sericitized clasts, 0.02 - 0.2mm in size. These look too well-compacted and free of slimes to be flocculated aggregates, but it seems unlikely that a tailings product would contain such coarse particles.

The grain size range is, therefore, tentatively estimated (on the basis of clearly disaggregated components) as 5 - 200 microns.

Sulfides are principally pyrite, as ragged, sub-angular grains, 5 - 75 microns in size, mainly homogenous, free particles. A proportion of the tiniest grains are as inclusions in gangue.

Accessory traces of base metal sulfides are present, partly as free specks and partly in gangue. The minute traces of galena are normally composite with other sulfides. Magnetite - partially hematized - is of similar mode: mainly free, partly as specks within gangue. It is not generally associated with sulfides.

Sample ELT

Estimated mode

Gangue	
Quartz	75
Feldspars	15
Sericite	5
Opaques	
Pyrite	5
Pyrrhotite	trace
Chalcopyrite) Galena)	trace

This is another sulfide-poor product, of relatively coarse particle size.

It consists largely of angular grains of quartz and feldspar, 0.05 - 1.0mm in size. The feldspar shows varying degrees of sericitization. The coarsest grains are often composites of quartz and sericitized feldspar.

Sulfides are minor and consist almost entirely of pyrite. This occurs as free grains, 0.02 - 0.2mm in size. Fine-grained disseminations of sulfides in gangue are apparently absent. The pyrite is as fresh angular grains.

Sparse grains of pyrrhotite are also seen, and very rare traces of chalcopyrite (free grains) and galena (a single case of an inclusion in a pyrite grain).

Sample KLT

Estimated mode

Gangue	
Quartz	76
Mineral X	20
Leucoxene) Rutile)	2
Zircon) Monazite)	trace
Opaques	
Ni-arsenides	1
Pyrite	trace
Graphite	1

This sample consists predominantly of angular fragments of monocrystalline quartz, 0.05 - 0.3mm in size.

The other major constituent is a mineral of uncertain identity which shows a lath-like/acicular habit and occurs as individual elongate crystals, 0.03 - 0.2mm in length. This has a very low birefringence, straight extinction and a low to moderate relief: it is sometimes twinned (when it resembles microlitic plagioclase) and often dusted with sub-micron sized sub-opaque material.

It is not possible that liberated, perfectly formed, minute, individual crystals like this could be produced by grinding a normal rock. It therefore seems likely that this is a by-product of some processing step of which this material is the residue. It may, perhaps, be gypsum.

Opaques are very sparse. They consist of individual grains, 10 - 100 microns in size, of various cream, pinkish and white minerals - some of them anisotropic - which are thought to be nickel arsenides and sulfarsenides such as niccolite, rammelsbergite, gersdorffite etc. Some are tiny isometric euhedra showing concentric zoning.

Traces of pyrite are also seen.

Graphite, as relatively coarse, contorted flakes, is a notable minor constituent.

Sample NBT

Estimated mode

Gangue	
Quartz	52
Sericite	17
Plagioclase	20
Carbonate	5
Biotite	1
Opaques	
Pyrite	4
Chalcopyrite	trace
Bornite	trace
Hematite) Magnetite)	1

This product shows a rather wide particle size, from 10 - 500 microns.

Quartz is the predominant constituent, commonly as polygranular particles or composites with sericite and/or plagioclase.

Carbonate is a notable accessory.

Composites of the various gangue components are common, but it is difficult to determine to what extent these are true lithic fragments as opposed to artificial agglomerates. The slide includes numerous relatively coarse, subrounded patches, 0.5 - 2.0mm in size, which look exactly like a natural, poorly sorted, volcaniclastic rock (greywacke), but which may be a function of poor disaggregation of a partially cemented tailings.

Sulfides consist mainly of angular fragments of pyrite, 5 - 120 microns in size. These are typically fully liberated.

Minor and trace components are iron oxides (hematite and magnetite) and chalcopyrite - occasionally with intergrown bornite. The oxides and the copper minerals are generally unassociated with the pyrite. The chalcopyrite is sometimes seen as minute specks in gangue or intergrown with Fe-oxides.

Sample WAT

Estimated mode

Gangue	
Quartz	25
Feldspar	16
Amphibole	20
Muscovite	3
Epidote	7
Chlorite	5
Garnet	1
Sphene	1
Opaques	
Pyrite	12
Pyrrhotite	9
Magnetite	1
Chalcopyrite	trace

This is a well-sorted, slimes-free material, having a particle size range of 50 - 250 microns.

The gangue particles are a mixture of liberated mineral grains and lithic fragments of an apparent fine-grained meta-igneous rock.

Sulfides are relatively abundant, as well-liberated grains of pyrite and pyrrhotite, 30 - 250 microns in size. The pyrrhotite commonly shows varying degrees of alteration to mottled, dusty, secondary oxides. Pyrite and pyrrhotite are seldom seen intergrown.

An estimated 5% of the sulfides occur as fine-grained disseminations (10 - 50 microns) in silicates.

Traces of chalcopyrite are partially as free grains, but more often as tiny specks in gangue or intergrown with magnetite.

Magnetite occurs predominantly as free grains, but about 10% of it shows small inclusions of sulfides.

Sample WMT

Estimated mode

Gangue	
Quartz	35
Feldspar	15
Sericite	8
Carbonate	2
Opaques	
Pyrite	40
Pyrrhotite	trace
Sphalerite	trace
Chalcopyrite	trace

This is a very finely ground product with an estimated particle size range of 2 - 70 microns. It shows severe flocculation/agglomeration and masking by slimes, tending to hamper accurate observation of mineral proportions.

Sulfides are abundant and appear to be essentially all pyrite, as fresh, homogenous, finely comminuted, often splinter-like fragments. It exhibits almost perfect liberation from the gangue.

Accessory sulfides are sparse. They also occur principally as free grains, though occasional tiny composites of chalcopyrite and sphalerite with pyrite are seen.

Sample CUWR

Estimated mode

Gangue		
Quartz		30
Feldspar		30
Biotite		10
Muscovite		15
Epidote		1
Carbonate		2
Garnet		trace
Sphene		trace
Opaques		
Pyrite		11
Magnetite	)	
Sphalerite	)	
Chalcopyrite	)	1
Pyrrhotite	)	
Galena	)	

This sample consists of rock fragments and disaggregated mineral grains 0.05 - 2.5mm in size.

The host rock is a crystalline schist composed of quartz and plagioclase with biotite, muscovite and occasional garnet.

The dominant sulfide is pyrite, as homogenous well-polished fragments, 0.05 - 1.0mm or more in size. These are partly liberated grains and partly as simple coarse-grained composites with silicates (principally quartz). One or two composites of pyrite with brown carbonate were seen.

Accessory sulfides are minor in quantity and occur, in various combinations, as fine-grained intergrowths in pyrite, on the scale 10 - 50 microns. Occasional grains of intergrown sphalerite and chalcopyrite up to 100 microns are seen.

Magnetite is another minor component, chiefly as granules in silicate host rock particles.

The trace constituents are listed above in estimated decreasing order of abundance.

Sample HSWR

Estimated mode

Gangue	
Plagioclase) Felsite)	20
Quartz	18
Sericite	36
Chlorite	18
Hornblende	trace
Carbonate	trace
Sulfides	
Pyrite	3
Pyrrhotite	2
Sphalerite	2
Chalcopyrite	0.5
Galena	0.5
Arsenopyrite	trace
Fe-oxides	trace

This material consists of particles in the size range 0.1 - 3.0mm. These are principally rock fragments of fine-grained metavolcanics and metasediments with some apparent vein quartz.

The majority of the sulfides are composite with, or more or less finely disseminated in, silicates.

The various sulfides typically show rather fine-grained mutual intergrowths on the scale of 5 - 100 microns. Typical associations are pyrrhotite cementing pyrite euhedra; pyrite in a sphalerite matrix; pyrrhotite/galena/sphalerite in emulsion-type, tri-component intergrowth; very fine networks of chalcopyrite in pyrite; multicomponent sulfide disseminations in gangue, etc.

Occasionally sphalerite is seen intimately intergrown with carbonate, but the latter is not a quantitatively significant component in this material.

Sample ESWR

Estimated mode

Gangue	
Sericitized felsite	30
Volcanic lithic fragments	5
Plagioclase	2
Quartz	1
Carbonate	1
Chlorite	1
Sphene	trace
Opaques	
Pyrite	56
Pyrrhotite) Altered pyrrhotite)	3
Magnetite	1
Hematite	trace
Arsenopyrite	trace
Tetrahedrite	trace

This sample consists of rock and disaggregated mineral particles, principally in the size range 0.02 - 2.5mm. A few elongate particles up to 5.0mm are also present.

Pyrite is abundant, chiefly as liberated fragments, 0.1 - 3.0mm or more in size. This is a homogenous, massive variety, generally lacking crystal form.

A very minor proportion of pyrite occurs as fine-grained disseminations (grains 5 - 50 microns in size) in silicates.

A little of the pyrite is somewhat brownish in colour and shows a relict cleavage; this type grades to definite altered pyrrhotite and is presumably a secondary alteration of that mineral.

Traces of arsenopyrite are seen as fine-grained intergrowths in pyrite, and traces of tetrahedrite as simple composites with pyrite.

Magnetite occurs as a widespread, though minor constituent. It is seen in some coarse particles in the form of a microgranular matrix to clumps of pyrite; as simple or finely intergrown composites with pyrite, as fine disseminations in silicates and as liberated grains 20 - 400 microns in size. The magnetite sometimes shows partial replacement by hematite, and a few discrete grains of hematite are present.

Sample INWR

Estimated mode

Gangue	
Plagioclase	32
Quartz	10
Pyroxene	10
Hornblende	25
Biotite	15
Sphene	trace
Epidote	1
Chlorite	trace
Ilmenite	1
Black glass	4
Sulfides	
Pyrrhotite	1
Chalcopyrite	0.5
Pyrite	0.5
Pentlandite	trace

This material consists of rock fragments and disaggregated mineral grains, 0.05 - 2.0mm in size. The rocks appear to be gabbroic and dioritic intrusives with some diabase. There are also fragments of a black glass, with minute oxide, silicate and sulfide microlites and granules, which looks like slag or matte, and is probably not of natural origin.

Sulfides are sparse. They include rare free grains of pyrrhotite, pyrite and chalcopyrite, to 300 microns in size, but are chiefly fine-grained disseminations, on the scale 10 - 50 microns, in silicates.

Chalcopyrite and pyrrhotite are commonly intergrown, and the pyrrhotite often contains micron-sized exsolution bodies of pentlandite.

Scattered grains of ilmenite show no particular association with sulfides.

APPENDIX 3

B.C. RESEARCH INITIAL TEST DATA

B.C. RESEARCH INITIAL TEST
ACID TITRATION RESULTS

SAMPLE	INITIAL pH	SULPHURIC ACID CONSUMPTION (kg/t) 1h	3h	5h	8h	21h	24h	48h	96h	120h
CUT	4.5	6.9	11.5		13.0		22.5	26.4		
ELT	7.2	2.9	3.4		3.9		15.7	21.6		
EST	8.2	12.5	16.1		17.6		25.0	27.7		
HST	3.8	0.0	0.0		0.0		2.0	3.4		
KLT	8.8	53.9	55.9		59.3		70.6	88.6		98.5
NBT	8.4	23.5	27.7		39.9		61.7	70.1		96.5
WAT	3.1	0.5	0.5		0.5		0.5	0.5		1.0
WMT	5.8	19.6	20.6		21.3		22.0	22.0		22.3
CUWR	7.8	20.3	22.3	22.8	23.3	29.6	31.6		38.5	
ESWR	4.9	3.4	3.9	4.4	4.4	6.4	6.9		10.8	
HSWR	6.6	7.8	10.3	11.2	11.8	17.6	19.1		29.4	
INWR	7.3	8.7	4.2	4.6	4.7	7.6	8.6		13.9	

APPENDIX 4

ACID-BASE ACCOUNTING DATA

ACID-BASE ACCOUNT
METHOD A

Sample : Curragh Tailing CUT (1)

S[T] (%): 24.95 AP ** 785.9

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 4.76

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-734.9
0.00	0.00	1.020	51.0	-734.9
0.00	0.00	1.020	51.0	-734.9
0.00	0.00	1.020	51.0	-734.9
2.78	0.00	1.020	51.0	-734.9
2.80	0.10	1.015	50.8	-735.2
3.50	1.85	0.929	46.4	-739.5
4.00	2.24	0.909	45.5	-740.5
5.00	3.00	0.872	43.6	-742.3
6.00	4.98	0.774	38.7	-747.2
7.00	15.58	0.250	12.5	-773.4

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Elliot Lake Tailing ELT (1)

S[T] (%): 3.79 AP ** 119.4

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 6.79

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-68.4
0.00	0.00	1.020	51.0	-68.4
1.80	0.00	1.020	51.0	-68.4
2.00	6.90	0.679	33.9	-85.4
2.20	10.60	0.496	24.8	-94.6
2.80	17.00	0.179	9.0	-110.4
3.50	17.98	0.131	6.5	-112.8
4.00	18.50	0.105	5.3	-114.1
5.00	19.95	0.033	1.7	-117.7
6.00	20.26	0.018	0.9	-118.5
7.00	20.52	0.005	0.3	-119.1

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Equity Silver Tailing EST (1)

S[T] (%): 3.4 AP ** 107.1

N acid : 0.52
N base: 0.50
Wt sample: 2.00
mL acid: 40.00
paste pH: 7.68

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.87	0	10.440	522.0	414.9
1.00	10.92	7.737	386.9	279.8
1.50	27.15	3.720	186.0	78.9
1.80	31.10	2.743	137.1	30.0
2.00	32.08	2.500	125.0	17.9
2.20	33.30	2.198	109.9	2.8
2.80	34.30	1.951	97.5	-9.6
3.50	34.85	1.815	90.7	-16.4
4.00	35.15	1.740	87.0	-20.1
5.00	36.50	1.406	70.3	-36.8
6.00	36.90	1.307	65.4	-41.7
7.00	37.88	1.065	53.2	-53.9

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT

Sample : Heath Steele Tailing HST (1)

S[T] (%): 39.9 AP ** 1256.9

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 2.68

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-1205.9
0.00	0.00	1.020	51.0	-1205.9
1.94	0.00	1.020	51.0	-1205.9
2.00	1.62	0.940	47.0	-1209.9
2.20	5.80	0.733	36.7	-1220.2
2.80	12.00	0.427	21.3	-1235.5
3.50	13.80	0.338	16.9	-1240.0
4.00	14.65	0.296	14.8	-1242.1
5.00	20.20	0.021	1.1	-1255.8
6.00	23.76	-0.155	-7.7	-1264.6
7.00	28.05	-0.367	-18.4	-1275.2

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Key Lake Tailing KLT (1)

S[T] (%):	4.68	AP **	147.4

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 40.00
paste pH: 8.5

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	2.040	102.0	-45.4
0.00	0.00	2.040	102.0	-45.4
0.00	0.00	2.040	102.0	-45.4
0.00	0.00	2.040	102.0	-45.4
2.20	0.00	2.040	102.0	-45.4
2.80	6.30	1.728	86.4	-61.0
3.50	8.20	1.635	81.7	-65.7
4.00	9.82	1.554	77.7	-69.7
5.00	15.71	1.263	63.2	-84.3
6.00	17.64	1.168	58.4	-89.0
7.00	20.44	1.029	51.5	-96.0

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Noranda Bell Tailing NBT (1)

S[T] (%): 2.99 AP ** 94.2

N acid : 0.52
N base: 0.50
Wt sample: 2.00
mL acid: 80.00
paste pH: 7.34

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.37	0	20.880	1044.0	949.8
1.00	57.50	6.649	332.4	238.3
1.50	69.50	3.679	183.9	89.8
1.80	72.05	3.048	152.4	58.2
2.00	72.95	2.825	141.2	47.1
2.20	73.66	2.649	132.5	38.3
2.80	74.94	2.332	116.6	22.4
3.50	75.71	2.142	107.1	12.9
4.00	75.90	2.095	104.7	10.6
5.00	76.35	1.983	99.2	5.0
6.00	77.00	1.823	91.1	-3.1
7.00	77.30	1.748	87.4	-6.8

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Waite Amulet Tailing WAT (1)

S[T] (%): 11.85 AP ** 373.3

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 2.92

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-322.3
0.00	0.00	1.020	51.0	-322.3
1.97	0.00	1.020	51.0	-322.3
2.00	1.00	0.971	48.5	-324.7
2.20	4.81	0.782	39.1	-334.2
2.80	10.29	0.511	25.6	-347.7
3.50	12.85	0.385	19.2	-354.0
4.00	13.20	0.367	18.4	-354.9
5.00	14.40	0.308	15.4	-357.9
6.00	16.29	0.214	10.7	-362.6
7.00	20.20	0.021	1.1	-372.2

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Westmin Tailing WMT (1)

S[T] (%): 22.9 AP ** 721.3

N acid : 0.52
N base: 0.50
Wt sample: 2.00
mL acid: 80.00
paste pH: 5.35

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.39	0	20.880	1044.0	322.7
1.00	56.22	6.966	348.3	-373.1
1.50	70.72	3.377	168.8	-552.5
1.80	74.00	2.565	128.3	-593.1
2.00	75.60	2.169	108.5	-612.9
2.20	76.70	1.897	94.8	-626.5
2.80	78.05	1.563	78.1	-643.2
3.50	78.90	1.352	67.6	-653.7
4.00	79.10	1.303	65.1	-656.2
5.00	79.70	1.154	57.7	-663.6
6.00	80.28	1.011	50.5	-670.8
7.00	80.85	0.870	43.5	-677.9

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Curragh Waste Rock CUWR (1)

S[T] (%): 8.66 AP ** 272.8

N acid : 0.52
N base: 0.50
Wt sample: 2.00
mL acid: 80.00
paste pH: 7.16

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.43	0	20.880	1044.0	771.2
1.00	50.00	8.505	425.3	152.5
1.50	63.90	5.065	253.2	-19.6
1.80	66.68	4.377	218.8	-54.0
2.00	67.80	4.100	205.0	-67.8
2.20	68.75	3.864	193.2	-79.6
2.80	70.05	3.543	177.1	-95.7
3.50	71.10	3.283	164.1	-108.7
4.00	71.75	3.122	156.1	-116.7
5.00	75.20	2.268	113.4	-159.4
6.00	75.72	2.139	107.0	-165.8
7.00	76.21	2.018	100.9	-171.9

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Equity Silver Waste Rock ESWR (1)

S[T] (%): 19.1 AP ** 601.7

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 4.33

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-550.7
0.00	0.00	1.020	51.0	-550.7
1.97	0.00	1.020	51.0	-550.7
2.00	0.70	0.985	49.3	-552.4
2.20	6.78	0.685	34.2	-567.4
2.80	10.99	0.477	23.8	-577.8
3.50	12.91	0.382	19.1	-582.6
4.00	13.70	0.343	17.1	-584.5
5.00	15.20	0.268	13.4	-588.2
6.00	16.40	0.209	10.5	-591.2
7.00	18.75	0.093	4.6	-597.0

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Heath Steele Waste Rock HSWR (1)

S[T] (%): 6.12 AP ** 192.8

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 5.85

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-141.8
0.00	0.00	1.020	51.0	-141.8
0.00	0.00	1.020	51.0	-141.8
2.08	0.00	1.020	51.0	-141.8
2.20	2.50	0.896	44.8	-148.0
2.80	8.20	0.615	30.7	-162.1
3.50	10.25	0.513	25.7	-167.1
4.00	10.61	0.495	24.8	-168.0
5.00	12.10	0.422	21.1	-171.7
6.00	13.10	0.372	18.6	-174.2
7.00	15.15	0.271	13.5	-179.2

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD A

Sample : Inco Waste Rock INWR (1)

S[T] (%): 0.694 AP ** 21.9

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 7.05

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	29.1
0.00	0.00	1.020	51.0	29.1
0.00	0.00	1.020	51.0	29.1
0.00	0.00	1.020	51.0	29.1
2.24	0.00	1.020	51.0	29.1
2.80	5.64	0.741	37.1	15.2
3.50	7.75	0.637	31.8	10.0
4.00	8.40	0.605	30.2	8.4
5.00	10.90	0.481	24.0	2.2
6.00	12.24	0.415	20.7	-1.1
7.00	14.95	0.281	14.0	-7.8

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Curragh Tailing CUT (2)

S= (%) : 24.21 AP **: 762.6

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 4.76

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-711.6
0.00	0.00	1.020	51.0	-711.6
0.00	0.00	1.020	51.0	-711.6
0.00	0.00	1.020	51.0	-711.6
0.00	0.00	1.020	51.0	-711.6
2.92	0.00	1.020	51.0	-711.6
3.50	1.50	0.946	47.3	-715.3
4.00	1.85	0.929	46.4	-716.2
5.00	2.92	0.876	43.8	-718.8
6.00	5.10	0.768	38.4	-724.2
7.00	15.61	0.248	12.4	-750.2

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Elliot Lake Tailing ELT (2)

S= (%) : 3.28 AP **: 103.3

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 6.79

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-52.3
0.00	0.00	1.020	51.0	-52.3
1.80	0.00	1.020	51.0	-52.3
2.00	7.25	0.661	33.1	-70.2
2.20	11.10	0.471	23.6	-79.8
2.80	16.40	0.209	10.5	-92.9
3.50	17.70	0.145	7.2	-96.1
4.00	18.20	0.120	6.0	-97.3
5.00	19.30	0.066	3.3	-100.0
6.00	19.76	0.043	2.1	-101.2
7.00	20.18	0.022	1.1	-102.2

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Equity Silver Tailing EST (2)

S= (%) : 3.11 AP **: 98.0

N acid : 0.52
N base: 0.50
Wt sample: 2.00
mL acid: 40.00
paste pH: 7.68

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.89	0	10.440	522.0	424.0
1.00	9.20	8.163	408.2	310.2
1.50	28.78	3.317	165.8	67.9
1.80	32.25	2.458	122.9	24.9
2.00	33.78	2.079	104.0	6.0
2.20	34.66	1.862	93.1	-4.9
2.80	36.18	1.485	74.3	-23.7
3.50	36.85	1.320	66.0	-32.0
4.00	37.20	1.233	61.6	-36.3
5.00	38.74	0.852	42.6	-55.4
6.00	39.42	0.684	34.2	-63.8
7.00	40.20	0.490	24.5	-73.4

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Heath Steele Tailing HST (2)

S= (%) : 38.05 AP **: 1198.6

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 2.68

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-1147.6
0.00	0.00	1.020	51.0	-1147.6
1.92	0.00	1.020	51.0	-1147.6
2.00	2.86	0.879	43.9	-1154.6
2.20	7.35	0.657	32.8	-1165.7
2.80	13.78	0.339	16.9	-1181.6
3.50	15.20	0.268	13.4	-1185.2
4.00	16.00	0.229	11.4	-1187.1
5.00	20.80	-0.009	-0.4	-1199.0
6.00	25.11	-0.222	-11.1	-1209.7
7.00	28.22	-0.375	-18.8	-1217.3

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Key Lake Tailing KLT (2)

S= (%) : 0.39 AP **: 12.3

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 40.00
paste pH: 8.5

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	2.040	102.0	89.7
0.00	0.00	2.040	102.0	89.7
0.00	0.00	2.040	102.0	89.7
2.19	0.00	2.040	102.0	89.7
2.20	0.50	2.015	100.8	88.5
2.80	7.14	1.687	84.3	72.1
3.50	8.55	1.617	80.9	68.6
4.00	10.10	1.541	77.0	64.7
5.00	16.38	1.230	61.5	49.2
6.00	18.16	1.142	57.1	44.8
7.00	21.05	0.999	50.0	37.7

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Noranda Bell Tailing NBT (2)

S= (%) : 2.59 AP **: 81.6

N acid : 0.52
N base: 0.50
Wt sample: 2.00
mL acid: 80.00
paste pH: 7.34

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.43	0	20.880	1044.0	962.4
1.00	52.60	7.862	393.1	311.5
1.50	66.72	4.367	218.3	136.8
1.80	70.20	3.506	175.3	93.7
2.00	71.60	3.159	158.0	76.4
2.20	72.50	2.936	146.8	65.2
2.80	74.20	2.516	125.8	44.2
3.50	75.20	2.268	113.4	31.8
4.00	75.50	2.194	109.7	28.1
5.00	76.05	2.058	102.9	21.3
6.00	76.45	1.959	97.9	16.3
7.00	77.26	1.758	87.9	6.3

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Waite Amulet Tailing WAT (2)

S= (%) : 12.74 AP **: 401.3

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 2.92

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-350.3
0.00	0.00	1.020	51.0	-350.3
1.94	0.00	1.020	51.0	-350.3
2.00	4.68	0.789	39.4	-361.9
2.20	8.25	0.612	30.6	-370.7
2.80	13.52	0.351	17.6	-383.7
3.50	15.24	0.266	13.3	-388.0
4.00	15.70	0.244	12.2	-389.1
5.00	16.60	0.199	10.0	-391.4
6.00	18.44	0.108	5.4	-395.9
7.00	20.84	-0.011	-0.5	-401.8

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Westmin Tailing WMT (2)

S= (%) : 22.13 AP **: 697.1

N acid : 0.52
N base: 0.50
Wt sample: 2.00
mL acid: 80.00
paste pH: 5.35

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.38	0	20.880	1044.0	346.9
1.00	61.90	5.560	278.0	-419.1
1.50	75.30	2.243	112.2	-584.9
1.80	77.94	1.590	79.5	-617.6
2.00	79.22	1.273	63.7	-633.4
2.20	80.00	1.080	54.0	-643.1
2.80	81.60	0.684	34.2	-662.9
3.50	82.40	0.486	24.3	-672.8
4.00	82.70	0.412	20.6	-676.5
5.00	83.50	0.214	10.7	-686.4
6.00	84.21	0.038	1.9	-695.2
7.00	84.68	-0.078	-3.9	-701.0

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Curragh Waste Rock CUWR (2)

S= (%) : 8.19 AP **: 258.0

N acid : 0.52
N base: 0.50
Wt sample: 2.00
mL acid: 80.00
paste pH: 7.16

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.44	0	20.880	1044.0	786.0
1.00	50.00	8.380	419.0	161.0
1.50	61.55	5.493	274.6	16.6
1.80	63.90	4.905	245.3	-12.7
2.00	65.26	4.565	228.2	-29.7
2.20	66.20	4.330	216.5	-41.5
2.80	67.60	3.980	199.0	-59.0
3.50	68.74	3.695	184.8	-73.2
4.00	69.36	3.540	177.0	-81.0
5.00	75.00	2.130	106.5	-151.5
6.00	75.64	1.970	98.5	-159.5
7.00	76.05	1.868	93.4	-164.6

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Equity Silver Waste Rock ESWR (2)

S= (%) : 19.73 AP **: 621.5

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 4.33

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-570.5
0.00	0.00	1.020	51.0	-570.5
1.88	0.00	1.020	51.0	-570.5
2.00	2.90	0.877	43.8	-577.7
2.20	6.72	0.688	34.4	-587.1
2.80	12.30	0.412	20.6	-600.9
3.50	13.78	0.339	16.9	-604.6
4.00	14.46	0.305	15.2	-606.2
5.00	15.54	0.252	12.6	-608.9
6.00	16.50	0.204	10.2	-611.3
7.00	18.40	0.110	5.5	-616.0

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Heath Steele Waste Rock HSWR (2)

S= (%) : 5.89 AP **: 185.5

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 5.85

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	-134.5
0.00	0.00	1.020	51.0	-134.5
0.00	0.00	1.020	51.0	-134.5
2.13	0.00	1.020	51.0	-134.5
2.20	1.46	0.948	47.4	-138.1
2.80	8.75	0.587	29.4	-156.2
3.50	10.24	0.514	25.7	-159.9
4.00	10.85	0.483	24.2	-161.4
5.00	12.26	0.414	20.7	-164.8
6.00	13.00	0.377	18.9	-166.7
7.00	14.85	0.286	14.3	-171.3

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD B

Sample : Inco Waste Rock INWR (2)

S= (%) : 0.2 AP **: 6.3

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 7.05

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.00	0.00	1.020	51.0	44.7
0.00	0.00	1.020	51.0	44.7
0.00	0.00	1.020	51.0	44.7
0.00	0.00	1.020	51.0	44.7
2.24	0.00	1.020	51.0	44.7
2.80	6.90	0.679	33.9	27.6
3.50	9.82	0.534	26.7	20.4
4.00	10.24	0.514	25.7	19.4
5.00	11.68	0.442	22.1	15.8
6.00	12.66	0.394	19.7	13.4
7.00	15.44	0.256	12.8	6.5

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD C

Sample : Elliot Lake Tailing ELT

S= (%) : 3.28 AP **: 103.3

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 20.00
paste pH: 6.79

pH	ml base	mg equiv acid/g	NP **	NET NP **
1.12	0.00	1.020	51.0	-52.3
1.50	9.36	0.571	28.5	-74.8
1.80	12.30	0.430	21.5	-81.8
2.00	14.06	0.345	17.3	-86.1
2.20	15.00	0.300	15.0	-88.3
2.80	16.70	0.218	10.9	-92.4
3.50	17.20	0.194	9.7	-93.6
4.00	17.49	0.180	9.0	-94.3
5.00	18.50	0.132	6.6	-96.7
6.00	18.84	0.116	5.8	-97.5
7.00	19.02	0.107	5.4	-98.0

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD C

Sample : Equity Silver Tailing C *

S= (%) : 3.11 AP **: 98.0

N acid : 0.54
N base: 0.48
Wt sample: 2.00
mL acid: 40.00
paste pH: 7.68

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.56	0	10.700	535.0	437.0
1.00	22.50	5.255	262.8	164.8
1.50	29.90	3.464	173.2	75.2
1.80	31.62	3.048	152.4	54.4
2.00	32.46	2.845	142.2	44.3
2.20	32.90	2.738	136.9	38.9
2.80	33.69	2.547	127.4	29.4
3.50	34.08	2.453	122.6	24.7
4.00	34.31	2.397	119.8	21.9
5.00	36.65	1.831	91.5	-6.4
6.00	36.74	1.809	90.4	-7.5
7.00	38.02	1.499	75.0	-23.0

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD C

Sample : Noranda Bell Tailing NBT

S= (%) : 2.59 AP **: 81.6

N acid : 0.54
N base: 0.48
Wt sample: 2.00
mL acid: 80.00
paste pH: 7.34

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.42	0	21.400	1070.0	988.4
1.00	54.20	8.284	414.2	332.6
1.50	67.80	4.992	249.6	168.0
1.80	71.19	4.172	208.6	127.0
2.00	72.30	3.903	195.2	113.6
2.20	73.24	3.676	183.8	102.2
2.80	74.80	3.298	164.9	83.3
3.50	75.85	3.044	152.2	70.6
4.00	76.05	2.996	149.8	68.2
5.00	76.70	2.839	141.9	60.3
6.00	77.14	2.732	136.6	55.0
7.00	77.70	2.597	129.8	48.2

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD C

Sample : Curragh Waste Rock CUWR

S= (%) : 8.19 AP **: 258.0

N acid : 0.54
N base: 0.48
Wt sample: 2.00
mL acid: 80.00
paste pH: 7.16

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.48	0	21.400	1070.0	812.0
1.00	43.10	10.970	548.5	290.5
1.50	59.40	7.025	351.3	93.3
1.80	62.71	6.224	311.2	53.2
2.00	64.60	5.767	288.3	30.4
2.20	64.92	5.689	284.5	26.5
2.80	66.69	5.261	263.1	5.1
3.50	67.89	4.971	248.5	-9.5
4.00	69.00	4.702	235.1	-22.9
5.00	74.72	3.318	165.9	-92.1
6.00	75.25	3.190	159.5	-98.5
7.00	76.04	2.998	149.9	-108.1

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD D

Sample : Elliot Lake Tailing ELT

S= (%): 3.28 AP **: 103.3

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 35.00
paste pH: 6.79

pH	ml base	mg equiv acid/g	NP **	NET NP **
1.00	0.00	1.785	89.3	-14.1
1.50	20.20	0.815	40.8	-62.6
1.80	20.50	0.801	40.0	-63.3
2.00	27.08	0.485	24.3	-79.1
2.20	28.70	0.407	20.4	-83.0
2.80	31.21	0.287	14.3	-89.0
3.50	32.19	0.240	12.0	-91.3
4.00	32.62	0.219	11.0	-92.4
5.00	33.50	0.177	8.8	-94.5
6.00	33.90	0.158	7.9	-95.4
7.00	34.10	0.148	7.4	-95.9

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD D

Sample : Equity Silver Tailing EST

S= (%): 3.11 AP **: 98.0

N acid : 0.10
N base: 0.10
Wt sample: 2.00
mL acid: 50.00
paste pH: 7.68

pH	ml base	mg equiv acid/g	NP **	NET NP **
0	0	2.490	124.5	26.5
1.32	0.00	2.490	124.5	26.5
1.50	8.00	2.106	105.3	7.3
1.80	15.21	1.760	88.0	-10.0
2.00	17.60	1.645	82.3	-15.7
2.20	20.22	1.519	76.0	-22.0
2.80	23.40	1.367	68.3	-29.6
3.50	24.52	1.313	65.7	-32.3
4.00	25.36	1.273	63.6	-34.3
5.00	28.75	1.110	55.5	-42.5
6.00	30.15	1.043	52.1	-45.8
7.00	37.80	0.676	33.8	-64.2

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD D

Sample : Noranda Bell Tailing NBT

$S^{=}$ (%):	2.59	AP **:	81.6

N acid :	0.54
N base:	0.48
Wt sample:	2.00
mL acid:	50.00
paste pH:	7.34

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.57	0	13.375	668.8	587.2
1.00	33.11	5.362	268.1	186.5
1.50	40.90	3.477	173.9	92.3
1.80	42.90	2.993	149.7	68.1
2.00	43.18	2.925	146.3	64.7
2.20	43.52	2.843	142.2	60.6
2.80	44.20	2.679	133.9	52.3
3.50	44.92	2.504	125.2	43.6
4.00	45.06	2.470	123.5	41.9
5.00	45.70	2.316	115.8	34.2
6.00	46.00	2.243	112.2	30.6
7.00	47.05	1.989	99.4	17.9

** Potentials expressed as kg calcium carbonate per tonne of sample

ACID-BASE ACCOUNT
METHOD D

Sample : Curraugh Waste Rock CUWR

S= (%):	8.19	AP **:	258.0

N acid :	0.54
N base:	0.48
Wt sample:	2.00
mL acid:	50.00
paste pH:	7.16

pH	ml base	mg equiv acid/g	NP **	NET NP **
0.53	0	13.375	668.8	410.8
1.00	26.30	7.010	350.5	92.5
1.50	33.06	5.374	268.7	10.7
1.80	34.70	4.978	248.9	-9.1
2.00	35.25	4.845	242.2	-15.8
2.20	35.71	4.733	236.7	-21.3
2.80	36.50	4.542	227.1	-30.9
3.50	37.40	4.324	216.2	-41.8
4.00	38.94	3.952	197.6	-60.4
5.00	43.75	2.788	139.4	-118.6
6.00	43.90	2.751	137.6	-120.4
7.00	45.60	2.340	117.0	-141.0

** Potentials expressed as kg calcium carbonate per tonne of sample

APPENDIX 5

ALKALINE PRODUCTION POTENTIAL DATA

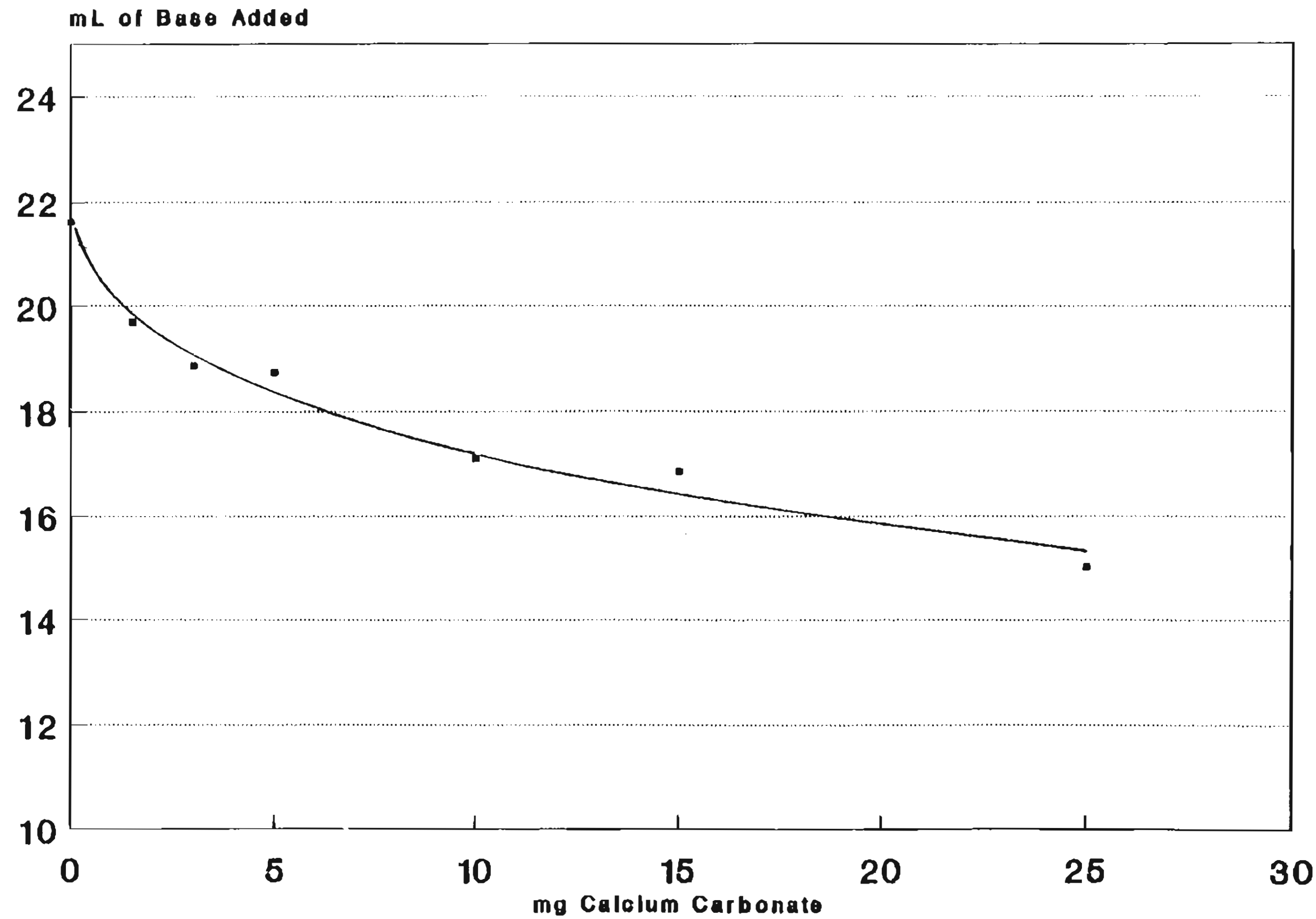
ALKALINE PRODUCTION POTENTIAL

TITRATION RESULTS FOR CALCIUM CARBONATE STANDARDS

N acid (HCl)	0.0996
N base (NaOH)	0.0995
Volume acid	20.0 mL
Volume d. water	20.0 mL
Endpoint pH	5.0

STANDARD (mg CaCO3)	VOLUME BASE
0.0	21.60
1.5	19.68
3.0	18.86
5.0	18.72
10.0	17.10
15.0	16.89
25.0	15.00

ALKALINE PRODUCTION POTENTIAL
CaCO3 STANDARD CURVE



ALKALINE PRODUCTION POTENTIAL

TITRATION RESULTS

Sample weight	500 mg
N acid (HCl)	0.0996
N base (NaOH)	0.0996
Volume acid	20.00 mL
Volume d. water	20.00 mL
Endpoint pH	5.0

SAMPLE	VOLUME BASE (mL)	
	SERIES A	SERIES B
TAILING :		
CUT	19.08	18.89
ELT	19.80	19.70
EST	17.20	17.19
HST	20.45	-
KLT	13.75	13.51
NBT	15.12	14.65
WAT	20.17	19.85
WMT	17.70	17.74
WASTE ROCK :		
CUWR	17.32	17.34
ESWR	19.36	19.30
HSWR	18.50	18.35
INWR	18.70	18.76

APPENDIX 6

HYDROGEN PEROXIDE TEST DATA

HYDROGEN PEROXIDE TEST

STANDARD: 0 WT %

TIME	pH	TEMP. C
0.0	3.76	21.5
1.0	4.12	21.0
2.0	4.18	21.0
4.0	4.24	21.0
6.0	4.29	21.0
8.0	4.31	21.0
10.0	4.33	21.0
12.0	4.34	21.0
14.0	4.35	21.0
15.0	4.36	21.0
20.0	4.37	21.0
25.0	4.38	21.2
30.0	4.38	21.2

STANDARD: 1 WT %

TIME	pH	TEMP. C
0.0	4.02	21.0
1.0	3.98	21.0
2.0	3.99	21.0
4.0	3.99	21.2
6.0	3.90	21.2
8.0	3.83	21.4
10.0	3.73	21.5
12.0	3.72	21.6
14.0	3.61	21.6
15.0	3.57	21.6
20.0	3.43	22.0
25.0	3.33	22.2
30.0	3.24	22.5

HYDROGEN PEROXIDE TEST

STANDARD: 2 WT %

TIME	pH	TEMP. C
0.0	3.98	21.0
1.0	3.94	21.2
2.0	3.90	21.5
4.0	3.74	21.5
6.0	3.59	21.7
8.0	3.43	22.0
10.0	3.31	22.0
12.0	3.21	22.2
14.0	3.11	22.5
15.0	3.08	22.8
20.0	2.89	23.2
25.0	2.74	24.0
30.0	2.60	25.0

STANDARD: 3 WT %

TIME	pH	TEMP. C
0.0	3.93	21.0
1.0	3.67	21.0
2.0	3.57	21.5
4.0	3.37	21.8
6.0	3.28	21.8
8.0	3.17	22.0
10.0	3.09	22.2
12.0	3.02	22.6
14.0	2.96	23.0
15.0	2.92	23.0
20.0	2.77	24.0
25.0	2.62	25.5
30.0	2.45	28.0
30.0		

HYDROGEN PEROXIDE TEST

STANDARD: 4 WT %

TIME	pH	TEMP. C
0.0	3.91	21.4
1.0	3.67	21.7
2.0	3.52	21.9
4.0	3.28	22.0
6.0	3.09	22.6
8.0	2.94	22.9
10.0	2.81	23.2
12.0	2.72	24.0
14.0	2.63	24.4
15.0	2.61	24.8
20.0	2.42	26.2
25.0	2.26	29.0
30.0	2.10	36.0

STANDARD: 5 WT %

TIME	pH	TEMP. C
0.0	3.71	21.5
1.0	3.29	21.8
2.0	3.21	22.0
4.0	3.03	22.2
6.0	2.89	22.6
8.0	2.79	23.2
10.0	2.68	23.9
12.0	2.60	24.6
14.0	2.52	25.5
15.0	2.48	26.0
20.0	2.28	29.6
25.0	1.95	39.9
30.0	1.47	67.8

HYDROGEN PEROXIDE TEST

STANDARD: 6 WT %

TIME	pH	TEMP. C
0.0	3.66	22.0
1.0	3.39	22.0
2.0	3.21	22.2
4.0	2.96	22.9
6.0	2.76	23.8
8.0	2.62	24.8
10.0	2.50	25.4
12.0	2.40	26.5
14.0	2.31	28.0
15.0	2.27	29.2
20.0	1.99	38.0
25.0	1.59	71.0
30.0	1.74	52.5

STANDARD: 8 WT %

TIME	pH	TEMP. C
0.0	3.35	22.0
1.0	2.96	22.8
2.0	2.89	23.2
4.0	2.65	24.4
6.0	2.50	25.5
8.0	2.36	27.8
10.0	2.22	30.0
12.0	2.07	35.0
14.0	1.82	44.0
15.0	1.57	57.0
18.0	1.29	68.5
20.0	1.36	55.9

HYDROGEN PEROXIDE TEST

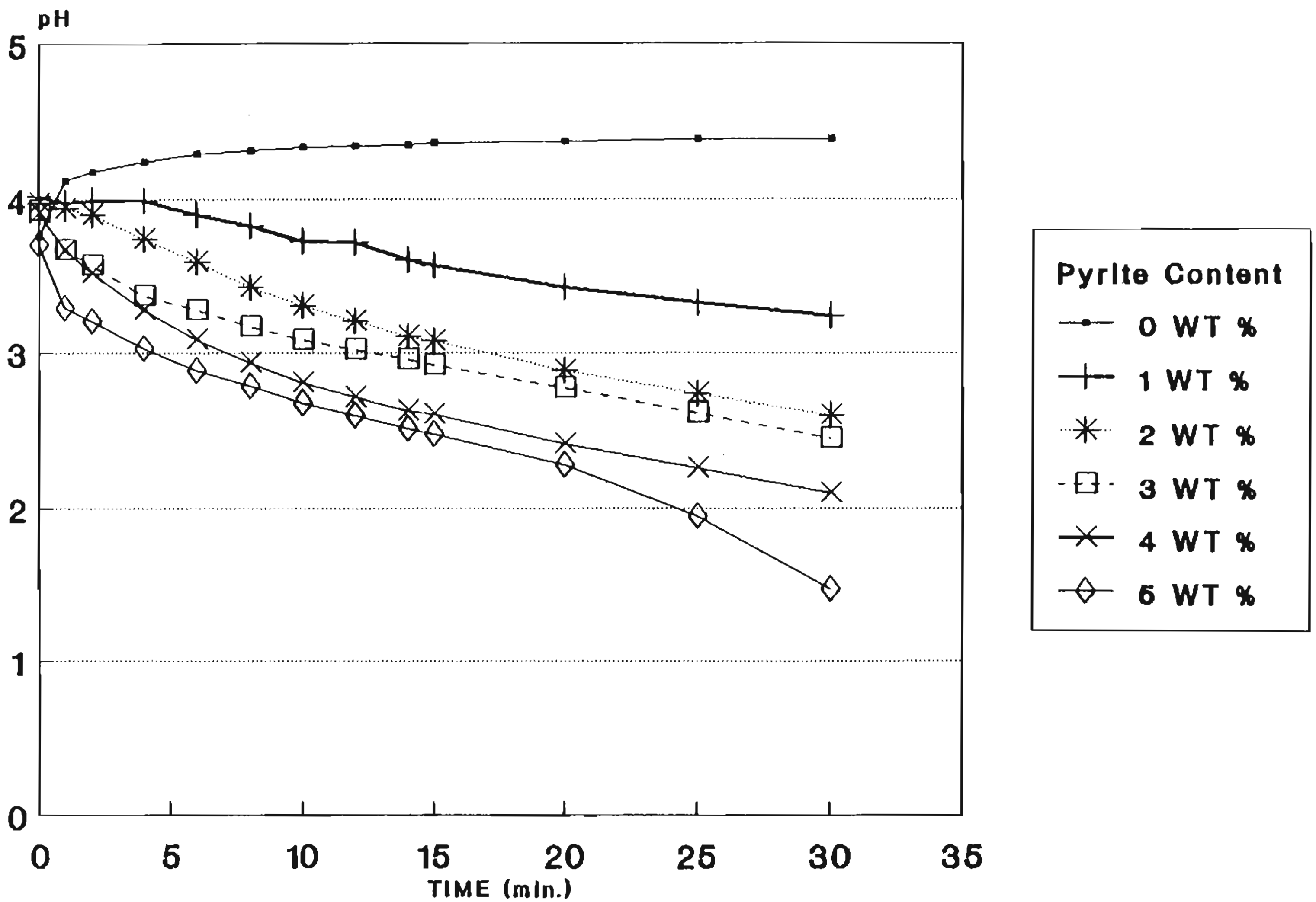
STANDARD: 10 WT %

TIME	pH	TEMP. C
0.0	3.38	22.5
1.0	3.08	22.9
2.0	2.83	23.0
4.0		25.0
6.0	2.35	27.2
8.0	2.16	31.0
10.0	1.95	37.8
12.0	1.49	60.0
14.0	1.45	73.0
15.0	1.48	66.0
20.0	1.64	51.0

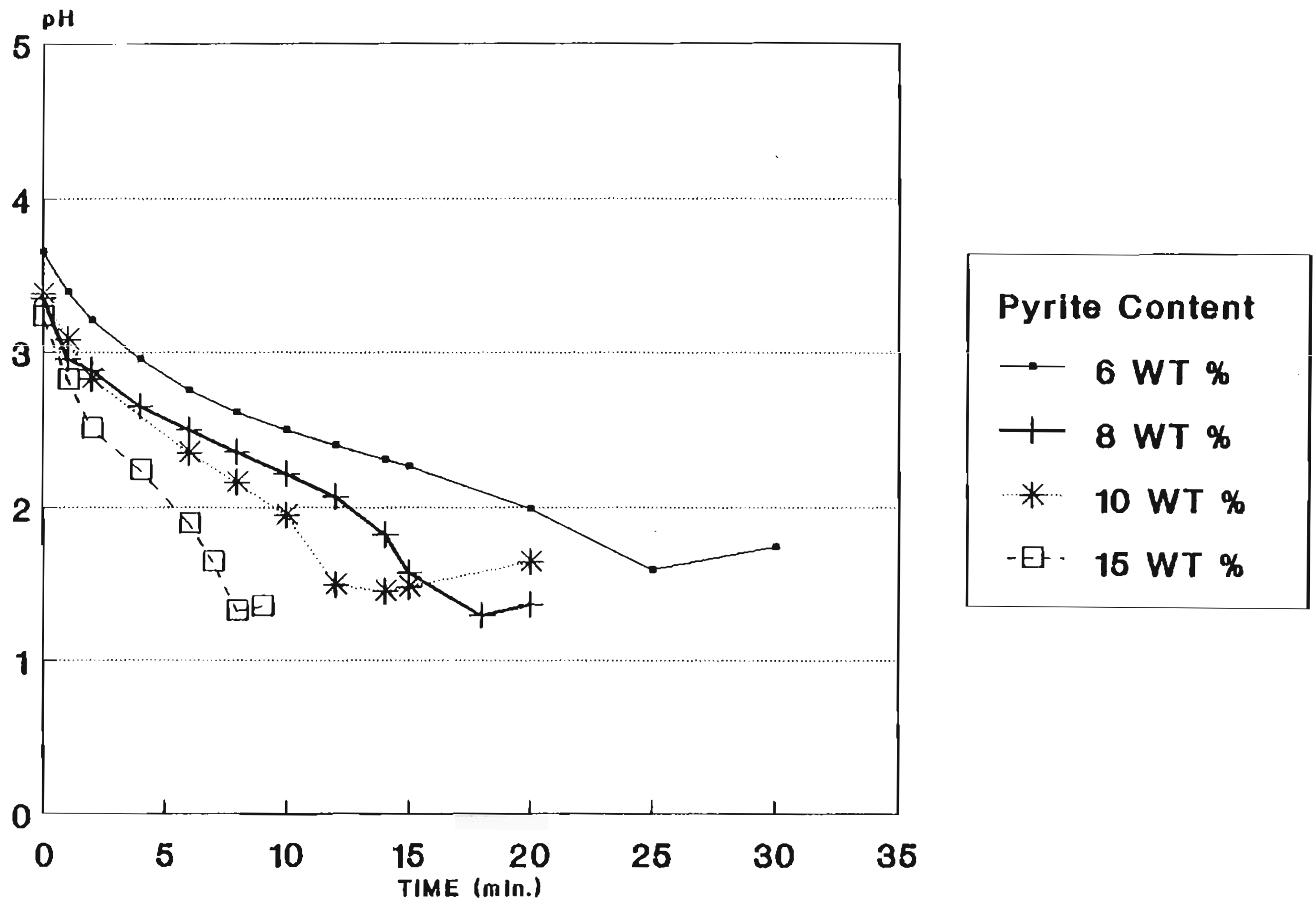
STANDARD: 15 WT %

TIME	pH	TEMP. C
0.0	3.23	22.6
1.0	2.82	24.0
2.0	2.51	25.5
4.0	2.24	28.5
6.0	1.89	36.5
7.0	1.64	46.5
8.0	1.32	82.0
9.0	1.35	75.0

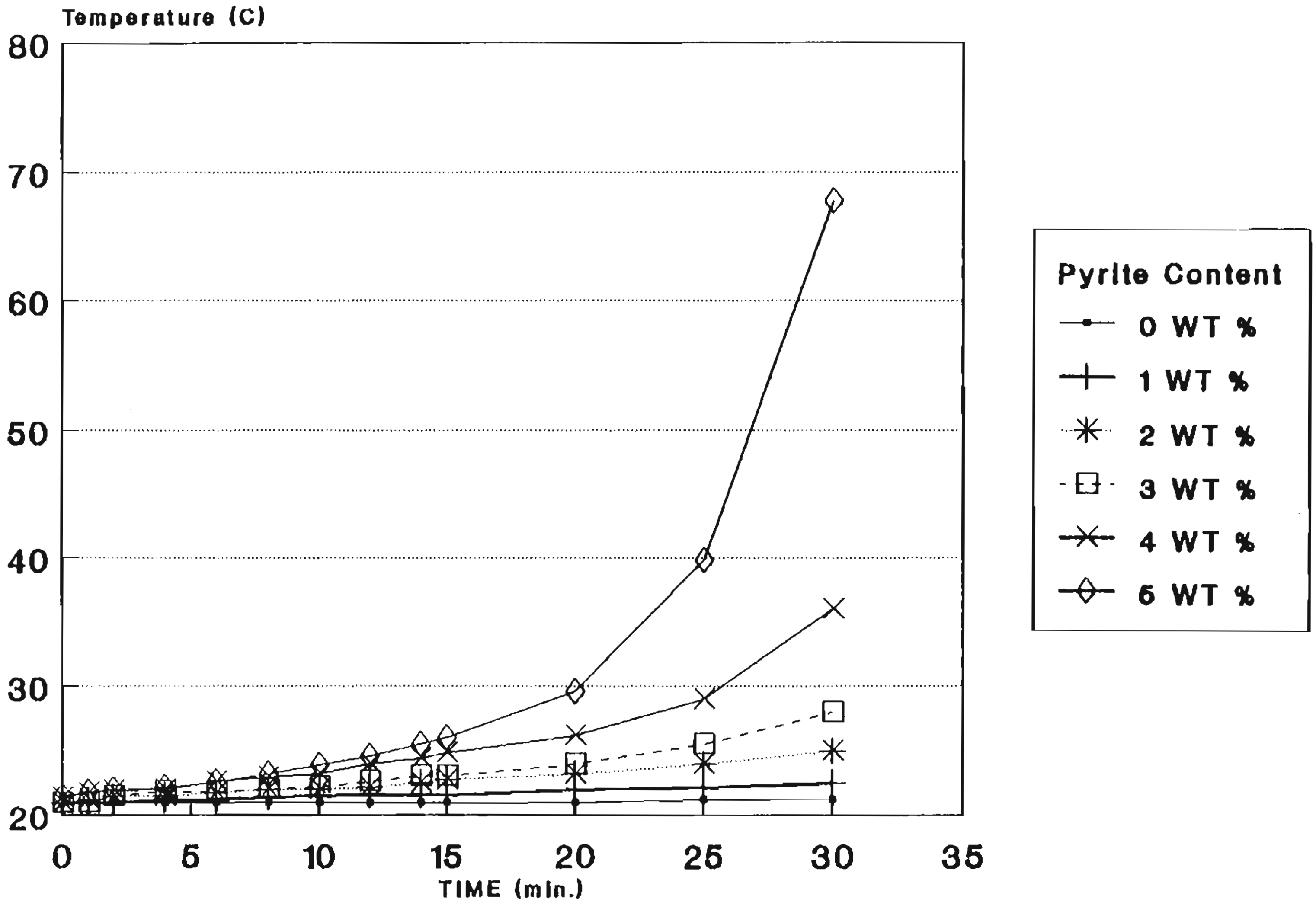
HYDROGEN PEROXIDE TEST
pH CURVES : STANDARDS



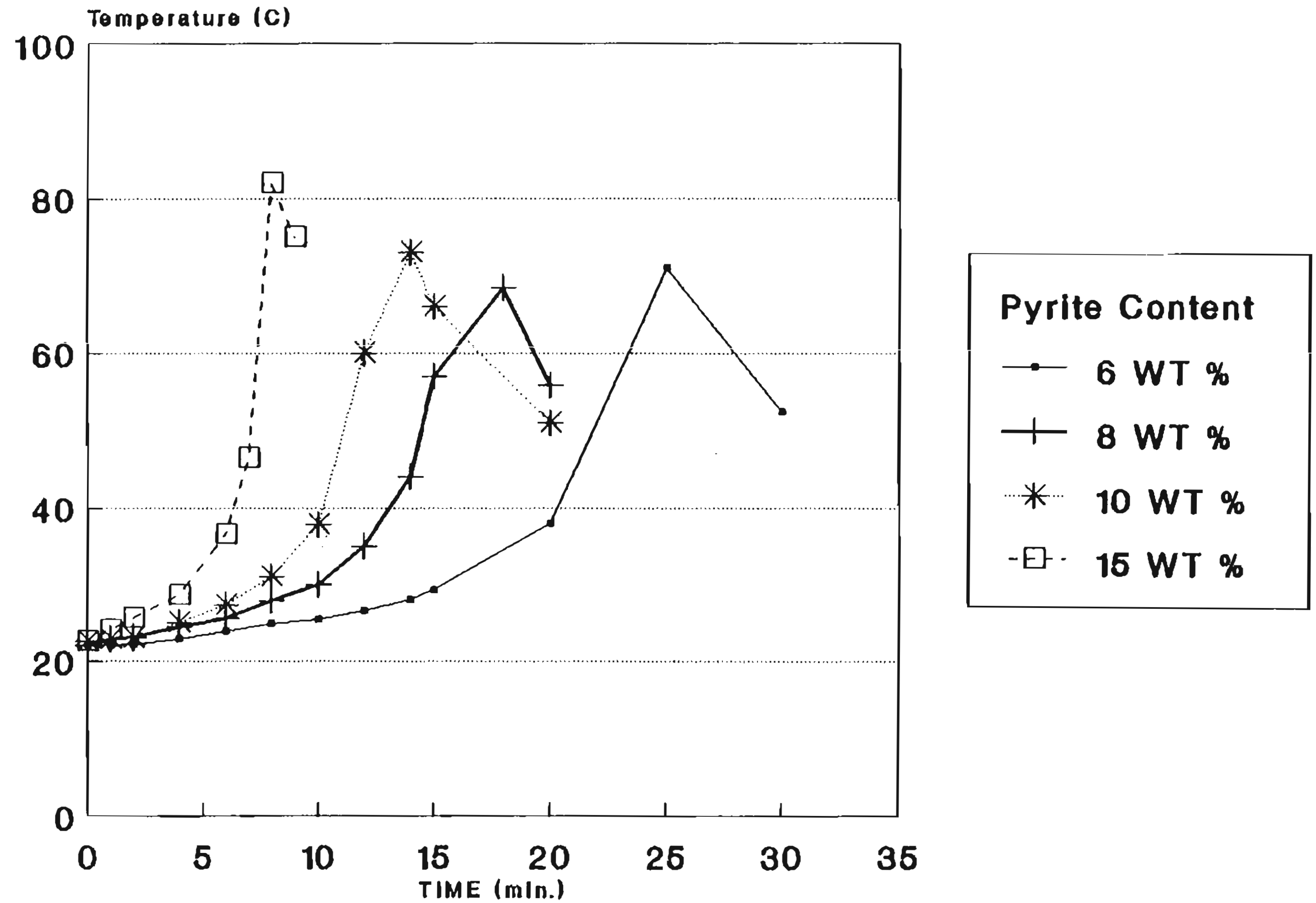
HYDROGEN PEROXIDE TEST
pH CURVES : STANDARDS



HYDROGEN PEROXIDE TEST
TEMPERATURE PROFILES : STANDARDS



HYDROGEN PEROXIDE TEST
TEMPERATURE PROFILES : STANDARDS



HYDROGEN PEROXIDE TEST

SAMPLE: Curragh Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	3.22	19.5
1.0	1.93	24.0
2.0	0.93	81.0
4.0	0.09	69.5
6.0	1.16	58.0
8.0	1.30	52.0

SAMPLE: Curragh Tailing B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	3.42	22.0
0.2	2.66	26.0
0.3	2.39	27.5
0.5	2.17	31.0
0.7	1.93	37.0
0.8	1.49	55.0
1.0	0.75	92.0
1.2	0.80	87.0
1.3	0.83	85.0
1.5	0.87	83.0
1.7	0.90	81.5
1.8	0.93	80.0
2.0	0.96	77.0

HYDROGEN PEROXIDE TEST

SAMPLE: Elliot Lake Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	4.56	19.5
1.0	5.15	19.5
2.0	5.27	19.5
4.0	5.38	20.0
6.0	5.46	20.0
8.0	5.51	20.0
10.0	5.55	20.0
12.0	5.58	20.0
14.0	5.59	20.0
15.0	5.60	20.0

HYDROGEN PEROXIDE TEST

SAMPLE: Elliot Lake Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	4.56	19.5
1.0	5.15	19.5
2.0	5.27	19.5
4.0	5.38	20.0
6.0	5.46	20.0
8.0	5.51	20.0
10.0	5.55	20.0
12.0	5.58	20.0
14.0	5.59	20.0
15.0	5.60	20.0

HYDROGEN PEROXIDE TEST

SAMPLE: Equity Silver Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	5.72	19.5
1.0	6.52	19.5
2.0	6.66	19.8
3.0	6.73	19.8
4.0	6.78	19.9
5.0	6.81	20.0
6.0	6.84	20.0
7.0	6.86	20.0
8.0	6.88	20.0
9.0	6.90	20.1
10.0	6.92	20.4
12.0	6.94	20.1
14.0	6.97	20.1
15.0	6.98	20.1

SAMPLE: Equity Silver Tailing B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	5.20	25.0
1.0	6.19	26.5
2.0	6.29	26.8
3.0	6.32	27.0
5.0	6.40	27.2
6.0	6.41	27.5
7.0	6.42	27.5
8.0	6.44	28.0
9.0	6.45	28.0
10.0	6.46	28.0
12.0	6.48	28.2
14.0	6.50	28.8
15.0	6.51	28.8

HYDROGEN PEROXIDE TEST

SAMPLE: Heath Steele Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	2.68	21.0
0.5	1.72	41.0
1.0	1.57	82.0
1.5	1.61	73.5
2.0	1.63	70.0
2.5	1.66	66.0
3.0	1.67	63.2
3.5	1.70	60.0
4.0	1.72	58.0

SAMPLE: Heath Steele Tailing B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	3.01	22.0
0.2	2.28	31.0
0.3	1.15	99.0
0.5	1.12	86.0
0.7	1.18	84.0
0.8	1.20	81.0
1.0	1.23	80.0
1.2	1.24	78.0
1.3	1.36	76.0
1.5	1.28	75.0

HYDROGEN PEROXIDE TEST

SAMPLE: Key Lake Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	6.18	22.0
1.0	7.18	25.0
2.0	7.22	26.0
4.0	7.24	26.5
6.0	7.25	27.2
8.0	7.25	27.8
10.0	7.25	28.0
12.0	7.25	28.2
14.0	7.25	28.5
15.0	7.25	28.8

HYDROGEN PEROXIDE TEST

SAMPLE: Key Lake Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	6.18	22.0
1.0	7.18	25.0
2.0	7.22	26.0
4.0	7.24	26.5
6.0	7.25	27.2
8.0	7.25	27.8
10.0	7.25	28.0
12.0	7.25	28.2
14.0	7.25	28.5
15.0	7.25	28.8

HYDROGEN PEROXIDE TEST

SAMPLE: Westmin Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	3.98	22.0
0.5	3.97	24.0
1.0	3.73	24.5
1.5	3.21	26.0
2.0	2.69	29.9
2.5	2.21	40.0
3.0	1.41	85.0
3.5	1.51	78.0

SAMPLE: Westmin Tailing B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	3.44	27.0
0.3	2.99	29.0
0.5	2.63	31.2
0.8	2.24	36.5
1.0	1.55	52.0
1.3	0.94	93.0
1.5	1.03	87.0
1.8	1.07	83.0
2.0	1.11	81.0
2.5	1.17	76.5
3.0	1.23	74.0
3.5	1.28	70.0
4.0	1.32	67.5

HYDROGEN PEROXIDE TEST

SAMPLE: Curragh Waste Rock A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	5.98	23.5
0.5	6.35	24.5
1.0	6.43	24.8
2.0	6.43	25.0
4.0	6.37	25.5
6.0	6.31	25.8
8.0	6.26	26.0
10.0	6.22	26.5
12.0	6.18	27.0
14.0	6.13	27.2
16.0	6.09	27.5
18.0	6.03	27.8
20.0	5.97	28.0
25.0	5.78	29.0
30.0	5.34	31.0

SAMPLE: Curragh Waste Rock B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	4.32	24.0
2.0	6.33	26.0
4.0	6.33	26.2
6.0	6.29	26.5
8.0	6.25	26.8
10.0	6.21	27.0
12.0	6.18	27.0
14.0	6.15	27.5
16.0	6.10	27.8
18.0	6.05	28.0
20.0	6.01	28.0
25.0	5.88	29.0
30.0	5.70	29.8
35.0	5.46	30.8
40.0	4.92	32.8
42.0	4.50	33.5
44.0	4.00	34.0
45.0	3.84	34.0
50.0	3.21	35.5
55.0	2.81	38.0
58.0	2.60	41.0
60.0	2.44	46.0
60.5	2.39	50.0
61.0	2.33	50.0
61.5	2.24	53.0
62.0	2.15	57.0
62.5	2.05	63.0
62.8	2.00	66.0
63.0	1.94	70.0
63.5	1.87	74.8
64.0	1.87	76.0
64.5	1.88	75.5
65.0	1.91	73.0

HYDROGEN PEROXIDE TEST

SAMPLE: Noranda Bell Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	6.63	23.5
1.0	6.56	24.5
2.0	6.66	25.0
4.0	6.76	25.0
6.0	6.80	25.5
8.0	6.83	25.8
10.0	6.86	26.0
12.0	6.87	26.2
14.0	6.89	26.2
15.0	6.90	26.5

SAMPLE: Noranda Bell Tailing B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.1	6.19	26.0
0.2	6.25	26.0
0.3	6.37	26.0
0.3	6.42	26.5
0.5	6.52	26.5
0.7	6.52	26.5
0.8	6.55	26.5
1.0	6.59	26.5
2.0	6.67	26.8
3.0	6.74	27.0
4.0	6.76	27.0
5.0	6.80	27.0
6.0	6.81	27.5
7.0	6.83	27.8

HYDROGEN PEROXIDE TEST

SAMPLE: Waite Amulet Tailing A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	2.48	22.0
0.5	2.29	25.0
1.0	2.17	27.0
1.5	2.01	31.2
2.0	1.85	39.0
2.5	1.62	62.0
3.0	1.25	82.0
3.5	1.28	76.0
4.0	1.33	72.0

SAMPLE: Waite Amulet Tailing B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	2.72	25.0
0.3	2.24	28.5
0.5	2.00	32.0
0.8	1.89	36.0
1.0	1.71	42.0
1.3	1.39	56.0
1.5	0.80	94.0
1.8	0.86	89.5
2.0	0.90	85.5
2.5	0.97	80.5
3.0	1.04	76.0
3.5	1.10	74.0
4.0	1.15	70.0

HYDROGEN PEROXIDE TEST

SAMPLE: Equity Silver Waste Rock A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	3.42	21.0
0.5	3.10	21.2
1.0	2.97	21.8
1.5	2.80	22.0
2.0	2.64	22.2
2.5	2.51	22.5
3.0	2.45	23.2
3.5	2.35	23.8
4.0	2.28	24.2
4.5	2.20	25.4
5.0	2.13	26.2
5.5	2.05	27.4
6.0	1.98	28.5
6.5	1.91	30.0
7.0	1.84	31.0
7.5	1.76	33.0
8.0	1.69	35.0
9.0	1.53	40.8
10.0	1.33	52.0
11.0	0.97	82.8

SAMPLE: Equity Silver Waste Rock B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	3.32	29.5
1.0	2.32	29.5
1.5	2.01	32.0
2.0	1.80	35.0
2.3	1.70	37.5
2.5	1.60	39.0
2.8	1.47	42.5
3.0	1.33	46.0
3.3	1.14	53.0
3.5	0.88	65.0
3.8	0.56	93.0
4.0	0.59	91.0
4.3	0.65	88.0
4.5	0.69	85.0
5.0	0.77	80.0

HYDROGEN PEROXIDE TEST

SAMPLE: Heath Steele Waste Rock A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	4.25	23.2
1.0	3.75	25.8
2.0	3.34	26.0
4.0	2.94	27.5
6.0	2.70	29.0
8.0	2.52	32.0
10.0	2.37	35.0
12.0	2.14	46.0
12.5	2.03	51.0
13.0	1.86	61.0
13.2	1.68	70.0
13.5	1.47	87.0
13.8	1.47	92.0
14.0	1.50	89.0
14.5	1.58	83.0
15.0	1.62	79.0

SAMPLE: Heath Steele Waste Rock B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	3.67	27.0
0.5	3.89	28.0
1.0	3.65	28.5
2.0	3.14	29.5
4.0	2.69	31.5
6.0	2.44	34.5
8.0	2.24	40.5
10.0	1.67	67.0
10.3	1.35	85.0
10.5	1.31	93.0
10.8	1.39	87.0
11.0	1.43	83.0
11.5	1.48	79.0
12.0	1.56	72.0
13.0	1.62	67.0
14.0	1.66	65.0
15.0	1.69	63.0

HYDROGEN PEROXIDE TEST

SAMPLE: Inco Waste Rock A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	4.33	25.0
1.0	5.31	26.2
2.0	5.26	27.0
6.0	4.58	28.0
8.0	4.34	28.0
10.0	4.16	28.5
12.0	3.99	28.9
14.0	3.85	29.0
15.0	3.80	29.0
18.0	3.62	29.5
20.0	3.52	30.0
25.0	3.34	30.5
27.0	3.28	31.0
29.0	3.21	31.2
30.0	3.18	31.5

SAMPLE: Inco Waste Rock B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	2.97	25.2
2.0	4.77	25.8
4.0	4.96	26.0
6.0	4.73	26.2
8.0	4.50	26.5
10.0	4.31	26.8
12.0	4.15	27.0
14.0	4.00	27.2
16.0	3.83	27.5
18.0	3.76	27.8
20.0	3.66	28.0
25.0	3.48	29.5
30.0	3.31	29.5
35.0	3.19	30.0
40.0	3.09	31.0
45.0	2.99	32.0
50.0	2.90	33.5
55.0	2.81	35.5
60.0	2.72	38.0
62.0	2.68	39.0
65.0	2.62	41.0
67.0	2.57	43.0
68	2.54	45
70	2.49	47.8
72	2.42	51.5
74	2.33	57
75	2.30	59.8
78	2.23	65
80	2.24	63.5

HYDROGEN PEROXIDE TEST

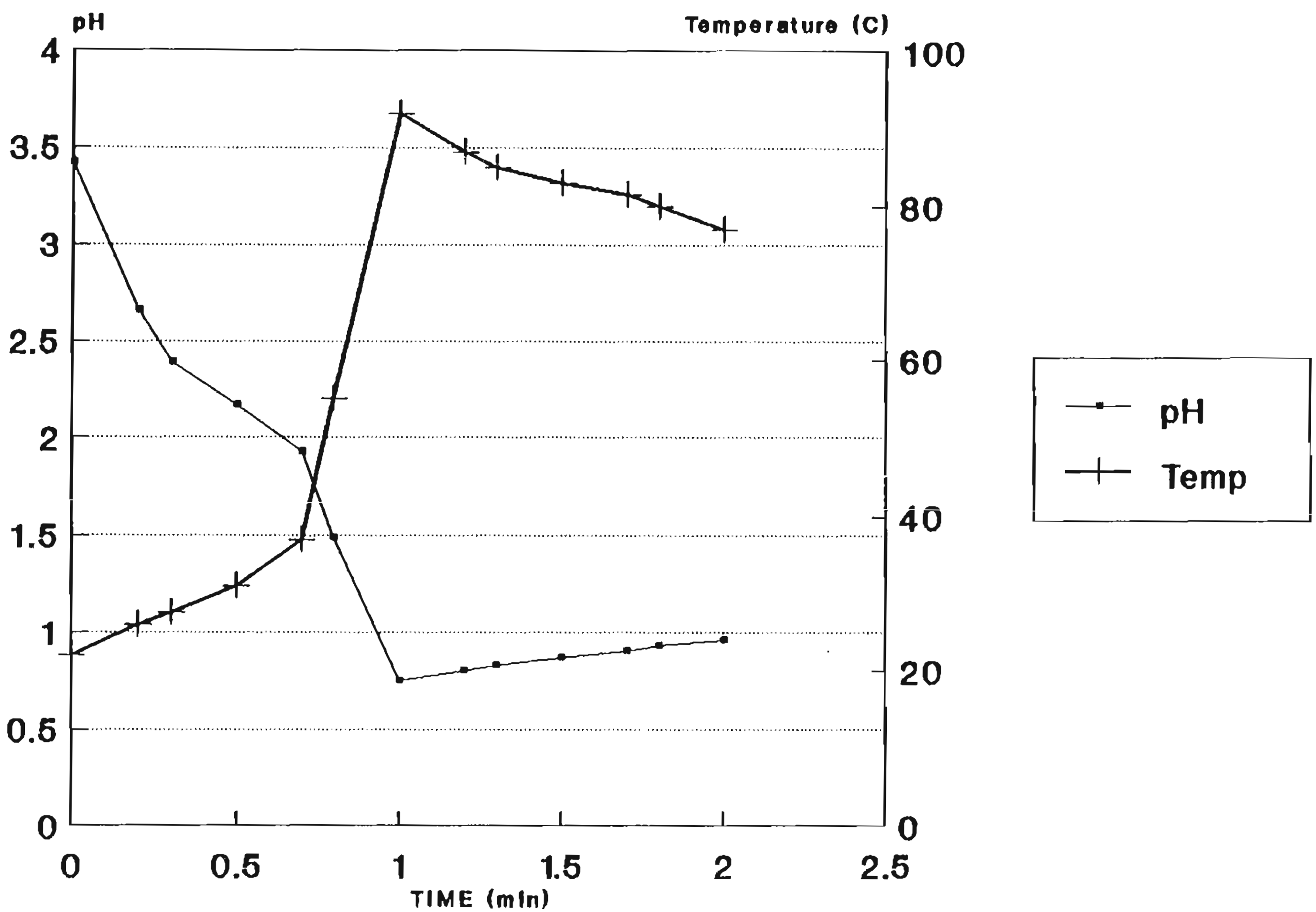
SAMPLE: Inco Waste Rock A
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	4.33	25.0
1.0	5.31	26.2
2.0	5.26	27.0
6.0	4.58	28.0
8.0	4.34	28.0
10.0	4.16	28.5
12.0	3.99	28.9
14.0	3.85	29.0
15.0	3.80	29.0
18.0	3.62	29.5
20.0	3.52	30.0
25.0	3.34	30.5
27.0	3.28	31.0
29.0	3.21	31.2
30.0	3.18	31.5

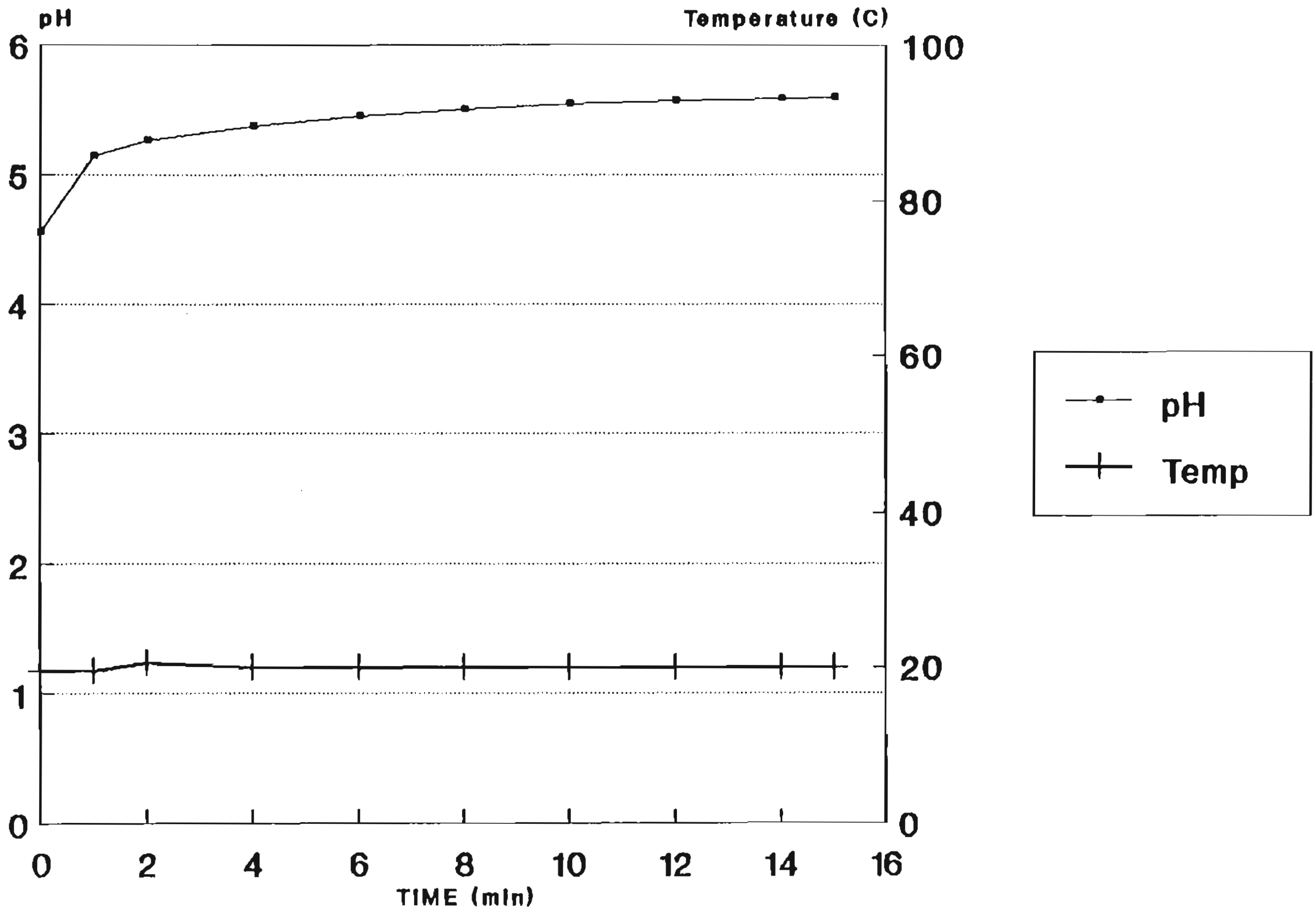
SAMPLE: Inco Waste Rock B
SAMPLE WT: 5.00

TIME	pH	TEMP. C
0.0	2.97	25.2
2.0	4.77	25.8
4.0	4.96	26.0
6.0	4.73	26.2
8.0	4.50	26.5
10.0	4.31	26.8
12.0	4.15	27.0
14.0	4.00	27.2
16.0	3.83	27.5
18.0	3.76	27.8
20.0	3.66	28.0
25.0	3.48	29.5
30.0	3.31	29.5
35.0	3.19	30.0
40.0	3.09	31.0
45.0	2.99	32.0
50.0	2.90	33.5
55.0	2.81	35.5
60.0	2.72	38.0
62.0	2.68	39.0
65.0	2.62	41.0
67.0	2.57	43.0
68.0	2.54	45.0
70.0	2.49	47.8
72.0	2.42	51.5
74.0	2.33	57.0
75.0	2.30	59.8
78.0	2.23	65.0
80.0	2.24	63.5

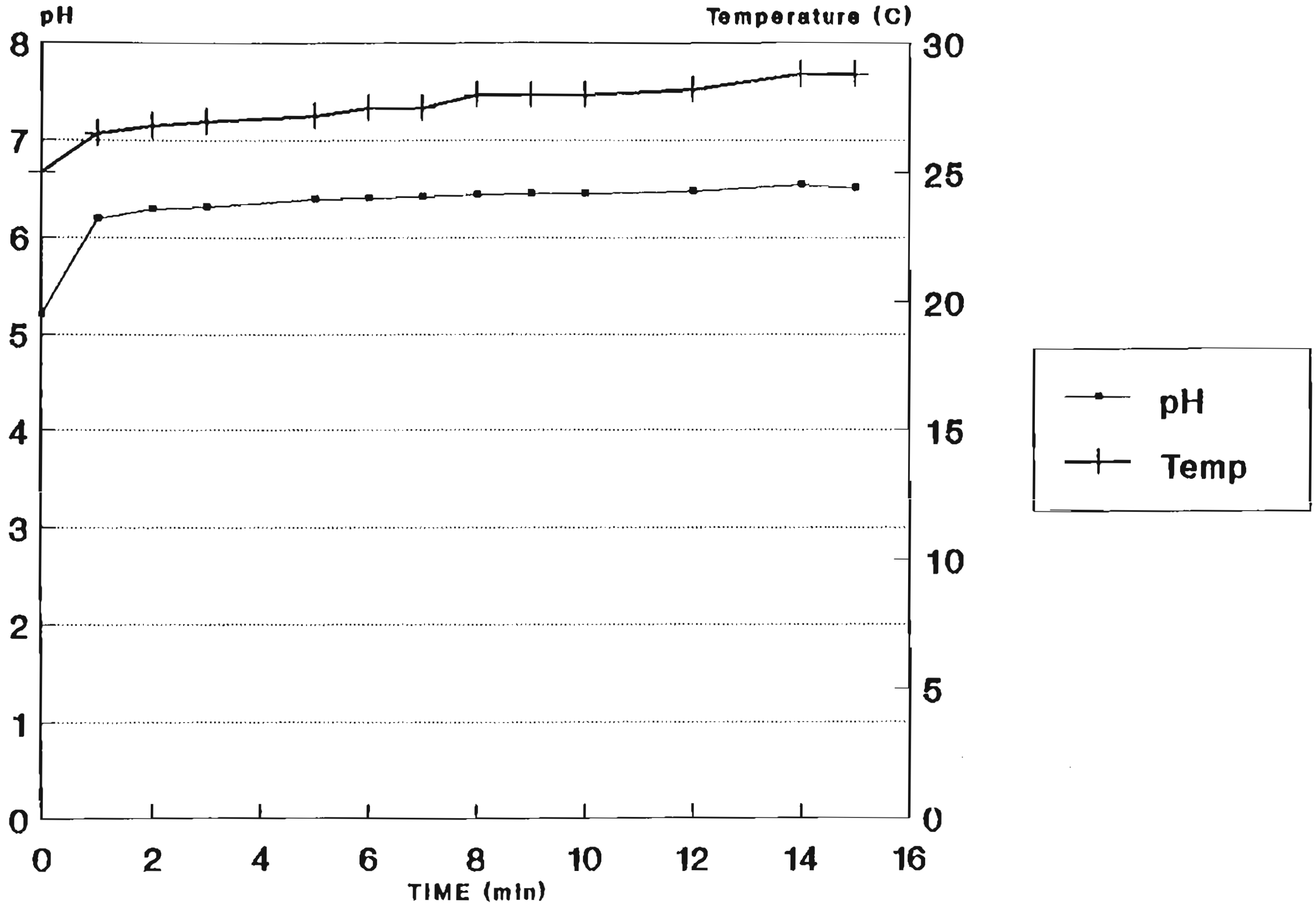
CURRAGH TAILING CUT
HYDROGEN PEROXIDE TEST



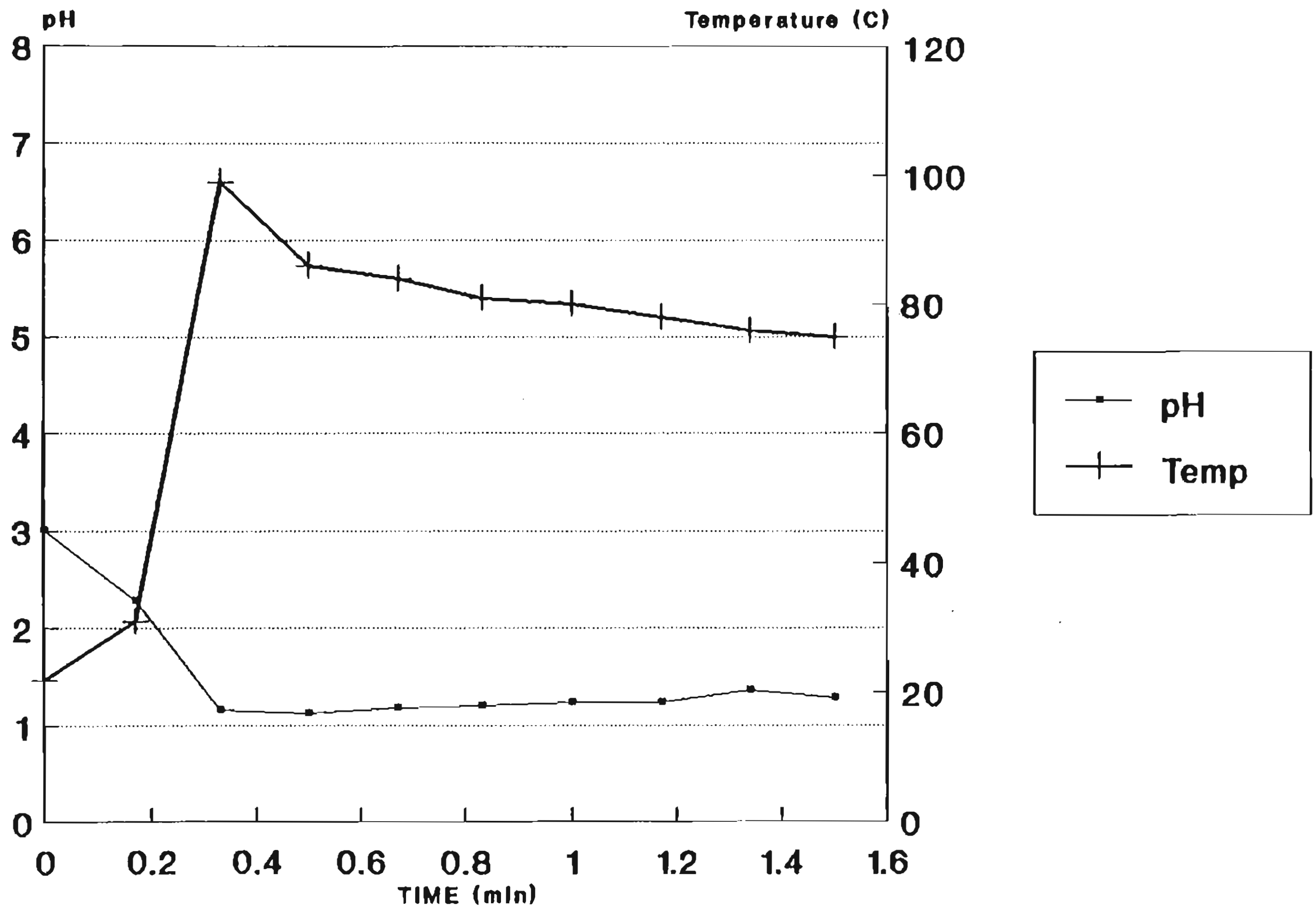
ELLIOT LAKE TAILING ELT
HYDROGEN PEROXIDE TEST



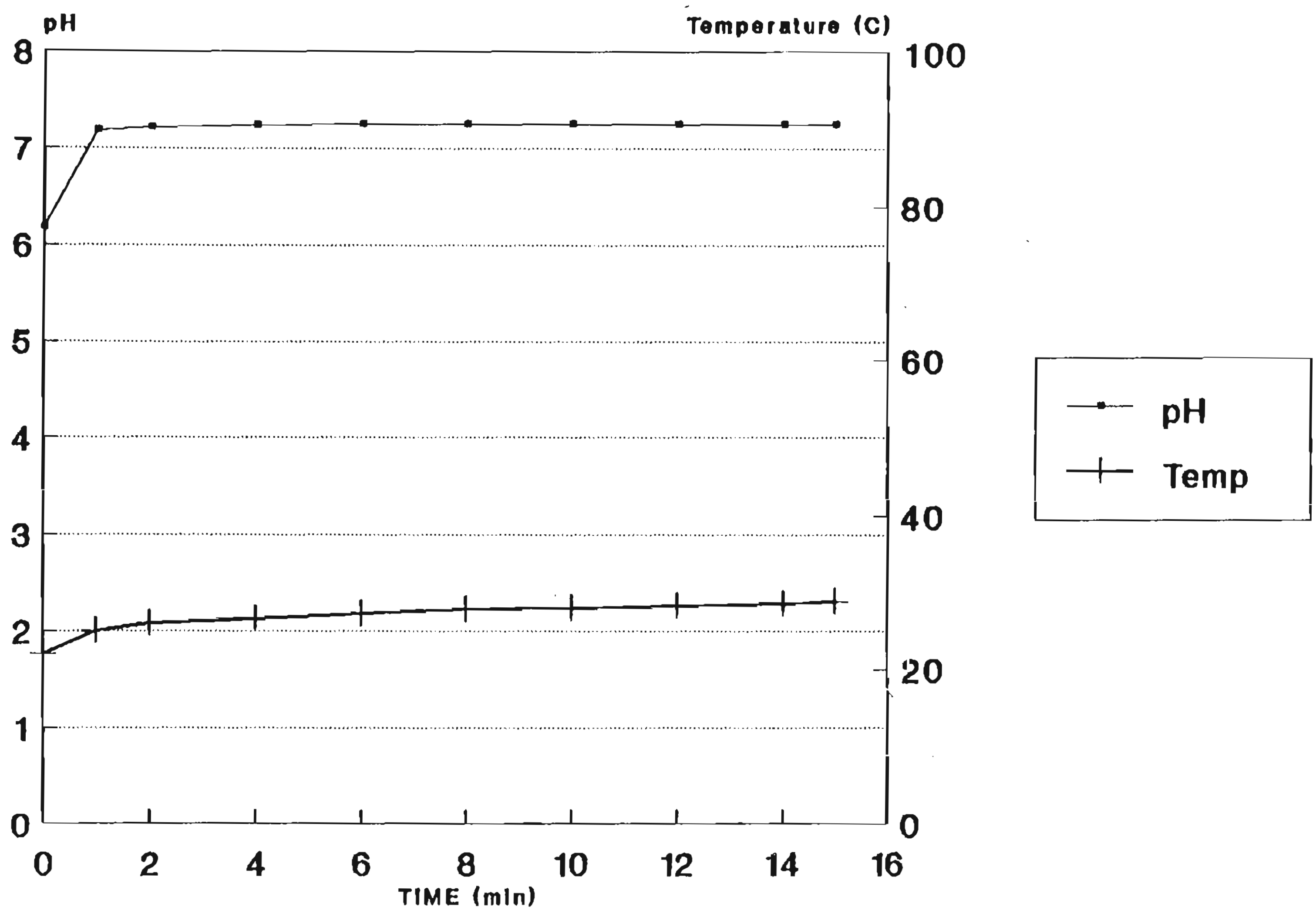
EQUITY SILVER TAILING EST
HYDROGEN PEROXIDE TEST



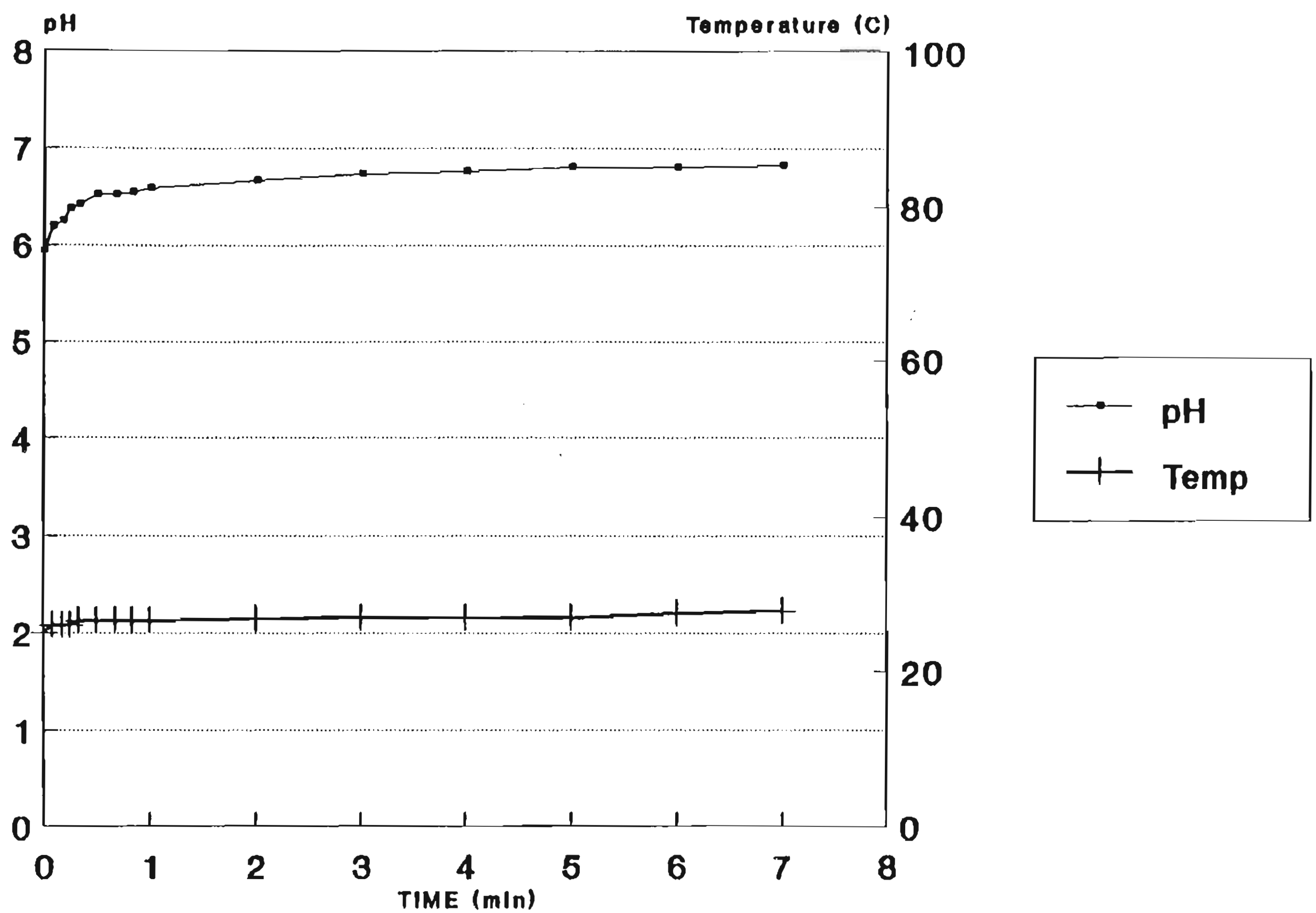
HEATH STEEL TAILING HST
HYDROGEN PEROXIDE TEST

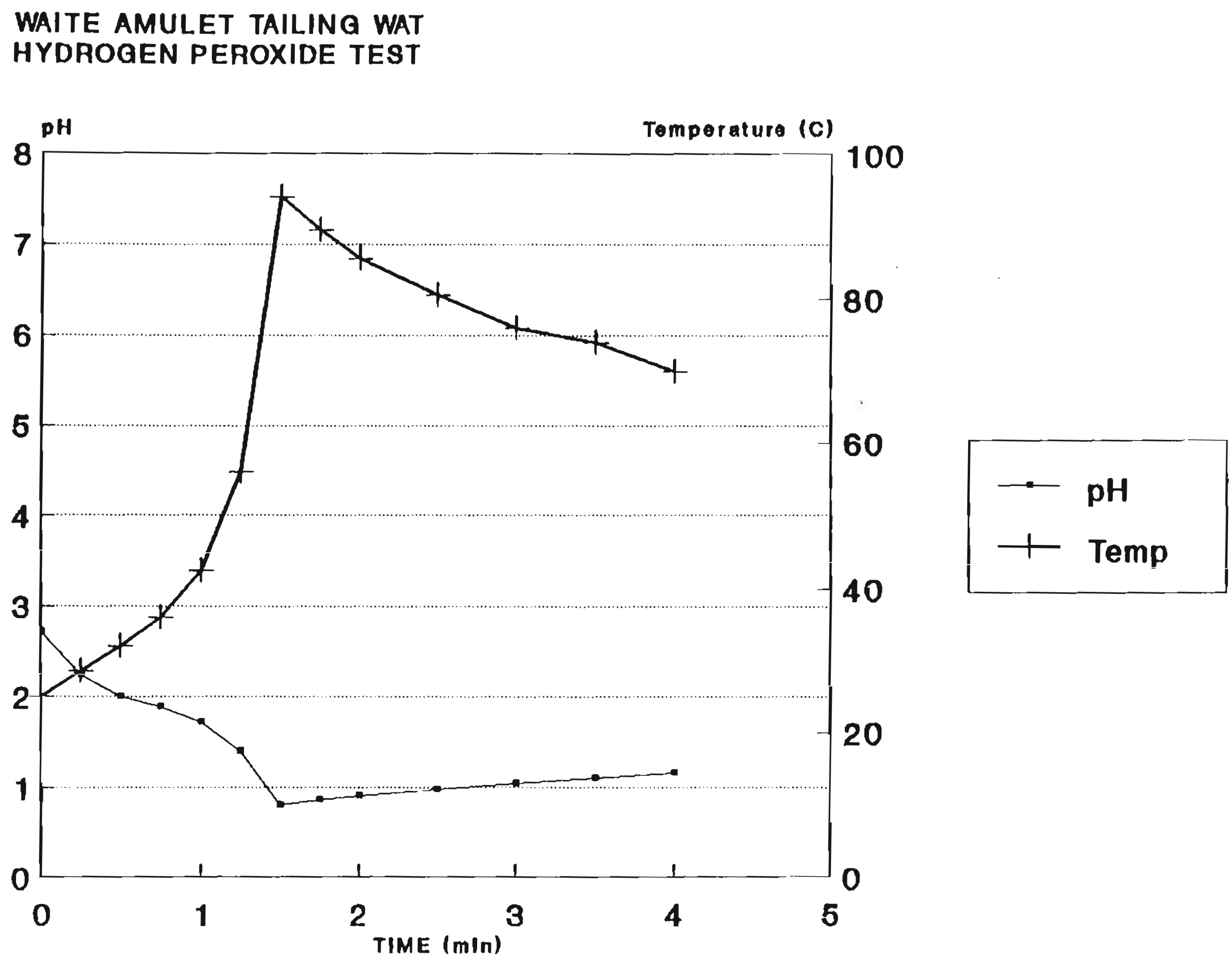


KEY LAKE TAILING KLT
HYDROGEN PEROXIDE TEST

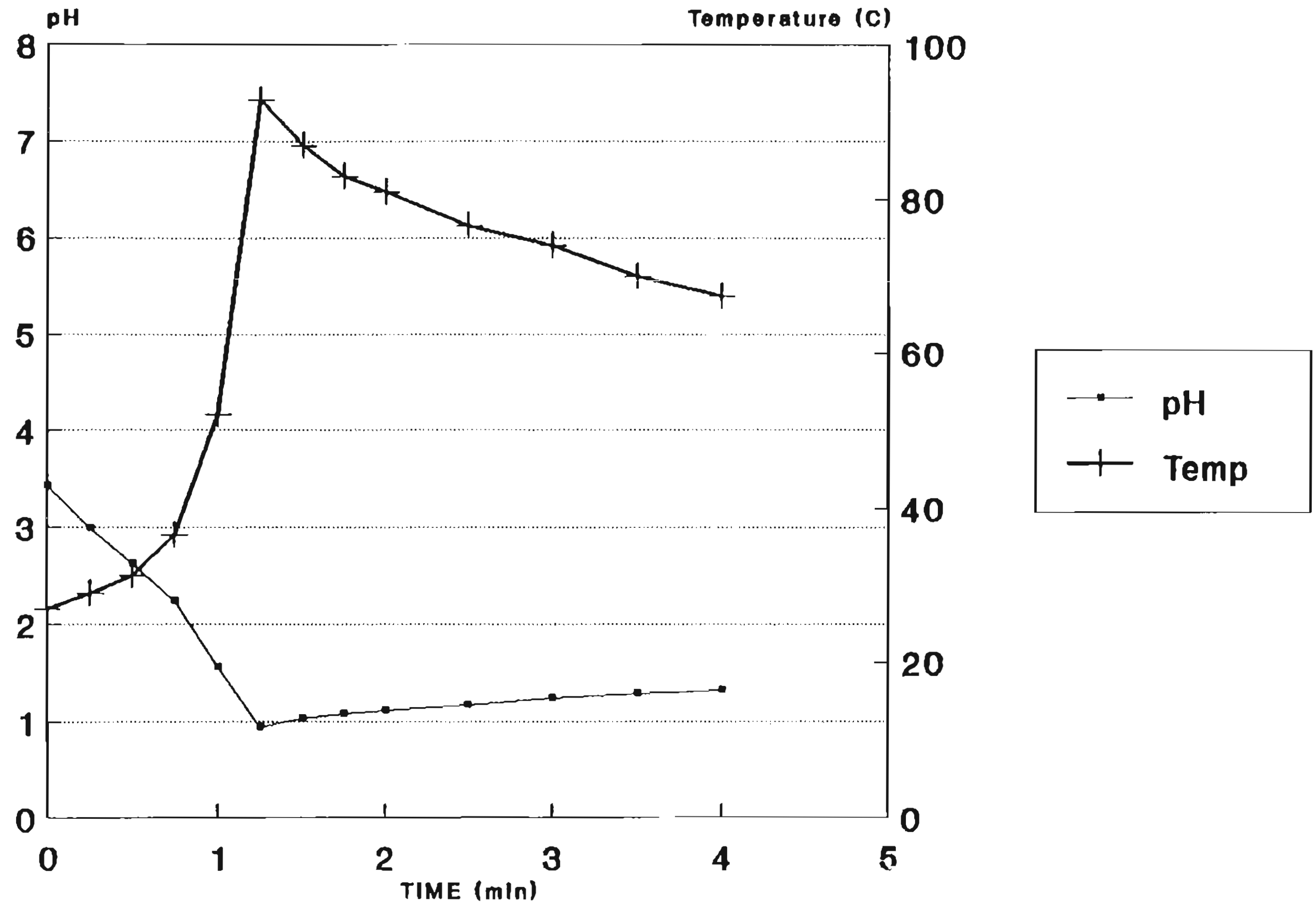


NORANDA BELL TAILING NBT
HYDROGEN PEROXIDE TEST

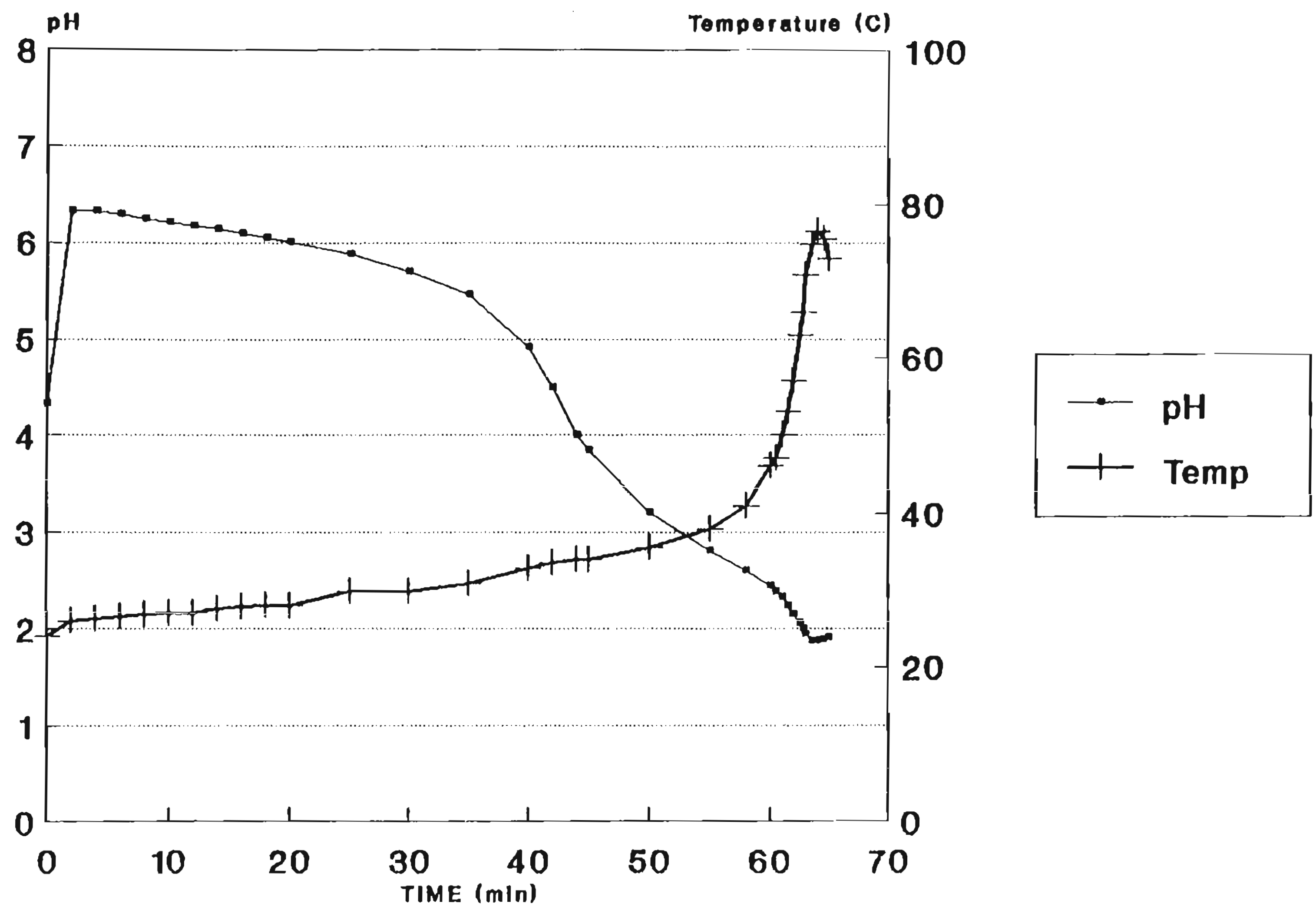



WAITE AMULET TAILING WAT
HYDROGEN PEROXIDE TEST
pH
Temperature (C)
8
7
6
5
4
3
2
1
0
100
80
60
40
20
0
0
1
2
3
4
5
TIME (min)
pH
Temp

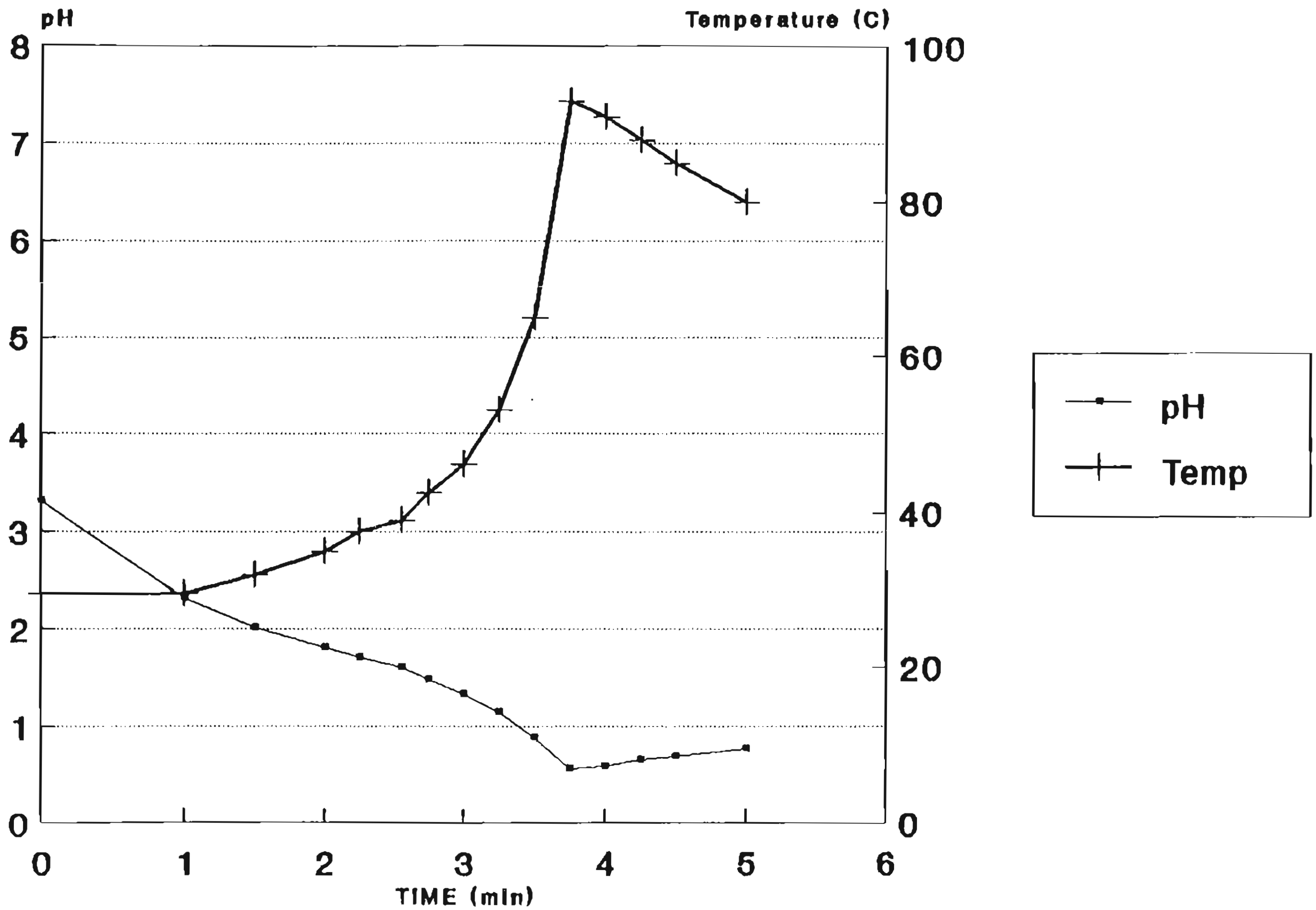
WESTMIN TAILING WMT
HYDROGEN PEROXIDE TEST



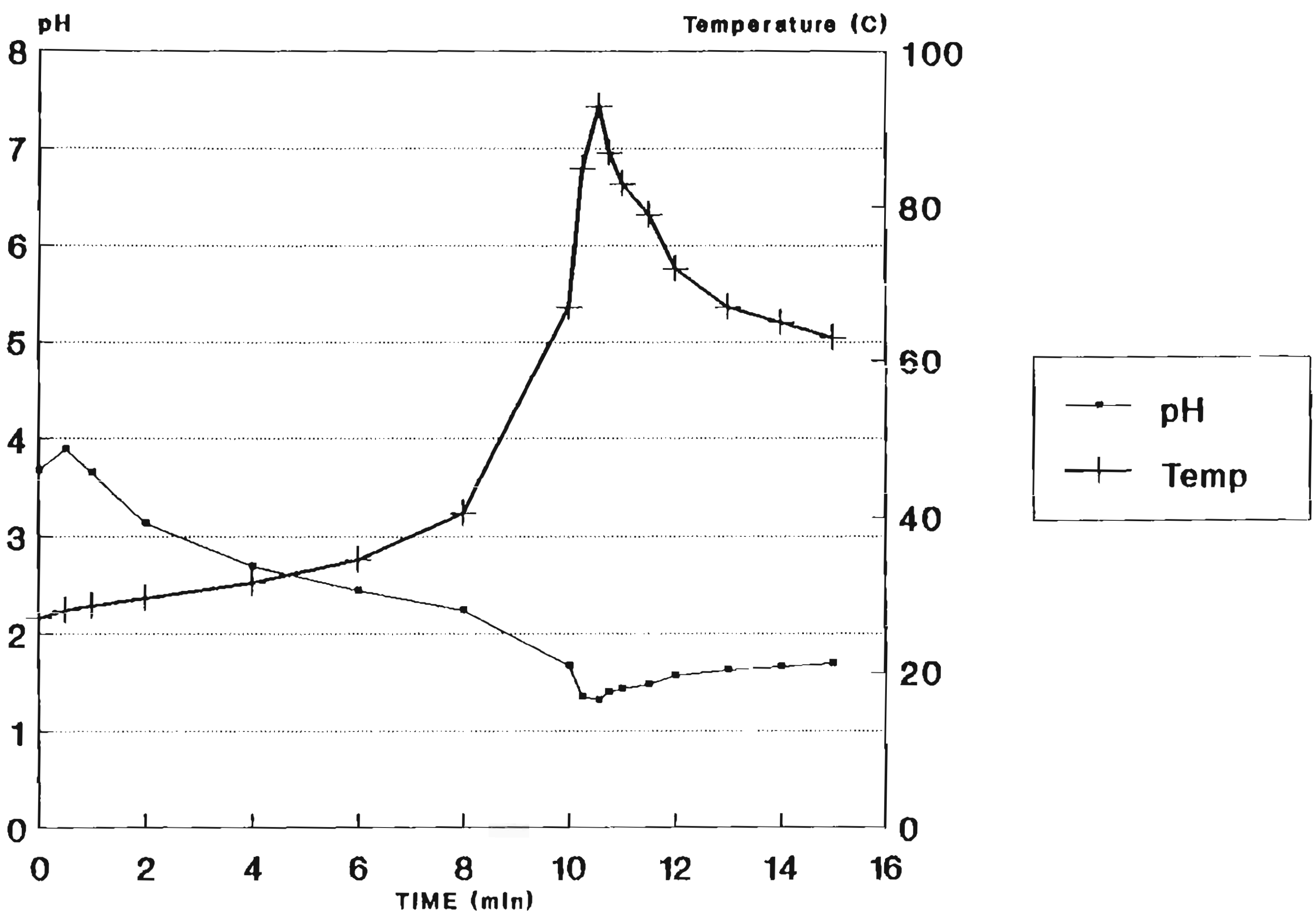
CURRAGH WASTE ROCK CUWR
HYDROGEN PEROXIDE TEST



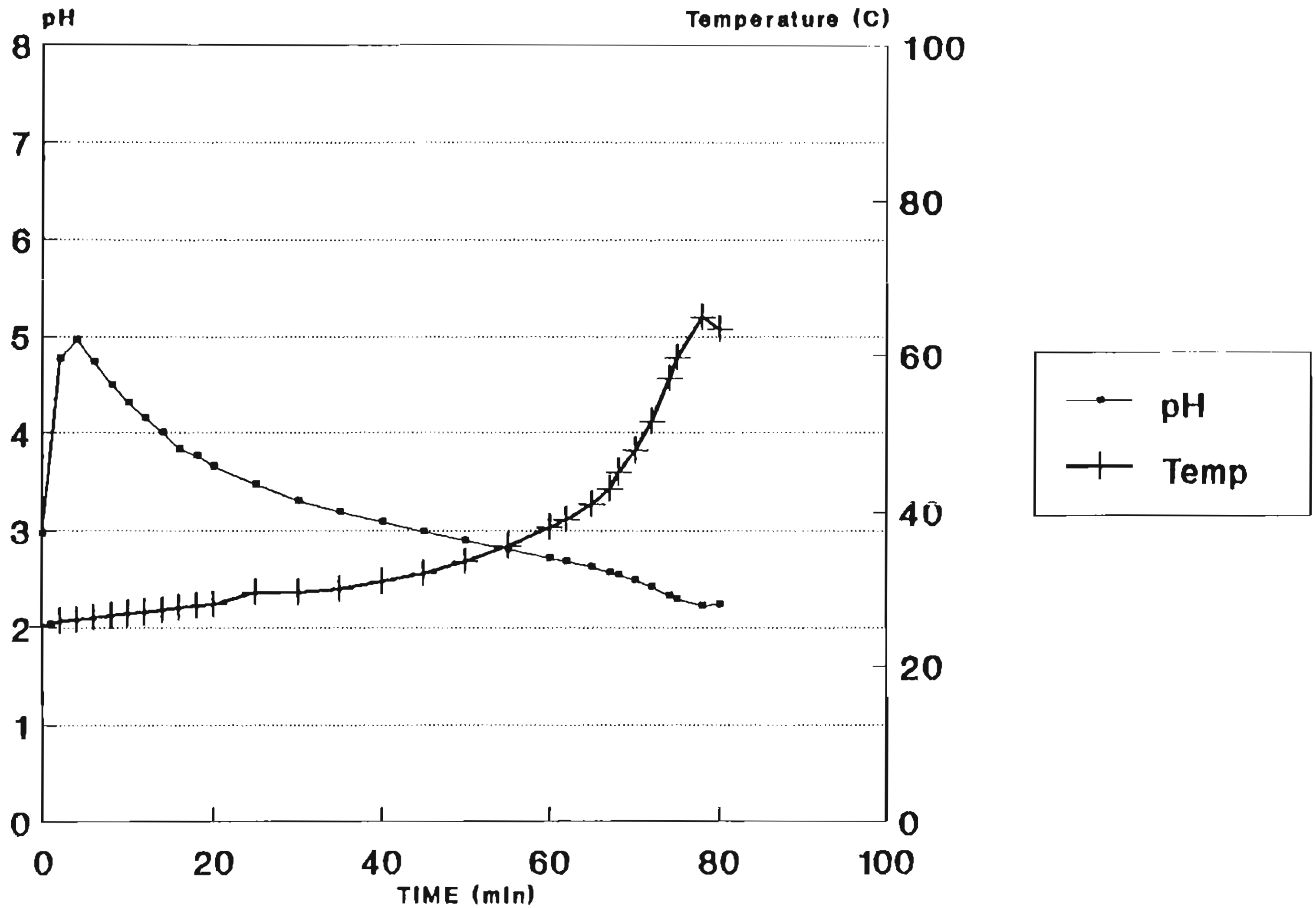
EQUITY SILVER WASTE ROCK ESWR
HYDROGEN PEROXIDE TEST



HEATH STEELE WASTE ROCK HSWR
HYDROGEN PEROXIDE TEST



INCO WASTE ROCK INWR
HYDROGEN PEROXIDE TEST



APPENDIX 7

NET ACID PRODUCTION POTENTIAL TEST DATA

NET ACID PRODUCTION TEST
METHOD B

Sample weight	5.00 g
Volume 15% (v/v) peroxide	100.0 mL
NaOH normality	0.0959
Temperature	25 C
Reaction time before titration	5 min

SAMPLE	pH AFTER REACTION	VOLUME NaOH ADDED (mL) pH 2.2	pH 3.5	pH 7.0
TAILING :				
CUT	1.98	13.1	61.5	91.4
HST	2.03	8.0	31.1	70.3
WASTE ROCK :				
CUWR	2.79	0.0	2.8	10.0
ESWR	1.89	17.5	75.7	88.2
HSWR	2.41	0.0	8.6	17.7
INWR	2.74	0.0	2.0	7.2

NET ACID PRODUCTION TEST
METHOD A

Sample weight	5.00 g
Volume 15% (v/v) peroxide	100.0 mL
NaOH normality	0.0959
Temperature	25 C
Reaction time before titration	1 hour

SAMPLE	pH AFTER REACTION	VOLUME NaOH ADDED (mL) pH 2.2	pH 3.5	pH 7.0
TAILING :				
CUT	2.19	0.5	42.8	85.8
ELT	2.16	0.9	16.0	21.5
EST	4.54	0.0	0.0	7.5
HST	2.08	3.8	21.3	72.2
KLT	7.56	0.0	0.0	0.0
NBT	7.13	0.0	0.0	0.0
WAT	2.14	1.6	22.8	43.0
WMT	2.05	10.7	28.7	50.5
WASTE ROCK :				
CUWR	2.76	0.0	3.5	10.0
ESWR	1.87	19.6	73.0	88.5
HSWR	2.45	0.0	6.4	7.6
INWR	2.71	0.0	2.5	7.1

APPENDIX 8

HUMIDITY CELL TEST DATA

HUMIDITY CELL TEST

Sample: Curragh Tailing CUT

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	5.05	248	798	1000	138	30.88	4.26
2	5.15	248	638	330	173	32.90	7.78
3	4.45	295	594	330	204	103.40	17.40
4	4.52	325	682	340	241	129.60	31.39
5	4.15	378	1520	800	305	263.20	52.45
6	4.68	283	1100	1000	413	819.00	140.90
7	4.14	319	957	1150	523	552.82	193.97
8	4.84	313	1414	1350	678	532.98	255.27
9	4.34	299	1366	1350	830	108.68	267.44
10	4.21	322	887	1050	945	79.50	276.18
11	4.04	318	981	950	1050	279.84	306.96
12	3.79	334	912	1050	1165	264.88	335.97
13	3.85	326	918	1050	1286	367.50	378.42
14	3.62	378	662	400	1323	212.80	398.31
15	3.56	429	962	700	1398	504.00	451.99
16	3.24	413	1168	1200	1500	947.52	532.53
17	3.81	317	2210	2100	1744	2661.23	842.56
18	3.64	408	NA	1400	1896	1573.56	1012.50
19	3.10	388	1960	1600	2043	1803.04	1178.38

HUMIDITY CELL TEST

Sample: Elliot Lake Tailing ELT

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	6.82	253	969	1400	160	2.4	0.27
2	6.72	284	1160	800	247	0.0	0.27
3	6.62	255	682	400	281	0.0	0.27
4	6.51	310	627	360	320	2.4	0.53
5	6.61	388	605	400	358	2.4	0.76
6	7.29	290	5610	330	393	0.0	0.76
7	6.08	283	737	480	434	0.0	0.76
8	6.63	280	420	240	461	0.0	0.76
9	6.29	302	597	330	500	2.4	1.04
10	6.22	312	723	440	554	3.5	1.47
11	6.43	321	921	570	631	2.2	1.76
12	6.05	328	606	380	675	2.2	2.02
13	6.05	307	651	290	707	0.0	2.02
14	5.64	358	508	250	738	0.0	2.02
15	5.44	440	349	190	753	5.6	2.47
16	5.10	398	563	175	767	15.7	3.76
17	5.16	364	458	240	795	479.5	59.38
18	4.85	419	NA	230	822	57.7	66.18
19	4.78	338	443	245	851	77.9	75.22

HUMIDITY CELL TEST

Sample: Equity Silver Tailing EST

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	7.72	238	684	270	31	0.0	0.00
2	7.46	252	429	250	60	0.0	0.00
3	7.24	248	319	180	79	0.0	0.00
4	7.04	291	242	140	93	0.0	0.00
5	7.13	381	627	260	124	0.0	0.00
6	7.21	288	275	170	142	0.0	0.00
7	6.85	287	171	130	153	0.0	0.00
8	7.24	281	594	280	183	0.0	0.00
9	7.24	310	616	300	221	0.0	0.00
10	7.19	304	461	260	252	0.0	0.00
11	7.52	317	404	210	276	0.0	0.00
12	7.24	324	401	240	304	0.0	0.00
13	7.19	294	380	200	328	0.0	0.00
14	7.15	348	122	75	334	0.0	0.00
15	7.16	311	240	130	344	0.0	0.00
16	7.15	316	335	270	379	0.0	0.00
17	7.10	284	305	155	397	0.0	0.00
18	7.29	418	NA	165	417	0.0	0.00
19	7.41	241	170	80	424	0.0	0.00

HUMIDITY CELL TEST

Sample: Heath Steele Tailing HST

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	3.23	330	3140	560	80	23180.00	3303.15
2	3.52	328	1540	1600	254	1818.90	3501.41
3	3.43	355	1380	1200	373	2298.30	3728.94
4	3.22	360	1950	800	466	4776.00	4282.96
5	3.04	349	4620	3200	872	9230.80	5455.27
6	2.87	347	4070	2900	1232	8849.75	6552.64
7	3.09	369	2110	2100	1478	8743.61	7575.64
8	2.93	387	2020	1700	1683	5197.50	8204.54
9	2.72	361	4960	4600	2254	16334.32	10229.99
10	2.75	370	3090	2700	2575	9520.00	11362.87
11	2.48	405	2480	2200	2819	6595.60	12094.99
12	2.87	400	3040	2800	3169	7296.08	13007.00
13	2.96	395	2460	1950	3401	5654.60	13679.89
14	2.94	415	2210	1900	3637	5107.20	14313.19
15	3.08	404	991	500	3678	1316.00	14422.41
16	2.62	391	4120	3250	4081	10668.00	15745.25
17	2.87	426	2280	1750	4296	6065.67	16488.29
18	2.73	419	2480	1900	4519	6854.10	17293.65
19	2.69	408	2890	2300	4785	NA	NA

HUMIDITY CELL TEST

Sample: Key Lake Tailing KLT

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	7.81	254	1790	1300	116	0.00	0.00
2	8.03	236	2040	1900	321	0.00	0.00
3	7.53	252	1900	1600	483	0.00	0.00
4	7.46	281	1730	1400	644	0.00	0.00
5	7.38	342	1980	1800	807	0.00	0.00
6	7.48	276	1830	1850	998	0.00	0.00
7	7.47	274	1870	1850	1148	0.00	0.00
8	7.54	295	2030	1850	1344	0.00	0.00
9	5.55	306	2040	2250	1607	0.00	0.00
10	7.69	279	1659	1600	1789	0.00	0.00
11	7.98	297	1466	1400	1970	0.00	0.00
12	7.46	323	1168	1300	2121	0.00	0.00
13	7.62	300	1066	1050	2244	0.00	0.00
14	7.70	328	1146	1550	2441	0.00	0.00
15	7.60	253	1963	1800	2553	0.00	0.00
16	7.64	287	1371	1200	2684	0.00	0.00
17	7.66	269	1849	1750	2847	0.00	0.00
18	7.07	401	1669	1600	3029	0.00	0.00
19	7.69	242	1395	1400	3191	0.00	0.00

HUMIDITY CELL TEST

Sample: Noranda Bell Tailing NBT

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	7.60	245	257	200	24	0.00	0.00
2	7.70	236	341	180	44	0.00	0.00
3	7.71	244	385	190	65	0.00	0.00
4	7.58	269	330	170	84	0.00	0.00
5	4.53	272	1020	600	133	1182.05	96.93
6	6.53	290	438	240	160	0.00	96.93
7	6.98	254	310	190	182	0.00	96.93
8	7.84	276	322	150	199	0.00	96.93
9	7.41	289	457	240	230	0.00	96.93
10	7.59	263	351	190	254	0.00	96.93
11	8.00	287	287	155	272	0.00	96.93
12	7.48	313	238	130	287	0.00	96.93
13	7.53	276	256	135	303	0.00	96.93
14	7.58	317	303	155	323	0.00	96.93
15	7.55	255	1156	100	330	0.00	96.93
16	7.64	221	306	150	347	0.00	96.93
17	7.03	280	180	100	355	0.00	96.93
18	7.33	396	420	240	385	0.00	96.93
19	7.42	226	426	220	414	0.00	96.93

HUMIDITY CELL TEST

Sample: Waite Amulet Tailing WAT

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	4.03	239	2050	2100	250	5400.30	642.64
2	4.12	258	924	1200	378	1236.10	774.90
3	3.59	300	660	330	410	1254.90	894.11
4	3.85	256	1090	670	481	1795.20	1086.20
5	2.90	358	1200	1400	592	2237.20	1262.94
6	2.86	359	1270	1200	712	2727.73	1535.71
7	2.89	384	1620	1550	842	3902.85	1863.55
8	3.14	349	1818	1650	1030	2948.40	2199.67
9	3.28	333	1301	1200	1157	2220.75	2435.07
10	3.26	345	1163	1200	1287	4824.00	2956.06
11	3.42	307	1731	1600	1464	4829.44	3489.71
12	3.43	299	1714	1550	1639	2271.28	3746.37
13	3.34	327	1418	1250	1767	1886.50	3939.73
14	3.54	312	1631	1200	1924	2940.00	4324.87
15	2.99	407	NA	500	1963	1646.40	4453.29
16	2.83	410	1639	1250	2063	2800.00	4677.29
17	3.10	382	2510	2500	2338	4564.84	5179.43
18	2.98	401	1853	1700	2527	4149.66	5640.04
19	2.95	397	2200	1950	2761	4061.56	6127.43

HUMIDITY CELL TEST

Sample: Westmin Tailing WMT

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	7.40	174	980	1000	111	0.00	0.00
2	6.70	244	424	220	135	0.00	0.00
3	6.53	258	407	260	162	32.90	3.42
4	5.89	304	473	290	197	19.20	5.73
5	4.84	315	308	180	210	37.60	8.36
6	5.20	347	572	320	246	18.20	10.45
7	4.38	335	451	280	277	602.44	75.51
8	4.39	331	459	220	301	91.66	85.60
9	4.30	336	598	295	335	51.98	91.63
10	4.70	316	603	290	370	68.00	99.79
11	4.05	348	342	180	387	74.80	106.85
12	4.46	335	630	340	426	35.20	110.90
13	4.31	331	740	380	472	88.20	121.57
14	4.33	322	688	370	519	46.48	127.48
15	3.79	386	342	155	531	263.20	147.88
16	3.44	391	993	450	560	812.00	200.66
17	3.38	357	2170	1110	695	6248.84	959.89
18	3.14	396	2190	1900	935	5513.04	1654.53
19	3.22	375	1334	1550	1112	2081.52	1892.87

HUMIDITY CELL TEST

Sample: Curragh Waste Rock CUWR

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	7.74	185	479	220	23	0.00	0.00
2	7.50	229	242	130	37	0.00	0.00
3	7.50	240	242	150	51	0.00	0.00
4	7.34	280	341	170	69	0.00	0.00
5	7.04	307	253	130	80	0.00	0.00
6	7.03	319	165	125	92	0.00	0.00
7	6.72	322	176	125	105	0.00	0.00
8	6.88	294	219	120	117	0.00	0.00
9	7.44	308	188	100	127	0.00	0.00
10	7.28	296	204	120	140	0.00	0.00
11	7.85	296	217	125	154	0.00	0.00
12	7.49	302	143	70	162	0.00	0.00
13	7.41	299	206	110	174	0.00	0.00
14	7.44	296	211	110	188	0.00	0.00
15	7.33	254	120	40	191	0.00	0.00
16	7.62	231	202	120	207	0.00	0.00
17	7.04	279	134	10	208	0.00	0.00
18	7.06	388	138	35	212	0.00	0.00
19	7.14	227	134	35	216	0.00	0.00

HUMIDITY CELL TEST

Sample: Equity Silver Waste Rock ESWR

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	7.10	202	342	190	24	0.00	0.00
2	6.10	258	199	140	40	0.00	0.00
3	5.71	229	187	130	53	9.40	0.96
4	4.91	284	352	195	74	52.80	6.77
5	4.77	307	330	195	92	51.70	11.37
6	4.74	306	275	180	113	50.05	17.17
7	4.24	325	240	165	129	122.85	29.46
8	4.67	291	297	170	148	87.41	39.07
9	4.43	299	325	180	169	93.56	50.39
10	4.46	294	255	145	188	99.00	62.72
11	4.34	305	198	120	200	57.20	68.78
12	4.33	317	329	165	220	116.60	82.48
13	4.38	305	270	155	238	166.60	101.73
14	4.20	330	263	125	254	109.20	115.92
15	4.18	309	227	120	265	84.00	123.57
16	3.91	337	315	170	281	179.76	140.37
17	4.04	312	383	200	306	456.00	198.29
18	3.88	384	254	150	323	226.92	223.25
19	3.55	381	353	180	342	354.00	262.36

HUMIDITY CELL TEST

Sample: Heath Steele Waste Rock HSWR

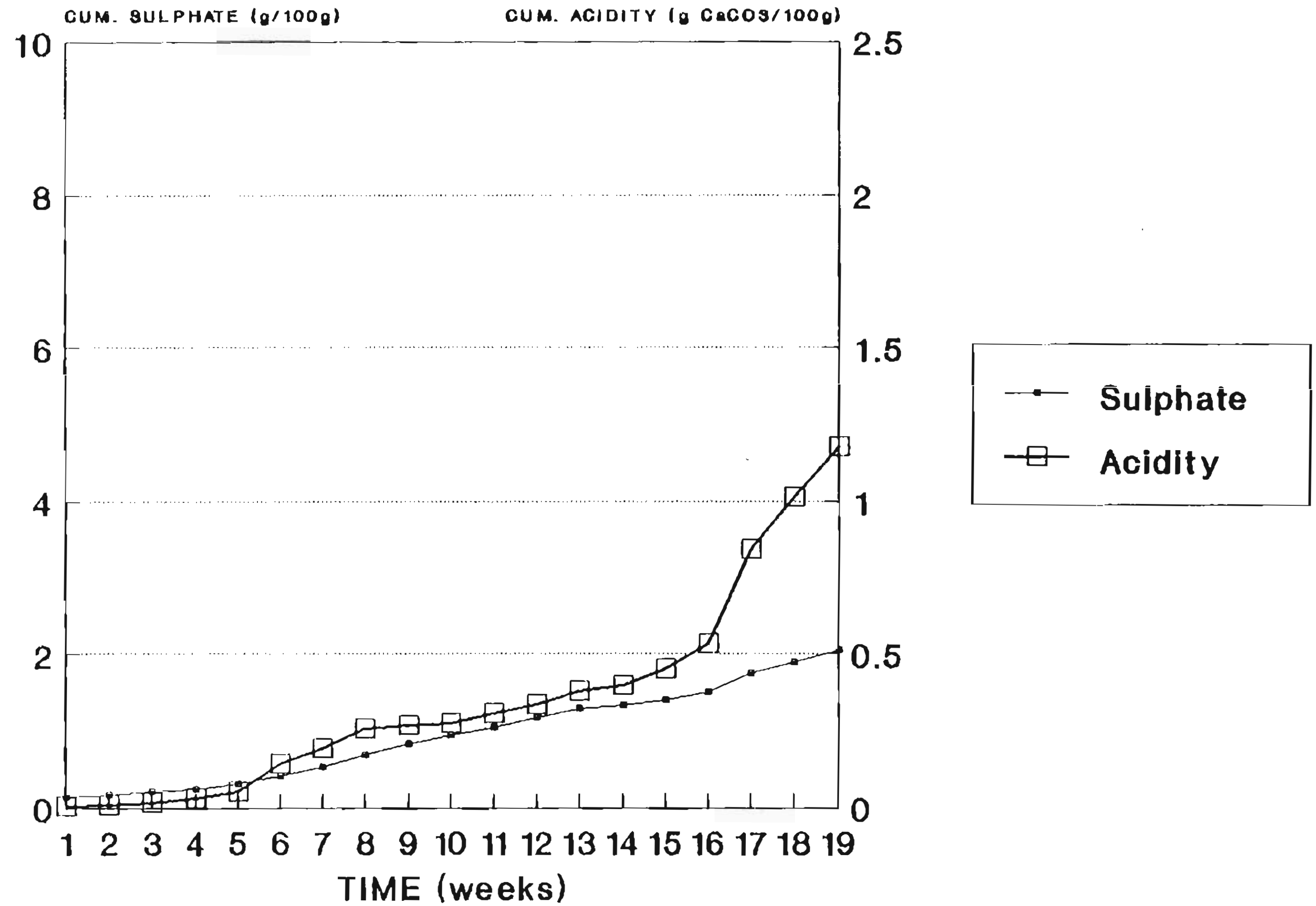
CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	7.71	198	513	210	36	0.00	0.00
2	6.58	252	429	160	53	0.00	0.00
3	6.40	234	209	120	64	2.35	0.21
4	6.34	295	319	175	82	4.80	0.71
5	6.10	296	341	180	99	2.35	0.93
6	6.14	308	231	160	114	4.55	1.37
7	5.71	281	253	175	130	0.00	1.37
8	6.27	279	330	180	148	0.00	1.37
9	6.54	289	361	210	171	1.89	1.58
10	5.73	285	342	180	190	5.00	2.11
11	6.75	286	620	330	232	0.00	2.11
12	6.46	306	284	160	250	0.00	2.11
13	6.41	288	265	145	264	0.00	2.11
14	6.51	315	399	190	287	11.20	3.45
15	6.23	271	356	160	305	0.00	3.45
16	6.54	274	329	190	326	14.00	5.04
17	6.18	304	376	200	352	0.00	5.04
18	5.50	382	305	150	368	4.65	5.55
19	5.78	231	468	260	391	26.43	7.88

HUMIDITY CELL TEST

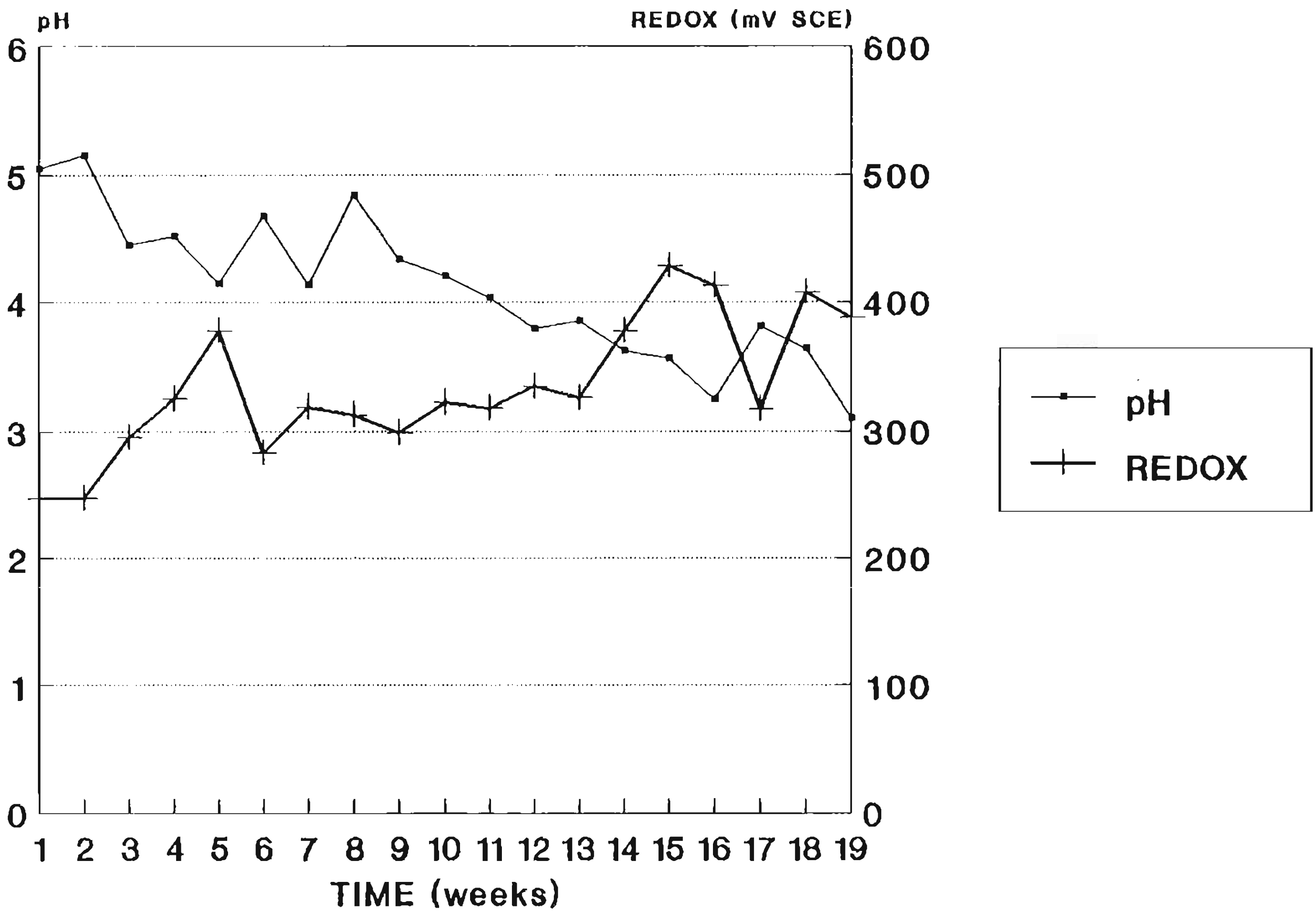
Sample: Inco Waste Rock IWR

CYCLE	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	CUM. SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	7.19	196	399	190	24	0.00	0.00
2	6.94	249	308	180	43	0.00	0.00
3	6.60	230	165	110	55	2.35	0.25
4	6.11	317	187	120	68	4.80	0.75
5	6.23	299	429	225	87	0.00	0.75
6	6.19	293	198	125	100	13.65	2.12
7	5.92	351	176	130	114	0.00	2.12
8	6.41	284	253	135	127	0.00	2.12
9	4.54	324	282	160	146	2.65	2.42
10	5.59	273	285	155	165	6.50	3.23
11	6.19	282	216	140	182	4.40	3.75
12	6.08	300	165	110	194	6.60	4.48
13	5.98	279	242	100	206	9.80	5.62
14	5.71	303	269	140	225	5.60	6.41
15	5.98	221	160	120	236	2.80	6.67
16	5.50	232	212	120	247	9.52	7.48
17	5.58	289	222	130	263	40.76	12.56
18	5.39	357	173	105	275	18.60	14.69
19	5.18	277	233	125	289	25.96	17.71

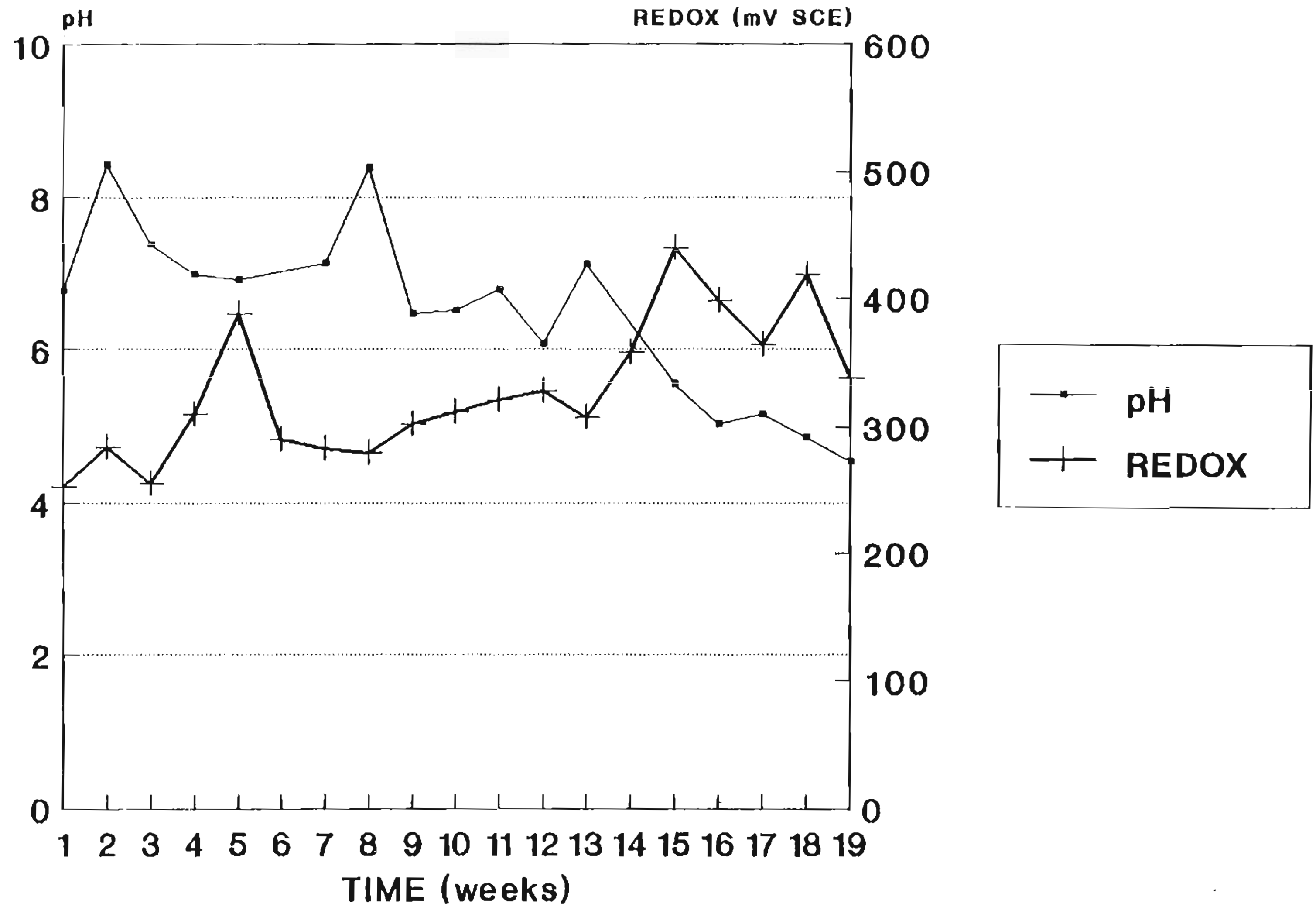
HUMIDITY CELL TEST
CURRAGH TAILING



HUMIDITY CELL TEST
CURRAGH TAILING



HUMIDITY CELL TEST
ELLIOT LAKE TAILING



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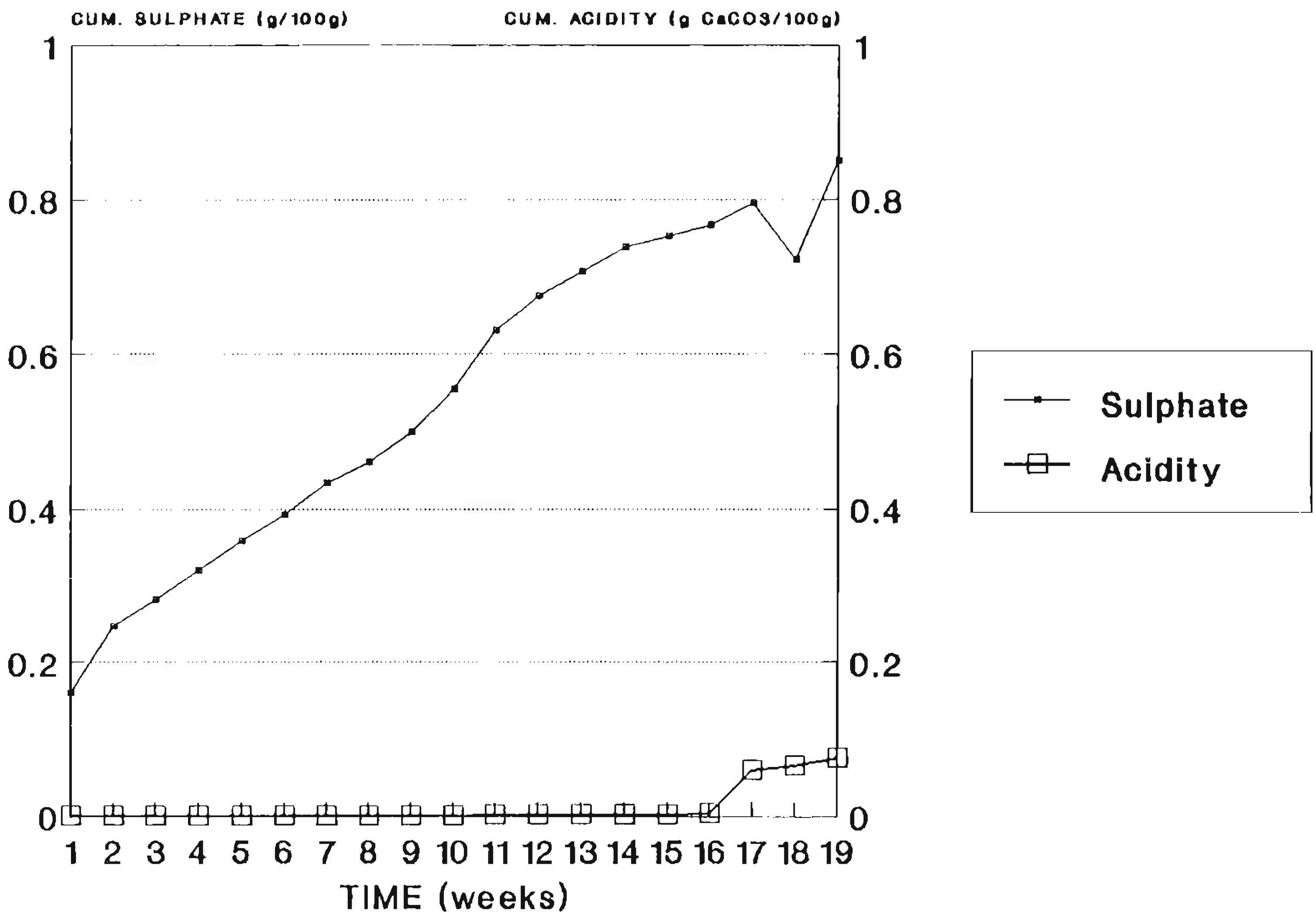

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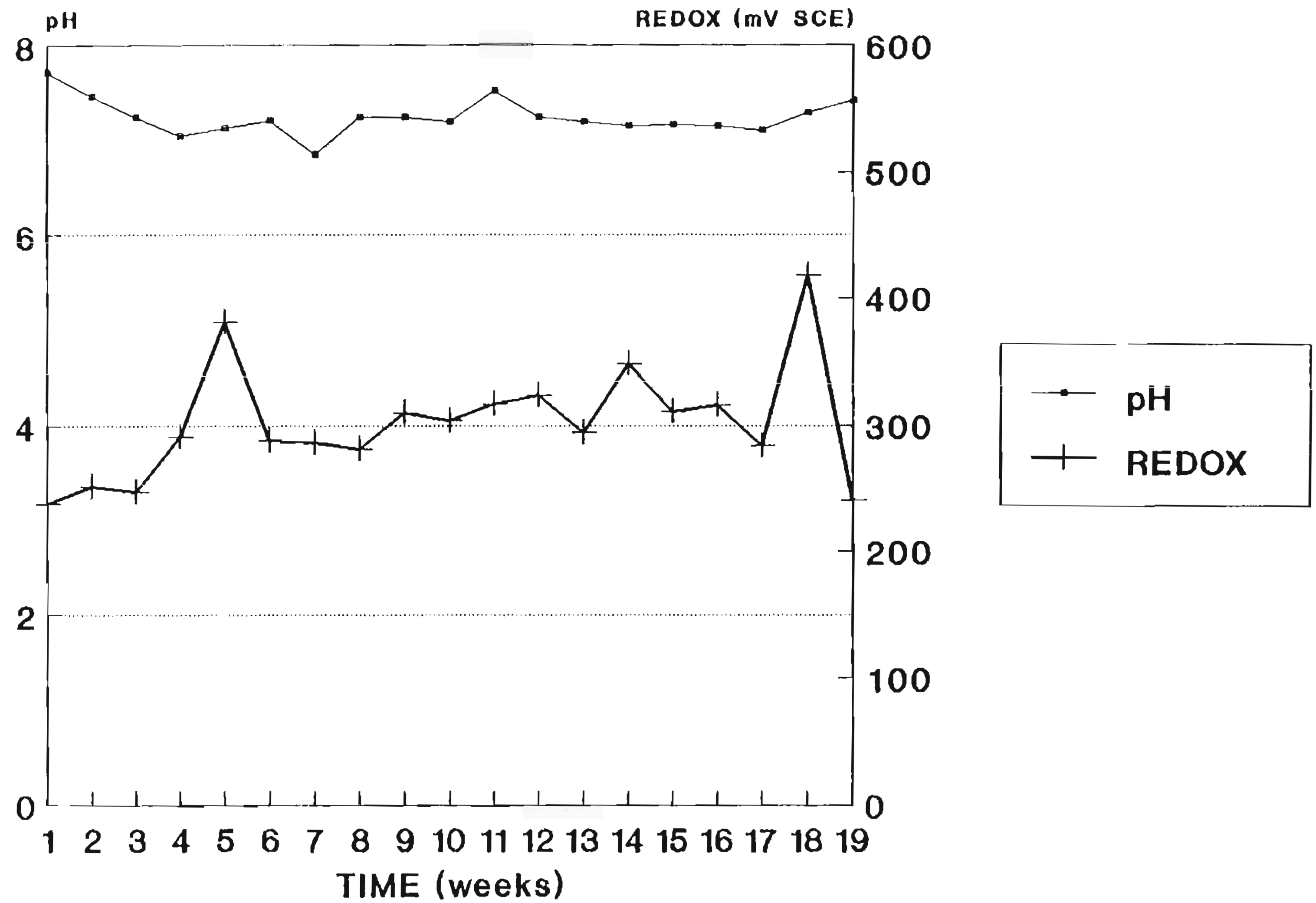

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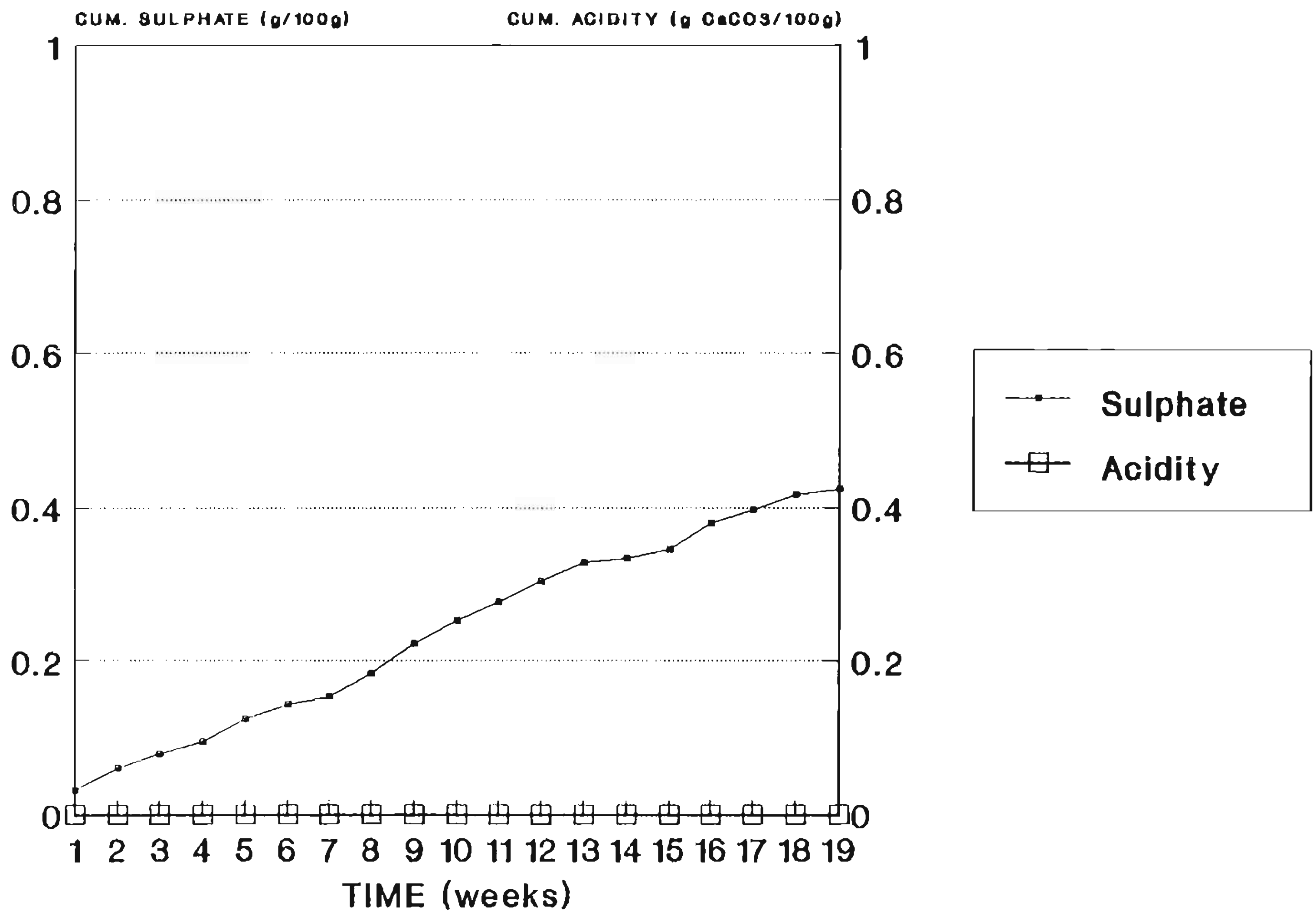

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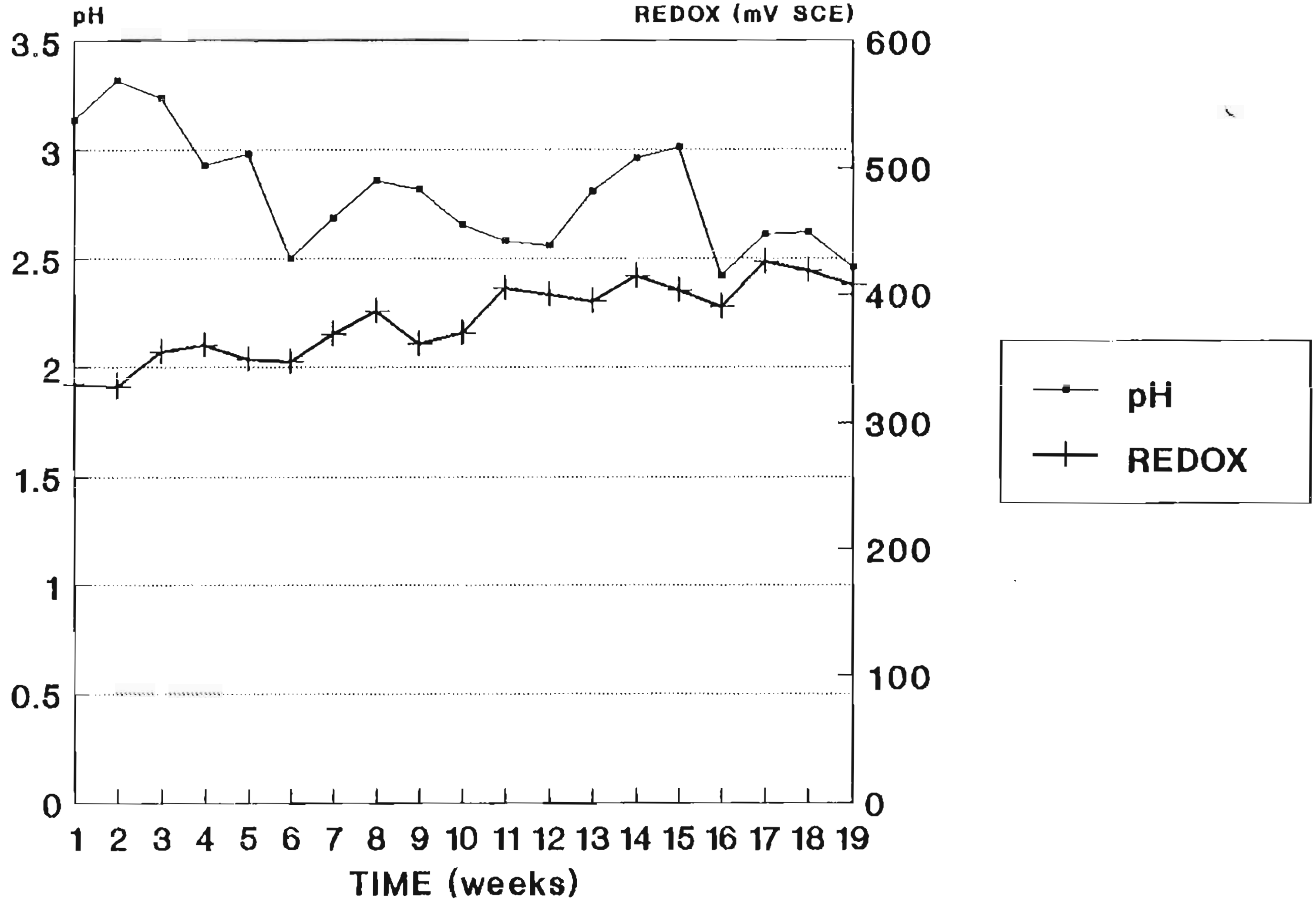

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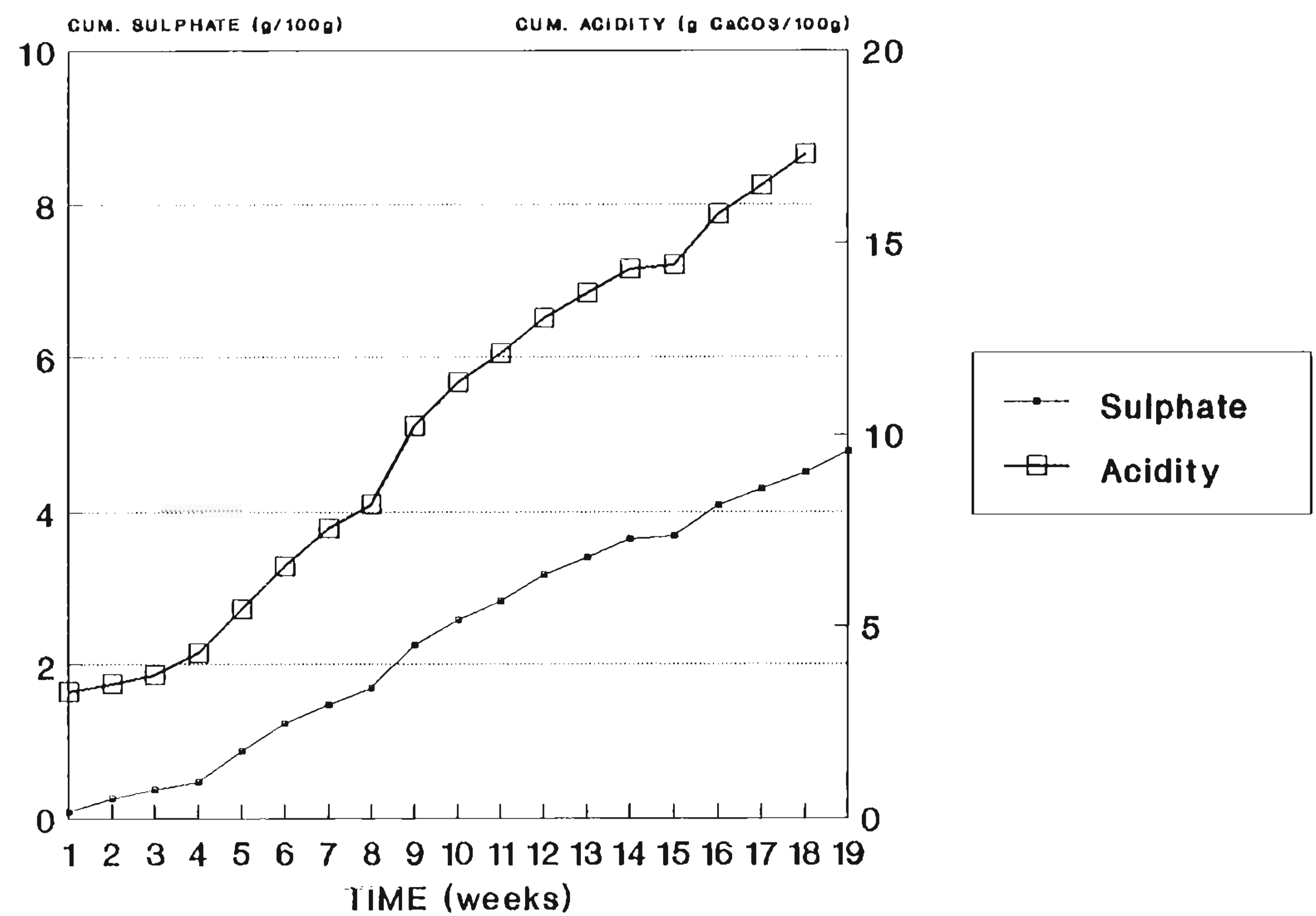

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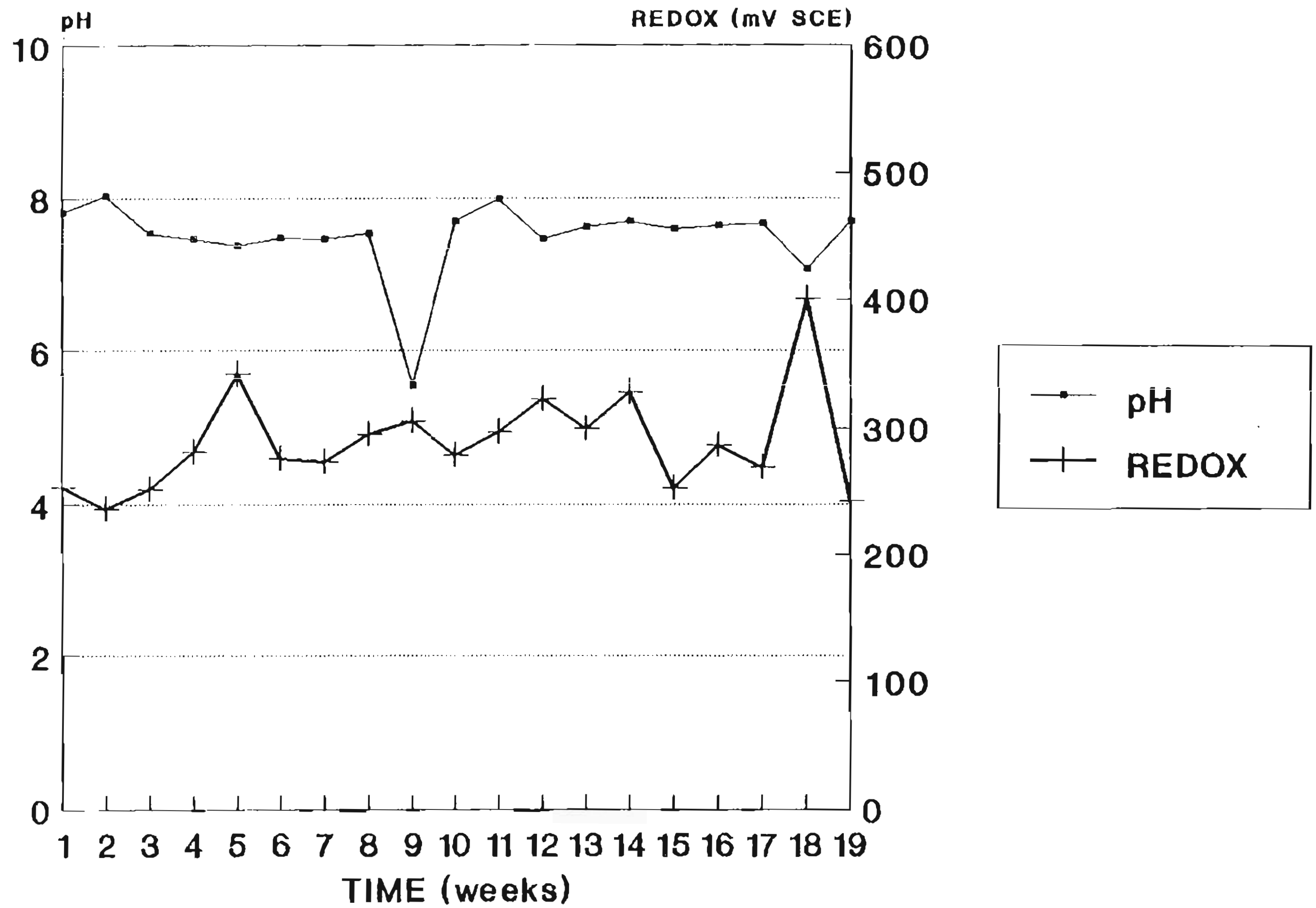

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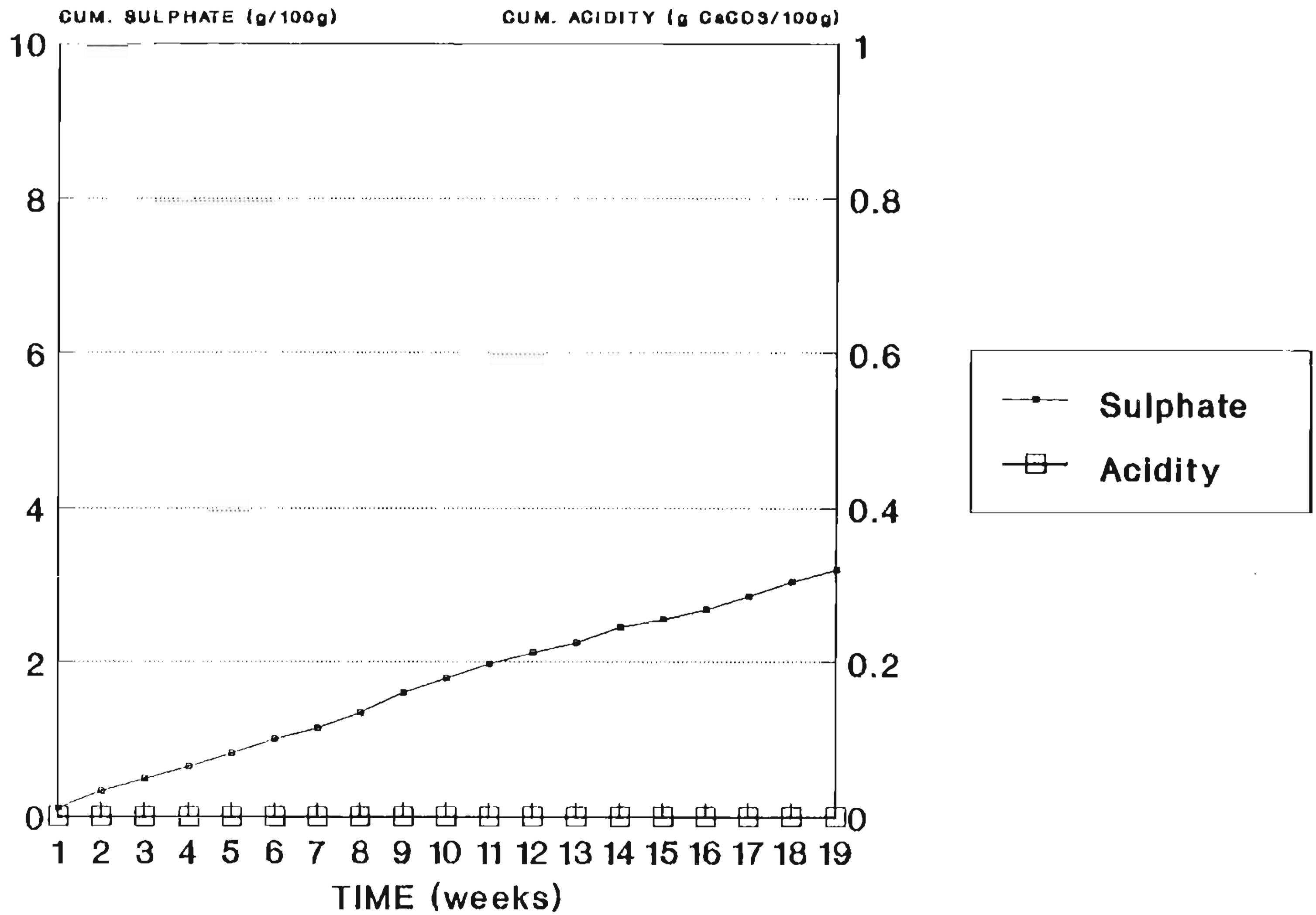

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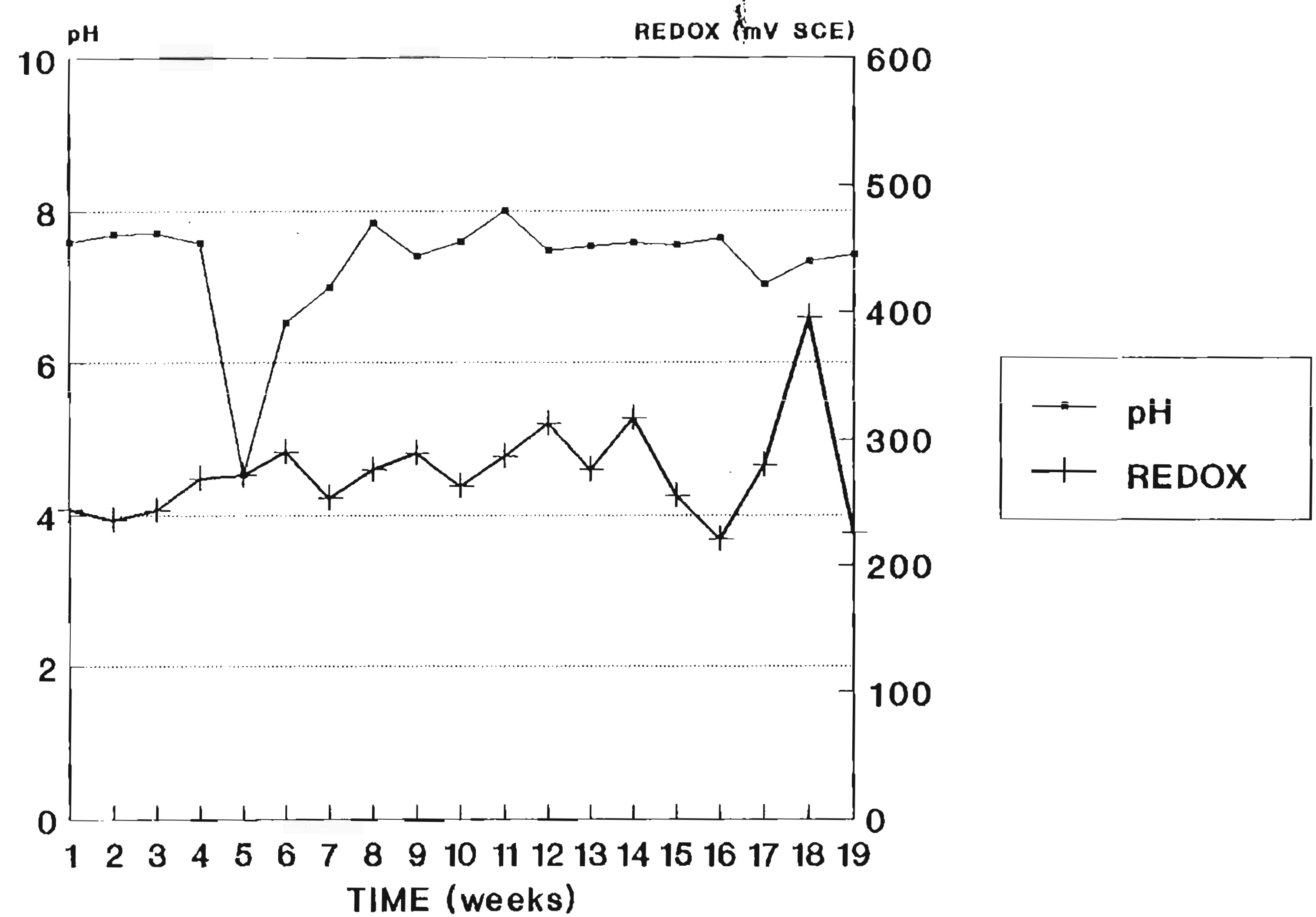

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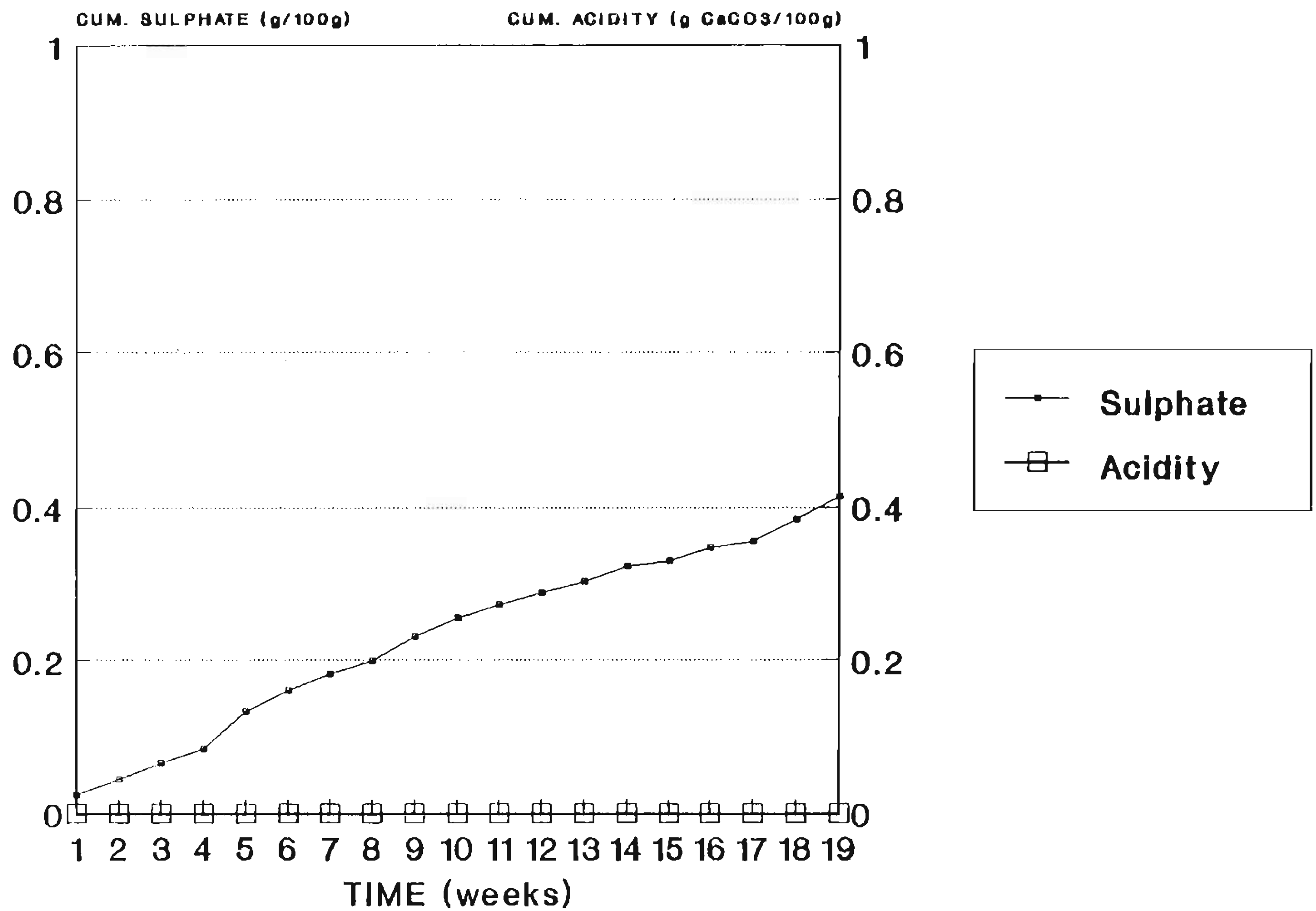

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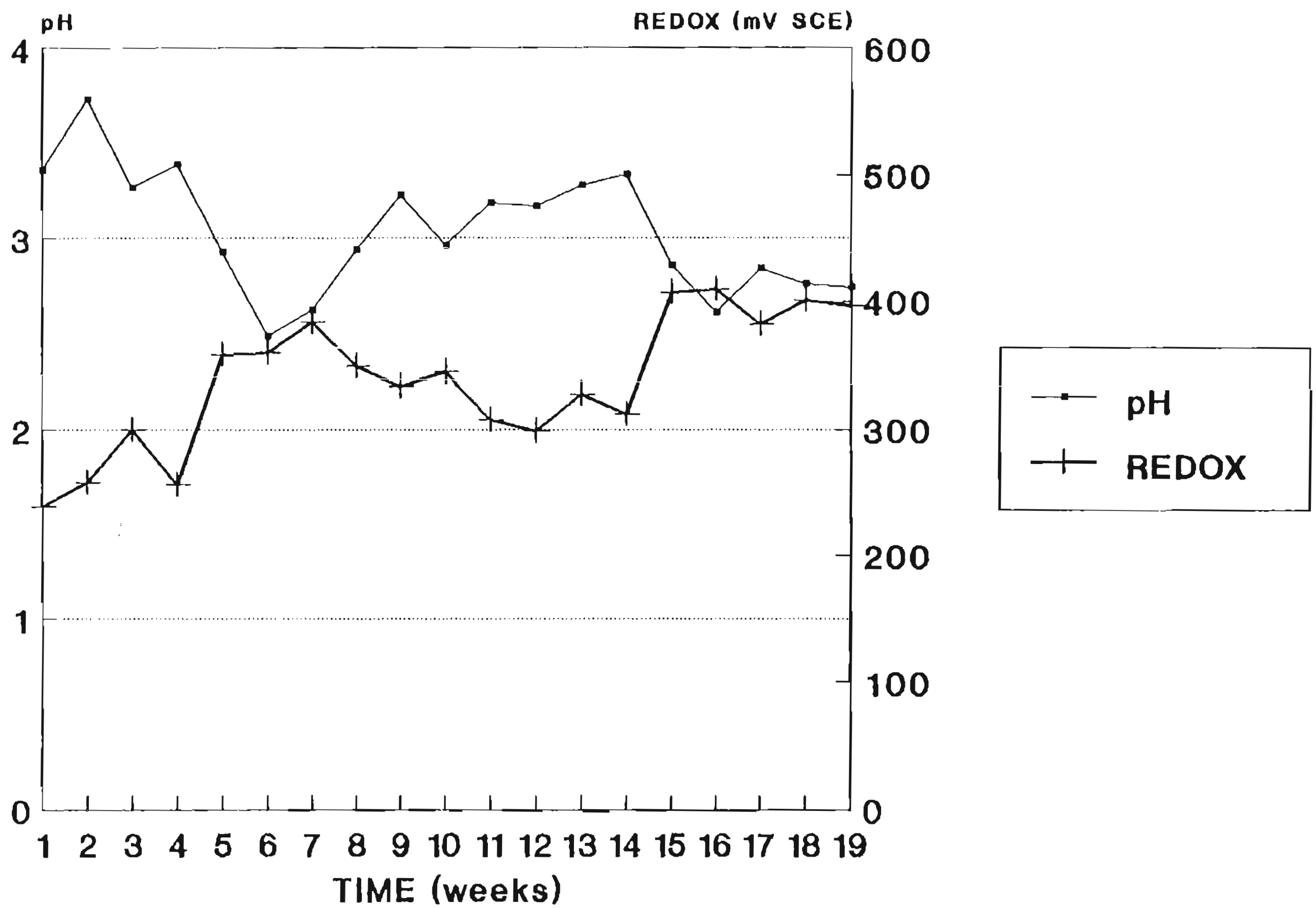

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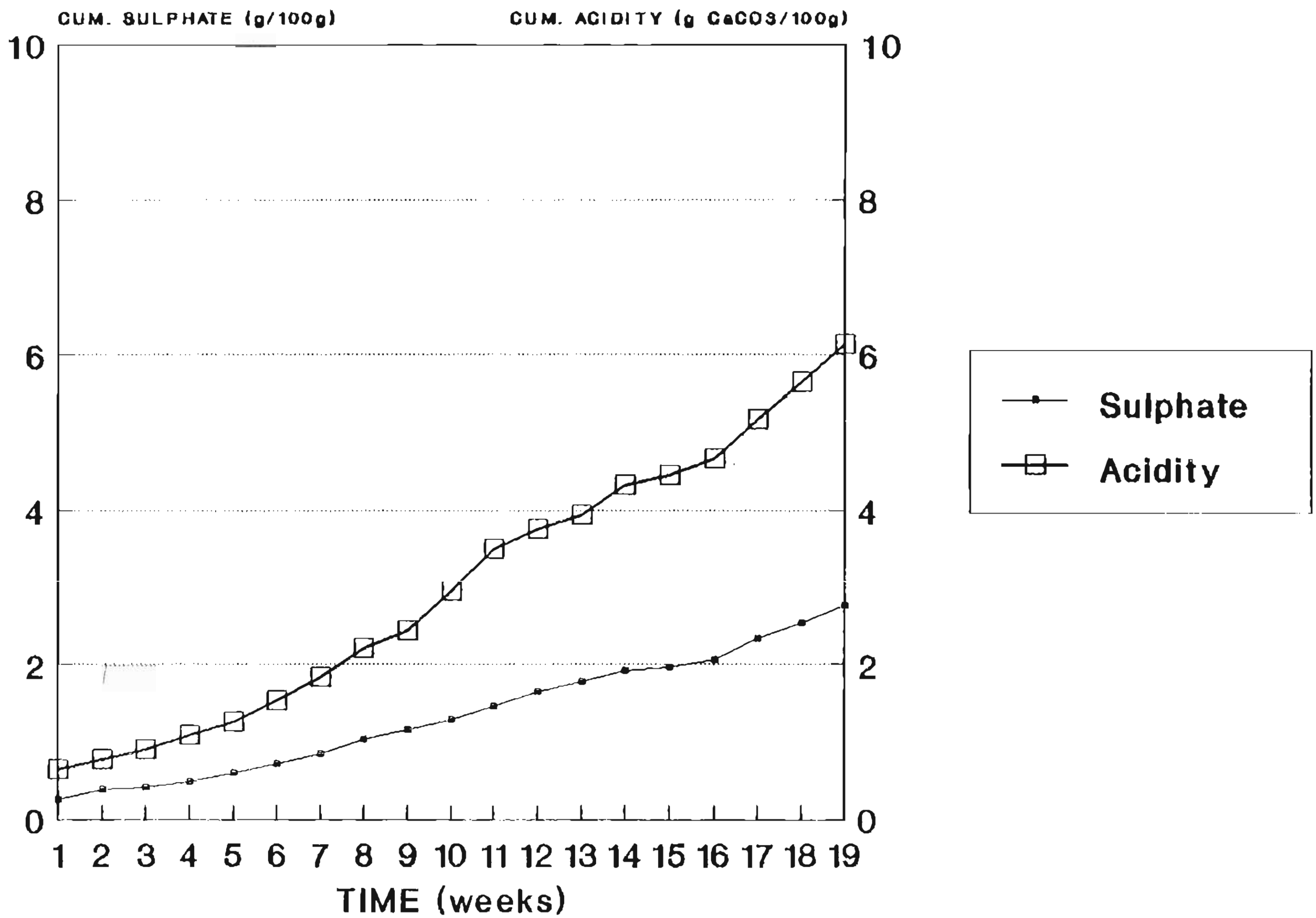
WAITE AMULET TAILING



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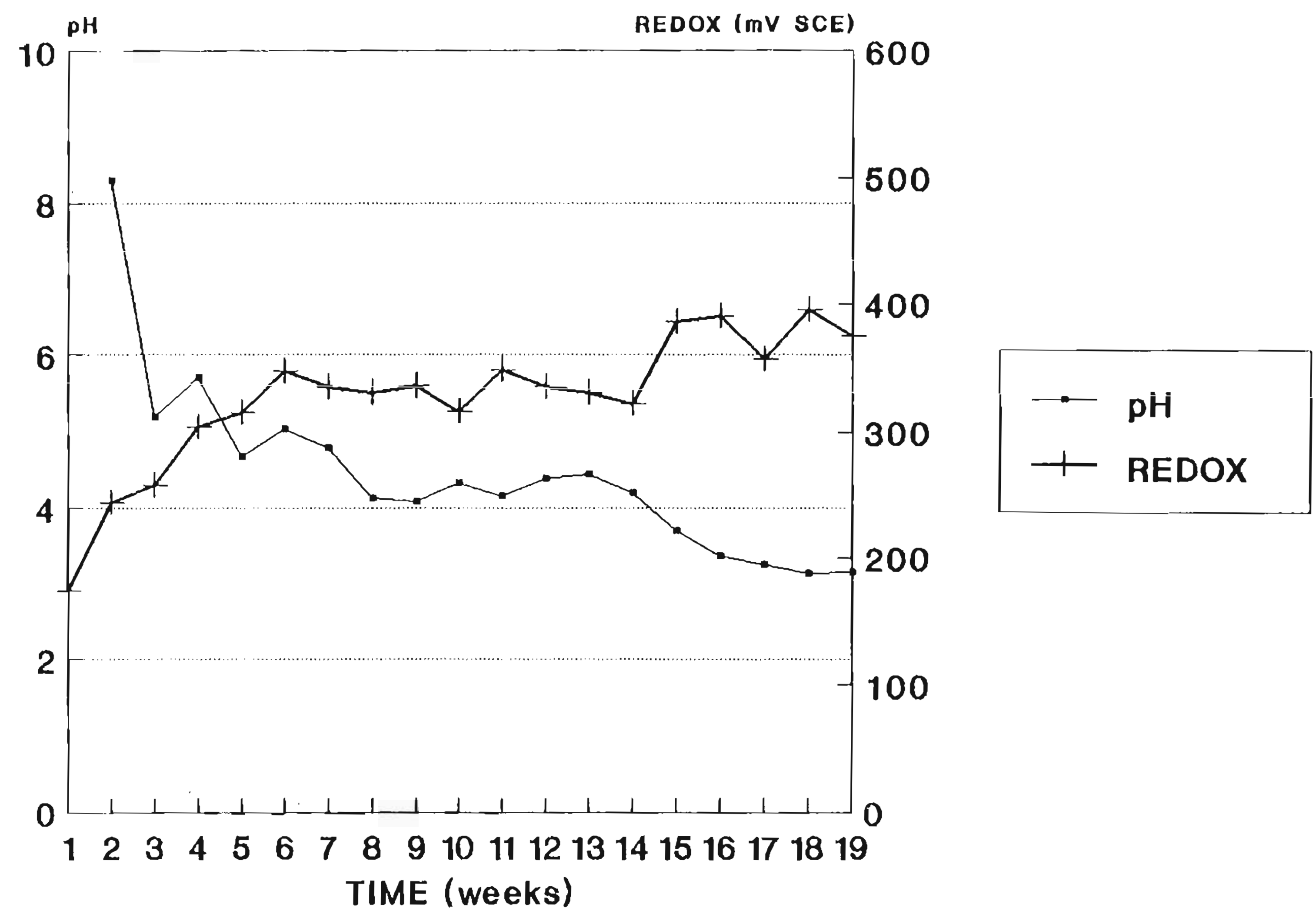
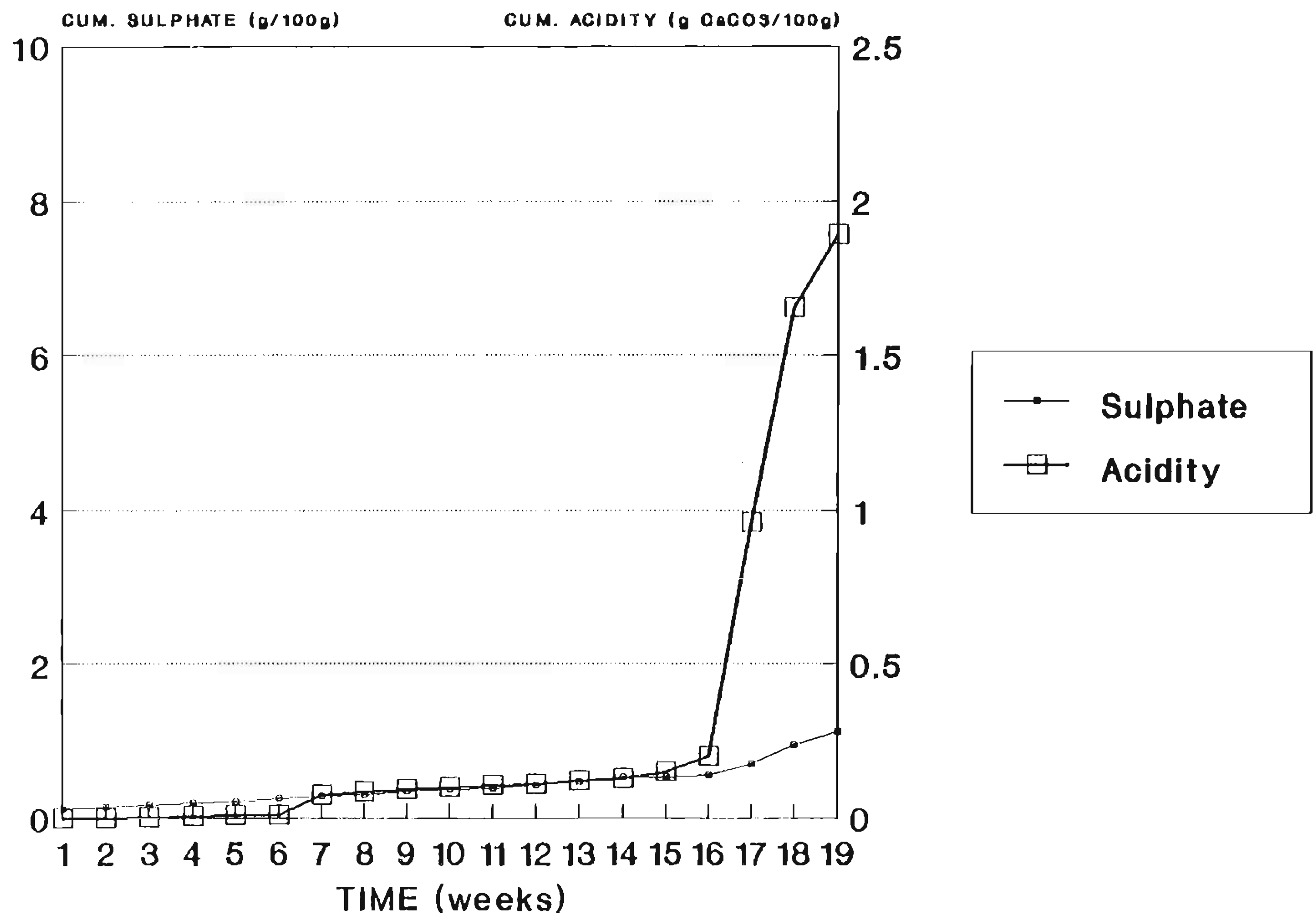
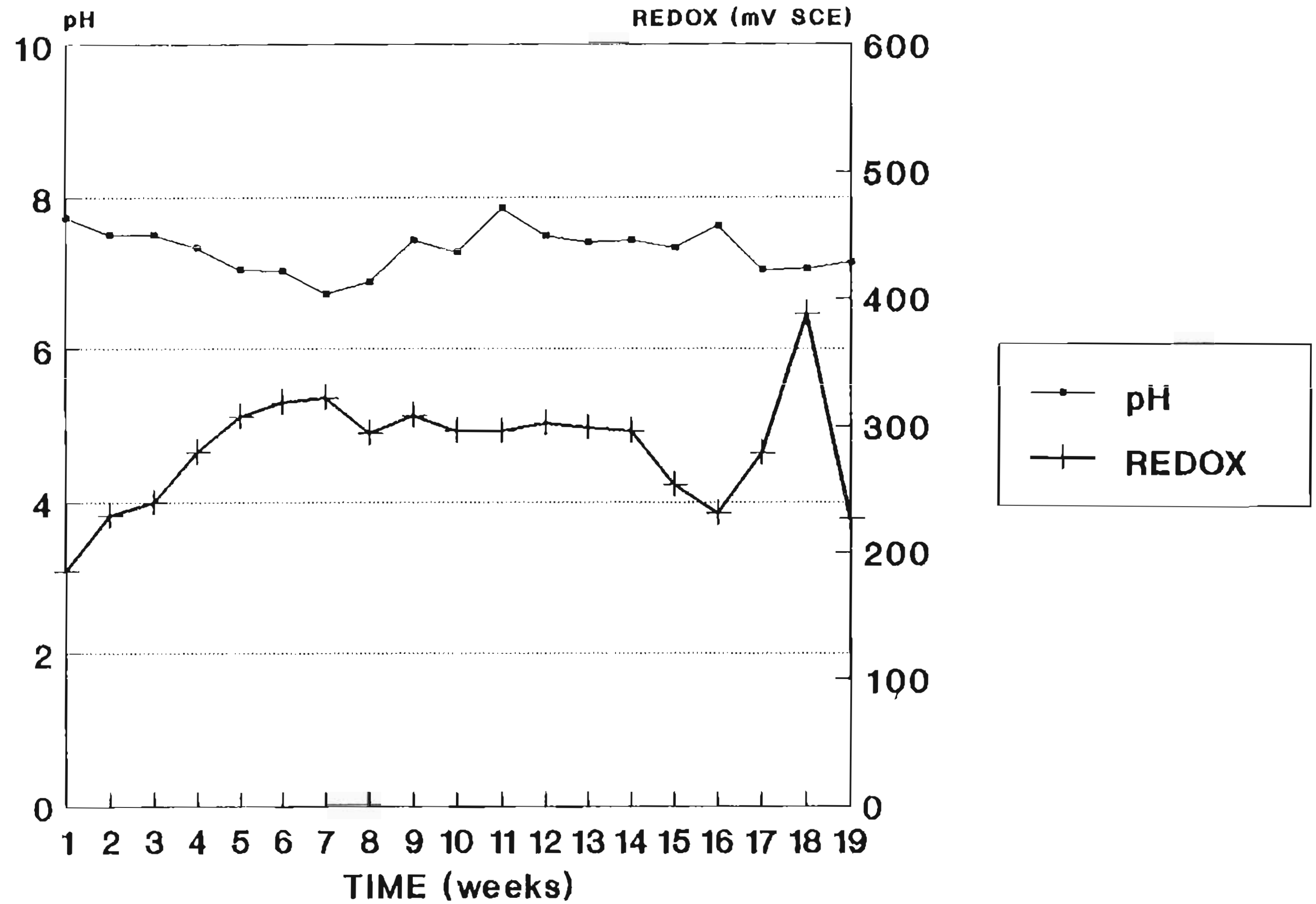


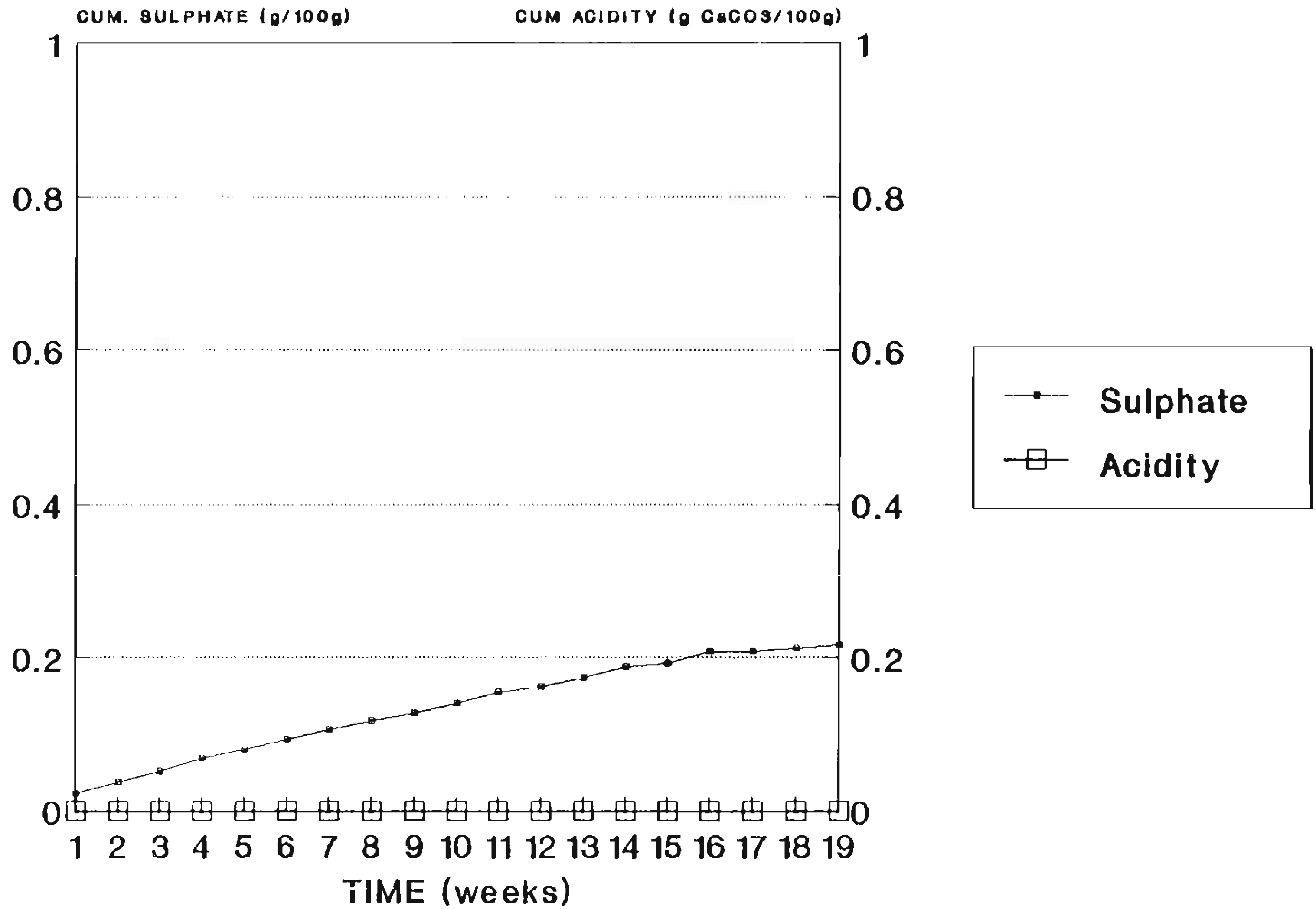
HUMIDITY CELL TEST
WESTMIN TAILING



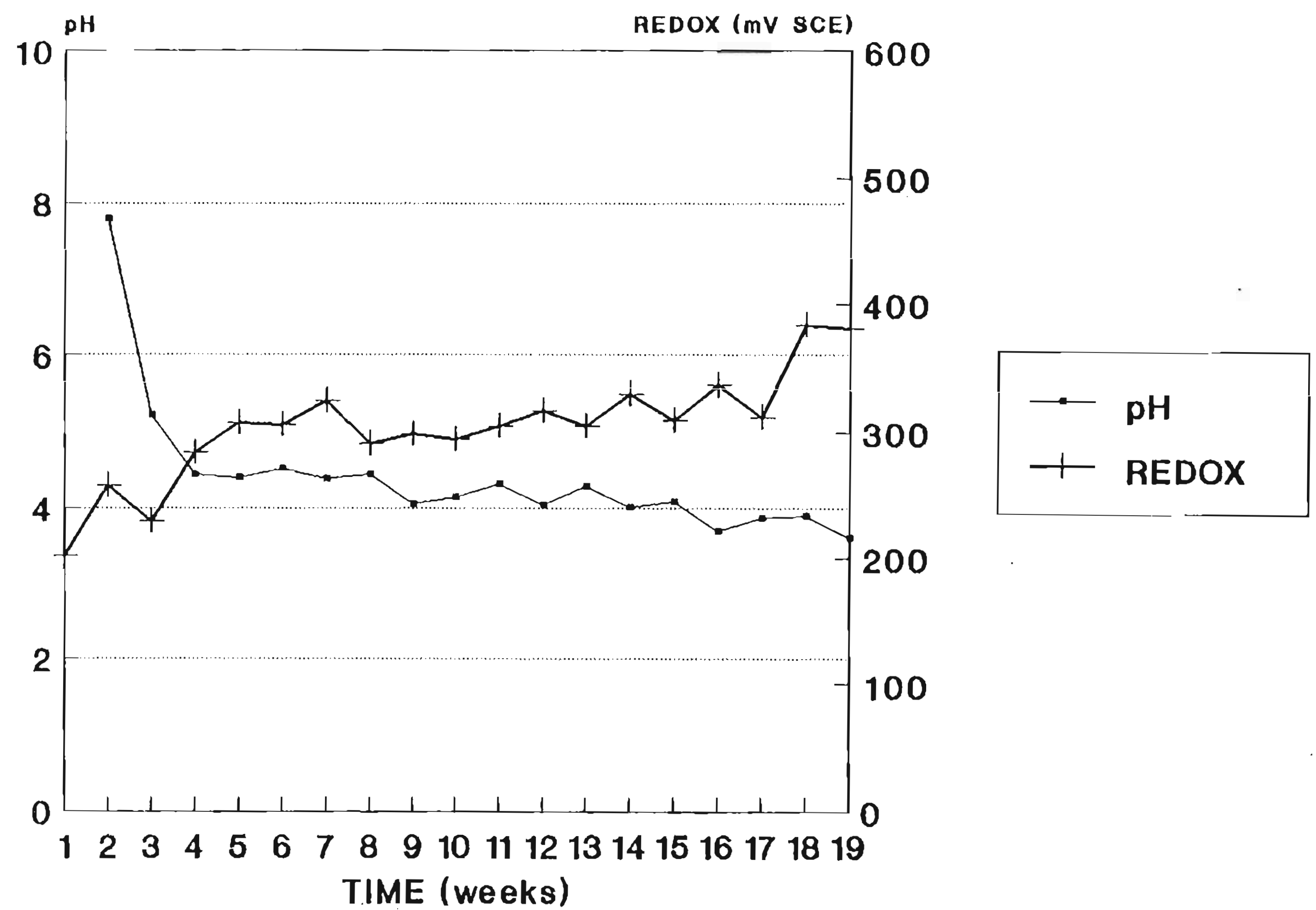
HUMIDITY CELL TEST
CURRAGH WASTE ROCK



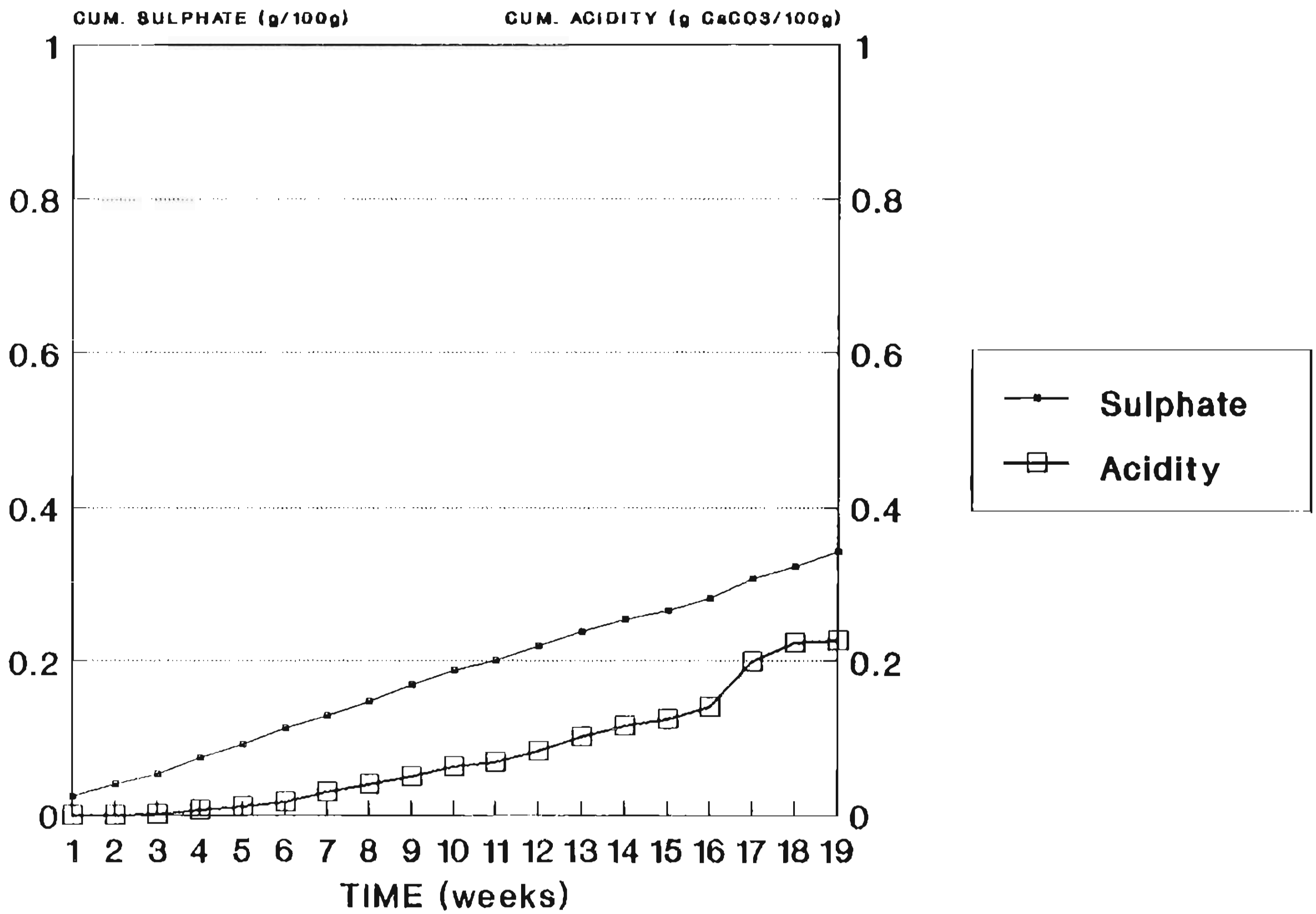
HUMIDITY CELL TEST
CURRAGH WASTE ROCK



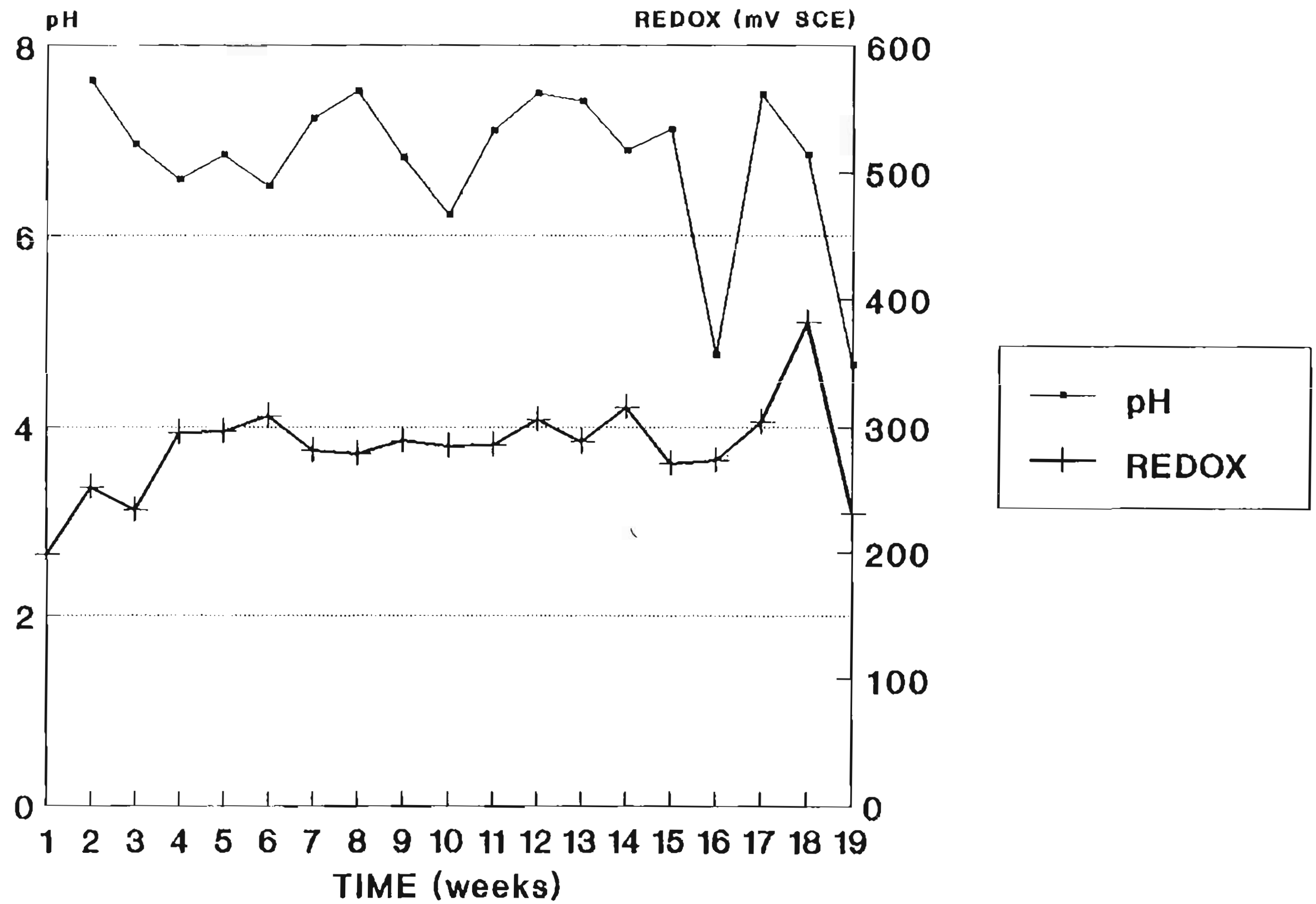
HUMIDITY CELL TEST
EQUITY SILVER WASTE ROCK



HUMIDITY CELL TEST
EQUITY SILVER WASTE ROCK



HUMIDITY CELL TEST
HEATH STEELE WASTE ROCK



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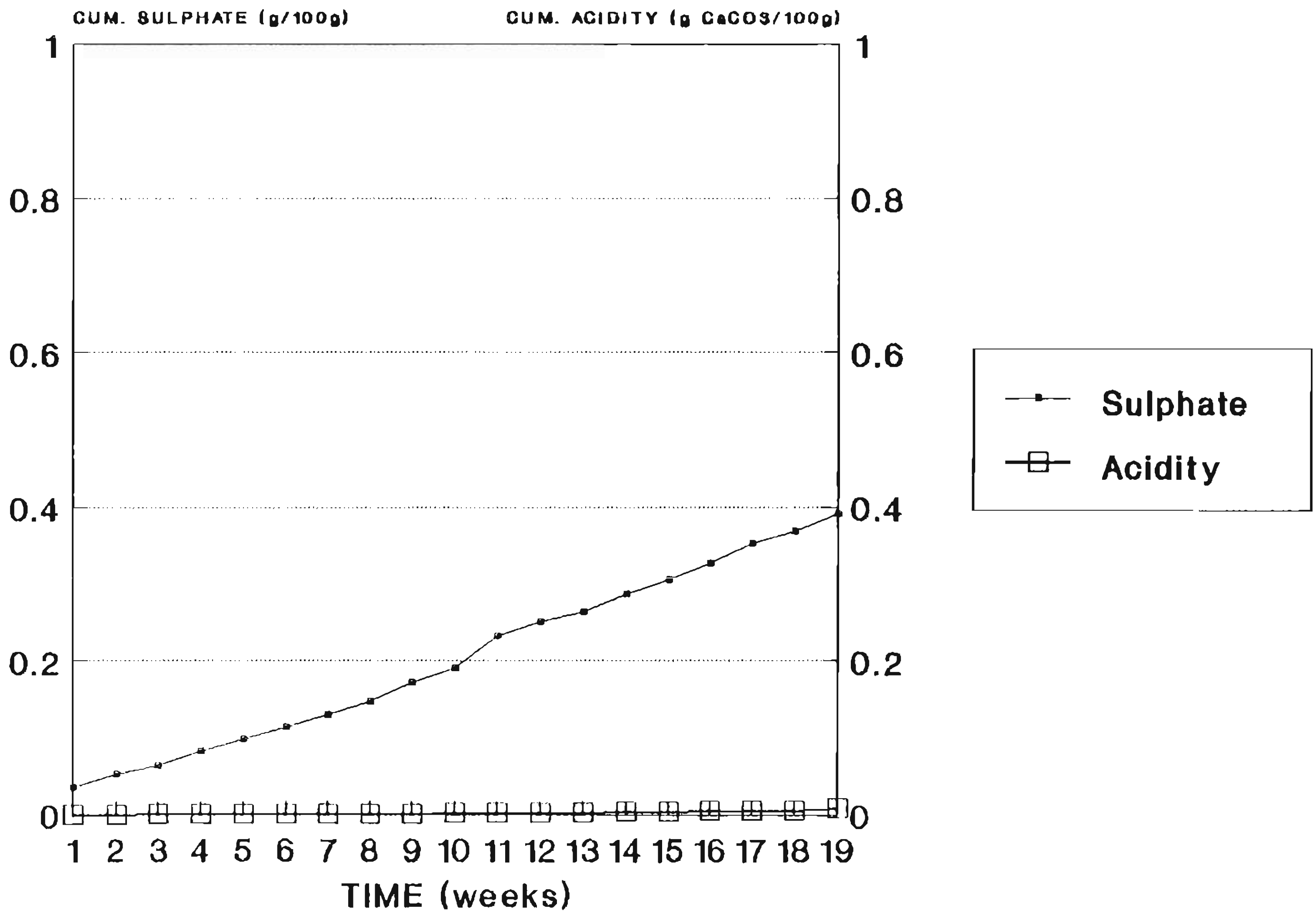
HEATH STEELE WASTE ROCK



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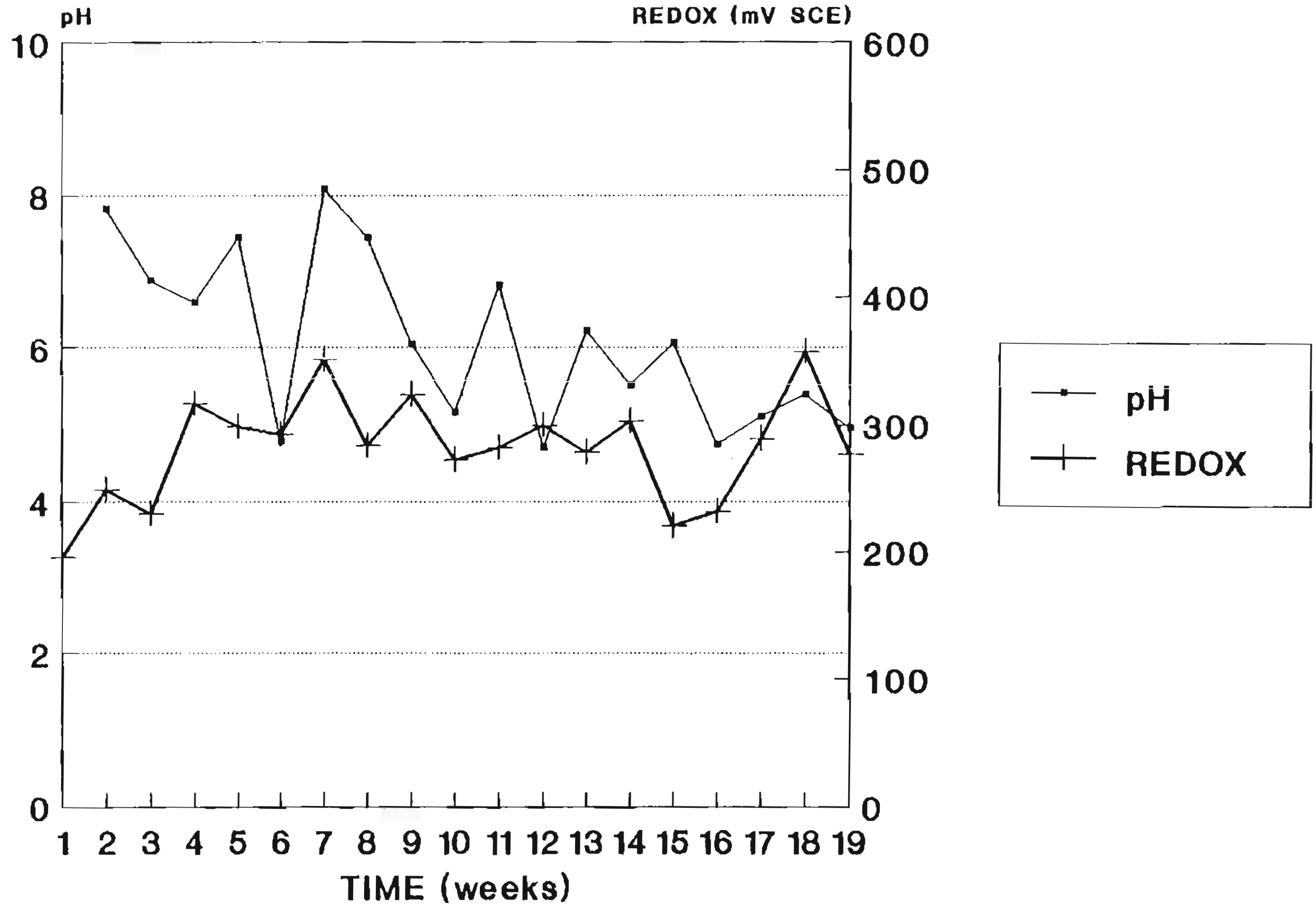
INCO WASTE ROCK



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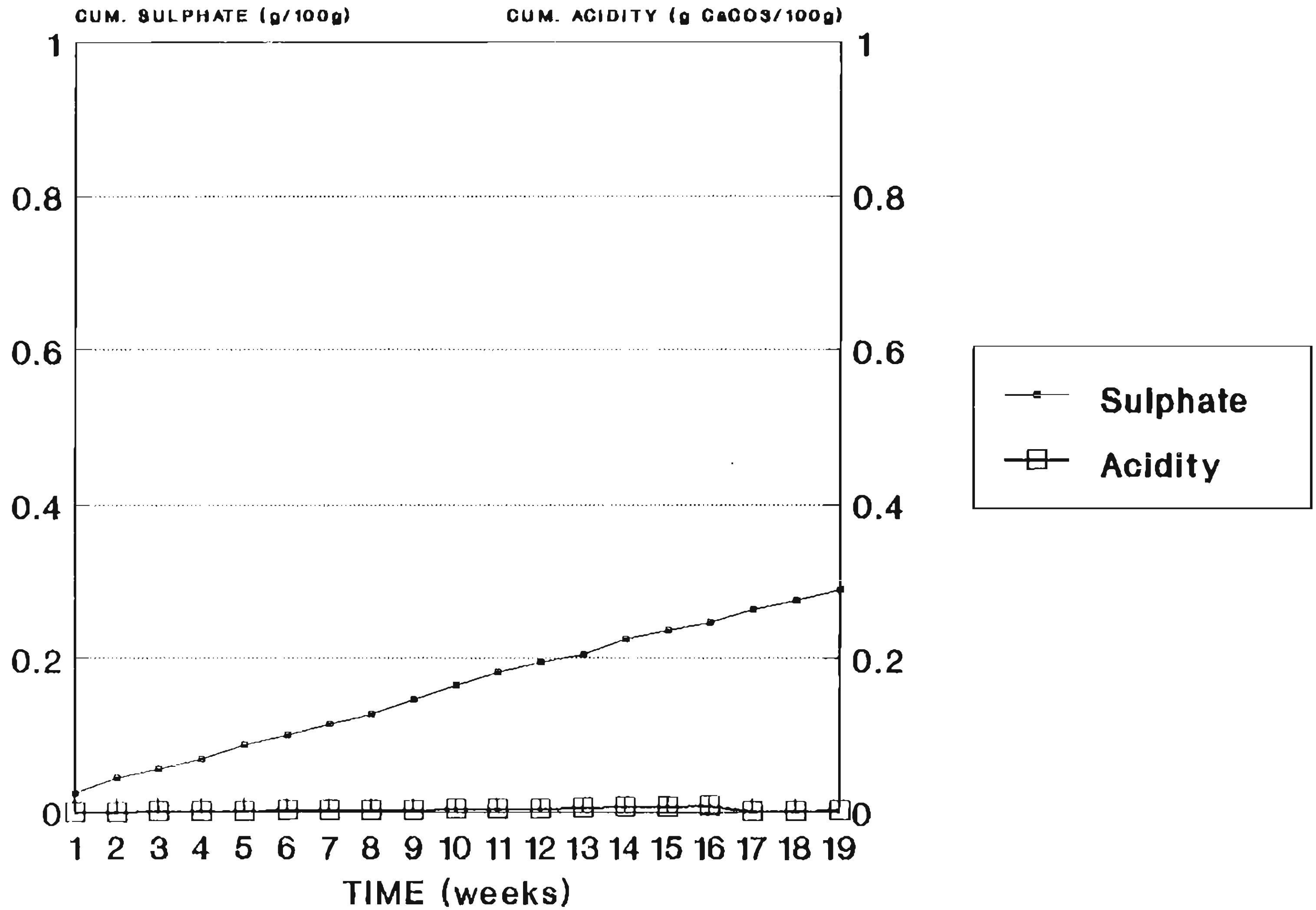
INCO WASTE ROCK



HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Curragh Tailing

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.01	<0.01	<0.01	<0.003
1	0.24	<0.04	<0.2	0.046	0.021	89.30	0.012	0.05	0.096	1.650	3.72	42.40	18.00	<0.02	0.55	2.81	11.20	45.50
2	<0.10	<0.10	0.3	0.035	0.016	46.60	<0.010	0.03	0.088	1.270	3.75	35.50	15.30	0.02	0.27	1.65	6.52	29.30
3	0.22	<0.04	<0.2	0.028	0.050	53.70	<0.015	0.15	1.310	2.850	4.19	33.80	15.60	<0.02	0.15	1.23	4.52	42.50
4	0.22	<0.04	<0.2	0.035	0.027	49.00	<0.015	0.04	0.240	2.430	3.25	53.60	26.10	<0.02	0.17	1.29	5.08	30.00
5	0.90	<0.04	<0.2	<0.005	0.250	111.00	<0.015	0.61	3.660	9.630	2.65	92.30	42.80	<0.02	0.40	23.70	26.10	159.00
6	0.28	0.05	<0.2	0.062	0.053	74.70	0.036	0.16	0.061	55.800	2.40	106.00	38.70	<0.02	0.20	2.39	5.81	47.40
7	0.60	<0.04	<0.2	0.060	0.210	97.20	0.150	0.20	1.650	6.400	2.90	78.20	35.30	<0.02	<0.15	1.30	3.30	49.10
8	0.28	<0.04	<0.2	0.022	0.050	67.40	0.033	0.09	0.160	26.400	2.35	157.00	55.00	<0.02	0.17	8.95	24.00	15.20
9	0.30	0.10	<0.2	0.035	0.048	62.10	0.062	0.06	0.120	9.960	2.59	168.00	56.50	<0.02	0.10	2.76	4.93	6.96
10	0.24	<0.04	<0.2	0.031	0.016	37.20	<0.015	0.02	0.110	4.210	1.74	86.30	28.40	<0.02	0.07	1.71	2.83	3.39
11	0.87	<0.04	<0.2	0.029	0.019	64.20	0.045	0.05	0.130	37.100	2.84	97.50	37.50	<0.02	0.06	1.85	3.34	4.57
12	0.84	<0.04	<0.2	0.045	0.007	41.30	0.021	0.02	0.260	29.700	1.66	83.40	28.90	<0.02	0.04	1.90	2.16	3.80
13	0.75	<0.04	<0.2	0.055	0.017	37.5	0.016	0.03	0.18	27.4	1.37	88.4	32.6	<0.02	0.03	2.88	3.42	5.09
14	0.84	<0.04	<0.2	0.021	0.110	43.70	0.026	0.14	1.740	13.200	3.98	43.80	20.70	<0.02	0.06	1.14	2.11	12.10
15	2.15	0.06	<0.2	0.034	0.065	37.10	0.026	0.17	0.690	35.200	2.35	68.40	31.50	<0.02	0.08	1.47	7.55	17.50

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Curragh Tailing

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.03	0.01	0.03	0.01	0.00	12.32	0.00	0.01	0.01	0.23	0.51	5.85	2.48	0.00	0.08	0.39	1.55	6.28
2	0.04	0.02	0.07	0.01	0.00	17.31	0.00	0.01	0.02	0.36	0.91	9.65	4.12	0.00	0.10	0.56	2.24	9.41
3	0.06	0.02	0.09	0.01	0.01	22.30	0.00	0.02	0.14	0.63	1.30	12.79	5.57	0.01	0.12	0.68	2.66	13.37
4	0.09	0.02	0.11	0.02	0.01	27.60	0.01	0.03	0.17	0.89	1.66	18.58	8.39	0.01	0.14	0.82	3.21	16.61
5	0.16	0.03	0.12	0.02	0.03	36.48	0.01	0.08	0.46	1.66	1.87	25.97	11.81	0.01	0.17	2.71	5.30	29.33
6	0.19	0.03	0.15	0.02	0.04	44.54	0.01	0.09	0.47	7.69	2.13	37.41	15.99	0.01	0.19	2.97	5.93	34.45
7	0.25	0.04	0.17	0.03	0.06	53.87	0.03	0.11	0.63	8.30	2.40	44.92	19.38	0.01	0.21	3.10	6.24	39.16
8	0.28	0.04	0.19	0.03	0.06	61.63	0.03	0.12	0.65	11.34	2.68	62.98	25.71	0.02	0.22	4.13	9.00	40.91
9	0.31	0.05	0.21	0.04	0.07	68.58	0.04	0.13	0.66	12.45	2.97	81.79	32.04	0.02	0.24	4.44	9.56	41.69
10	0.34	0.06	0.23	0.04	0.07	72.67	0.04	0.13	0.67	12.92	3.16	91.29	35.16	0.02	0.24	4.62	9.87	42.06
11	0.44	0.06	0.25	0.04	0.07	79.73	0.04	0.14	0.69	17.00	3.47	102.01	39.29	0.02	0.25	4.83	10.24	42.56
12	0.53	0.07	0.28	0.05	0.07	84.26	0.04	0.14	0.71	20.25	3.65	111.14	42.45	0.03	0.25	5.03	10.47	42.98
13	0.61	0.07	0.30	0.05	0.08	88.59	0.05	0.14	0.74	23.41	3.81	121.35	46.21	0.03	0.26	5.37	10.87	43.57
14	0.69	0.07	0.32	0.06	0.09	92.67	0.05	0.16	0.90	24.65	4.18	125.45	48.15	0.03	0.26	5.47	11.06	44.70
15	0.92	0.08	0.34	0.06	0.09	96.63	0.05	0.17	0.97	28.40	4.43	132.73	51.51	0.03	0.27	5.63	11.87	46.56

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Elliot Lake Tailing

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.01	<0.01	<0.01	<0.003
1	<0.10	<0.10	<0.1	0.040	<0.005	366.00	<0.010	<0.01	<0.010	< 0.003	<0.05	12.30	0.28	<0.02	0.04	13.20	3.95	0.14
2	<0.10	<0.10	0.1	0.030	<0.005	322.00	<0.010	<0.01	<0.010	0.090	<0.05	6.69	0.40	<0.02	<0.02	7.80	3.13	0.51
3	0.64	<0.04	<0.2	0.048	<0.005	184.00	<0.015	<0.01	0.009	0.031	<0.05	2.95	0.13	<0.02	<0.01	4.05	2.51	0.11
4	0.52	<0.04	<0.2	0.040	0.009	133.00	<0.015	<0.01	0.005	0.025	<0.05	4.87	0.17	<0.02	<0.01	6.64	3.26	0.11
5	0.22	<0.04	<0.2	0.065	<0.005	87.50	<0.015	<0.01	0.025	0.130	<0.05	3.87	0.13	<0.02	<0.01	30.60	27.60	0.17
6	0.33	0.05	<0.2	0.032	<0.005	149.00	0.035	<0.01	0.003	0.036	0.09	2.82	0.01	<0.02	<0.01	5.38	3.99	0.16
7	0.56	0.07	<0.2	0.037	<0.005	176.00	0.034	<0.01	0.010	0.031	<0.05	3.84	0.18	<0.02	<0.01	5.86	4.23	0.21
8	0.18	<0.04	<0.2	0.028	<0.005	81.50	0.042	<0.01	0.008	0.035	<0.05	1.85	0.22	<0.02	<0.01	15.10	16.70	0.07
9	0.25	<0.04	<0.2	0.045	0.026	120.00	0.054	0.02	0.005	0.025	<0.05	3.56	0.37	<0.02	<0.01	4.63	3.30	0.10
10	0.38	<0.04	<0.2	0.020	0.019	155.00	0.019	0.03	0.012	0.027	<0.05	3.53	0.44	<0.02	0.03	3.97	2.28	0.12
11	0.66	0.05	<0.2	0.040	0.006	283.00	0.072	0.06	0.019	0.029	<0.05	4.19	0.73	<0.02	0.05	4.35	2.81	0.19
12	1.35	<0.04	0.0	0.020	<0.005	138.00	0.042	0.05	0.027	0.036	0.07	1.89	0.34	<0.02	0.03	2.60	1.50	0.21
13	0.64	<0.04	<0.2	0.03	<0.005	144	0.026	0.06	0.03	0.1	0.1	1.75	0.39	<0.02	0.02	2.7	2.43	0.25
14	0.87	<0.04	<0.2	0.029	<0.005	113.00	0.030	0.07	0.032	0.031	0.05	1.49	0.43	<0.02	0.06	2.02	1.90	0.27
15	0.45	<0.04	<0.2	0.055	0.015	67.90	0.023	0.04	0.023	0.140	0.14	0.70	0.21	<0.02	0.06	1.35	2.82	0.20

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Elliot Lake Tailing

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.01	0.01	0.01	0.00	0.00	41.72	0.00	0.00	0.00	0.00	0.01	1.40	0.03	0.00	0.00	1.50	0.45	0.02
2	0.02	0.02	0.02	0.01	0.00	76.82	0.00	0.00	0.00	0.01	0.01	2.13	0.08	0.00	0.01	2.36	0.79	0.07
3	0.08	0.03	0.04	0.01	0.00	92.46	0.00	0.00	0.00	0.01	0.02	2.38	0.09	0.01	0.01	2.70	1.00	0.08
4	0.13	0.03	0.06	0.02	0.00	106.96	0.01	0.00	0.00	0.02	0.02	2.91	0.11	0.01	0.01	3.42	1.36	0.09
5	0.15	0.03	0.08	0.02	0.00	115.27	0.01	0.01	0.01	0.03	0.03	3.28	0.12	0.01	0.01	6.33	3.98	0.11
6	0.19	0.04	0.10	0.03	0.00	130.92	0.01	0.01	0.01	0.03	0.04	3.58	0.12	0.01	0.01	6.89	4.40	0.13
7	0.24	0.05	0.12	0.03	0.00	146.23	0.01	0.01	0.01	0.03	0.04	3.91	0.13	0.01	0.01	7.40	4.77	0.14
8	0.26	0.05	0.14	0.03	0.00	155.19	0.02	0.01	0.01	0.04	0.04	4.11	0.16	0.02	0.01	9.07	6.61	0.15
9	0.29	0.05	0.16	0.04	0.01	169.47	0.02	0.01	0.01	0.04	0.05	4.54	0.20	0.02	0.01	9.62	7.00	0.16
10	0.33	0.06	0.19	0.04	0.01	188.54	0.03	0.01	0.01	0.04	0.06	4.97	0.26	0.02	0.02	10.11	7.28	0.18
11	0.42	0.07	0.22	0.05	0.01	226.46	0.04	0.02	0.01	0.05	0.06	5.53	0.35	0.02	0.02	10.69	7.66	0.20
12	0.58	0.07	0.22	0.05	0.01	242.47	0.04	0.03	0.02	0.05	0.07	5.75	0.39	0.03	0.03	10.99	7.83	0.23
13	0.65	0.08	0.24	0.05	0.01	258.60	0.04	0.03	0.02	0.06	0.08	5.95	0.44	0.03	0.03	11.29	8.10	0.26
14	0.76	0.08	0.27	0.05	0.01	272.38	0.05	0.04	0.02	0.07	0.09	6.13	0.49	0.03	0.03	11.54	8.33	0.29
15	0.79	0.08	0.28	0.06	0.01	277.88	0.05	0.05	0.02	0.08	0.10	6.19	0.51	0.03	0.04	11.65	8.56	0.31

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Equity Silver Tailing

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.01	<0.01	<0.01	<0.003
1	<0.10	<0.10	<0.1	0.062	<0.005	79.40	<0.010	<0.01	<0.010	< 0.030	<0.05	8.43	0.18	<0.02	<0.02	21.90	22.40	0.130
2	<0.10	<0.10	<0.1	0.039	<0.005	51.50	<0.010	<0.01	<0.010	< 0.030	<0.05	7.17	0.27	<0.02	<0.02	14.40	21.60	0.160
3	0.10	<0.04	<0.2	0.048	<0.005	44.70	<0.015	<0.01	0.023	0.024	0.09	5.54	0.34	<0.02	<0.02	11.70	16.50	0.280
4	<0.04	<0.04	<0.2	<0.005	<0.005	25.70	<0.015	<0.01	<0.002	< 0.003	<0.05	4.11	0.24	<0.02	<0.02	10.20	11.90	0.190
5	0.16	0.04	<0.2	0.066	0.009	69.90	<0.015	0.01	0.025	0.110	<0.05	11.80	0.50	<0.02	<0.02	36.40	43.00	0.300
6	0.13	<0.04	<0.2	0.150	0.019	47.50	0.020	<0.01	0.007	0.041	<0.05	7.54	0.35	<0.02	0.03	11.10	10.70	0.420
7	0.10	<0.04	<0.2	0.100	<0.005	22.20	<0.015	<0.01	0.023	0.110	<0.05	3.57	0.17	<0.02	<0.01	6.01	5.48	0.420
8	0.38	<0.04	<0.2	0.025	<0.005	101.00	0.047	<0.01	0.009	0.036	<0.05	12.20	0.55	<0.02	<0.01	37.80	35.00	0.190
9	0.10	<0.04	<0.2	0.030	<0.005	45.00	<0.015	<0.01	0.020	< 0.003	0.12	10.50	0.35	<0.02	<0.01	11.40	10.60	0.210
10	0.19	<0.04	<0.2	0.031	0.011	67.70	<0.015	<0.01	0.024	0.019	<0.05	10.40	0.49	<0.02	<0.01	9.06	8.02	0.200
11	0.23	<0.04	0.0	0.047	<0.005	78.80	0.042	<0.01	0.038	0.022	<0.05	9.48	0.57	<0.02	<0.01	7.50	5.35	0.230
12	0.16	<0.04	<0.2	0.036	0.011	65.60	0.028	0.02	0.034	0.027	<0.05	8.97	0.49	<0.02	<0.01	6.75	3.96	0.330
13	0.23	<0.04	<0.2	0.029	0.010	52.80	0.015	<0.01	0.031	0.070	0.08	7.51	0.44	<0.02	0.05	6.13	4.30	0.320
14	0.11	0.04	<0.2	0.038	<0.005	14.40	0.013	<0.01	0.021	0.048	0.08	1.98	0.10	<0.02	0.02	2.47	2.51	0.088
15	0.25	0.04	<0.2	0.048	<0.005	34.90	0.011	0.01	0.024	0.120	0.13	3.63	0.13	<0.02	0.02	4.26	4.09	0.051

HUMIDITY CELL TESTING

LEACHATE ANALYSIS

Sample: Equity Silver Tailing

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.01	0.01	0.01	0.01	0.00	9.21	0.00	0.00	0.00	0.00	0.01	0.98	0.02	0.00	0.00	2.54	2.60	0.02
2	0.02	0.02	0.02	0.01	0.00	15.13	0.00	0.00	0.00	0.01	0.01	1.80	0.05	0.00	0.00	4.20	5.08	0.03
3	0.03	0.03	0.04	0.02	0.00	19.74	0.00	0.00	0.00	0.01	0.02	2.37	0.09	0.01	0.01	5.40	6.78	0.06
4	0.04	0.03	0.06	0.02	0.00	22.36	0.01	0.00	0.00	0.01	0.03	2.79	0.11	0.01	0.01	6.44	8.00	0.08
5	0.06	0.04	0.09	0.02	0.00	30.61	0.01	0.01	0.01	0.02	0.03	4.18	0.17	0.01	0.01	10.74	13.07	0.12
6	0.07	0.04	0.11	0.04	0.01	35.88	0.01	0.01	0.01	0.03	0.04	5.02	0.21	0.01	0.01	11.97	14.26	0.16
7	0.08	0.04	0.13	0.05	0.01	37.66	0.01	0.01	0.01	0.04	0.04	5.31	0.22	0.01	0.02	12.45	14.70	0.20
8	0.12	0.05	0.15	0.05	0.01	48.66	0.02	0.01	0.01	0.04	0.05	6.64	0.28	0.02	0.02	16.57	18.51	0.22
9	0.13	0.05	0.17	0.06	0.01	54.33	0.02	0.01	0.01	0.04	0.06	7.96	0.33	0.02	0.02	18.01	19.85	0.24
10	0.16	0.06	0.20	0.06	0.01	62.32	0.02	0.01	0.02	0.04	0.07	9.19	0.38	0.02	0.02	19.08	20.79	0.27
11	0.18	0.06	0.20	0.07	0.01	71.54	0.02	0.01	0.02	0.05	0.07	10.30	0.45	0.02	0.02	19.95	21.42	0.30
12	0.20	0.07	0.23	0.07	0.01	79.09	0.03	0.01	0.03	0.05	0.08	11.33	0.51	0.03	0.02	20.73	21.87	0.33
13	0.23	0.07	0.25	0.07	0.01	85.50	0.03	0.02	0.03	0.06	0.09	12.24	0.56	0.03	0.03	21.47	22.40	0.37
14	0.24	0.08	0.27	0.08	0.01	86.61	0.03	0.02	0.03	0.06	0.10	12.39	0.57	0.03	0.03	21.66	22.59	0.38
15	0.26	0.08	0.28	0.08	0.01	89.40	0.03	0.02	0.03	0.07	0.11	12.68	0.58	0.03	0.03	22.01	22.92	0.38

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Heath Steele Tailing

CYCLE	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.015	<0.01	<0.01	<0.003
1	408.00	<0.10	1.15	0.027	7.210	146.00	1.210	71.90	675.000	525.000	0.51	117.00	68.20	<0.02	6.27	0.05	1.55	1350.00
2	59.00	<0.10	0.42	0.019	1.500	62.00	0.280	11.80	38.900	157.000	0.98	22.90	13.10	0.08	0.91	0.08	1.69	237.00
3	51.20	<0.04	0.27	<0.005	1.120	68.80	<0.015	9.35	92.100	88.100	<0.05	18.20	10.50	<0.02	0.08	0.12	2.02	275.00
4	75.90	<0.04	0.9	0.010	1.530	61.20	<0.015	11.60	78.500	231.000	<0.05	27.50	14.20	<0.02	0.41	0.11	1.83	425.00
5	170.00	<0.04	1.86	0.018	3.820	115.00	1.800	22.80	151.000	672.000	<0.05	53.10	30.40	<0.02	0.63	22.50	23.60	930.00
6	90.50	<0.40	< 0.2	<0.050	2.160	77.10	1.180	11.60	83.800	454.000	1.00	30.40	15.70	<0.20	0.37	0.20	2.80	632.00
7	58.40	<0.40	< 0.2	0.410	1.460	64.50	1.040	6.90	85.000	335.000	<0.50	21.20	8.97	<0.20	<0.15	0.10	2.20	509.00
8	24.30	0.70	< 0.2	<0.050	0.940	48.80	0.630	4.50	300.000	202.000	<0.50	8.10	3.38	<0.20	<0.15	0.30	12.10	405.00
9	84.80	<0.40	3	0.080	2.100	106.00	2.850	10.50	450.000	902.000	<0.50	8.60	< 0.20	<0.20	0.23	0.41	1.92	1120.00
10	48.00	0.50	< 0.2	0.670	1.230	57.40	1.280	4.23	166.000	464.000	<0.50	21.10	4.06	<0.20	<0.15	0.10	1.79	465.00
11	36.10	<0.40	1.5	<0.050	1.400	77.80	1.500	22.30	107.000	506.000	<0.50	20.40	3.80	<0.20	0.19	2.40	24.20	465.00
12	55.70	<0.40	2.4	<0.050	1.450	79.50	1.760	2.67	159.000	592.000	<0.50	27.00	4.16	<0.20	<0.15	0.30	1.70	569.00
13	28.00	<0.40	< 2.0	<0.500	0.910	51.00	0.850	1.70	107.000	316.000	<0.50	15.20	2.02	<0.20	0.21	0.50	2.60	350.00
14	22.30	<0.40	3	0.070	0.630	55.70	0.082	1.50	102.000	270.000	<0.50	12.20	1.49	<0.20	0.39	0.20	1.70	306.00
15	3.10	0.80	< 2.0	0.130	0.120	56.80	0.250	0.70	56.000	61.600	1.07	1.40	0.17	<0.20	0.30	< 0.10	2.20	48.90

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Heath Steele Tailing

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	58.14	0.01	0.16	0.00	1.03	20.81	0.17	10.25	96.19	74.81	0.07	16.67	9.72	0.00	0.89	0.01	0.22	192.38
2	64.57	0.03	0.21	0.01	1.19	27.56	0.20	11.53	100.43	91.93	0.18	19.17	11.15	0.01	0.99	0.02	0.41	218.21
3	69.64	0.03	0.24	0.01	1.30	34.37	0.20	12.46	109.55	100.65	0.18	20.97	12.19	0.01	1.00	0.03	0.61	245.43
4	78.44	0.03	0.34	0.01	1.48	41.47	0.21	13.80	118.65	127.44	0.19	24.16	13.83	0.02	1.05	0.04	0.82	294.73
5	100.03	0.04	0.58	0.01	1.96	56.08	0.43	16.70	137.83	212.79	0.20	30.90	17.69	0.02	1.13	2.90	3.81	412.84
6	111.26	0.09	0.60	0.02	2.23	65.64	0.58	18.14	148.22	269.08	0.32	34.67	19.64	0.04	1.17	2.92	4.16	491.21
7	118.09	0.14	0.63	0.06	2.40	73.19	0.70	18.94	158.16	308.28	0.38	37.15	20.69	0.07	1.19	2.93	4.42	550.76
8	121.03	0.22	0.65	0.07	2.52	79.09	0.78	19.49	194.46	332.72	0.44	38.13	21.10	0.09	1.21	2.97	5.88	599.77
9	131.54	0.27	1.02	0.08	2.78	92.23	1.13	20.79	250.26	444.57	0.50	39.20	21.12	0.12	1.24	3.02	6.12	738.65
10	137.26	0.33	1.05	0.16	2.92	99.06	1.28	21.29	270.02	499.78	0.56	41.71	21.61	0.14	1.26	3.03	6.33	793.98
11	141.26	0.37	1.21	0.17	3.08	107.70	1.45	23.77	281.90	555.95	0.62	43.98	22.03	0.16	1.28	3.30	9.02	845.60
12	148.23	0.42	1.51	0.17	3.26	117.64	1.67	24.10	301.77	629.95	0.68	47.35	22.55	0.19	1.30	3.34	9.23	916.72
13	151.56	0.47	1.75	0.23	3.37	123.71	1.77	24.31	314.50	667.55	0.74	49.16	22.79	0.21	1.32	3.40	9.54	958.37
14	154.32	0.52	2.12	0.24	3.45	130.61	1.78	24.49	327.15	701.03	0.80	50.67	22.97	0.24	1.37	3.42	9.75	996.32
15	154.58	0.59	2.29	0.25	3.46	135.33	1.80	24.55	331.80	706.15	0.89	50.79	22.99	0.25	1.39	3.43	9.94	1000.38

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Key Lake Tailing

CYCLE	LEACHATE ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.015	<0.01	<0.01	<0.003
1	0.66	0.13	10.5	0.061	<0.005	446.00	<0.010	0.07	0.460	0.080	<0.05	2.88	0.06	0.43	0.38	3.15	12.70	1.26
2	0.63	0.28	13.2	0.032	<0.005	512.00	0.018	0.05	0.120	0.110	0.19	2.83	0.03	0.52	0.19	3.17	132.00	0.48
3	0.96	<0.04	14.6	<0.005	<0.005	667.00	<0.015	0.01	< 0.002	< 0.003	<0.05	2.75	< 0.00	0.37	0.31	1.87	9.32	0.11
4	2.00	0.07	15.8	0.050	0.012	624.00	<0.015	< 0.01	0.011	0.150	<0.05	3.66	0.01	0.36	0.67	1.71	8.66	0.23
5	5.96	0.13	16.8	0.042	<0.005	987.00	<0.015	0.02	0.040	0.300	0.06	5.18	0.03	0.51	0.85	25.20	32.70	0.45
6	2.30	<0.40	15	<0.050	0.060	709.00	0.190	< 0.10	< 0.020	0.240	<0.50	5.80	< 0.01	0.30	0.81	3.30	10.30	< 0.00
7	1.40	<0.40	20	0.060	<0.050	727.00	0.250	< 0.10	0.050	0.180	<0.50	6.80	0.01	0.20	0.59	2.60	9.70	0.44
8	1.90	<0.40	18	<0.050	<0.050	769.00	0.190	0.10	0.110	0.210	<0.50	7.30	0.01	<0.20	0.49	11.40	30.70	0.13
9	1.00	<0.40	17	0.180	<0.050	592.00	0.380	< 0.10	0.080	0.650	0.70	7.70	< 0.01	<0.20	0.79	2.84	7.63	0.22
10	2.00	<0.40	12	0.080	<0.050	487.00	<0.150	< 0.10	0.040	0.250	<0.50	6.50	< 0.01	<0.20	0.34	1.83	4.73	0.06
11	0.70	0.13	16.1	0.025	<0.050	476.00	0.100	0.02	0.009	0.110	0.09	7.78	0.01	0.41	0.59	2.22	6.61	0.03
12	0.80	<0.40	10.7	<0.050	<0.050	344.00	<0.150	0.02	0.030	0.090	<0.50	5.80	< 0.01	0.20	0.46	1.30	3.40	< 0.03
13	0.90	<0.40	9	<0.050	<0.050	202.00	<0.150	< 0.10	0.060	0.300	0.70	4.70	< 0.01	<0.20	0.33	1.80	4.50	0.07
14	1.70	<0.40	10	0.070	<0.050	245.00	0.170	< 0.10	0.080	0.270	0.61	6.00	< 0.01	<0.20	0.55	1.60	4.00	< 0.03
15	2.40	0.70	19	0.100	<0.050	640.00	0.180	0.10	0.080	0.280	1.21	9.30	0.01	<0.20	1.10	1.70	4.30	0.14

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Key Lake Tailing

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.06	0.01	0.93	0.01	0.00	39.69	0.00	0.01	0.04	0.01	0.00	0.26	0.01	0.04	0.03	0.28	1.13	0.11
2	0.13	0.04	2.36	0.01	0.00	94.99	0.00	0.01	0.05	0.02	0.02	0.56	0.01	0.09	0.05	0.62	15.39	0.16
3	0.22	0.05	3.83	0.01	0.00	162.36	0.00	0.01	0.05	0.02	0.03	0.84	0.01	0.13	0.09	0.81	16.33	0.18
4	0.45	0.05	5.65	0.02	0.00	234.12	0.01	0.01	0.06	0.04	0.04	1.26	0.01	0.17	0.16	1.01	17.32	0.20
5	1.00	0.07	7.18	0.02	0.00	323.93	0.01	0.02	0.06	0.06	0.04	1.73	0.01	0.22	0.24	3.30	20.30	0.24
6	1.23	0.11	8.73	0.02	0.01	396.96	0.03	0.03	0.06	0.09	0.09	2.33	0.01	0.25	0.32	3.64	21.36	0.24
7	1.35	0.14	10.35	0.03	0.01	455.85	0.05	0.03	0.07	0.10	0.13	2.88	0.01	0.27	0.37	3.85	22.15	0.28
8	1.55	0.18	12.25	0.03	0.02	537.36	0.07	0.04	0.08	0.13	0.19	3.65	0.02	0.29	0.42	5.06	25.40	0.29
9	1.66	0.23	14.24	0.06	0.02	606.63	0.11	0.06	0.09	0.20	0.27	4.55	0.02	0.31	0.52	5.39	26.29	0.32
10	1.89	0.27	15.61	0.06	0.03	662.14	0.13	0.07	0.09	0.23	0.33	5.30	0.02	0.33	0.55	5.60	26.83	0.32
11	1.98	0.29	17.69	0.07	0.04	723.55	0.14	0.07	0.09	0.24	0.34	6.30	0.02	0.39	0.63	5.89	27.68	0.33
12	2.08	0.34	18.93	0.07	0.04	763.45	0.16	0.07	0.10	0.25	0.39	6.97	0.02	0.41	0.68	6.04	28.08	0.33
13	2.18	0.38	19.98	0.08	0.05	787.09	0.18	0.08	0.10	0.29	0.48	7.52	0.02	0.43	0.72	6.25	28.61	0.34
14	2.40	0.43	21.25	0.09	0.05	818.20	0.20	0.10	0.11	0.32	0.55	8.28	0.02	0.46	0.79	6.45	29.11	0.34
15	2.55	0.48	22.44	0.09	0.06	858.20	0.21	0.10	0.12	0.34	0.63	8.87	0.02	0.47	0.86	6.56	29.38	0.35

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Noranda Bell Tailing

CYCLE	LEACHATE ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.015	<0.01	<0.01	<0.003
1	0.13	<0.10	< 0.1	0.048	<0.005	52.20	<0.010	< 0.01	0.038	< 0.030	<0.05	16.70	0.08	<0.02	0.03	14.40	6.26	0.24
2	0.43	0.28	0.53	0.029	0.009	41.10	0.030	0.06	0.076	< 0.030	0.25	12.10	0.06	0.05	0.16	8.52	4.02	0.12
3	0.10	<0.04	< 0.2	0.036	0.007	58.40	<0.015	< 0.01	0.006	0.034	0.07	14.70	0.08	<0.02	<0.01	10.30	4.92	0.12
4	0.21	<0.04	< 0.2	0.040	<0.005	67.20	<0.015	< 0.01	0.013	0.029	0.06	18.40	0.13	<0.02	0.03	8.41	4.48	0.12
5	9.81	<0.04	< 0.2	0.071	0.510	75.80	0.170	3.73	21.100	113.000	<0.05	16.50	4.68	<0.02	0.13	11.20	9.33	1.46
6	0.18	<0.04	< 0.2	0.150	0.012	72.30	0.026	< 0.01	0.012	0.020	<0.05	23.70	0.08	<0.02	<0.01	8.54	4.67	0.17
7	0.10	<0.04	< 0.2	0.130	0.010	43.00	0.015	< 0.01	0.025	0.013	<0.05	13.00	0.07	<0.02	<0.01	5.23	3.73	0.12
8	0.15	<0.04	< 0.2	0.420	<0.005	43.00	<0.015	0.01	0.029	0.180	<0.05	15.20	0.28	<0.02	<0.01	17.70	17.70	0.12
9	0.13	<0.04	< 0.2	0.020	<0.005	42.50	0.035	< 0.01	0.010	0.090	<0.05	18.30	0.13	<0.02	<0.01	5.86	3.00	0.03
10	0.13	<0.04	< 0.2	0.020	0.016	40.20	<0.015	< 0.01	0.014	0.052	<0.05	13.50	0.11	<0.02	<0.01	4.31	2.10	0.02
11																		
12	0.12	<0.04	< 0.2	0.019	<0.005	29.70	<0.015	< 0.01	0.021	0.220	<0.05	9.99	0.09	<0.02	<0.01	2.58	1.67	0.08
13	0.14	<0.04	< 0.2	0.029	<0.005	25.00	0.011	< 0.01	0.022	0.077	0.07	9.84	0.08	<0.02	<0.02	3.02	2.76	0.04
14	0.16	<0.04	< 0.2	0.020	<0.005	31.00	0.013	< 0.01	0.013	0.110	0.12	12.20	0.07	<0.02	<0.02	2.85	1.85	0.02
15	0.24	<0.04	< 0.2	0.032	0.045	26.00	0.012	0.01	0.015	0.100	0.08	3.24	0.02	<0.02	0.02	1.52	2.91	0.04

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Noranda Bell Tailing

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.02	0.01	0.01	0.01	0.00	6.16	0.00	0.00	0.00	0.00	0.01	1.97	0.01	0.00	0.00	1.70	0.74	0.03
2	0.06	0.04	0.07	0.01	0.00	10.89	0.00	0.01	0.01	0.01	0.03	3.36	0.02	0.01	0.02	2.68	1.20	0.04
3	0.08	0.05	0.09	0.01	0.00	17.25	0.01	0.01	0.01	0.01	0.04	4.96	0.03	0.01	0.02	3.80	1.74	0.06
4	0.10	0.05	0.12	0.02	0.00	24.85	0.01	0.01	0.02	0.01	0.05	7.04	0.04	0.01	0.03	4.75	2.24	0.07
5	0.90	0.06	0.13	0.02	0.04	31.06	0.02	0.32	1.75	9.28	0.05	8.40	0.42	0.01	0.04	5.67	3.01	0.19
6	0.92	0.06	0.16	0.04	0.05	39.16	0.02	0.32	1.75	9.28	0.06	11.05	0.43	0.02	0.04	6.63	3.53	0.21
7	0.94	0.07	0.18	0.06	0.05	44.15	0.03	0.32	1.75	9.28	0.06	12.56	0.44	0.02	0.04	7.23	3.96	0.22
8	0.95	0.07	0.20	0.10	0.05	48.88	0.03	0.32	1.75	9.30	0.07	14.23	0.47	0.02	0.04	9.18	5.91	0.23
9	0.97	0.07	0.23	0.10	0.05	54.36	0.03	0.32	1.75	9.32	0.08	16.59	0.49	0.02	0.04	9.94	6.30	0.24
10	0.99	0.08	0.25	0.11	0.05	59.54	0.03	0.32	1.76	9.32	0.08	18.33	0.50	0.03	0.04	10.49	6.57	0.24
11	0.99	0.08	0.25	0.11	0.05	59.54	0.03	0.32	1.76	9.32	0.08	18.33	0.50	0.03	0.04	10.49	6.57	0.24
12	1.00	0.08	0.28	0.11	0.05	63.03	0.04	0.32	1.76	9.35	0.09	19.51	0.51	0.03	0.04	10.80	6.77	0.25
13	1.02	0.09	0.30	0.11	0.05	65.91	0.04	0.32	1.76	9.36	0.10	20.64	0.52	0.03	0.05	11.14	7.08	0.25
14	1.04	0.09	0.32	0.11	0.05	69.85	0.04	0.33	1.76	9.37	0.11	22.19	0.53	0.03	0.05	11.50	7.32	0.26
15	1.05	0.10	0.34	0.12	0.06	71.80	0.04	0.33	1.76	9.38	0.12	22.43	0.53	0.04	0.05	11.62	7.54	0.26

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Waite Amulet Tailing

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.01	<0.01	<0.01	<0.003
1	3.34	<0.10	< 0.1	0.031	0.077	96.80	0.063	0.22	0.038	550.000	0.27	84.70	24.10	0.04	3.11	6.37	3.98	224.00
2	2.15	0.24	0.34	0.025	0.038	32.60	0.050	0.14	0.110	176.000	0.39	21.90	5.72	0.07	0.71	2.43	2.33	68.90
3	3.66	<0.04	< 0.2	0.028	0.071	34.20	<0.015	0.75	0.430	94.300	0.25	10.10	3.27	<0.02	0.60	0.93	2.52	47.60
4	2.58	<0.04	0.4	0.027	0.130	53.10	<0.015	1.00	0.220	415.000	0.08	23.30	7.37	<0.02	1.13	1.02	2.72	76.00
5	11.90	<0.04	0.3	0.033	0.250	47.80	0.120	3.10	5.930	286.000	0.10	18.90	4.67	<0.02	1.72	2.75	5.22	69.80
6	5.04	<0.40	< 0.2	<0.050	0.190	32.50	<0.150	1.70	2.420	334.000	1.10	13.40	2.85	<0.20	1.10	0.30	2.80	38.00
7	11.10	<0.40	< 0.2	<0.050	0.270	32.10	<0.150	3.50	9.200	457.000	<0.50	17.40	2.66	<0.20	1.70	0.60	3.10	49.70
8	0.66	0.05	< 0.2	<0.005	0.017	4.05	<0.015	0.18	0.210	58.500	<0.05	1.76	0.23	<0.02	0.09	3.79	16.60	3.54
9	3.00	0.50	< 0.2	0.050	0.130	25.90	0.260	0.53	0.640	337.000	0.80	10.40	1.38	<0.20	0.21	1.21	2.68	20.10
10	3.20	<0.40	< 0.2	<0.050	<0.050	24.40	<0.150	0.40	0.730	320.000	<0.05	10.20	1.19	<0.20	0.38	0.94	1.99	15.30
11	4.30	<0.40	< 0.2	<0.050	0.160	44.90	0.330	0.34	0.650	612.000	0.70	19.30	2.32	<0.20	0.51	1.80	3.60	29.60
12	6.30	<0.40	0.3	<0.050	0.150	53.80	<0.150	0.38	0.340	615.000	<0.50	22.30	2.56	<0.20	0.62	1.70	2.00	28.50
13	4.20	<0.40	< 0.2	<0.500	<0.050	34.70	<0.150	0.40	0.930	358.420	1.50	14.24	1.54	<0.20	0.44	1.90	3.40	17.22
14	6.00	<0.40	< 0.2	0.080	0.060	45.78	0.130	0.50	0.090	480.200	0.68	17.70	1.62	<0.20	0.31	1.70	2.70	19.65
15	9.80	<0.40	< 0.2	0.130	0.130	29.29	0.120	2.00	8.290	188.140	0.70	7.30	0.70	<0.20	0.78	0.30	2.90	13.74

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Waite Amulet Tailing

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.40	0.01	0.01	0.00	0.01	11.52	0.01	0.03	0.00	65.45	0.03	10.08	2.87	0.00	0.37	0.76	0.47	26.66
2	0.63	0.04	0.05	0.01	0.01	15.01	0.01	0.04	0.02	84.28	0.07	12.42	3.48	0.01	0.45	1.02	0.72	34.03
3	0.98	0.04	0.07	0.01	0.02	18.26	0.01	0.11	0.06	93.24	0.10	13.38	3.79	0.01	0.50	1.11	0.96	38.55
4	1.25	0.05	0.11	0.01	0.03	23.94	0.02	0.22	0.08	137.65	0.11	15.88	4.58	0.02	0.62	1.22	1.25	46.68
5	2.19	0.05	0.13	0.01	0.05	27.71	0.03	0.46	0.55	160.24	0.11	17.37	4.95	0.02	0.76	1.43	1.67	52.20
6	2.70	0.09	0.15	0.02	0.07	30.96	0.04	0.63	0.79	193.64	0.22	18.71	5.23	0.04	0.87	1.46	1.95	56.00
7	3.63	0.12	0.17	0.02	0.10	33.66	0.05	0.93	1.56	232.03	0.27	20.17	5.46	0.05	1.01	1.51	2.21	60.17
8	3.70	0.13	0.19	0.02	0.10	34.12	0.05	0.95	1.59	238.70	0.27	20.37	5.48	0.06	1.02	1.95	4.10	60.57
9	4.02	0.18	0.21	0.03	0.11	36.87	0.08	1.01	1.66	274.42	0.36	21.47	5.63	0.08	1.04	2.07	4.38	62.71
10	4.37	0.22	0.24	0.03	0.12	39.50	0.10	1.05	1.73	308.98	0.36	22.57	5.76	0.10	1.09	2.18	4.60	64.36
11	4.84	0.27	0.26	0.04	0.13	44.46	0.13	1.09	1.81	376.60	0.44	24.71	6.01	0.12	1.14	2.37	5.00	67.63
12	5.55	0.31	0.29	0.05	0.15	50.54	0.15	1.13	1.84	446.10	0.50	27.23	6.30	0.14	1.21	2.57	5.22	70.85
13	5.98	0.35	0.31	0.10	0.16	54.10	0.17	1.17	1.94	482.84	0.65	28.69	6.46	0.16	1.26	2.76	5.57	72.61
14	6.77	0.41	0.34	0.11	0.16	60.10	0.18	1.24	1.95	545.74	0.74	31.01	6.67	0.19	1.30	2.98	5.92	75.19
15	7.53	0.44	0.35	0.12	0.17	62.38	0.19	1.39	2.60	560.42	0.79	31.57	6.73	0.21	1.36	3.01	6.15	76.26

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Westmin Tailing

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.01	<0.01	<0.01	<0.003
1	< 0.10	<0.10	< 0.1	0.048	0.006	214.00	<0.010	<0.01	<0.010	0.100	<0.05	14.00	5.63	<0.02	<0.02	10.00	5.44	2.28
2	0.49	0.31	0.44	0.038	0.015	67.10	0.031	0.06	0.075	0.050	0.31	5.17	2.15	0.05	0.16	3.85	2.82	2.46
3	0.25	<0.04	< 0.2	0.031	0.016	83.10	<0.015	<0.01	0.022	0.033	0.14	5.17	2.74	<0.02	0.02	2.90	3.29	5.89
4	0.49	<0.04	< 0.2	0.032	<0.005	126.00	<0.015	<0.01	0.310	0.130	0.07	11.60	4.36	<0.02	0.03	3.41	3.02	5.74
5	0.36	<0.04	< 0.2	0.071	0.021	70.70	0.056	<0.01	1.090	1.250	0.09	3.81	1.88	<0.02	<0.01	3.52	5.23	7.14
6	0.40	<0.04	< 0.2	0.051	0.034	129.00	0.039	<0.01	0.210	0.130	<0.05	16.50	9.54	<0.02	0.06	3.04	2.98	7.06
7	0.51	<0.04	< 0.2	0.100	0.046	64.40	0.019	<0.01	0.710	1.640	0.21	11.90	6.26	<0.02	0.05	2.41	2.68	9.14
8	0.41	<0.04	< 0.2	0.029	0.027	63.80	<0.015	<0.01	0.610	1.680	0.21	15.00	7.34	<0.02	0.03	9.13	14.80	9.57
9	0.30	<0.04	< 0.2	0.100	0.026	57.50	0.042	<0.01	0.280	1.230	0.28	16.60	9.47	<0.02	0.04	2.60	2.80	14.20
10	0.23	<0.04	< 0.2	0.010	0.038	86.50	0.017	<0.01	0.260	0.580	0.15	22.60	12.30	<0.02	0.06	2.30	1.79	17.20
11	0.25	<0.04	< 0.2	0.043	0.032	44.00	0.043	<0.10	1.530	1.890	0.50	6.52	3.81	<0.02	0.03	1.00	2.53	10.50
12	0.43	<0.04	0.05	0.023	0.070	67.70	0.042	0.02	0.410	1.110	0.24	19.10	9.89	<0.02	0.15	1.82	1.73	41.10
13	0.50	<0.04	< 0.2	0.017	0.066	83.29	0.045	0.02	0.307	1.425	0.39	26.31	13.19	<0.02	0.19	2.25	2.92	59.30
14	0.62	<0.04	< 0.2	0.020	0.049	73.88	0.042	<0.01	0.274	1.047	0.31	19.40	8.56	<0.02	0.19	1.45	1.91	49.82
15	0.63	0.05	< 0.2	0.045	0.078	30.82	0.020	0.02	3.522	3.412	0.93	2.76	1.25	<0.02	0.06	0.53	1.90	18.03

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Westmin Tailing

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.01	0.01	0.01	0.01	0.00	23.75	0.00	0.00	0.00	0.01	0.01	1.55	0.62	0.00	0.00	1.11	0.60	0.25
2	0.07	0.05	0.06	0.01	0.00	31.14	0.00	0.01	0.01	0.02	0.04	2.12	0.86	0.01	0.02	1.53	0.91	0.52
3	0.09	0.05	0.08	0.01	0.00	39.78	0.01	0.01	0.01	0.02	0.05	2.66	1.15	0.01	0.02	1.84	1.26	1.14
4	0.15	0.05	0.10	0.02	0.00	54.90	0.01	0.01	0.05	0.04	0.06	4.05	1.67	0.01	0.03	2.24	1.62	1.83
5	0.18	0.06	0.12	0.02	0.01	59.85	0.01	0.01	0.13	0.12	0.07	4.32	1.80	0.01	0.03	2.49	1.98	2.32
6	0.22	0.06	0.14	0.03	0.01	74.68	0.02	0.01	0.15	0.14	0.07	6.22	2.90	0.02	0.03	2.84	2.33	3.14
7	0.28	0.07	0.16	0.04	0.01	81.64	0.02	0.01	0.23	0.32	0.10	7.50	3.57	0.02	0.04	3.10	2.62	4.12
8	0.32	0.07	0.18	0.04	0.02	88.65	0.02	0.01	0.29	0.50	0.12	9.15	4.38	0.02	0.04	4.10	4.24	5.18
9	0.36	0.07	0.21	0.05	0.02	95.32	0.02	0.02	0.33	0.64	0.15	11.08	5.48	0.02	0.05	4.41	4.57	6.82
10	0.38	0.08	0.23	0.05	0.03	105.70	0.03	0.02	0.36	0.71	0.17	13.79	6.96	0.03	0.05	4.68	4.78	8.89
11	0.41	0.08	0.25	0.06	0.03	109.86	0.03	0.03	0.50	0.89	0.22	14.41	7.32	0.03	0.06	4.78	5.02	9.88
12	0.46	0.09	0.26	0.06	0.04	117.65	0.04	0.03	0.55	1.02	0.25	16.60	8.45	0.03	0.07	4.99	5.22	14.61
13	0.52	0.09	0.28	0.06	0.04	127.73	0.04	0.03	0.59	1.19	0.29	19.79	10.05	0.03	0.10	5.26	5.58	21.78
14	0.60	0.10	0.31	0.07	0.05	137.11	0.05	0.03	0.62	1.32	0.33	22.25	11.14	0.03	0.12	5.44	5.82	28.11
15	0.64	0.10	0.32	0.07	0.06	139.50	0.05	0.03	0.89	1.59	0.40	22.46	11.23	0.04	0.12	5.48	5.97	29.51

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Curragh Waste Rock

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.01	<0.01	<0.01	<0.003
1	0.16	<0.10	< 0.1	0.062	<0.002	75.40	<0.010	<0.01	<0.010	< 0.030	<0.05	19.50	0.62	<0.02	0.04	7.65	4.03	0.27
2	0.62	0.37	0.58	0.045	0.015	32.20	0.040	0.08	0.099	< 0.030	0.35	7.37	0.21	0.06	0.23	2.91	2.52	0.17
3	0.07	<0.04	< 0.2	0.038	<0.005	40.50	<0.015	<0.01	0.005	0.027	<0.05	4.81	0.10	<0.02	<0.01	2.25	2.60	0.09
4	0.40	<0.04	< 0.2	0.027	<0.005	86.30	<0.015	<0.01	0.010	0.026	<0.05	12.10	0.42	<0.02	<0.01	3.23	2.72	0.13
5	0.12	<0.04	< 0.2	0.063	<0.005	54.00	0.045	<0.01	0.018	0.120	<0.05	7.31	0.16	<0.02	<0.01	4.13	5.18	0.23
6	0.08	<0.04	< 0.2	0.070	<0.005	31.50	<0.015	<0.01	0.006	0.035	<0.05	4.17	0.08	<0.02	<0.01	2.00	2.52	0.23
7	0.15	0.06	< 0.2	0.073	0.005	35.20	0.016	<0.01	0.016	0.021	<0.05	4.20	0.09	<0.02	<0.01	2.00	2.60	0.15
8	0.06	<0.04	< 0.2	0.047	<0.005	36.70	<0.015	<0.01	0.023	0.052	<0.05	4.90	0.10	<0.02	0.02	8.54	16.30	0.03
9	0.11	<0.04	< 0.2	0.093	<0.005	27.20	0.025	<0.01	0.011	0.039	<0.05	3.83	0.08	<0.02	<0.01	1.79	2.74	0.05
10	0.17	<0.04	< 0.2	0.035	0.026	30.90	<0.015	0.02	0.008	0.014	<0.05	4.38	0.12	<0.02	0.02	1.70	2.12	0.04
11	0.11	<0.04	< 0.2	0.040	0.006	32.10	0.036	<0.01	0.012	0.031	<0.05	5.08	0.16	<0.02	<0.01	1.70	2.63	0.05
12	0.10	<0.04	< 0.2	0.036	<0.005	21.00	<0.015	<0.01	0.012	0.037	0.08	3.19	0.11	<0.02	<0.01	1.12	1.67	0.08
13	0.19	<0.04	< 0.2	0.030	<0.005	21.13	0.014	0.01	0.015	0.050	<0.05	3.82	0.12	<0.02	0.04	1.94	2.48	0.06
14	0.13	<0.04	< 0.2	0.029	<0.005	25.25	0.015	0.01	0.012	0.019	0.11	4.51	0.17	<0.02	0.02	1.73	1.97	0.08
15	0.24	0.07	< 0.2	0.041	<0.005	15.90	0.011	0.01	0.008	0.096	0.10	1.92	0.05	<0.02	0.03	1.23	1.90	0.03

HUMIDITY CELL TESTING

LEACHATE ANALYSIS

Sample: Curragh Waste Rock

CYCLE	CUMMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.02	0.01	0.01	0.01	0.00	7.92	0.00	0.00	0.00	0.00	0.01	2.05	0.07	0.00	0.00	0.80	0.42	0.03
2	0.08	0.05	0.07	0.01	0.00	11.33	0.01	0.01	0.01	0.01	0.04	2.83	0.09	0.01	0.03	1.11	0.69	0.05
3	0.09	0.05	0.09	0.01	0.00	15.02	0.01	0.01	0.01	0.01	0.05	3.27	0.10	0.01	0.03	1.32	0.93	0.05
4	0.13	0.06	0.11	0.02	0.00	24.16	0.01	0.01	0.01	0.01	0.05	4.55	0.14	0.01	0.03	1.66	1.22	0.07
5	0.14	0.06	0.13	0.02	0.00	29.02	0.01	0.01	0.01	0.02	0.06	5.21	0.16	0.01	0.03	2.03	1.68	0.09
6	0.15	0.07	0.15	0.03	0.00	32.09	0.01	0.01	0.02	0.03	0.06	5.61	0.16	0.02	0.03	2.23	1.93	0.11
7	0.17	0.07	0.17	0.04	0.00	35.72	0.02	0.01	0.02	0.03	0.07	6.05	0.17	0.02	0.03	2.43	2.19	0.13
8	0.17	0.08	0.19	0.04	0.00	39.43	0.02	0.01	0.02	0.03	0.07	6.54	0.18	0.02	0.04	3.29	3.84	0.13
9	0.18	0.08	0.21	0.05	0.01	42.12	0.02	0.02	0.02	0.04	0.08	6.92	0.19	0.02	0.04	3.47	4.11	0.14
10	0.20	0.08	0.23	0.06	0.01	45.40	0.02	0.02	0.02	0.04	0.08	7.38	0.20	0.02	0.04	3.65	4.34	0.14
11	0.21	0.09	0.25	0.06	0.01	49.09	0.03	0.02	0.02	0.04	0.09	7.97	0.22	0.03	0.04	3.85	4.64	0.15
12	0.22	0.09	0.28	0.06	0.01	51.33	0.03	0.02	0.02	0.05	0.10	8.31	0.23	0.03	0.04	3.97	4.82	0.15
13	0.24	0.10	0.30	0.07	0.01	53.61	0.03	0.02	0.03	0.05	0.10	8.72	0.25	0.03	0.04	4.18	5.08	0.16
14	0.26	0.10	0.32	0.07	0.01	56.80	0.03	0.02	0.03	0.05	0.12	9.29	0.27	0.03	0.05	4.39	5.33	0.17
15	0.28	0.11	0.34	0.07	0.01	58.19	0.03	0.02	0.03	0.06	0.12	9.46	0.27	0.04	0.05	4.50	5.50	0.17

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Equity Silver Waste Rock

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.015	<0.01	<0.01	<0.003
1	0.10	<0.10	<0.1	0.044	0.029	57.10	<0.010	<0.01	<0.010	<0.030	<0.05	8.58	2.27	<0.02	0.03	4.74	4.26	0.33
2	0.34	0.22	0.3	0.039	0.063	26.40	0.021	0.06	0.067	0.040	0.20	4.47	1.46	0.03	0.13	2.35	2.36	0.76
3	0.21	<0.04	<0.2	0.047	0.063	32.70	<0.015	0.02	0.084	0.360	<0.05	2.84	1.52	0.03	0.06	1.66	2.48	1.48
4	0.79	<0.04	<0.2	0.053	0.290	77.30	<0.015	0.10	0.240	1.610	<0.05	9.73	5.79	<0.02	0.23	2.98	2.96	5.54
5	0.69	<0.04	<0.2	0.045	0.169	55.50	0.020	0.06	0.210	2.130	<0.05	6.50	3.15	<0.02	0.14	4.93	5.58	3.54
6	0.53	0.05	<0.2	0.028	0.190	40.60	0.021	0.07	0.160	2.380	2.40	6.50	3.87	<0.02	0.13	2.46	2.89	4.53
7	0.71	0.08	<0.2	0.075	0.140	40.70	<0.015	0.05	0.260	3.210	<0.05	5.14	3.10	<0.02	0.14	1.59	2.53	4.74
8	0.74	<0.04	<0.2	0.420	0.170	36.60	<0.015	0.07	0.300	4.100	0.06	7.08	4.35	<0.02	0.20	6.86	16.10	6.02
9	0.78	<0.04	<0.2	0.042	0.170	45.20	<0.015	0.10	0.310	5.030	<0.05	8.05	5.95	<0.02	0.20	1.68	2.48	6.52
10	0.52	<0.04	<0.2	0.035	0.150	27.00	<0.015	0.06	0.210	3.470	<0.05	5.25	4.32	<0.02	0.12	1.03	1.62	5.46
11	0.10	<0.40	<0.2	0.100	0.090	22.40	0.250	0.03	0.170	3.170	<0.50	4.00	3.57	<0.20	0.17	0.80	2.10	4.72
12	0.90	<0.40	0.4	<0.050	0.150	38.40	<0.150	0.02	0.360	7.330	<0.50	7.00	7.59	<0.20	0.27	1.10	1.90	10.20
13	0.80	<0.40	<0.2	0.050	0.070	24.44	<0.015	0.10	0.290	5.130	<0.50	5.40	5.37	<0.20	0.19	1.30	2.60	7.37
14	0.80	<0.40	<0.2	0.090	0.050	21.14	0.120	<0.10	0.210	3.460	0.60	4.20	4.55	<0.20	0.24	1.00	1.80	6.65
15	1.10	0.80	<0.2	0.140	<0.050	21.80	0.100	0.10	0.200	3.730	0.60	2.50	2.98	<0.20	0.20	0.80	1.80	4.46

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Equity Silver Waste Rock

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/ 100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.01	0.01	0.01	0.01	0.00	7.14	0.00	0.00	0.00	0.00	0.01	1.07	0.28	0.00	0.00	0.59	0.53	0.04
2	0.05	0.04	0.05	0.01	0.01	10.12	0.00	0.01	0.01	0.01	0.03	1.58	0.45	0.01	0.02	0.86	0.80	0.13
3	0.07	0.04	0.07	0.01	0.02	13.46	0.01	0.01	0.02	0.04	0.03	1.87	0.60	0.01	0.02	1.03	1.05	0.28
4	0.16	0.05	0.09	0.02	0.05	21.96	0.01	0.02	0.04	0.22	0.04	2.94	1.24	0.01	0.05	1.36	1.38	0.89
5	0.22	0.05	0.11	0.02	0.06	26.90	0.01	0.03	0.06	0.41	0.04	3.52	1.52	0.01	0.06	1.79	1.87	1.20
6	0.28	0.06	0.13	0.03	0.09	31.61	0.01	0.03	0.08	0.69	0.32	4.27	1.97	0.02	0.08	2.08	2.21	1.73
7	0.35	0.06	0.15	0.04	0.10	35.68	0.01	0.04	0.11	1.01	0.33	4.78	2.28	0.02	0.09	2.24	2.46	2.20
8	0.43	0.07	0.18	0.08	0.12	39.70	0.01	0.05	0.14	1.46	0.33	5.56	2.76	0.02	0.11	2.99	4.23	2.86
9	0.53	0.07	0.20	0.09	0.14	45.17	0.02	0.06	0.18	2.07	0.34	6.54	3.48	0.02	0.14	3.20	4.53	3.65
10	0.59	0.08	0.23	0.09	0.16	48.53	0.02	0.07	0.20	2.50	0.35	7.19	4.02	0.02	0.15	3.32	4.74	4.33
11	0.60	0.12	0.25	0.10	0.17	50.91	0.04	0.07	0.22	2.84	0.40	7.61	4.39	0.05	0.17	3.41	4.96	4.83
12	0.71	0.17	0.29	0.11	0.19	55.42	0.06	0.07	0.26	3.70	0.46	8.44	5.29	0.07	0.20	3.54	5.18	6.03
13	0.80	0.21	0.32	0.11	0.19	58.24	0.06	0.08	0.30	4.29	0.52	9.06	5.91	0.09	0.22	3.69	5.48	6.88
14	0.91	0.27	0.34	0.12	0.20	60.99	0.08	0.10	0.32	4.74	0.59	9.61	6.50	0.12	0.26	3.82	5.72	7.75
15	1.01	0.34	0.36	0.14	0.20	62.98	0.09	0.11	0.34	5.08	0.65	9.83	6.77	0.14	0.27	3.89	5.88	8.15

HUMIDITY CELL TESTING

LEACHATE ANALYSIS

Sample: Heath Steele Waste Rock

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.015	<0.01	<0.01	<0.003
1	<0.10	<0.10	<0.1	0.052	<0.005	106.00	<0.010	<0.01	<0.010	<0.030	<0.05	7.43	1.32	<0.02	0.01	4.46	2.30	0.25
2	0.18	0.09	0.1	0.029	0.011	37.60	0.009	0.03	0.026	0.030	0.11	3.74	1.14	0.01	0.07	2.79	1.98	0.48
3	0.14	<0.04	<0.2	0.037	0.014	40.30	<0.015	0.04	<0.002	0.023	0.13	3.25	1.64	<0.02	< 0.02	1.71	2.02	1.23
4	0.22	<0.04	<0.2	0.042	0.012	66.50	<0.015	0.03	0.005	0.042	<0.05	10.50	4.40	<0.02	0.03	2.77	2.06	1.38
5	0.32	<0.04	<0.2	0.056	0.005	58.90	0.022	0.04	0.014	0.280	<0.05	10.00	3.18	<0.02	0.02	4.89	4.86	1.46
6	0.11	<0.04	<0.2	0.029	0.025	39.90	0.019	0.03	0.006	0.041	<0.05	8.29	3.03	<0.02	0.05	2.06	2.42	1.44
7	0.11	<0.04	<0.2	0.130	0.013	36.30	<0.015	0.03	0.029	0.033	0.09	7.04	2.41	<0.02	< 0.02	1.80	2.40	1.40
8	0.14	<0.04	<0.2	0.031	0.011	50.60	<0.015	0.05	0.033	0.043	0.08	10.10	3.20	<0.02	0.02	8.76	14.00	1.49
9	0.12	<0.04	<0.2	0.050	0.019	45.30	<0.015	0.06	0.006	0.023	<0.05	12.70	4.16	<0.02	0.02	2.34	2.35	1.33
10	0.08	<0.04	<0.2	0.014	0.037	43.20	<0.015	0.04	0.006	0.018	<0.05	12.30	4.10	<0.02	0.04	1.72	1.60	0.94
11	0.41	<0.04	<0.2	0.020	0.005	103.00	<0.015	<0.01	0.010	0.120	<0.05	18.20	6.79	<0.02	0.03	2.64	2.45	1.00
12	0.20	<0.40	<0.2	0.026	0.006	41.70	<0.015	<0.01	0.007	0.061	<0.05	6.33	2.40	<0.02	0.02	1.34	1.30	0.64
13	0.41	<0.04	<0.2	<0.005	<0.005	35.89	0.011	<0.01	<0.002	<0.003	1.31	6.00	2.16	<0.02	0.12	1.90	2.47	0.63
14	0.70	<0.40	<0.2	0.190	<0.050	56.90	0.120	0.10	0.050	0.040	<0.50	10.00	3.76	<0.02	0.28	1.90	1.90	0.74
15	0.70	<0.40	<0.2	0.150	<0.050	52.31	<0.015	0.10	<0.002	0.110	0.50	7.70	2.86	<0.02	0.32	1.60	1.50	0.68

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample : Heath Steele Waste Rock

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/ 100 g sample)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.02	0.02	0.02	0.01	0.00	18.29	0.00	0.00	0.00	0.01	0.01	1.28	0.23	0.00	0.00	0.77	0.40	0.04
2	0.04	0.03	0.03	0.01	0.00	22.23	0.00	0.01	0.00	0.01	0.02	1.67	0.35	0.00	0.01	1.06	0.60	0.09
3	0.05	0.03	0.05	0.02	0.00	25.86	0.00	0.01	0.00	0.01	0.03	1.97	0.50	0.01	0.01	1.22	0.79	0.20
4	0.07	0.03	0.07	0.02	0.00	32.78	0.01	0.01	0.01	0.01	0.04	3.06	0.95	0.01	0.01	1.50	1.00	0.35
5	0.10	0.04	0.09	0.02	0.00	38.19	0.01	0.02	0.01	0.04	0.04	3.98	1.25	0.01	0.02	1.95	1.45	0.48
6	0.11	0.04	0.11	0.03	0.01	42.07	0.01	0.02	0.01	0.04	0.05	4.78	1.54	0.01	0.02	2.15	1.68	0.62
7	0.12	0.05	0.12	0.04	0.01	45.42	0.01	0.02	0.01	0.05	0.05	5.43	1.76	0.01	0.02	2.32	1.90	0.75
8	0.14	0.05	0.14	0.04	0.01	50.33	0.01	0.03	0.01	0.05	0.06	6.41	2.07	0.02	0.02	3.17	3.26	0.90
9	0.15	0.05	0.17	0.05	0.01	55.43	0.01	0.03	0.01	0.05	0.07	7.84	2.54	0.02	0.03	3.43	3.53	1.05
10	0.16	0.06	0.19	0.05	0.02	59.96	0.02	0.04	0.01	0.06	0.07	9.13	2.97	0.02	0.03	3.61	3.69	1.14
11	0.21	0.06	0.21	0.05	0.02	73.10	0.02	0.04	0.02	0.07	0.08	11.45	3.84	0.02	0.03	3.95	4.01	1.27
12	0.23	0.11	0.23	0.06	0.02	77.68	0.02	0.04	0.02	0.08	0.09	12.15	4.10	0.03	0.03	4.10	4.15	1.34
13	0.27	0.11	0.25	0.06	0.02	81.18	0.02	0.04	0.02	0.08	0.21	12.74	4.31	0.03	0.05	4.28	4.39	1.40
14	0.36	0.16	0.28	0.08	0.02	88.01	0.03	0.05	0.02	0.08	0.27	13.94	4.76	0.03	0.08	4.51	4.62	1.49
15	0.43	0.20	0.30	0.10	0.03	93.87	0.04	0.06	0.02	0.10	0.33	14.80	5.08	0.03	0.12	4.69	4.79	1.57

HUMIDITY CELL TESTING
LEACHATE ANALYSIS

Sample: Inco Waste Rock

CYCLE	WATER EXTRACT ICP ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	<0.04	<0.04	<0.2	<0.005	<0.005	<0.02	<0.015	<0.01	<0.002	<0.003	<0.05	<0.01	<0.001	<0.02	<0.015	<0.01	<0.01	<0.003
1	<0.10	<0.10	<0.1	0.066	0.007	56.20	<0.015	<0.01	<0.010	<0.030	<0.05	13.30	0.30	<0.02	0.97	12.30	5.25	0.20
2	0.22	0.10	0.1	0.034	<0.005	44.50	0.010	0.04	0.025	<0.030	0.11	8.81	0.26	0.02	1.16	8.94	3.60	0.07
3	0.08	<0.04	<0.2	0.042	<0.005	24.30	<0.015	0.05	0.004	0.044	0.08	2.90	0.28	<0.02	1.70	4.68	2.63	0.08
4	0.25	<0.04	<0.2	0.063	<0.005	40.40	<0.015	0.13	0.008	0.042	<0.05	4.25	0.56	<0.02	3.55	5.41	2.75	0.17
5	0.23	<0.04	<0.2	0.035	<0.005	53.80	0.029	0.23	0.007	0.072	<0.05	6.01	0.91	<0.02	6.15	12.60	6.42	0.21
6	0.03	<0.04	<0.2	0.043	0.012	32.00	0.027	0.19	0.005	0.043	<0.05	2.77	0.60	<0.02	4.22	6.12	3.02	0.26
7	0.16	0.06	<0.2	0.076	0.009	29.70	<0.015	0.22	0.012	0.044	<0.05	2.85	0.61	<0.02	4.86	5.21	2.68	0.26
8	0.06	<0.04	<0.2	0.038	0.006	34.50	0.016	0.33	0.032	0.072	<0.05	3.61	0.83	<0.02	6.33	23.80	17.20	0.17
9	0.17	<0.04	<0.2	0.054	0.017	39.90	0.040	0.48	0.030	0.120	<0.05	4.89	1.18	<0.02	8.75	6.64	3.53	0.25
10	0.18	<0.04	<0.2	0.024	0.017	34.80	<0.015	0.46	0.027	0.088	<0.05	4.79	1.04	<0.02	8.09	6.54	2.24	0.03
11	0.05	<0.04	<0.2	0.037	0.009	28.60	0.049	0.26	0.026	0.170	<0.05	3.76	0.88	<0.20	6.29	5.03	2.58	0.22
12	0.13	<0.04	<0.2	0.026	0.007	19.10	0.016	0.18	0.034	0.150	0.06	3.03	0.62	<0.02	4.36	3.63	1.82	0.25
13	0.16	<0.04	<0.2	0.036	<0.005	25.57	0.028	0.35	0.027	0.261	0.08	4.50	0.89	<0.02	5.90	6.25	3.01	0.23
14	0.21	<0.04	<0.2	0.043	<0.005	25.63	0.022	0.41	0.046	0.366	0.10	5.21	0.92	<0.02	6.70	6.55	2.38	0.34
15	0.12	<0.04	<0.2	0.046	0.007	17.04	0.011	0.17	0.019	0.208	0.12	1.96	0.36	<0.02	2.64	3.02	2.05	0.18

HUMIDITY CELL TESTING

LEACHATE ANALYSIS

Sample : Inco Waste Rock

CYCLE	CUMULATIVE WATER EXTRACT ICP ANALYSIS (mg/100 g sample)																
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.01	0.01	0.01	0.01	0.00	6.97	0.00	0.00	0.00	0.00	0.01	1.65	0.04	0.00	0.12	1.53	0.65	0.02
2	0.04	0.02	0.03	0.01	0.00	11.86	0.00	0.01	0.00	0.01	0.02	2.62	0.07	0.00	0.25	2.51	1.05	0.03
3	0.05	0.03	0.05	0.02	0.00	14.42	0.00	0.01	0.00	0.01	0.03	2.92	0.10	0.01	0.43	3.00	1.32	0.04
4	0.07	0.03	0.07	0.02	0.00	18.66	0.01	0.02	0.01	0.02	0.03	3.37	0.15	0.01	0.80	3.57	1.61	0.06
5	0.09	0.04	0.09	0.03	0.00	23.39	0.01	0.04	0.01	0.02	0.04	3.90	0.23	0.01	1.34	4.68	2.18	0.08
6	0.09	0.04	0.11	0.03	0.00	26.59	0.01	0.06	0.01	0.03	0.04	4.17	0.29	0.01	1.76	5.29	2.48	0.10
7	0.11	0.05	0.13	0.04	0.01	29.81	0.01	0.09	0.01	0.03	0.05	4.48	0.36	0.01	2.29	5.85	2.77	0.13
8	0.12	0.05	0.15	0.04	0.01	33.26	0.01	0.12	0.01	0.04	0.05	4.85	0.44	0.02	2.92	8.23	4.49	0.15
9	0.14	0.05	0.17	0.05	0.01	37.87	0.02	0.18	0.01	0.05	0.06	5.41	0.58	0.02	3.93	9.00	4.90	0.18
10	0.16	0.06	0.20	0.05	0.01	42.19	0.02	0.23	0.02	0.06	0.06	6.00	0.71	0.02	4.94	9.81	5.18	0.18
11	0.17	0.06	0.22	0.06	0.01	45.58	0.03	0.26	0.02	0.08	0.07	6.45	0.81	0.05	5.68	10.41	5.48	0.21
12	0.18	0.07	0.25	0.06	0.01	47.71	0.03	0.28	0.02	0.10	0.08	6.79	0.88	0.05	6.17	10.81	5.68	0.24
13	0.20	0.07	0.27	0.06	0.01	50.67	0.03	0.32	0.03	0.13	0.09	7.31	0.99	0.05	6.85	11.54	6.03	0.26
14	0.23	0.08	0.30	0.07	0.01	54.26	0.03	0.38	0.03	0.18	0.10	8.04	1.11	0.05	7.79	12.45	6.37	0.31
15	0.24	0.08	0.32	0.07	0.01	55.85	0.04	0.40	0.04	0.20	0.11	8.22	1.15	0.05	8.04	12.74	6.56	0.33

SHAKE FLASK TEST

SAMPLE: Curragh Tailing

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	3.79	338	3250	2200	660.0	450.3	135.1
2	1	3.79	332	-	-	-	-	-
	2	3.57	353	4620	3100	930.0	543.4	163.0
3	1	3.78	318	-	-	-	-	-
	2	3.39	338	-	-	-	-	-
	3	4.08	276	6930	4500	1350	302.1	90.6
4	1	3.72	302	-	-	-	-	-
	2	3.49	340	-	-	-	-	-
	3	4.18	305	-	-	-	-	-
	4	4.14	314	7300	4900	1470	592.5	177.8
5	1	3.70	325	-	-	-	-	-
	2	3.40	339	-	-	-	-	-
	3	4.12	303	-	-	-	-	-
	4	3.75	308	-	-	-	-	-
	5	3.75	323	6030	5900	1770	1180.8	354.2
6	1	4.25	292	-	-	-	-	-
	2	3.74	318	-	-	-	-	-
	3	3.84	309	-	-	-	-	-
	4	4.14	310	-	-	-	-	-
	5	4.09	342	-	-	-	-	-
	6	3.77	378	5470	4600	1380	66.6	20.0
7	1	3.99	303	-	-	-	-	-
	2	3.62	336	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	3.83	338	-	-	-	-	-
	6	3.28	373	-	-	-	-	-
	7	2.95	368	6990	6250	1875	1255.1	376.5

SHAKE FLASK TEST

SAMPLE: Curragh Tailing (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	3.58	324	-	-	-	-	-
	2	3.70	322	-	-	-	-	-
	3	3.57	318	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	3.20	359	-	-	-	-	-
	7	2.52	403	-	-	-	-	-
	8	2.36	408	11490	18000	5400	4714.4	1414.3
9	1	4.82	219	-	-	-	-	-
	2	3.78	313	-	-	-	-	-
	3	3.93	313	-	-	-	-	-
	4	3.78	322	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	3.65	357	-	-	-	-	-
	8	2.48	383	-	-	-	-	-
	9	2.80	367	9730	9500	2850	1815.8	544.7
10	1	4.69	213	-	-	-	-	-
	2	3.74	318	-	-	-	-	-
	3	3.84	309	-	-	-	-	-
	4	3.63	334	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	3.30	353	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	2.51	396	-	-	-	-	-
	10	2.45	402	12020	16500	4950	4377.3	1313.2

SHAKE FLASK TEST

SAMPLE: Elliot Lake Tailing

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	7.32	242	2040	1700	510	0.0	0.0
2	1	7.19	211	-	-	-	-	-
	2	6.76	428	1960	1800	540	0.0	0.0
3	1	7.19	216	-	-	-	-	-
	2	6.92	358	-	-	-	-	-
	3	6.84	257	2040	1800	540	0.5	0.1
4	1	7.22	211	-	-	-	-	-
	2	7.04	333	-	-	-	-	-
	3	6.94	245	-	-	-	-	-
	4	6.82	295	2240	1900	570	1.9	0.6
5	1	7.24	213	-	-	-	-	-
	2	7.08	308	-	-	-	-	-
	3	7.04	239	-	-	-	-	-
	4	6.88	264	-	-	-	-	-
	5	6.64	280	2260	2200	660	4.7	1.4
6	1	7.32	235	-	-	-	-	-
	2	7.07	268	-	-	-	-	-
	3	6.59	239	-	-	-	-	-
	4	7.35	337	-	-	-	-	-
	5	6.95	405	-	-	-	-	-
	6	7.05	405	2180	1900	570	0.0	0.0
7	1	6.93	232	-	-	-	-	-
	2	7.16	283	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	7.15	336	-	-	-	-	-
	6	6.47	404	-	-	-	-	-
	7	6.70	340	2150	1700	510	1.0	0.3

SHAKE FLASK TEST

SAMPLE: Elliot Lake Tailing (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	7.24	258	-	-	-	-	-
	2	6.88	230	-	-	-	-	-
	3	7.02	288	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	6.48	332	-	-	-	-	-
	7	5.69	400	-	-	-	-	-
	8	6.38	490	2200	2000	600	1.0	0.3
9	1	7.37	232	-	-	-	-	-
	2	7.17	263	-	-	-	-	-
	3	6.74	233	-	-	-	-	-
	4	6.90	295	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	6.02	331	-	-	-	-	-
	8	5.31	396	-	-	-	-	-
	9	5.12	535	2120	1800	540	6.4	1.9
10	1	7.32	235	-	-	-	-	-
	2	7.07	268	-	-	-	-	-
	3	6.59	239	-	-	-	-	-
	4	6.56	301	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	6.69	326	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	5.77	395	-	-	-	-	-
	10	4.90	376	2200	1850	555	9.6	2.9

SHAKE FLASK TEST

SAMPLE: Equity Silver Tailing

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	7.44	216	1350	1100	330	0.0	0.0
2	1	7.55	261	-	-	-	-	-
	2	7.10	331	1450	1300	390	0.0	0.0
3	1	7.61	245	-	-	-	-	-
	2	7.42	298	-	-	-	-	-
	3	7.39	238	1550	1400	420	0.0	0.0
4	1	7.63	220	-	-	-	-	-
	2	7.54	282	-	-	-	-	-
	3	7.70	244	-	-	-	-	-
	4	7.52	251	1584	1600	480	0.0	0.0
5	1	7.64	216	-	-	-	-	-
	2	7.56	270	-	-	-	-	-
	3	7.72	236	-	-	-	-	-
	4	7.48	278	-	-	-	-	-
	5	7.47	264	1790	1400	420	0.0	0.0
6	1	7.76	214	-	-	-	-	-
	2	7.58	277	-	-	-	-	-
	3	7.57	218	-	-	-	-	-
	4	8.03	318	-	-	-	-	-
	5	7.74	347	-	-	-	-	-
	6	7.64	397	1721	1300	390	0.0	0.0
7	1	7.82	196	-	-	-	-	-
	2	7.75	231	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	8.02	320	-	-	-	-	-
	6	7.73	351	-	-	-	-	-
	7	7.14	285	1708	1300	390	0.0	0.0

SHAKE FLASK TEST

SAMPLE: Equity Silver Tailing (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	7.63	255	-	-	-	-	-
	2	7.78	198	-	-	-	-	-
	3	7.74	242	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	8.02	323	-	-	-	-	-
	7	7.76	359	-	-	-	-	-
	8	6.67	370	1779	1500	450	0.5	0.2
9	1	7.80	208	-	-	-	-	-
	2	7.60	262	-	-	-	-	-
	3	7.74	206	-	-	-	-	-
	4	7.70	252	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	8.01	320	-	-	-	-	-
	8	7.43	377	-	-	-	-	-
	9	6.94	408	1782	1450	435	0.5	0.2
10	1	7.79	222	-	-	-	-	-
	2	7.58	277	-	-	-	-	-
	3	7.57	218	-	-	-	-	-
	4	7.59	270	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	7.95	324	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	7.47	410	-	-	-	-	-
	10	7.52	242	1828	1400	420	0.0	0.0

SHAKE FLASK TEST

SAMPLE: Heath Steele Tailing

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	3.30	348	10700	6500	1950	NA	NA
2	1	3.24	348	-	-	-	-	-
	2	3.07	369	9570	17500	5250	4054.1	1216.2
3	1	3.23	353	-	-	-	-	-
	2	2.95	353	-	-	-	-	-
	3	3.16	356	15200	28000	8400	5318.0	1595.4
4	1	3.28	348	-	-	-	-	-
	2	2.93	359	-	-	-	-	-
	3	2.95	370	-	-	-	-	-
	4	2.83	377	17400	22000	6600	8989.0	2696.7
5	1	3.25	349	-	-	-	-	-
	2	2.97	362	-	-	-	-	-
	3	2.93	371	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	2.44	385	13870	20500	6150	12102.0	3630.6
6	1	3.13	344	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	3.18	364	-	-	-	-	-
	4	2.71	391	-	-	-	-	-
	5	2.35	398	-	-	-	-	-
	6	2.15	402	15510	19000	5700	11209.0	3362.7
7	1	3.24	346	-	-	-	-	-
	2	3.03	349	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	2.62	391	-	-	-	-	-
	6	2.30	399	-	-	-	-	-
	7	2.12	410	15960	22000	6600	13168.2	3950.5

SHAKE FLASK TEST

SAMPLE: Heath Steele Tailing (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	NA	NA	-	-	-	-	-
	2	3.15	365	-	-	-	-	-
	3	2.85	372	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	2.29	401	-	-	-	-	-
	7	2.15	406	-	-	-	-	-
	8	2.03	408	18600	33000	9900	17614.2	5284.3
9	1	3.14	353	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	3.16	366	-	-	-	-	-
	4	2.83	372	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	2.33	405	-	-	-	-	-
	8	2.18	409	-	-	-	-	-
	9	2.13	409	17960	30000	9000	16953.6	5086.1
10	1	3.13	354	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	3.18	364	-	-	-	-	-
	4	2.82	371	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	2.20	399	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	2.05	406	-	-	-	-	-
	10	2.05	407	19430	26000	7800	13752.2	4125.6

SHAKE FLASK TEST

SAMPLE: Key Lake Tailing

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	8.14	257	2970	1500	450	0.0	0.0
2	1	8.26	224	-	-	-	-	-
	2	7.81	316	2750	1700	510	0.0	0.0
3	1	8.27	208	-	-	-	-	-
	2	7.84	237	-	-	-	-	-
	3	7.33	268	2160	1900	570	0.0	0.0
4	1	8.29	205	-	-	-	-	-
	2	7.95	221	-	-	-	-	-
	3	8.03	224	-	-	-	-	-
	4	7.73	265	2150	2000	600	0.0	0.0
5	1	8.35	199	-	-	-	-	-
	2	7.92	209	-	-	-	-	-
	3	8.02	213	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	7.85	244	2420	2200	660	0.0	0.0
6	1	8.71	195	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	8.35	234	-	-	-	-	-
	5	8.00	343	-	-	-	-	-
	6	7.83	366	2290	1900	570	0.0	0.0
7	1	8.65	180	-	-	-	-	-
	2	8.18	215	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	8.25	234	-	-	-	-	-
	6	7.97	332	-	-	-	-	-
	7	7.90	338	2260	1900	570	0.0	0.0

SHAKE FLASK TEST

SAMPLE: Key Lake Tailing (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	NA	NA	-	-	-	-	-
	2	8.22	202	-	-	-	-	-
	3	7.96	226	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	8.10	245	-	-	-	-	-
	7	7.81	352	-	-	-	-	-
	8	7.21	496	1581	2000	600	0.0	0.0
9	1	8.91	169	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	8.03	219	-	-	-	-	-
	4	7.95	232	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	8.17	248	-	-	-	-	-
	8	7.86	341	-	-	-	-	-
	9	7.87	501	2390	1900	570	0.0	0.0
10	1	8.62	174	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	7.85	223	-	-	-	-	-
	4	7.88	228	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	8.10	247	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	7.83	371	-	-	-	-	-
	10	7.11	323	2370	2000	600	0.0	0.0

SHAKE FLASK TEST

SAMPLE: Noranda Bell Tailing

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	7.43	310	1210	1200	360	0.0	0.0
2	1	7.64	272	-	-	-	-	-
	2	7.22	355	1240	1200	360	0.0	0.0
3	1	7.65	259	-	-	-	-	-
	2	7.18	309	-	-	-	-	-
	3	7.76	245	1230	1300	390	0.0	0.0
4	1	7.61	245	-	-	-	-	-
	2	7.36	281	-	-	-	-	-
	3	7.61	176	-	-	-	-	-
	4	7.22	246	1360	1400	420	0.0	0.0
5	1	7.60	242	-	-	-	-	-
	2	7.46	271	-	-	-	-	-
	3	7.71	174	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	7.67	245	1559	1300	390	0.0	0.0
6	1	7.75	235	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	8.11	228	-	-	-	-	-
	5	7.84	346	-	-	-	-	-
	6	7.84	377	1413	1200	360	0.0	0.0
7	1	7.70	188	-	-	-	-	-
	2	7.78	239	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	8.09	227	-	-	-	-	-
	6	7.82	356	-	-	-	-	-
	7	7.83	328	1454	1300	390	0.0	0.0

SHAKE FLASK TEST

SAMPLE: Noranda Bell Tailing (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100 g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	NA	NA	-	-	-	-	-
	2	7.67	192	-	-	-	-	-
	3	7.75	242	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	8.06	225	-	-	-	-	-
	7	7.80	349	-	-	-	-	-
	8	6.26	398	2320	1550	465	4.1	1.2
9	1	7.71	173	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	7.60	188	-	-	-	-	-
	4	7.73	252	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	8.10	224	-	-	-	-	-
	8	7.78	365	-	-	-	-	-
	9	6.49	406	1473	1200	360	0.5	0.2
10	1	7.72	169	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	7.48	185	-	-	-	-	-
	4	7.56	280	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	8.10	223	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	7.65	360	-	-	-	-	-
	10	7.50	251	1505	1050	315	0.0	0.0

SHAKE FLASK TEST

SAMPLE: Waite Amulet Tailing

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	3.30	291	3630	2000	600.0	798.7	239.6
2	1	3.26	296	-	-	-	-	-
	2	2.86	338	3630	3000	900.0	1176.0	352.8
3	1	3.30	290	-	-	-	-	-
	2	2.83	313	-	-	-	-	-
	3	3.62	268	6930	5100	1530.0	1011.0	303.3
4	1	3.31	286	-	-	-	-	-
	2	2.89	308	-	-	-	-	-
	3	3.10	324	-	-	-	-	-
	4	2.84	341	7150	4600	1380.0	1793.5	538.0
5	1	3.33	289	-	-	-	-	-
	2	2.91	308	-	-	-	-	-
	3	3.09	327	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	2.69	351	5570	5300	1590.0	2696.2	808.9
6	1	3.14	304	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	3.22	344	-	-	-	-	-
	5	* 2.82	360	-	-	-	-	-
	6	2.84	350	5390	4600	1380.0	2202.2	660.7
7	1	3.37	281	-	-	-	-	-
	2	3.01	302	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	3.09	349	-	-	-	-	-
	6	* 2.80	363	-	-	-	-	-
	7	2.66	375	6050	4700	1410.0	2937.6	881.3

SHAKE FLASK TEST

SAMPLE: Waite Amulet Tailing (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	NA	NA	-	-	-	-	-
	2	3.11	316	-	-	-	-	-
	3	2.77	333	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	2.68	367	-	-	-	-	-
	7	* 2.64	375	-	-	-	-	-
	8	2.59	382	7430	8000	2400.0	2620.8	786.2
9	1	3.49	302	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	3.17	294	-	-	-	-	-
	4	2.77	330	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	2.63	363	-	-	-	-	-
	8	* 2.61	370	-	-	-	-	-
	9	2.58	387	7710	7500	2250.0	2591.5	777.5
10	1	3.10	324	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	3.20	306	-	-	-	-	-
	4	2.88	323	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	2.71	360	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	2.62	370	-	-	-	-	-
	10	2.78	378	8080	9000	2700.0	3647.6	1094.3

SHAKE FLASK TEST

SAMPLE: Westmin Tailing

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	5.47	373	3850	2100.0	630.0	32.6	9.8
2	1	5.45	322	-	-	-	-	-
	2	3.00	363	5830	4100.0	1230.0	1537.2	461.1
3	1	5.55	298	-	-	-	-	-
	2	2.87	361	-	-	-	-	-
	3	3.15	352	7700	5100.0	1530.0	1454.2	436.3
4	1	5.54	289	-	-	-	-	-
	2	2.87	361	-	-	-	-	-
	3	2.93	379	-	-	-	-	-
	4	2.65	384	9240	6500.0	1950.0	1521.2	456.4
5	1	5.54	275	-	-	-	-	-
	2	2.83	363	-	-	-	-	-
	3	2.85	381	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	2.44	385	6750	6800.0	2040.0	4115.5	1234.6
6	1	6.10	312	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	2.71	389	-	-	-	-	-
	5	* 2.56	390	-	-	-	-	-
	6	2.47	390	7740	5900.0	1770.0	3003.0	900.9
7	1	5.78	286	-	-	-	-	-
	2	3.49	293	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	2.53	393	-	-	-	-	-
	6	* 2.51	391	-	-	-	-	-
	7	2.40	399	8130	5400.0	1620.0	3471.6	1041.5

SHAKE FLASK TEST

SAMPLE: Westmin Tailing (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	NA	NA	-	-	-	-	-
	2	3.15	347	-	-	-	-	-
	3	2.63	377	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	2.42	395	-	-	-	-	-
	7	* 2.44	395	-	-	-	-	-
	8	2.41	395	9090	14000.0	4200.0	3666.9	1100.1
9	1	6.83	194	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	3.18	365	-	-	-	-	-
	4	2.65	374	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	2.43	395	-	-	-	-	-
	8	* 2.45	395	-	-	-	-	-
	9	2.43	396	8870	9000.0	2700.0	2973.6	892.1
10	1	6.74	303	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	3.20	363	-	-	-	-	-
	4	2.64	370	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	2.43	396	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	2.46	394	-	-	-	-	-
	10	2.48	394	8760	12500.0	3750.0	4000.4	1200.1

SHAKE FLASK TEST

SAMPLE: Curragh Waste Rock

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	7.37	296	715	330.0	99.0	0.0	0.0
2	1	7.65	269	-	-	-	-	-
	2	6.65	220	814	900.0	270.0	0.5	0.1
3	1	7.63	250	-	-	-	-	-
	2	6.85	329	-	-	-	-	-
	3	5.06	216	1770	1300.0	390.0	0.9	0.3
4	1	7.65	233	-	-	-	-	-
	2	7.06	298	-	-	-	-	-
	3	7.51	208	-	-	-	-	-
	4	7.52	267	980	1900.0	570.0	0.0	0.0
5	1	7.64	220	-	-	-	-	-
	2	7.22	278	-	-	-	-	-
	3	7.64	199	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	7.06	272	1215	1300.0	390.0	0.0	0.0
6	1	7.69	273	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	7.89	282	-	-	-	-	-
	5	* 7.67	314	-	-	-	-	-
	6	7.68	304	1317	1250.0	375.0	0.0	0.0
7	1	7.38	195	-	-	-	-	-
	2	7.66	288	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	7.83	285	-	-	-	-	-
	6	* 7.63	325	-	-	-	-	-
	7	7.64	337	1434	1650.0	495.0	0.0	0.0

SHAKE FLASK TEST

SAMPLE: Curragh Waste Rock (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	NA	NA	-	-	-	-	-
	2	7.19	208	-	-	-	-	-
	3	7.57	301	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	7.86	288	-	-	-	-	-
	7	* 7.64	326	-	-	-	-	-
	8	7.36	371	1363	1350.0	405.0	0.0	0.0
9	1	7.87	174	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	7.10	208	-	-	-	-	-
	4	7.56	314	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	7.84	294	-	-	-	-	-
	8	* 7.61	324	-	-	-	-	-
	9	7.48	500	1222	1100.0	330.0	0.0	0.0
10	1	7.84	186	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	6.87	235	-	-	-	-	-
	4	7.20	334	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	7.69	308	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	7.38	353	-	-	-	-	-
	10	7.03	269	1417	1250.0	375.0	0.0	0.0

SHAKE FLASK TEST

SAMPLE: Equity Silver Waste Rock

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	4.01	328	1360	800.0	240.0	94.1	28.2
2	1	4.00	317	-	-	-	-	-
	2	3.73	330	1617	1500.0	450.0	224.1	67.2
3	1	4.05	314	-	-	-	-	-
	2	3.62	317	-	-	-	-	-
	3	3.72	312	1790	1600.0	480.0	356.7	107.0
4	1	3.99	316	-	-	-	-	-
	2	3.62	318	-	-	-	-	-
	3	3.49	324	-	-	-	-	-
	4	3.34	339	2134	2300.0	690.0	464.8	139.4
5	1	3.99	316	-	-	-	-	-
	2	3.67	325	-	-	-	-	-
	3	3.51	337	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	3.29	339	2570	2300.0	690.0	590.4	177.1
6	1	4.35	295	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	3.55	352	-	-	-	-	-
	5	3.42	354	-	-	-	-	-
	6	3.36	351	2140	1700.0	510.0	624.8	187.4
7	1	4.90	289	-	-	-	-	-
	2	3.91	327	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	3.46	356	-	-	-	-	-
	6	3.38	357	-	-	-	-	-
	7	3.34	NA	2190	1500.0	450.0	611.5	183.4

SHAKE FLASK TEST

SAMPLE: Equity Silver Waste Rock (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	NA	NA	-	-	-	-	-
	2	3.74	324	-	-	-	-	-
	3	3.33	338	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	3.18	359	-	-	-	-	-
	7	3.11	372	-	-	-	-	-
	8	3.07	383	3130	2700.0	810.0	1363.7	409.1
9	1	5.00	276	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	3.58	331	-	-	-	-	-
	4	3.21	343	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	3.14	362	-	-	-	-	-
	8	3.15	362	-	-	-	-	-
	9	3.18	382	NA	1900.0	570.0	1150.3	345.1
10	1	5.01	296	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	3.65	328	-	-	-	-	-
	4	3.18	340	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	3.11	360	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	3.07	365	-	-	-	-	-
	10	3.18	367	3140	2500.0	750.0	1801.3	540.4

SHAKE FLASK TEST

SAMPLE: Heath Steele Waste Rock

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	6.89	293	979	540.0	162.0	0.5	0.1
2	1	7.32	227	-	-	-	-	-
	2	6.76	336	1170	1200.0	360.0	2.5	0.7
3	1	7.29	230	-	-	-	-	-
	2	7.03	284	-	-	-	-	-
	3	6.92	259	1570	1400.0	420.0	0.5	0.1
4	1	7.31	222	-	-	-	-	-
	2	7.25	233	-	-	-	-	-
	3	6.72	205	-	-	-	-	-
	4	6.49	266	1790	1500.0	450.0	19.7	5.9
5	1	7.38	210	-	-	-	-	-
	2	7.53	214	-	-	-	-	-
	3	7.04	204	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	6.72	303	1775	1550.0	465.0	49.1	14.7
6	1	7.33	223	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	7.15	242	-	-	-	-	-
	5	6.81	282	-	-	-	-	-
	6	6.84	330	2240	1900.0	570.0	0.6	0.2
7	1	6.88	184	-	-	-	-	-
	2	7.10	243	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	6.98	255	-	-	-	-	-
	6	6.71	281	-	-	-	-	-
	7	6.87	346	2450	2000.0	600.0	6.1	1.8

SHAKE FLASK TEST

SAMPLE: Heath Steele Waste Rock (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	NA	NA	-	-	-	-	-
	2	6.54	198	-	-	-	-	-
	3	7.03	264	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	6.89	276	-	-	-	-	-
	7	6.60	309	-	-	-	-	-
	8	6.55	455	2570	2200.0	660.0	0.5	0.2
9	1	7.66	183	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	6.36	222	-	-	-	-	-
	4	6.86	315	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	6.78	271	-	-	-	-	-
	8	6.52	301	-	-	-	-	-
	9	6.87	417	2760	2300.0	690.0	0.2	0.1
10	1	7.51	185	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	6.28	238	-	-	-	-	-
	4	6.79	327	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	6.74	305	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	6.25	302	-	-	-	-	-
	10	5.82	328	2940	2000.0	600.0	5.1	1.5

SHAKE FLASK TEST

SAMPLE: Inco Waste Rock

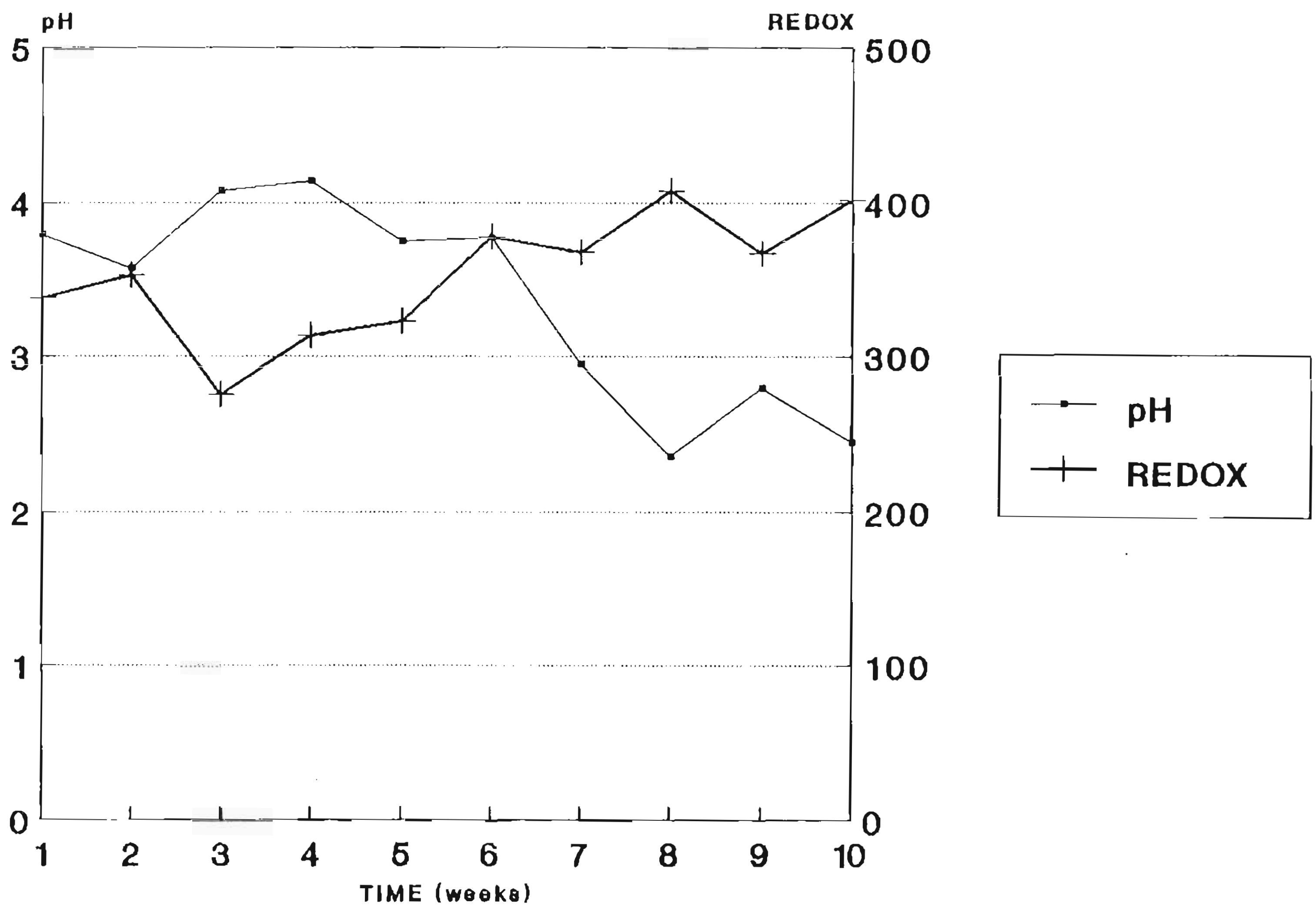
FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
1	1	7.37	292	528	250.0	75.0	0.0	0.0
2	1	7.59	252	-	-	-	-	-
	2	6.91	335	638	330.0	99.0	0.4	0.1
3	1	7.61	236	-	-	-	-	-
	2	7.54	244	-	-	-	-	-
	3	6.92	259	737	900.0	270.0	0.0	0.0
4	1	7.63	224	-	-	-	-	-
	2	7.60	231	-	-	-	-	-
	3	7.54	232	-	-	-	-	-
	4	7.25	2.89	870	1100.0	330.0	0.0	0.0
5	1	7.67	213	-	-	-	-	-
	2	7.60	224	-	-	-	-	-
	3	7.61	194	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	7.30	294	1020	1150.0	345.0	0.0	0.0
6	1	7.87	268	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	7.69	234	-	-	-	-	-
	5	7.20	296	-	-	-	-	-
	6	7.19	314	1018	1000.0	300.0	0.0	0.0
7	1	7.50	172	-	-	-	-	-
	2	7.80	275	-	-	-	-	-
	3	NA	NA	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	7.63	236	-	-	-	-	-
	6	7.04	300	-	-	-	-	-
	7	6.90	412	1040	1100.0	330.0	1.0	0.3

SHAKE FLASK TEST

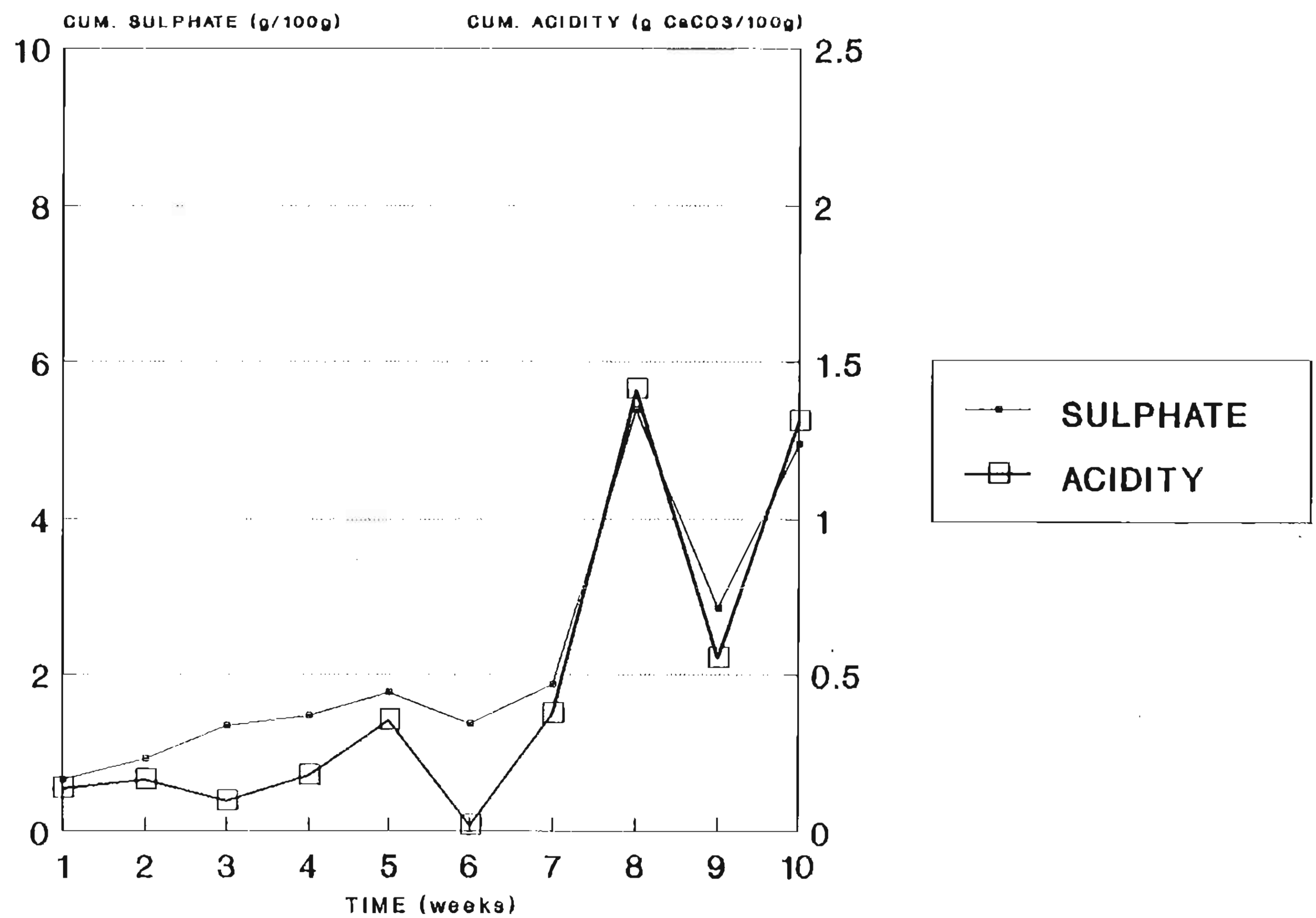
SAMPLE: Inco Waste Rock (cont'd)

FLASK	WEEK	pH	REDOX (mV SCE)	CONDUCTIVITY (mS/cm3)	SULPHATE (mg/L)	SULPHATE (mg/100g)	ACIDITY (mg CaCO3/L)	CUM. ACIDITY (mg CaCO3/100g)
8	1	NA	NA	-	-	-	-	-
	2	7.30	189	-	-	-	-	-
	3	7.59	292	-	-	-	-	-
	4	NA	NA	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	7.13	238	-	-	-	-	-
	7	6.41	303	-	-	-	-	-
	8	5.91	492	1219	1150.0	345.0	39.3	11.8
9	1	7.87	190	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	7.10	198	-	-	-	-	-
	4	7.55	301	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	7.30	238	-	-	-	-	-
	8	6.52	300	-	-	-	-	-
	9	6.77	412	1191	1200.0	360.0	1.1	0.3
10	1	7.90	195	-	-	-	-	-
	2	NA	NA	-	-	-	-	-
	3	7.06	202	-	-	-	-	-
	4	7.62	312	-	-	-	-	-
	5	NA	NA	-	-	-	-	-
	6	NA	NA	-	-	-	-	-
	7	7.44	238	-	-	-	-	-
	8	NA	NA	-	-	-	-	-
	9	6.67	293	-	-	-	-	-
	10	6.37	267	1187	1100.0	330.0	2.0	0.6

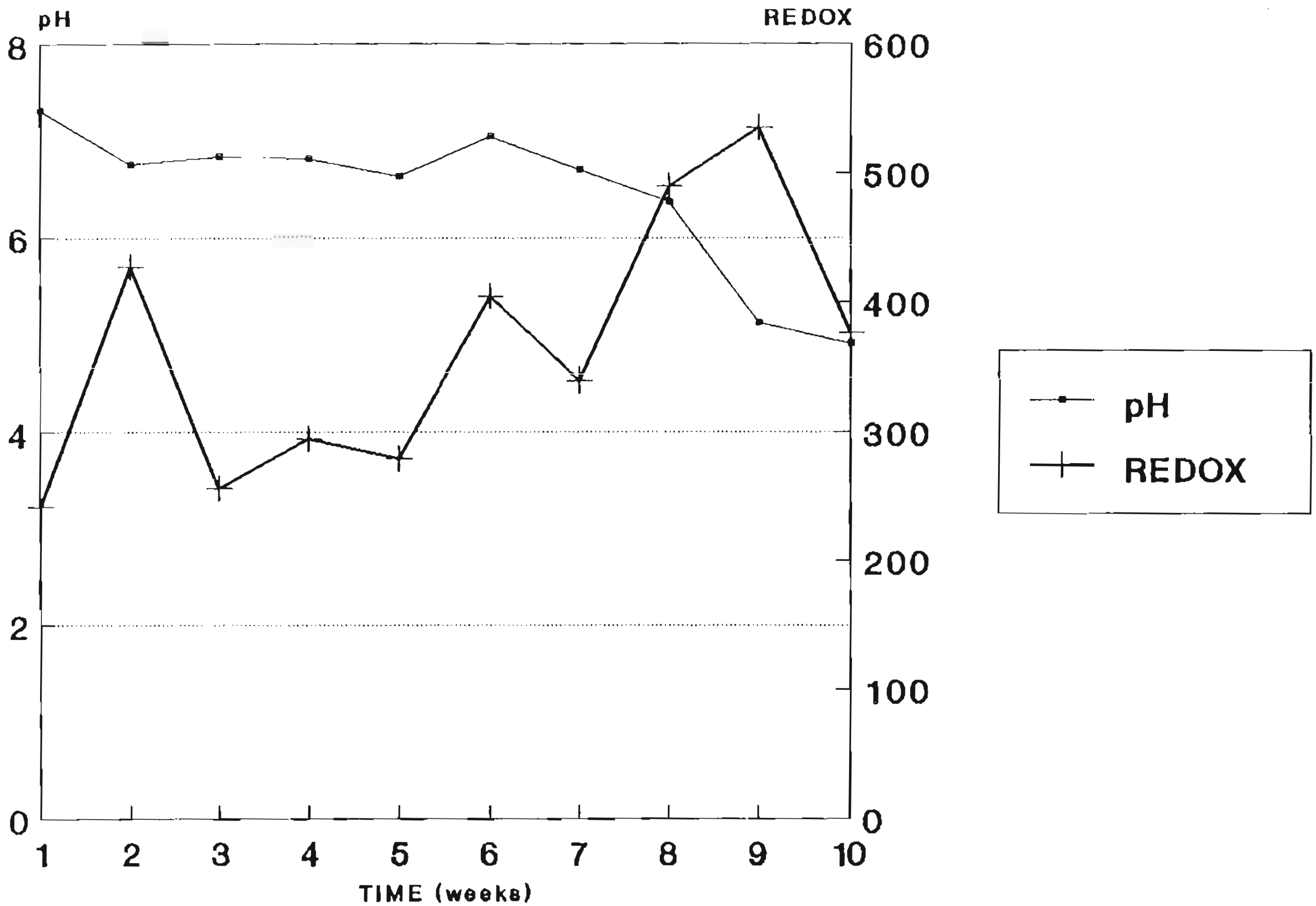
SHAKE FLASK TEST
CURRAGH TAILING



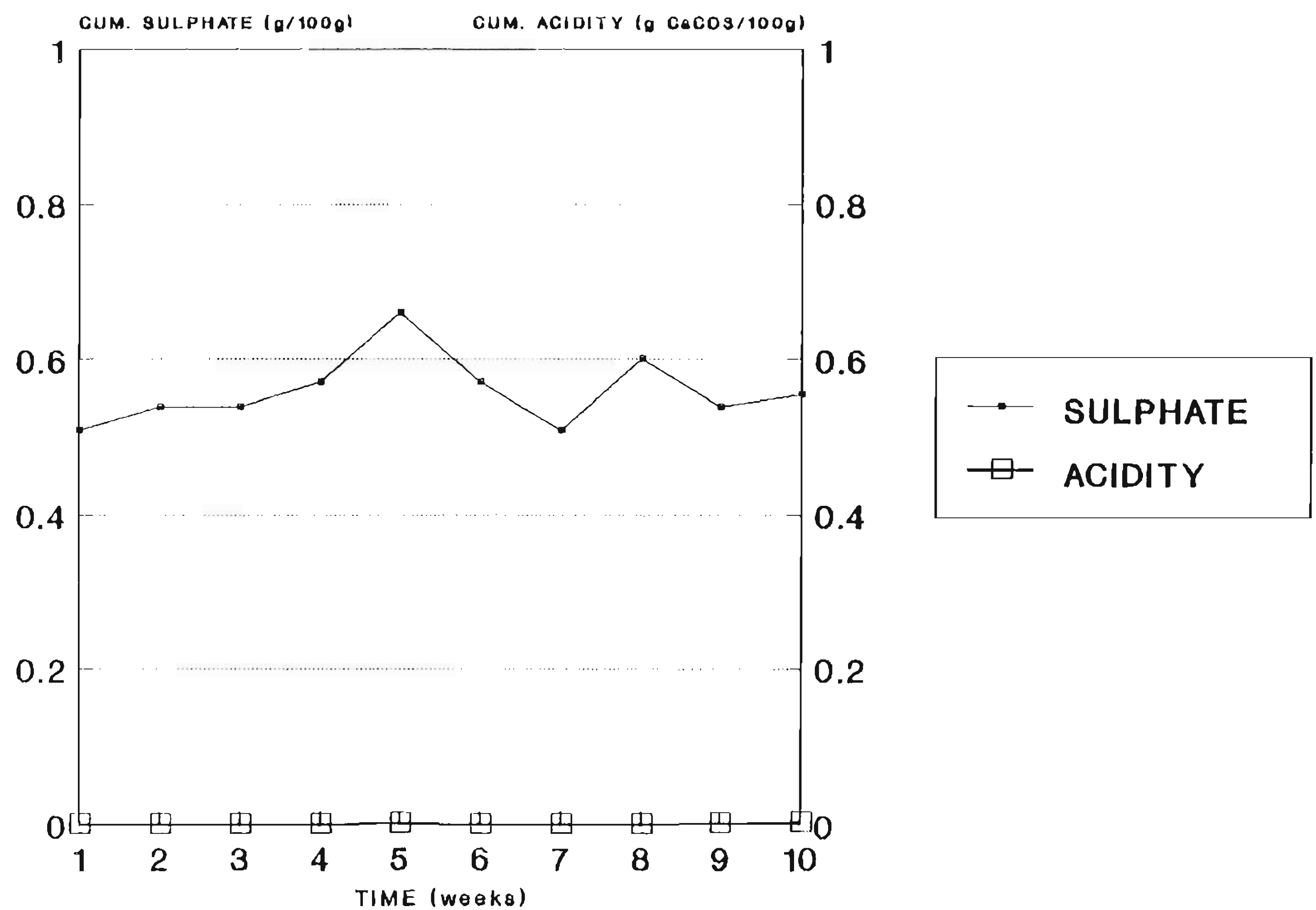
SHAKE FLASK TEST
CURRAGH TAILING



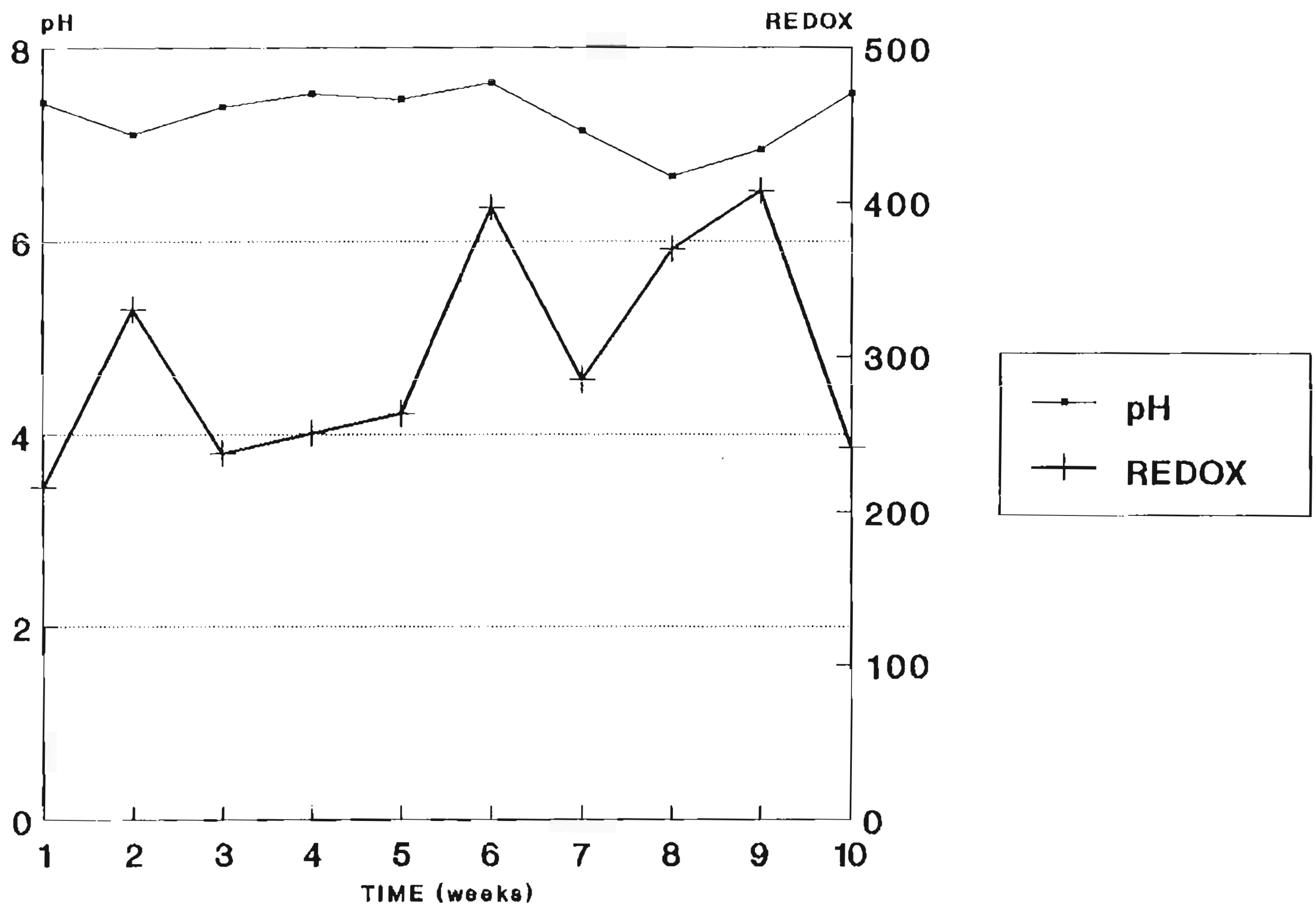
SHAKE FLASK TEST
ELLIOT LAKE TAILING



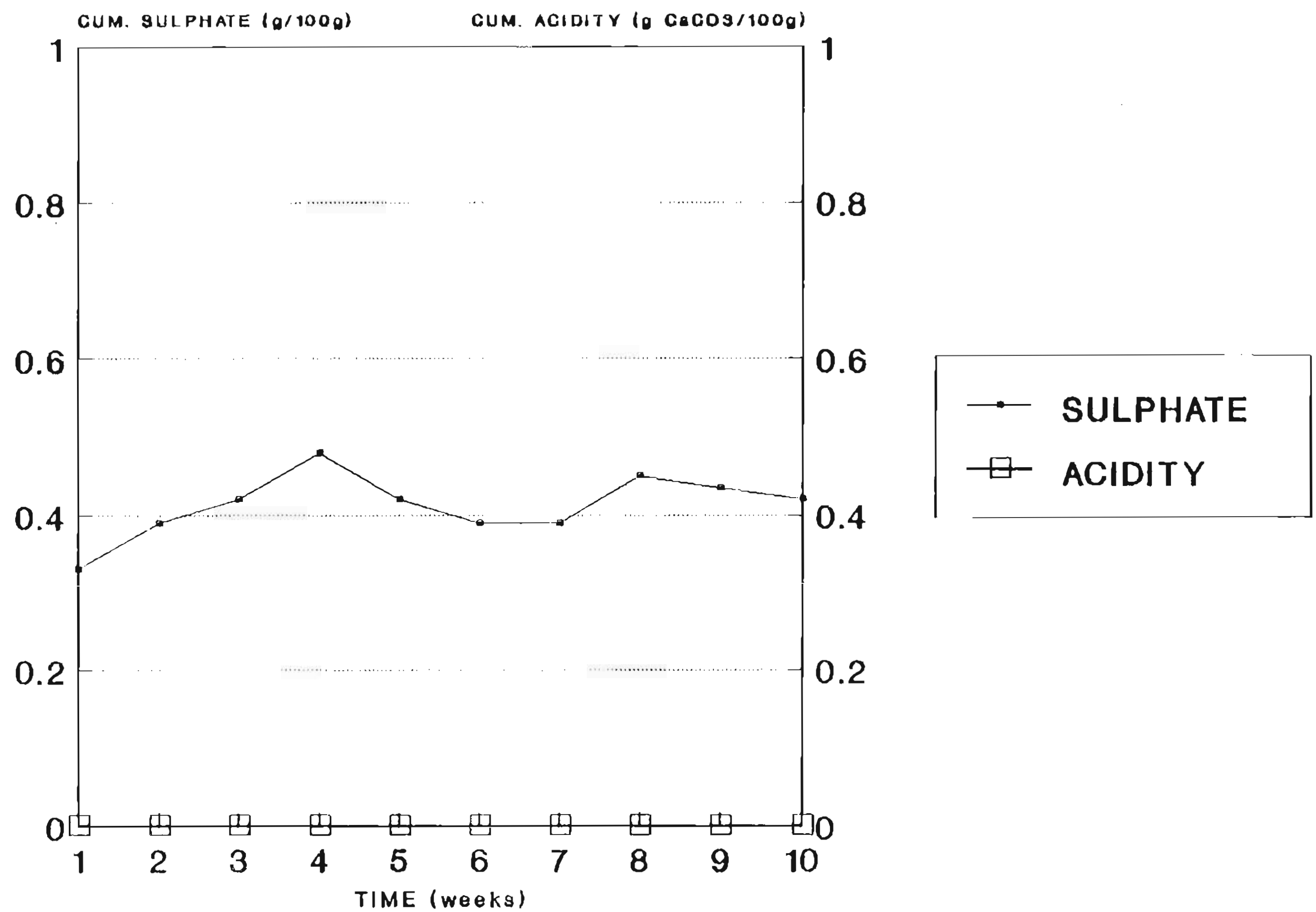
SHAKE FLASK TEST
ELLIOT LAKE TAILING



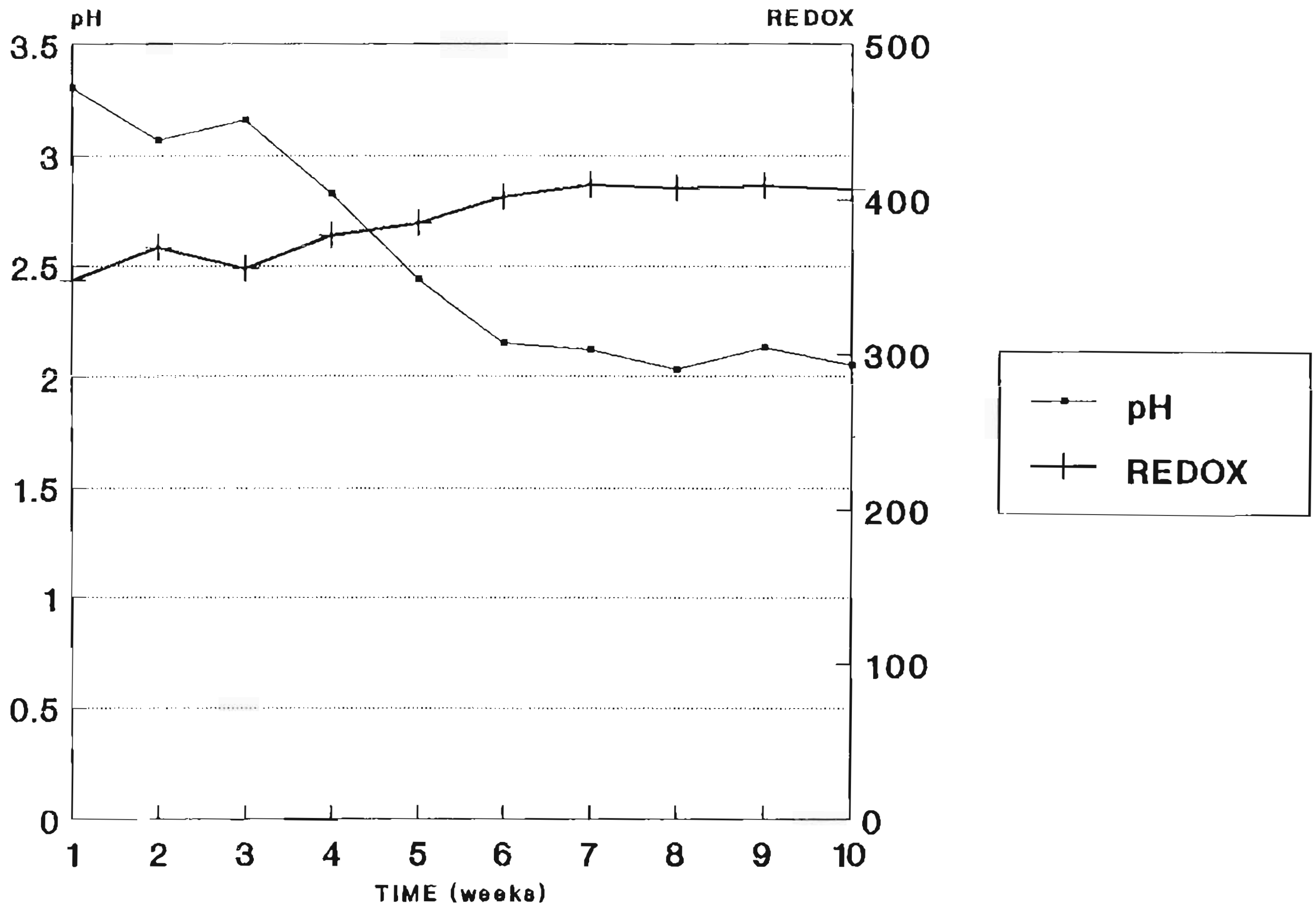
SHAKE FLASK TEST
EQUITY SILVER TAILING



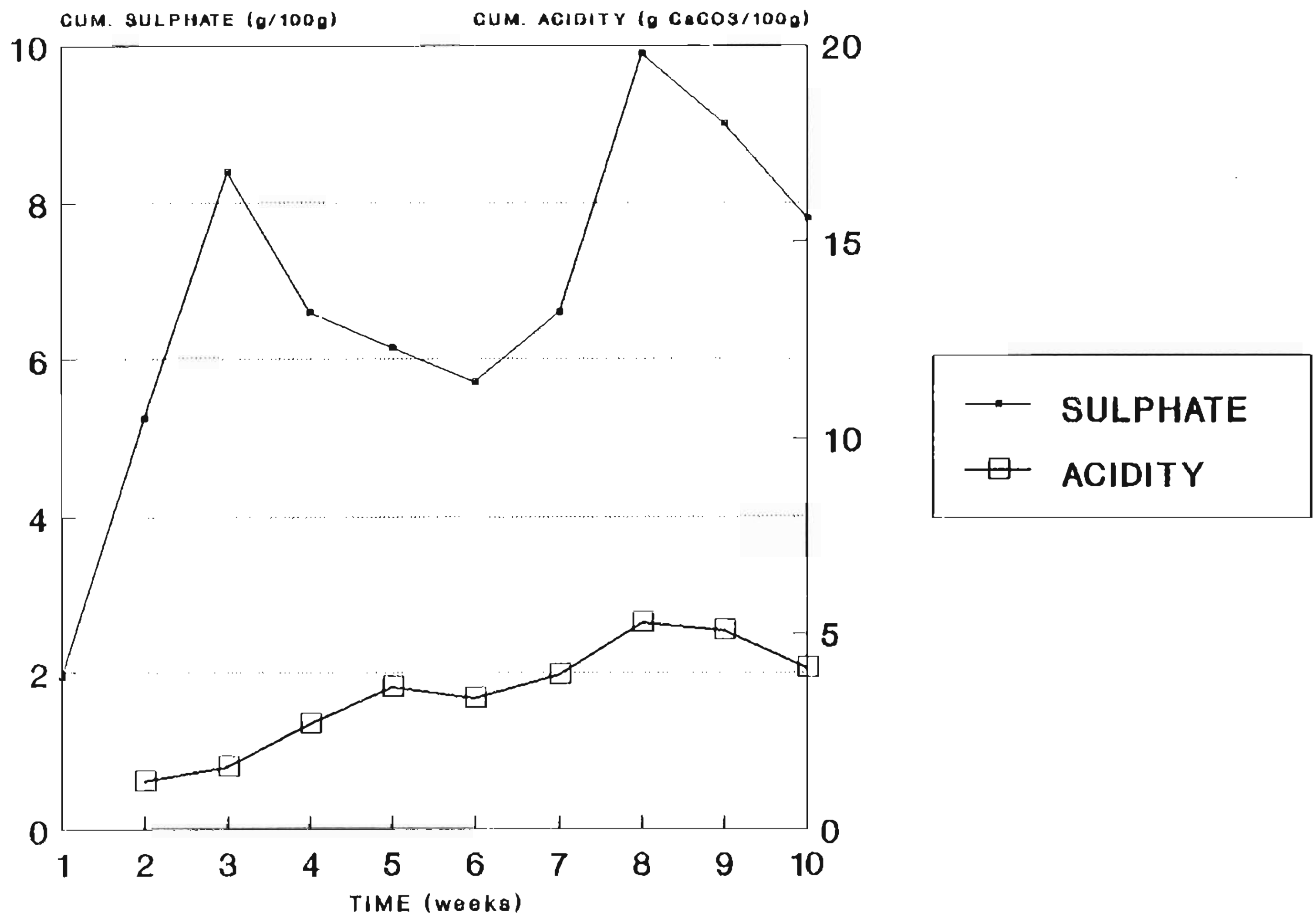
SHAKE FLASK TEST
EQUITY SILVER TAILING



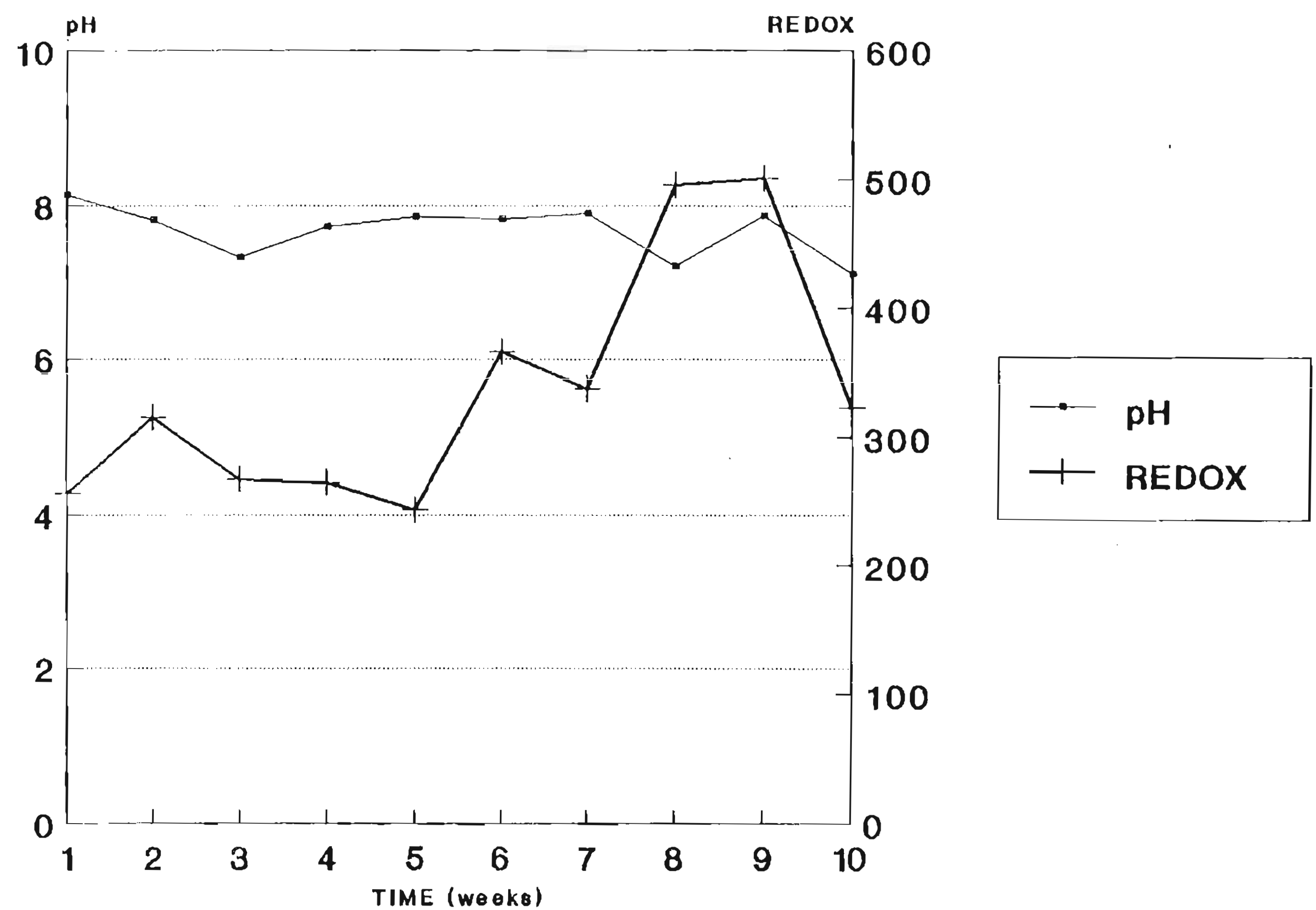
SHAKE FLASK TEST
HEATH STEELE TAILING



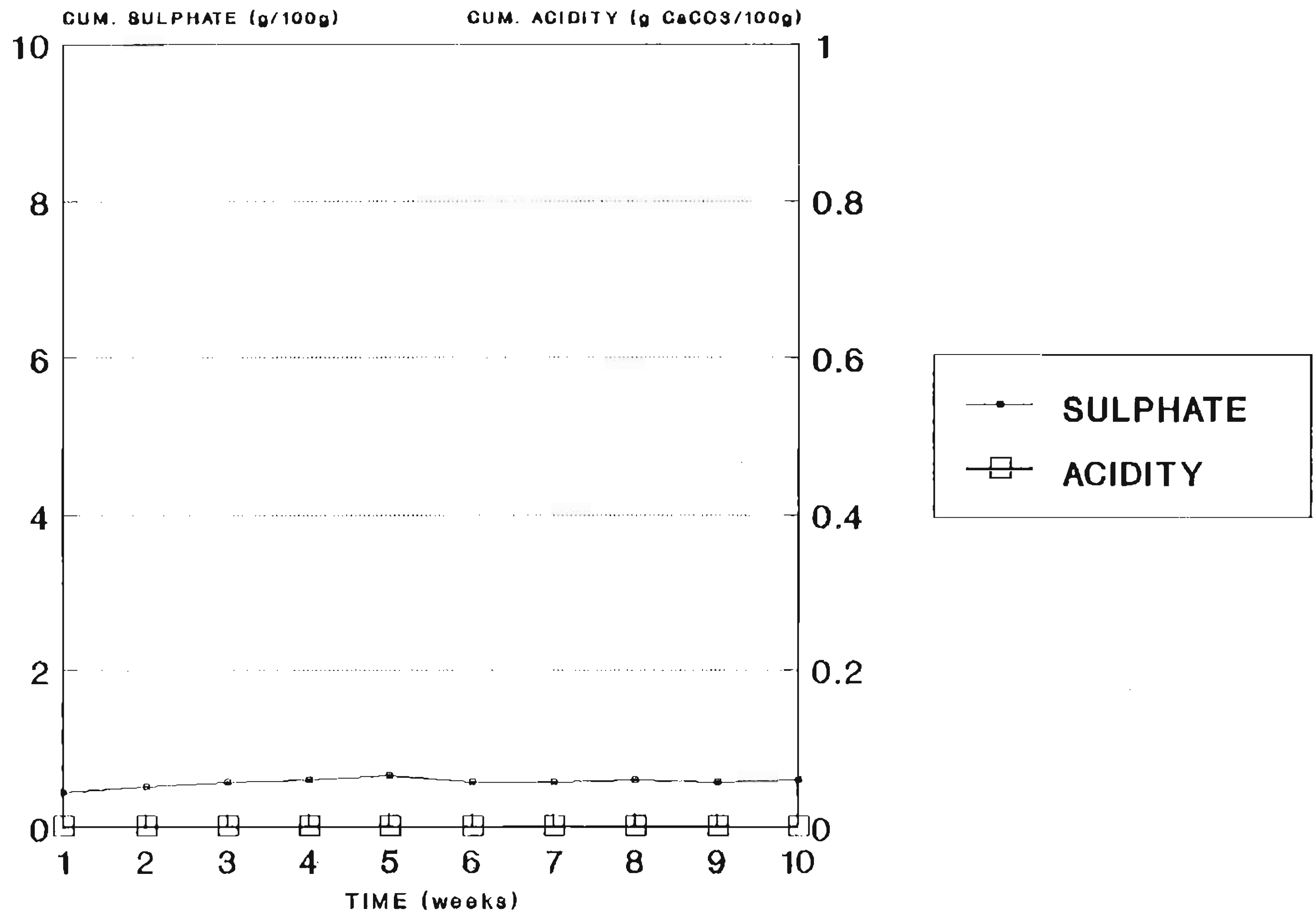
SHAKE FLASK TEST
HEATH STEELE TAILING



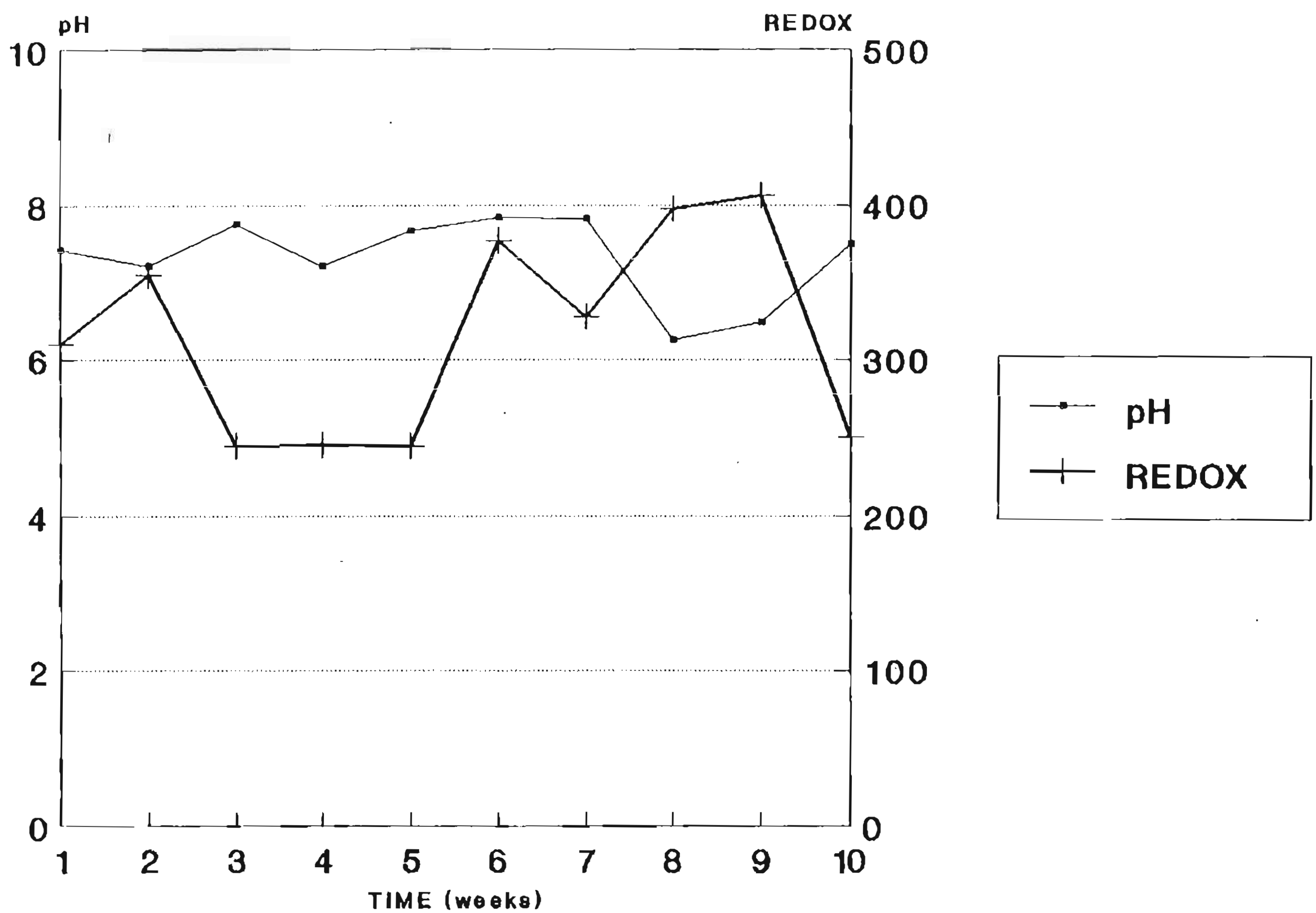
SHAKE FLASK TEST
KEY LAKE TAILING



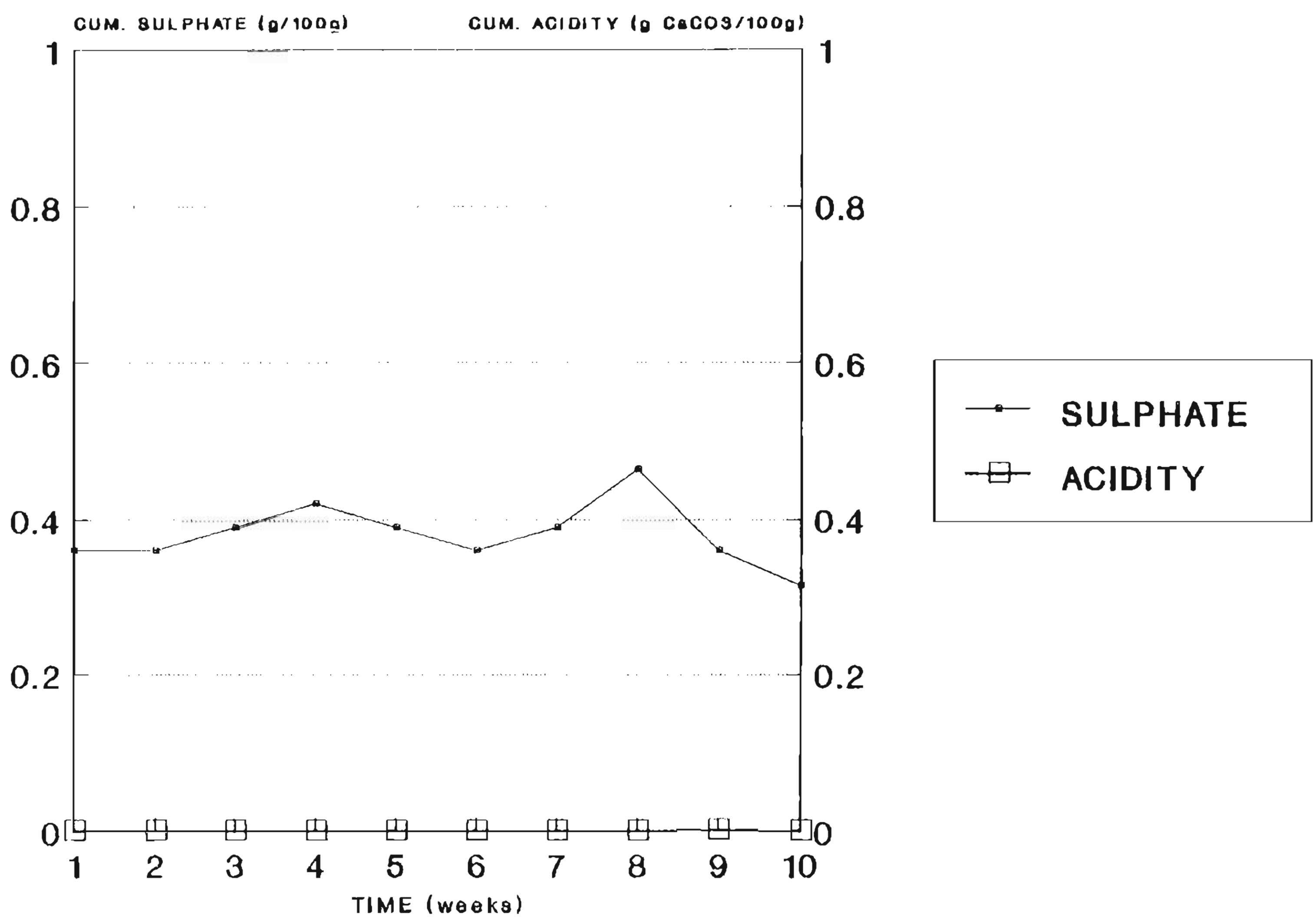
SHAKE FLASK TEST
KEY LAKE TAILING



SHAKE FLASK TEST
NORANDA BELL TAILING



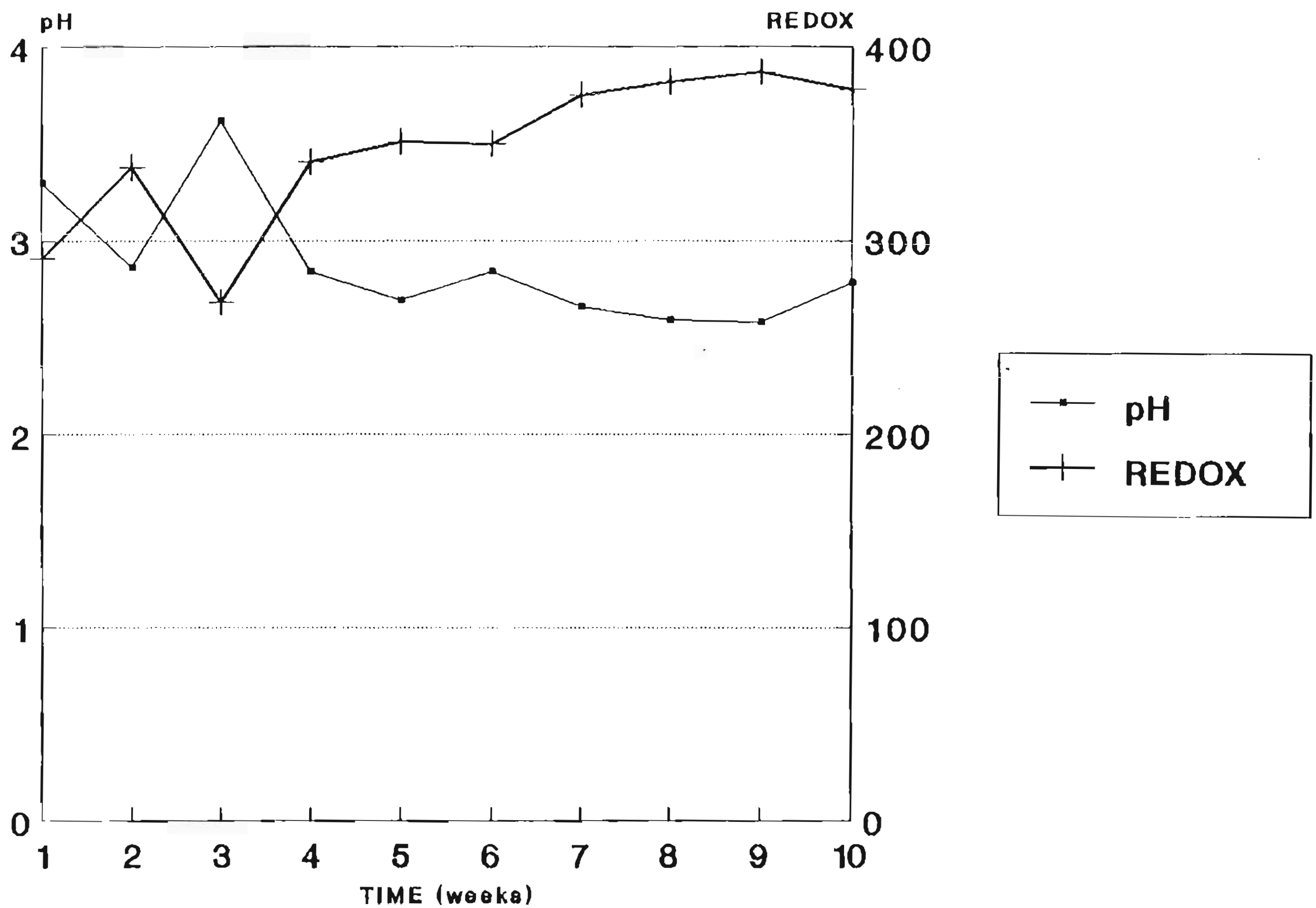
SHAKE FLASK TEST
NORANDA BELL TAILING



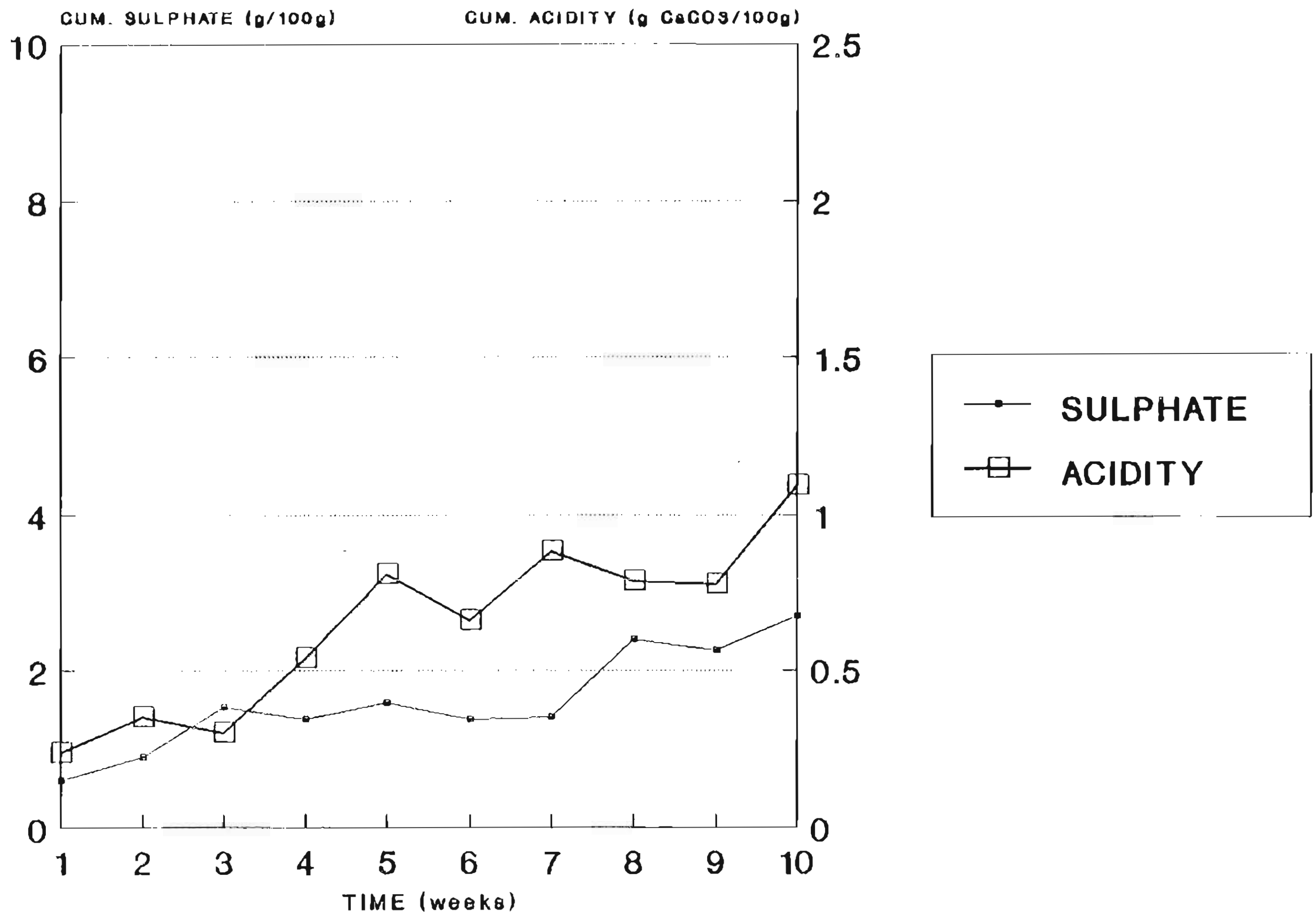
APPENDIX 9

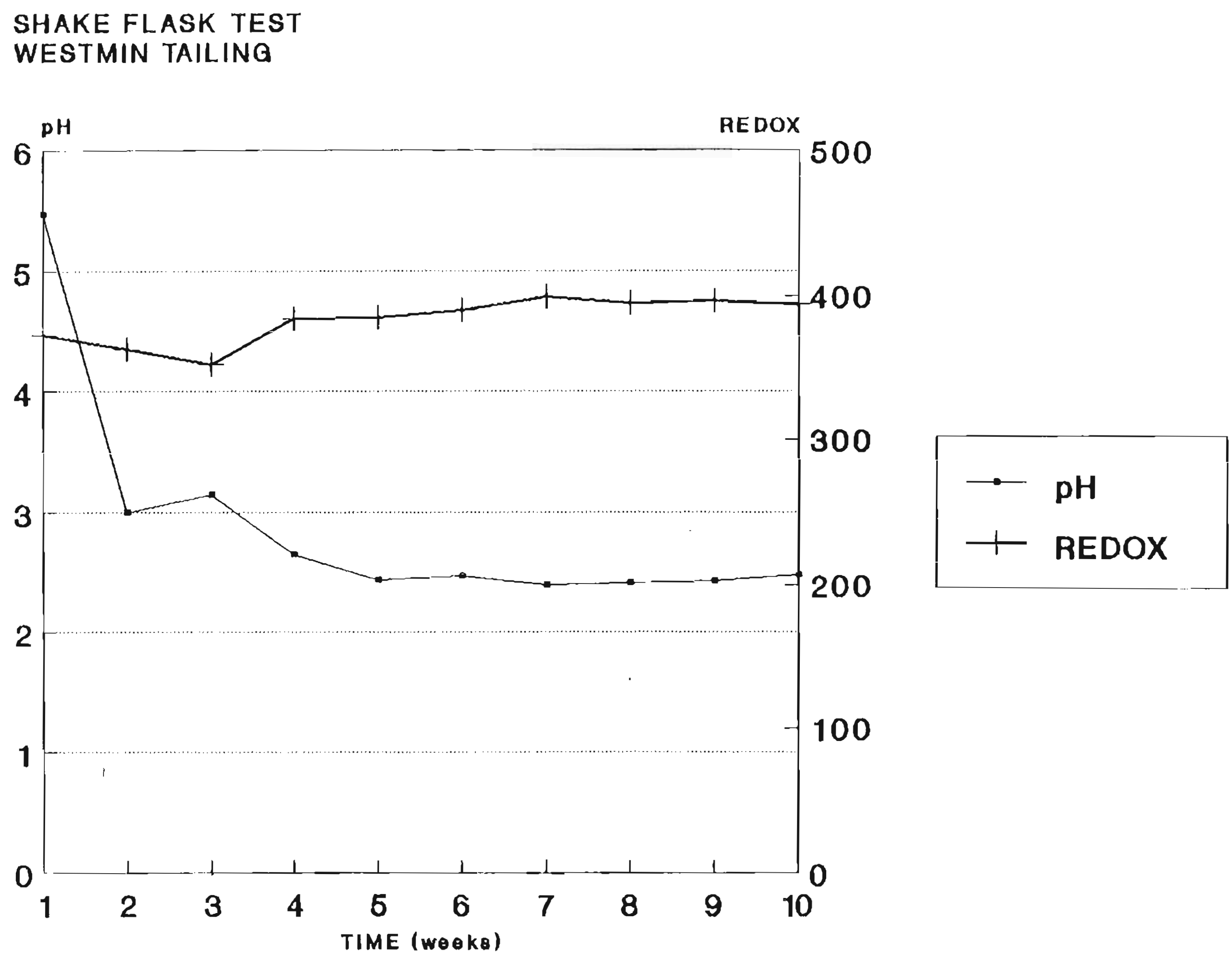
SHAKE FLASK TEST DATA

SHAKE FLASK TEST
WAITE AMULET TAILING

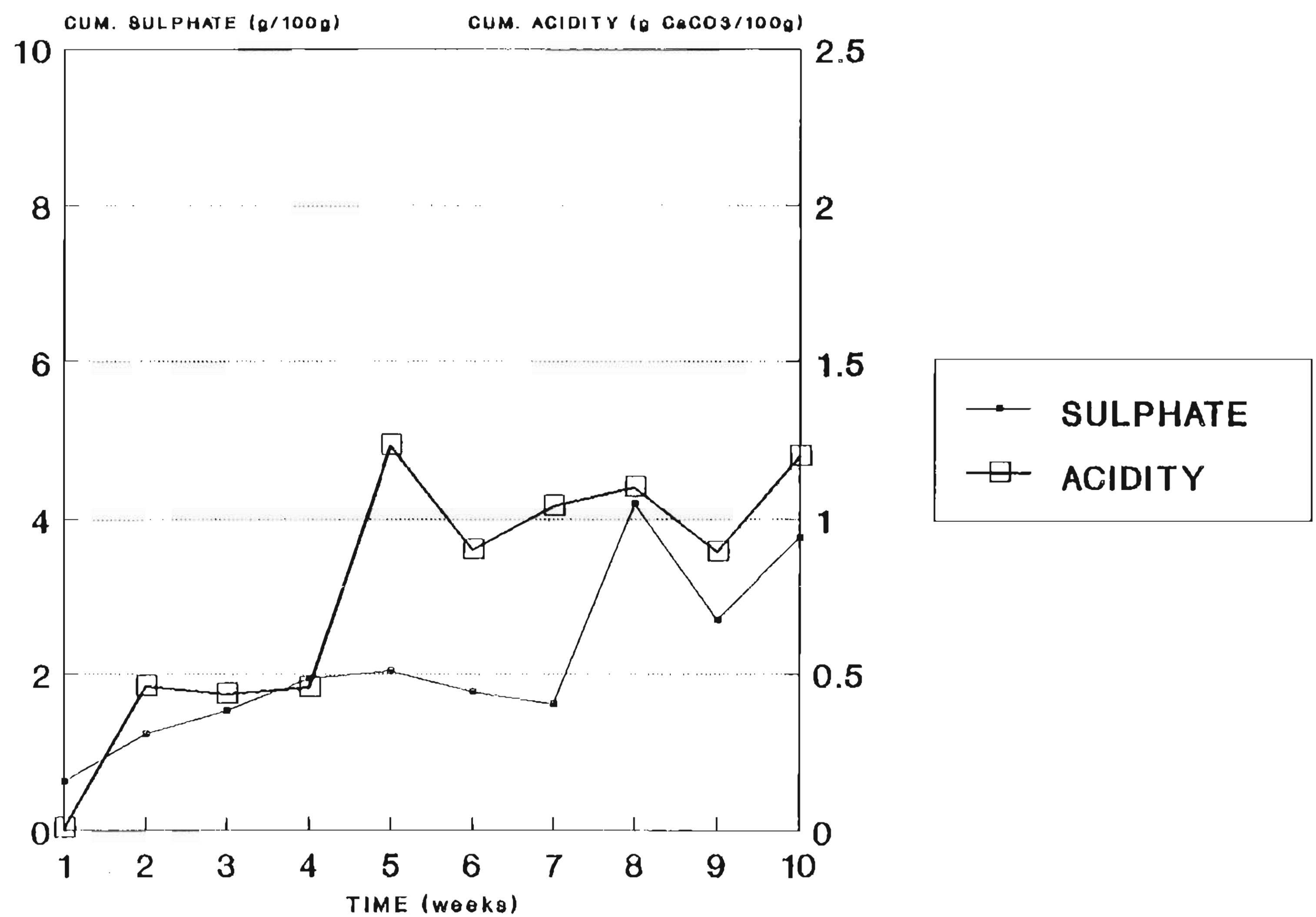


SHAKE FLASK TEST
WAITE AMULET TAILING

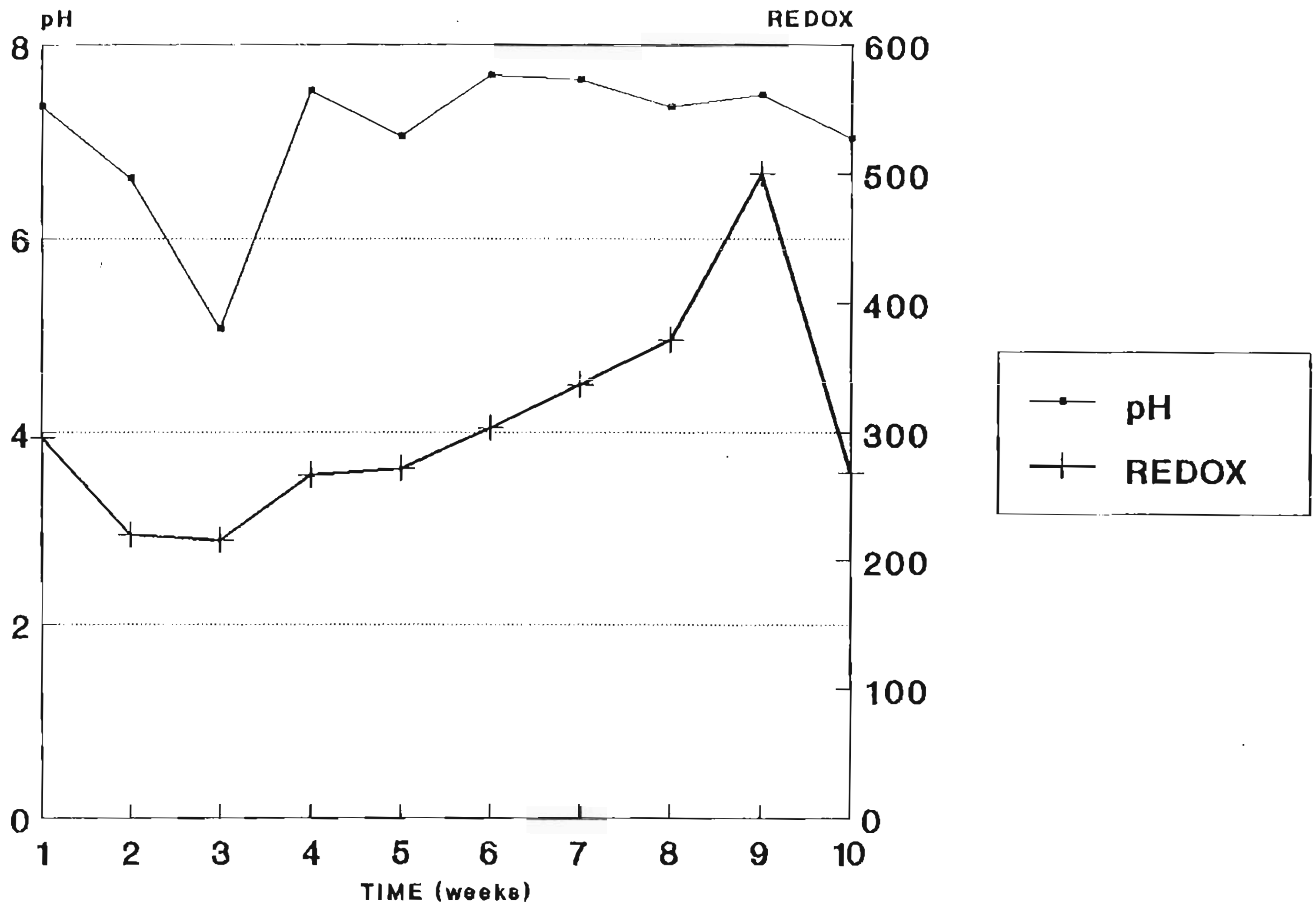



SHAKE FLASK TEST
WESTMIN TAILING
pH
REDOX
6
5
4
3
2
1
0
500
400
300
200
100
0
1
2
3
4
5
6
7
8
9
10
TIME (weeks)
pH
REDOX

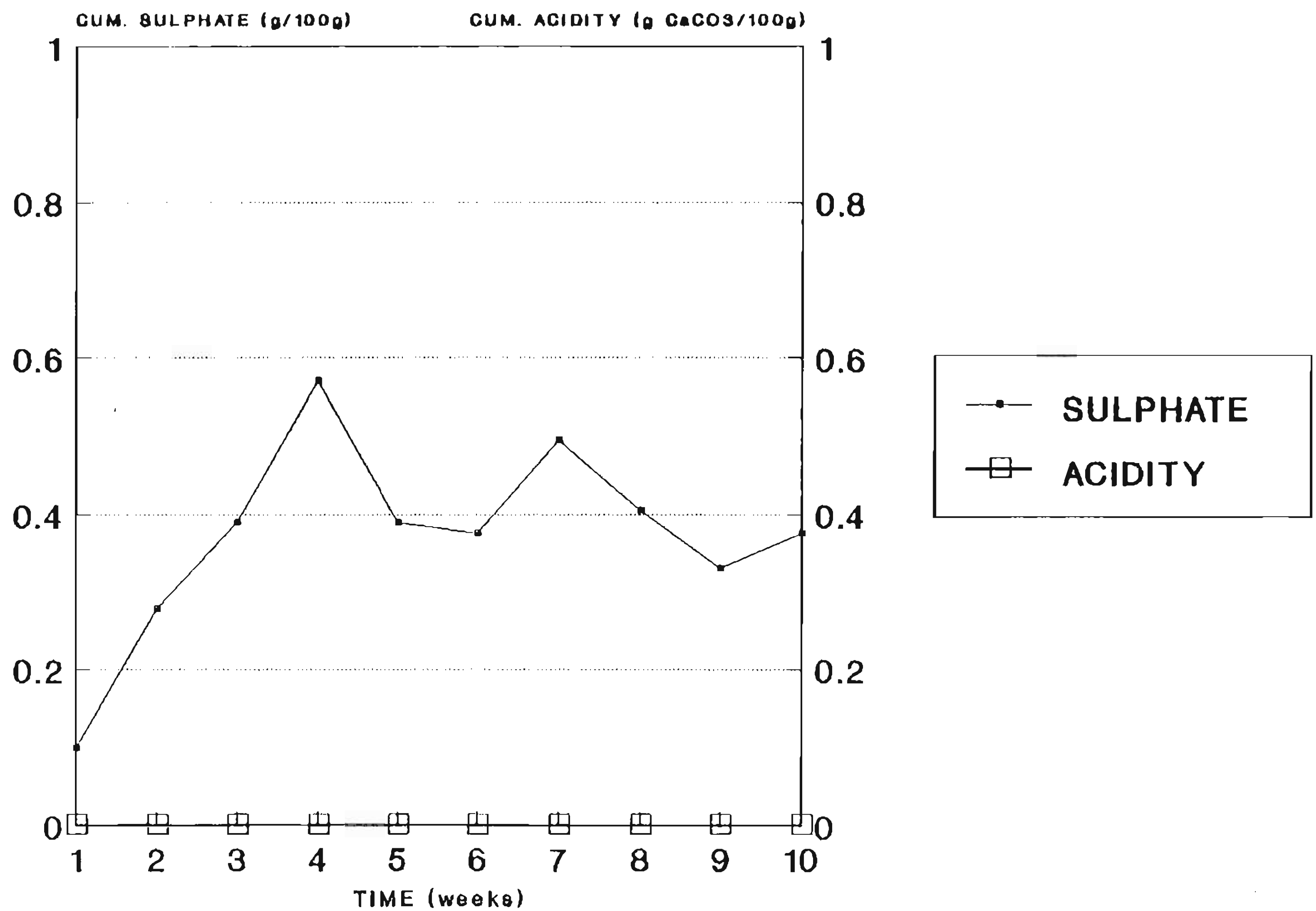
SHAKE FLASK TEST
WESTMIN TAILING



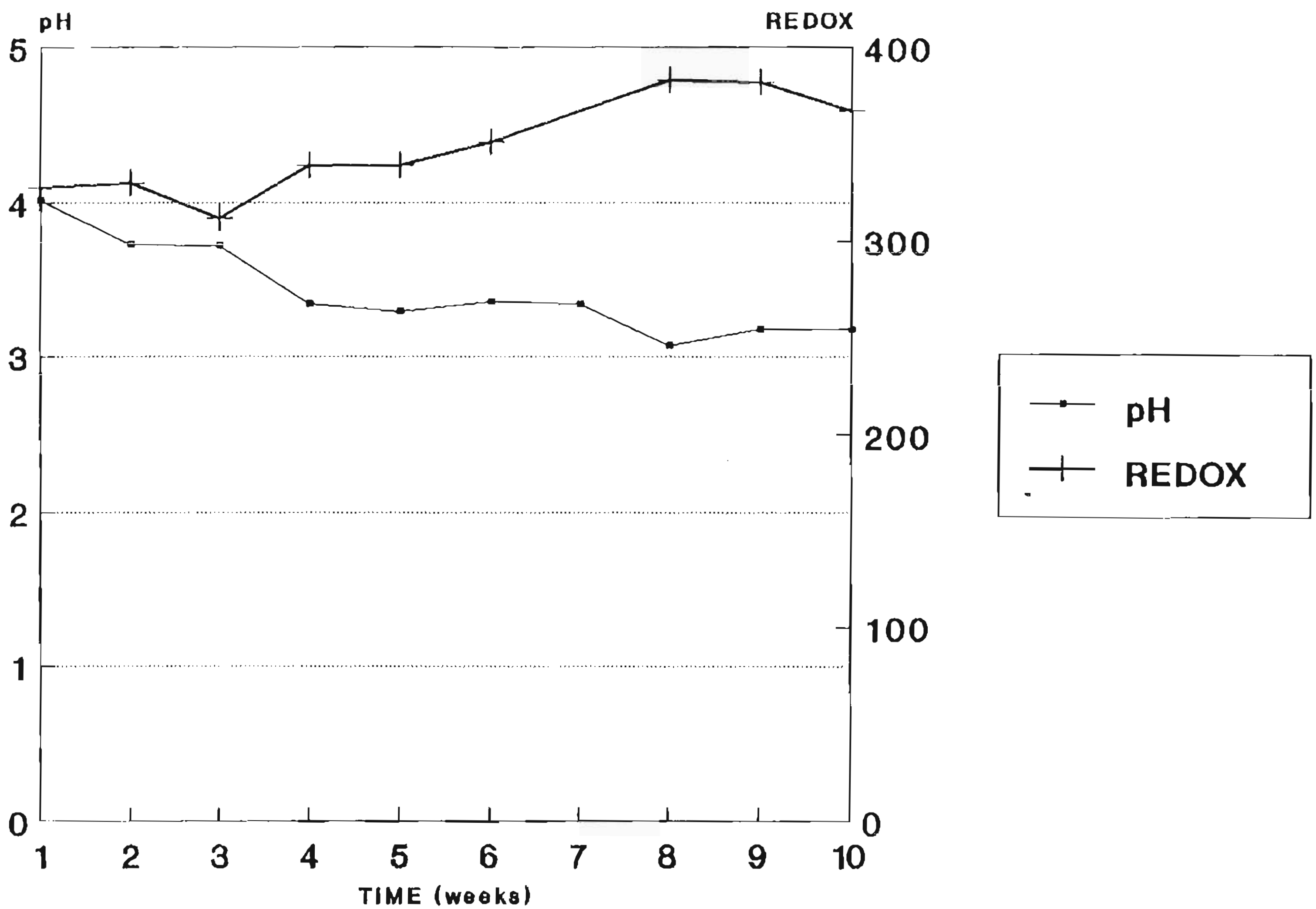
SHAKE FLASK TEST
CURRAGH WASTE ROCK



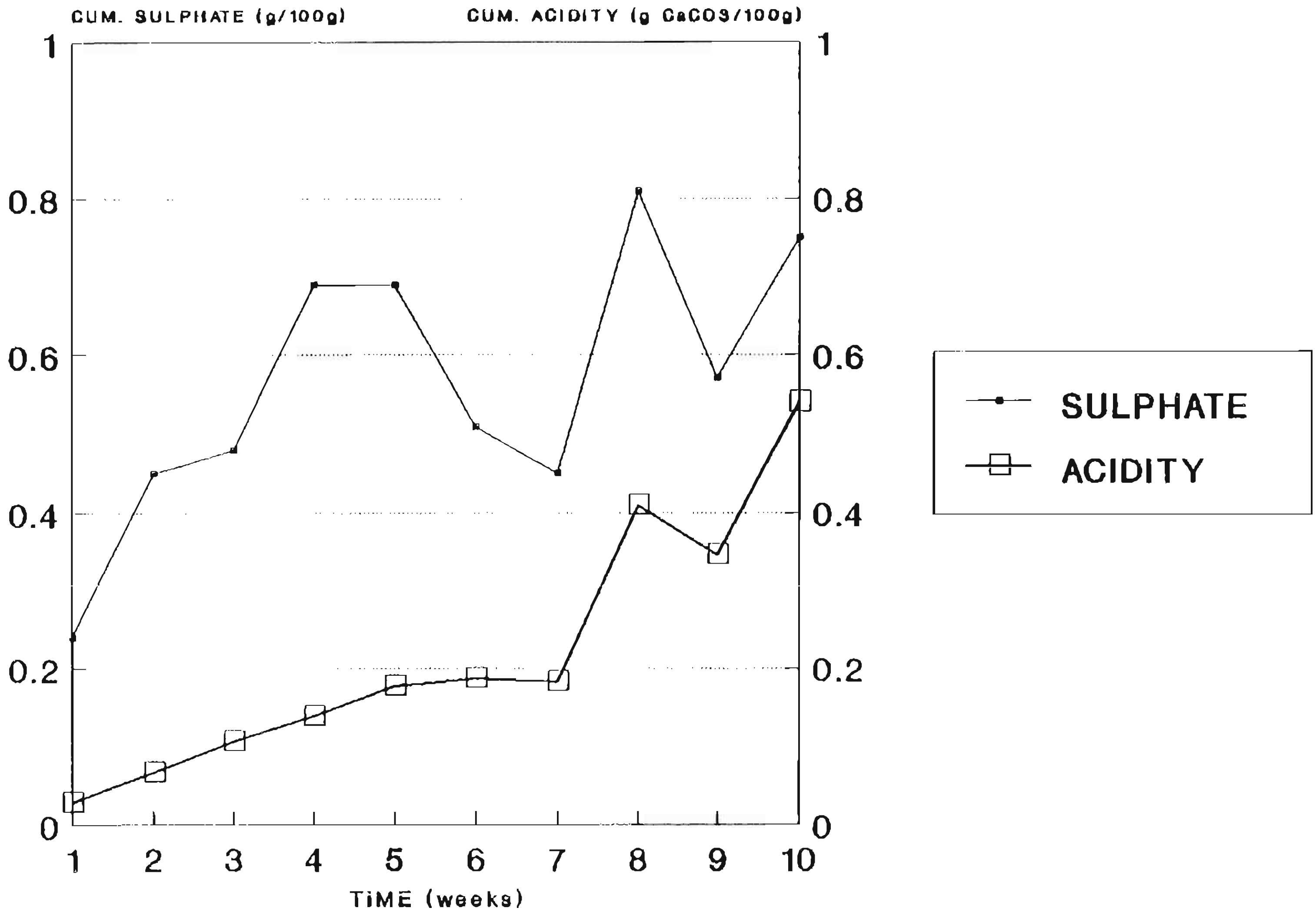
SHAKE FLASK TEST
CURRAGH WASTE ROCK



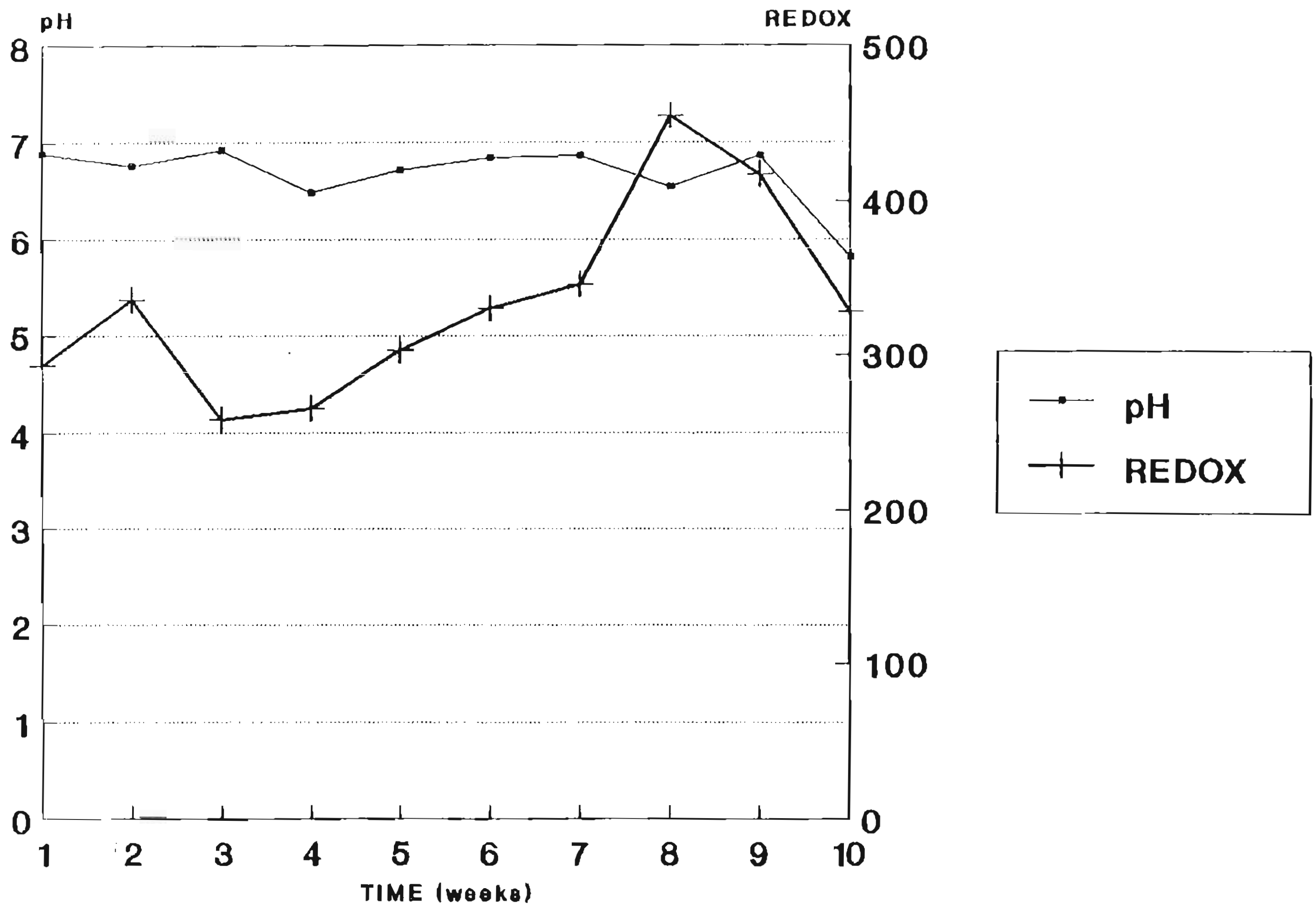
SHAKE FLASK TEST
EQUITY SILVER WASTE ROCK



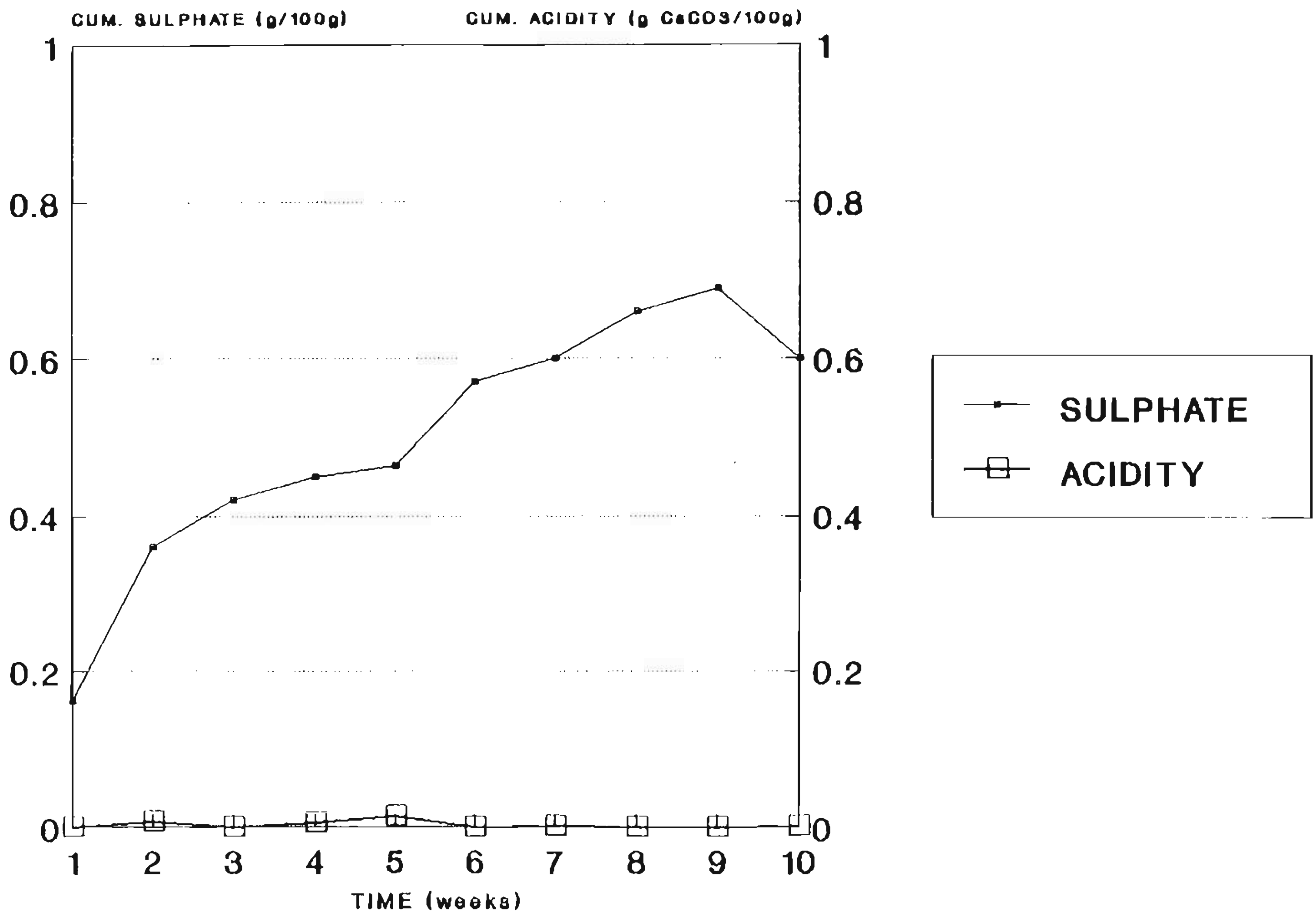
SHAKE FLASK TEST
EQUITY SILVER WASTE ROCK



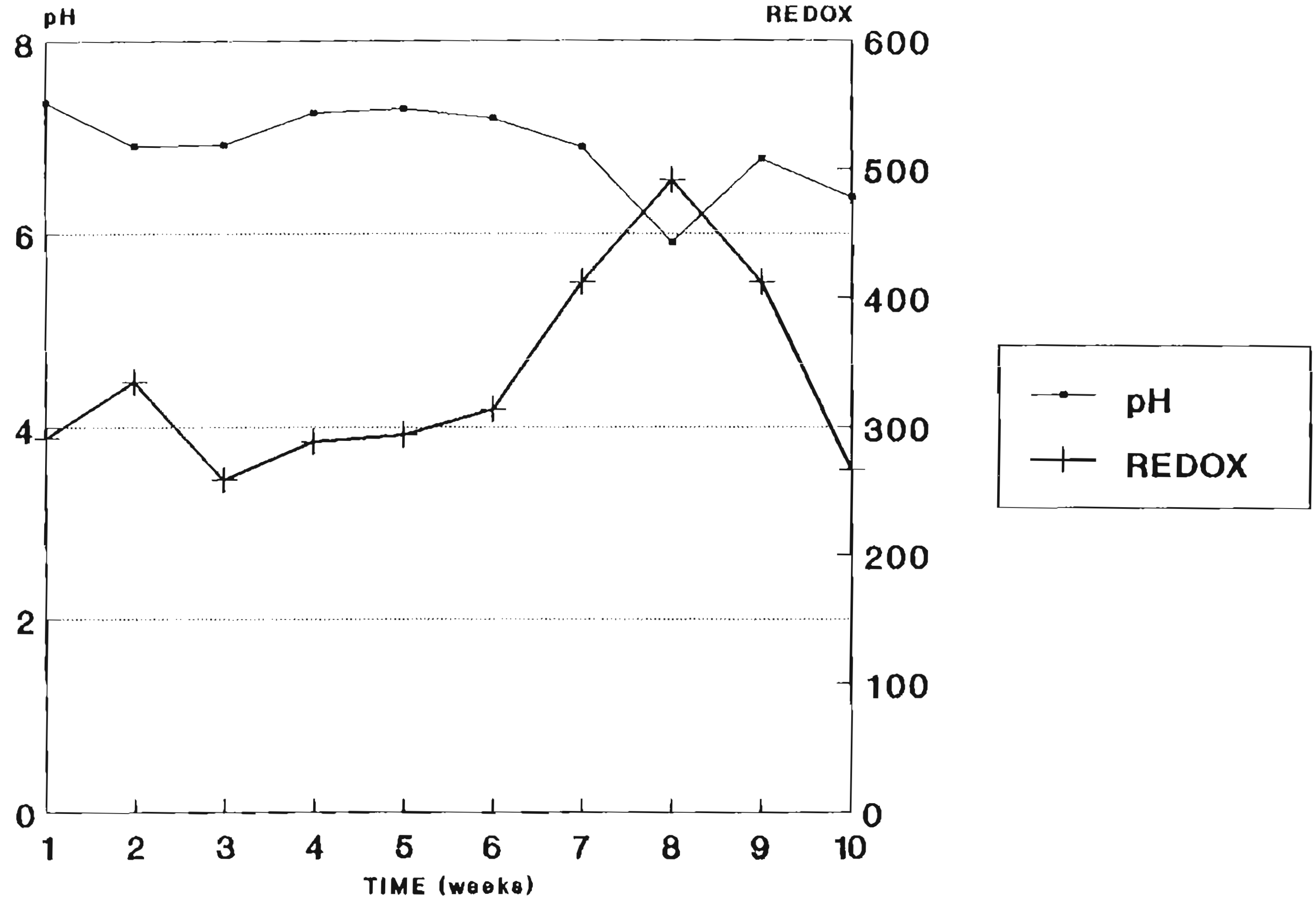
SHAKE FLASK TEST
HEATH STEELE WASTE ROCK



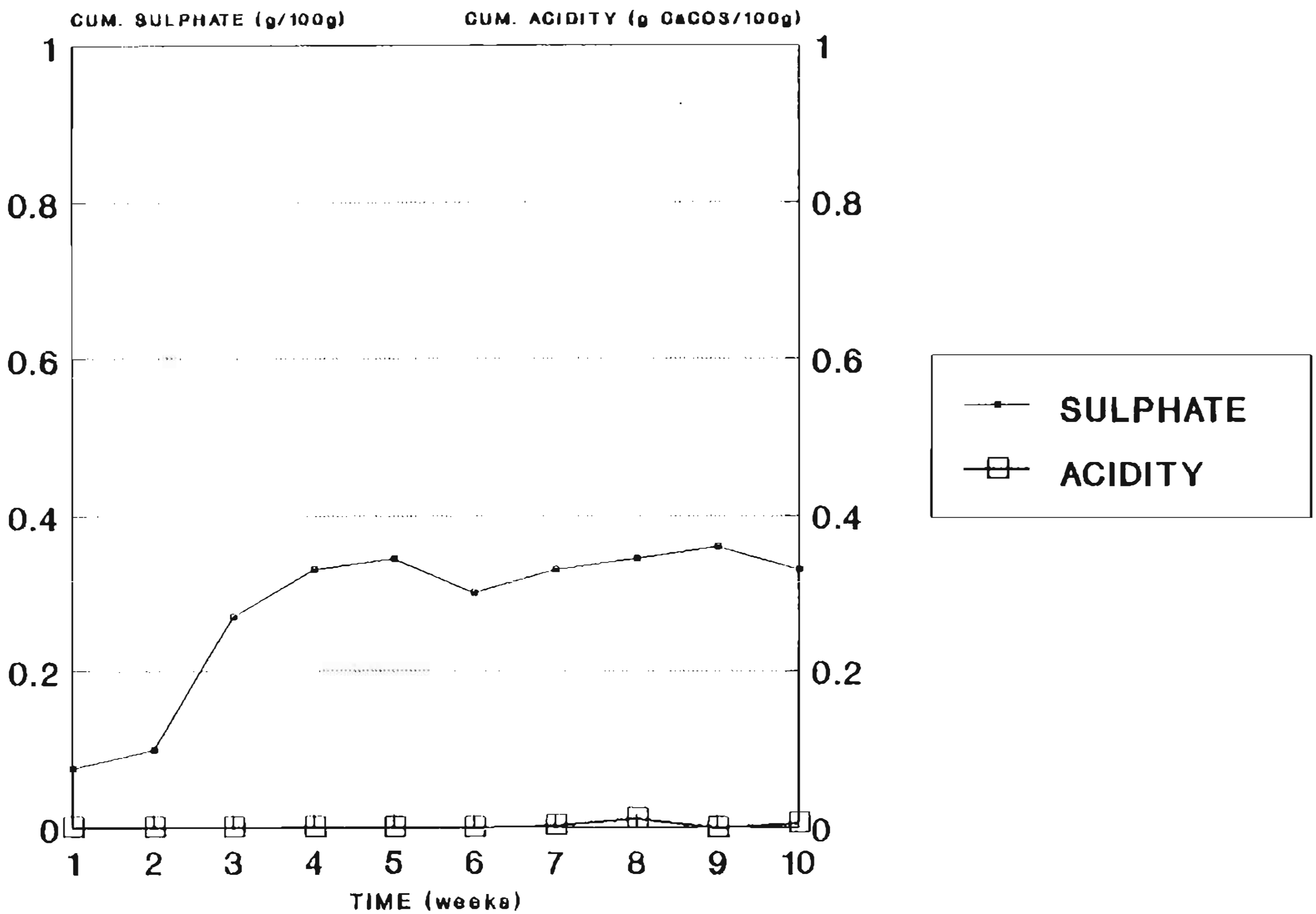
SHAKE FLASK TEST
HEATH STEELE WASTE ROCK



SHAKE FLASK TEST
INCO WASTE ROCK



SHAKE FLASK TEST
INCO WASTE ROCK



SHAKE FLASK TESTS

SAMPLE: Curragh Tailing

WEEK	SOLUTION ANALYSIS (mg/L)																
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	9.6	< 0.4	< 2.0	< 0.05	0.75	379	< 0.15	1.28	23.1	65	2.95	152	95	< 0.2	1.48	8.25	13.4	705
2	13.0	< 0.4	0.2	0.013	0.85	356	0.36	2.15	5.14	74	1.69	213	134	< 0.02	1.66	6.92	14.7	437
3	9.0	< 0.4	< 2.0	< 0.05	1.07	559	0.47	1.9	0.57	168	2.1	419	204	< 0.2	1.74	10.3	15.6	739
4	3.2	0.7	< 2.0	0.55	0.82	605	0.48	2	2.16	18.2	1.5	639	274	< 0.2	1.63	11.1	16	586
5	8.4	< 0.4	< 2.0	< 0.05	0.96	702	0.65	2.7	6.41	44.2	0.9	848	375	< 0.2	1.91	34.9	47.2	702
6	5.7	< 0.4	< 2.0	0.09	0.76	615	0.43	2	2.54	29.7	2.1	688	310	< 0.2	1.82	5.65	15.1	401
7	38.8	0.7	< 2.0	0.07	1.06	470	0.6	2.6	8.77	479	0.9	723	347	< 0.2	2.21	12.3	17.5	641
8	159.0	0.6	3.0	0.11	2.17	557	1.71	4.8	16	4040	2	1040	433	< 0.2	3.01	5.48	20.5	1150
9	91.3	< 0.4	< 2.0	0.13	1.54	543	1.05	3.2	15.9	3040	2.1	955	413	< 0.2	2.69	11.8	21.6	824
10	120.0	< 0.4	< 2.0	< 0.05	1.56	431	1.35	3.5	16.2	3420	1	751	317	< 0.2	2.78	3.45	20.4	759

SHAKE FLASK TESTS

SAMPLE: Elliot Lake Tailing

WEEK	SOLUTION ANALYSIS (mg/L) Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	2.0	< 0.4	< 2.0	< 0.2	0.011	178	<0.015	< 0.01	0.083	0.12	0.08	3.48	0.23	0.03	0.06	20.2	6.44	5.29
2	1.8	0.05	0.8	0.035	< 0.005	1000	0.16	0.02	0.013	0.3	< 0.05	15.4	0.31	0.03	0.03	19.8	6.84	0.32
3	1.3	< 0.4	< 2.0	< 0.05	< 0.05	778	0.22	< 0.1	0.03	0.14	< 0.5	18.3	0.55	< 0.2	< 0.15	25.4	6.62	0.27
4	3.1	< 0.4	< 2.0	0.05	< 0.05	715	0.17	< 0.1	0.02	< 0.03	< 0.5	19.7	0.53	< 0.2	0.17	21.2	6.7	0.42
5	1.4	< 0.4	< 2.0	< 2.00	0.00	703	0.27	< 0.1	< 0.02	0.79	< 0.5	20.8	0.54	< 0.2	< 0.15	60.8	28.1	0.42
6	1.7	0.7	< 2.0	0.05	0.05	510	0.16	< 0.1	< 0.02	< 0.03	< 0.5	14.8	0.42	< 0.2	0.27	19.8	5.15	0.04
7	3.4	0.6	< 2.0	0.05	< 0.05	629	0.31	< 0.1	0.02	< 0.03	< 0.5	16.6	0.79	< 0.2	0.39	20.4	5.2	0.08
8	4.0	< 0.4	< 2.0	0.06	0.05	758	0.29	0.1	0.07	0.67	< 0.5	22.5	1.74	< 0.2	0.55	22.8	5.8	0.79
9	3.4	0.4	< 2.0	0.08	< 0.05	725	0.27	0.3	0.1	0.41	0.9	26	2.29	< 0.2	0.62	27	6.18	1.21
10	2.3	0.7	< 2.0	0.06	0.05	585	0.26	0.3	0.07	1.11	< 0.5	18	1.37	< 0.2	0.21	24.8	6.55	0.56

SHAKE FLASK TESTS

SAMPLE: Equity Silver Tailing

WEEK	SOLUTION ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	1.2	0.04	< 0.2	0.049	< 0.005	341	<0.015	< 0.01	0.043	0.11	< 0.05	32.1	0.38	0.04	<0.015	46	52.6	0.2
2	2.1	<0.04	0.6	0.048	0.005	378	0.11	< 0.01	0.018	0.23	0.1	34.6	0.49	0.03	<0.015	48.2	54	0.45
3	0.6	< 0.4	< 2.0	< 0.05	< 0.05	416	< 0.15	< 0.1	< 0.02	0.31	< 0.5	49.9	0.73	< 0.2	0.33	48.9	55	0.65
4	1.5	0.6	< 2.0	0.06	< 0.05	370	0.16	< 0.1	0.03	0.03	< 0.5	43.7	0.76	< 0.2	< 0.15	49	57.2	0.89
5	1.4	0.07	0.3	0.92	0.025	485	0.041	0.038	0.51	0.82	0.1	65.3	0.96	0.04	0.054	91.9	77.1	1.48
6	1.6	0.8	< 2.0	0.06	< 0.05	350	0.17	< 0.1	0.04	< 0.03	< 0.5	45.3	1.19	< 0.2	0.38	41.6	52.7	0.53
7	1.6	< 0.4	< 2.0	0.14	< 0.05	413	0.28	0.1	0.15	1.31	0.6	58.8	0.85	< 0.2	0.19	46	54.1	1.4
8	2.5	< 0.4	< 2.0	0.12	< 0.05	411	0.21	< 0.1	0.07	0.57	< 0.5	58.8	0.96	< 0.2	< 0.15	43.5	52.9	0.53
9	1.6	< 0.4	< 2.0	0.14	< 0.05	413	0.28	0.1	0.15	1.3	0.6	58.8	0.85	< 0.2	0.19	46	54.1	1.4
10	1.7	0.8	< 2.0	0.09	< 0.05	312	0.3	< 0.1	0.02	0.26	< 0.5	46.8	0.68	< 0.2	< 0.15	48.3	53.5	0.2

SHAKE FLASK TESTS

SAMPLE: Heath Steele Tailing

WEEK	SOLUTION ANALYSIS (mg/L)																
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	389.0	< 0.4	3.0	< 0.05	15	641	< 0.15	115	1370	709	< 0.5	119	73.4	< 0.2	3.3	0.09	3.13	3220
2	341.0	< 0.4	3.7	0.07	14.2	616	3.62	90.6	1400	1103	< 0.5	111	71.9	< 0.2	2.31	0.09	3.12	4550
3	405.0	< 0.4	2.9	< 0.05	19.1	609	5.0	110	2320	2450	< 0.5	135	80.2	< 0.2	2.63	0.09	2.62	5710
4	330.0	< 0.4	8.0	0.13	13	495	4.75	78	2080	2680	< 0.5	105	60.4	< 0.2	1.52	0.1	2.7	5060
5	370.0	< 0.4	22	0.13	15.9	522	8.3	90.8	2200	3320	< 0.5	123	68	< 0.2	1.7	1.6	29.8	5550
6	381.0	1.1	75	0.06	16.1	518	8.31	84.5	2240	3930	< 0.5	125	73	< 0.2	2.51	0.16	3.18	4980
7	377.0	1.6	106	0.2	17.5	548	9.29	86.2	2070	4420	< 0.5	120	73	< 0.2	2.19	0.1	3.5	5270
8	454.0	2.2	256	0.06	18.9	583	12.4	100	2840	6930	< 0.5	149	76.3	< 0.2	2.2	0.12	4.44	6750
9	419.0	1.6	258	0.13	19.6	622	12.1	102	2900	7090	< 0.5	143	78.6	< 0.2	2.22	1.7	10.5	6610
10	423.0	1.9	218	0.08	17.4	545	11.7	94.1	2230	6170	< 0.5	147	73.2	< 0.2	2.26	0.17	5.8	5200

SHAKE FLASK TESTS

SAMPLE: Key Lake Tailing

WEEK	SOLUTION ANALYSIS (mg/L)																	
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	3.1	0.32	30.8	0.073	0.018	1220	0.19	0.18	1.88	1.25	< 0.05	9.56	0.14	2.13	0.26	8	30.5	6.55
2	2.4	0.16	27.1	0.027	< 0.005	1160	0.13	0.02	0.037	0.29	0.05	11.7	0.063	1.58	0.51	7.95	32.9	0.4
3	2.4	< 0.4	36.2	0.7	0.08	836	0.23	< 0.1	0.16	0.56	< 0.5	23.3	0.02	1.8	0.89	9.22	32.9	1.01
4	2.1	< 0.4	33	0.05	0.05	720	0.17	< 0.1	0.11	0.41	< 0.5	23.4	0.01	1.43	0.78	9.6	31.4	0.94
5	1.4	< 0.4	47	< 0.05	< 0.05	643	0.3	< 0.1	0.02	0.39	< 0.5	31.3	0.03	1.8	1.48	29.2	64	0.56
6	4.4	0.5	44	0.13	< 0.05	734	0.28	< 0.1	0.3	< 0.03	0.6	31.2	<0.01	1.5	1.29	7.73	30.7	0.13
7	2.6	< 0.4	49	0.05	< 0.05	736	0.36	< 0.1	0.47	3.07	0.6	29.5	<0.01	1.3	1.64	7.5	32	0.5
8	4.0	< 0.4	63	0.11	< 0.05	685	0.34	< 0.1	0.44	3.28	< 0.5	53.9	0.08	1.8	2.94	7.35	31.8	1.3
9	4.0	< 0.4	67	0.12	< 0.05	750	0.34	< 0.1	0.31	1.87	< 0.5	47.2	0.03	2	2.45	7.66	34.9	1.28
10	2.6	0.4	47	0.08	< 0.05	665	0.4	0.2	2.03	3.32	< 0.5	43.1	0.13	0.84	2.4	9.1	33.3	4.22

SHAKE FLASK TESTS

SAMPLE: Noranda Bell Tailing

WEEK	SOLUTION ANALYSIS (mg/L)																
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.6	<0.04	< 0.2	0.05	< 0.005	380	0.08	< 0.01	0.021	0.2	< 0.05	67.2	0.14	0.03	0.008	28.7	10	0.24
2	0.7	<0.04	< 0.2	0.033	0.005	308	0.061	< 0.01	0.003	0.07	< 0.05	62.5	0.084	< 0.02	<0.015	30.4	11.3	0.17
3	1.0	< 0.4	< 2	< 0.05	0.08	286	< 0.15	< 0.1	0.04	0.1	< 0.5	73.9	0.11	< 0.2	< 0.15	30.2	11.2	0.61
4	0.8	< 0.4	< 2	0.37	< 0.05	280	< 0.15	< 0.1	0.09	0.08	< 0.5	82.1	0.09	< 0.2	< 0.15	30.3	11.1	0.64
5	0.6	< 0.4	< 2	0.1	< 0.05	252	0.29	< 0.1	< 0.02	0.24	< 0.5	77.4	0.09	< 0.2	< 0.15	68.9	38.5	0.41
6	1.1	0.05	< 0.2	0.027	< 0.05	278	0.019	0.02	0.007	0.051	< 0.5	86.7	0.1	0.06	0.052	26.6	9.45	0.033
7	1.2	0.07	< 0.2	0.019	< 0.05	229	0.047	0.01	0.008	0.008	< 0.5	80.6	0.093	< 0.2	0.051	27.4	9.98	0.045
8																		
9	1.5	<0.04	< 0.2	0.029	0.011	246	0.067	0.01	0.104	0.29	< 0.05	78.1	0.166	< 0.02	<0.015	28.9	13	0.379
10	0.7	0.08	< 0.02	0.019	0.009	250	0.045	< 0.01	0.031	0.047	0.06	64.6	0.074	< 0.02	0.037	30.2	12.2	0.11

SHAKE FLASK TESTS

SAMPLE: Waite Amulet Tailing

WEEK	SOLUTION ANALYSIS (mg/L)																
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	23.8	< 0.4	< 2.0	0.07	0.49	235	0.24	4.65	1.17	914	1.14	70.1	19	< 0.2	3.52	12.2	5.12	269
2	28.7	<0.04	0.2	0.038	0.3	146	0.18	4.24	5.97	731	1.21	65	13.8	< 0.02	3.05	9.89	5.62	195
3	25.6	< 0.4	< 2.0	< 0.05	0.71	263	0.41	7.04	< 0.02	1650	1.3	89.2	22.9	< 0.2	5.01	16	6.92	321
4	48.4	< 0.4	< 2.0	0.15	0.79	233	0.31	9.9	24.8	1770	1.9	93.2	21	< 0.2	6.17	10.5	7.8	301
5	66.2	< 0.4	< 2.0	< 0.05	1.15	237	0.57	13.2	45.9	2230	1.1	102	21.8	< 0.2	6.23	24.6	33.6	372
6	81.6	0.9	< 2.0	< 0.05	1.03	331	0.58	11.3	46	2140	1.6	125	28.5	< 0.2	7.62	9.25	6.8	476
7	74.2	0.8	< 2.0	< 0.05	0.77	221	0.47	9.0	43.6	1570	0.8	93.5	20	< 0.2	5.63	5.38	7.6	327
8	158.0	0.9	< 2.0	0.09	1.28	332	0.81	14.1	94.4	3180	1.1	150.9	30.6	< 0.2	8.41	3.55	12	498
9	140.0	0.5	2.0	0.12	1.34	323	1.01	13.5	100	3100	0.9	141	26.1	< 0.2	8.56	7.35	14.2	521
10	138.0	0.6	< 2.0	0.1	1.07	276	0.77	14.7	98.8	3340	1.1	148	24.3	< 0.2	7.17	5.88	13.1	457

SHAKE FLASK TESTS

SAMPLE:Westmin Tailing

WEEK	SOLUTION ANALYSIS (mg/L) Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	1.1	<0.04	< 0.2	0.039	0.58	1210	< 0.015	0.07	0.48	0.096	<0.05	62.3	46.4	0.03	0.33	15.5	8.7	144
2	55.5	0.13	< 2.0	0.055	2.94	576	< 0.15	< 0.1	133	697	0.26	164	66.5	< 0.2	1.25	19.5	9.42	735
3	66.7	< 0.4	< 2.0	< 0.05	4.12	608	1.25	< 0.1	191	1030	2.9	191	78.9	< 0.2	1.35	24.9	9.0	1130
4	77.9	< 0.4	< 2.0	0.06	4	543	2	< 0.1	199	1140	3.2	183	67.8	< 0.2	1.45	20	10.4	1120
5	78.6	< 0.4	< 2.0	0.38	4.49	474	2.09	0.2	186	1430	5.1	168	63.8	< 0.2	1.73	49.7	36.1	1130
6	106.0	1.0	< 2.0	0.07	5.38	569	2.75	0.3	213	2470	4.3	184	75	< 0.2	2.3	5.18	7.52	1290
7	81.7	0.7	< 2.0	< 0.05	3.52	441	1.94	0.1	152	1950	2.6	138	52.2	< 0.2	1.85	4.15	8.3	867
8	116.0	1.3	< 2.0	< 0.05	5.21	531	3.32	0.5	221	3220	3.3	185	69.9	< 0.2	2.27	1.98	11.6	1270
9	101.0	0.7	< 2.0	0.11	5.01	520	3.42	0.1	189	2960	5.2	168	67	< 0.2	2.28	16.2	12.4	1210
10	112.0	0.6	< 2.0	0.07	4.51	448	2.64	0.4	197	2600	4.2	191	63.4	< 0.2	1.86	16.6	12	1290

SHAKE FLASK TESTS

SAMPLE:Curragh Waste Rock

WEEK	SOLUTION ANALYSIS (mg/L)																
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	0.5	<0.04	< 0.2	0.043	< 0.005	162	< 0.015	< 0.01	0.007	0.048	< 0.05	25.4	0.25	< 0.02	<0.015	16.2	6.23	0.42
2	0.6	<0.04	< 0.2	0.042	0.009	155	0.032	< 0.01	0.022	0.71	< 0.05	26.7	0.22	< 0.02	<0.015	17.5	6.73	0.4
3	0.4	<0.04	< 0.2	0.038	0.012	217	0.04	< 0.01	0.27	1.44	0.03	34.2	0.6	< 0.02	<0.015	22.5	7.63	1.9
4	0.8	<0.04	< 0.2	0.16	0.007	213	0.05	< 0.01	0.006	0.1	< 0.05	30.27	0.41	< 0.02	<0.015	20.8	7.62	0.58
5	0.6	<0.04	< 0.2	0.012	< 0.005	232	0.063	< 0.01	0.016	0.37	< 0.05	36.6	0.46	< 0.02	<0.015	53.7	30	0.53
6	1.3	0.05	< 0.2	0.034	< 0.005	305	0.056	< 0.01	0.009	<0.003	< 0.05	36	0.25	< 0.02	0.017	19.2	5.4	0.13
7	2.2	<0.04	< 0.2	0.027	< 0.005	315	0.056	0.01	0.009	<0.003	0.09	43.4	0.42	< 0.02	0.023	21.4	6.22	0.21
8	1.0	0.09	< 0.2	0.026	< 0.005	324	0.046	0.01	0.018	0.12	0.1	44.5	0.49	< 0.02	0.048	20.5	7.6	0.22
9	0.8	<0.04	< 0.2	0.02	< 0.005	213	0.051	< 0.01	0.023	0.19	< 0.05	34.2	0.55	< 0.02	0.019	20.5	8.5	0.37
10	0.8	<0.04	< 0.2	0.029	< 0.005	325	0.05	< 0.01	0.039	0.31	0.08	46.3	0.54	< 0.02	0.025	22.6	7.59	0.31

SHAKE FLASK TESTS

SAMPLE:Equity Silver Waste Rock

WEEK	SOLUTION ANALYSIS (mg/L)																
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	8.0	<0.04	0.4	0.027	0.5	292	< 0.015	0.24	0.2	22	< 0.05	32.1	11.9	< 0.02	0.71	22.4	8.73	7.48
2	16.9	<0.04	0.6	0.023	0.8	382	0.1	0.29	0.65	75.8	0.3	39	16.4	< 0.02	0.97	25.7	10	13.1
3	33.0	<0.04	< 0.2	< 0.05	1.08	393	0.17	0.4	1.24	178	0.5	46.4	22.1	< 0.2	1.47	31.9	10.8	20.7
4	48.0	< 0.4	< 2.0	0.09	1.13	364	0.15	0.3	1.9	365	< 0.5	47	23.7	< 0.2	1.55	27.7	10	24.7
5	57.7	< 0.4	< 2.0	< 0.05	1.16	389	0.22	0.7	2.42	352	< 0.5	50.6	26.2	< 0.2	1.6	61.4	37.4	29.1
6	41.6	< 0.4	2.2	0.07	1.03	326	0.31	0.5	8.2	186	1.3	40.9	30	< 0.2	1.29	17.9	7.52	40.7
7	47.8	0.8	< 2.0	< 0.05	0.86	303	0.22	0.5	8.87	203	0.5	41.5	30.4	< 0.2	1.19	16	7.55	40.7
8	90.7	0.6	< 2.0	< 0.05	1.32	375	0.42	0.6	2.5	573	0.6	53.9	35.9	< 0.2	2.21	2.15	12.3	42.8
9	80.6	< 0.4	< 2.0	0.18	1.38	375	0.57	0.6	2.55	614	0.6	49.4	35	< 0.2	1.81	1.93	12.6	44.4
10	83.3	< 0.4	< 2.0	< 0.05	1.02	311	0.3	0.7	2.63	510	0.8	49.9	31.6	< 0.2	1.72	2.15	12.5	30.9

SHAKE FLASK TESTS

SAMPLE:Heath Steele Waste Rock

WEEK	SOLUTION ANALYSIS (mg/L)																
	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
1	1.3	0.04	< 0.2	0.057	0.008	233	< 0.015	0.02	0.008	0.03	< 0.05	20	2.97	< 0.02	<0.015	14.5	4.78	0.91
2	0.6	<0.04	< 0.2	0.07	0.015	295	0.07	0.03	0.007	0.039	< 0.05	24.9	4.04	< 0.02	0.03	16.6	4.91	0.98
3	1.2	<0.04	< 0.2	0.055	0.035	419	0.085	0.06	0.005	0.012	< 0.05	28.1	8.43	< 0.02	<0.015	22.7	5.29	2.92
4	1.7	< 0.4	< 2.0	0.02	< 0.05	440	0.17	< 0.1	0.02	< 0.03	< 0.5	30.3	9.79	< 0.2	0.23	19.6	5.1	3.11
5	1.1	0.4	< 2.0	0.09	0.12	432	< 0.15	0.1	0.05	0.62	< 0.5	35.1	6.43	< 0.2	< 0.15	50.8	25.6	1.88
6	3.8	0.5	< 2.0	0.15	0.13	562	0.33	0.2	0.03	< 0.03	< 0.5	44.9	19	< 0.2	0.47	19.6	3.64	8.79
7	5.1	0.5	< 2.0	< 0.05	0.06	619	0.25	0.3	0.03	0.15	0.9	56.7	26.1	< 0.2	0.27	21.4	4.36	11.5
8	3.7	< 0.4	< 2.0	0.06	0.07	658	0.3	0.3	0.06	< 0.03	0.8	63.5	24.5	< 0.2	0.27	21.8	5.35	12.3
9	4.0	0.5	< 2.0	0.12	0.19	813	0.35	0.5	0.03	0.1	1.3	89.2	41.2	< 0.2	0.31	23.4	4.55	20.5
10	3.2	0.9	< 2.0	0.12	0.18	779	0.22	0.7	0.04	0.42	2.0	102	44	< 0.2	0.27	25.3	5.56	41.1

SHAKE FLASK TESTS

SAMPLE: Inco Waste Rock

WEEK	Al	Sb	As	Ba	Cd	Ca	Cr	Co	Cu	Fe	Pb	Mg	Mn	Mo	Ni	K	Na	Zn
	SOLUTION ANALYSIS (mg/L)																	
1	0.3	<0.04	< 0.2	0.066	< 0.005	84.7	< 0.015	0.01	0.005	0.047	< 0.05	12.9	0.069	< 0.02	0.15	23.1	8.27	0.21
2	0.3	<0.04	< 0.2	0.075	< 0.005	171	0.045	0.01	0.003	0.015	< 0.05	15.3	0.097	< 0.02	0.21	27.2	9.08	0.12
3	0.9	<0.04	< 0.2	0.046	0.017	156	0.036	< 0.01	0.01	0.022	0.03	17.8	0.12	< 0.02	0.25	30.9	10.4	0.24
4	0.6	0.05	< 0.2	0.12	< 0.005	162	0.033	< 0.01	0.007	0.045	< 0.05	17.4	0.11	< 0.02	0.2	44.4	9.0	0.41
5	0.5	<0.04	< 0.2	0.15	< 0.005	188	0.059	< 0.01	0.011	0.14	< 0.05	18	0.12	< 0.02	0.25	72.2	34.9	0.5
6	0.7	0.06	< 0.02	0.084	< 0.005	163	0.07	0.03	0.003	<0.003	< 0.05	16.2	0.14	< 0.02	0.43	29.5	7.02	0.033
7	1.4	0.08	< 0.02	0.11	< 0.005	182	0.044	0.02	0.003	0.01	< 0.05	22.3	0.23	< 0.02	0.8	33.2	7.6	0.036
8	0.9	0.1	< 0.02	0.081	< 0.005	196	0.066	0.21	0.009	0.039	< 0.05	28.9	1.32	< 0.02	7.14	40	9.8	0.068
9	1.9	<0.04	< 0.02	0.082	0.018	216	0.079	0.1	0.009	0.044	< 0.05	24.4	0.77	< 0.02	4.12	41	9.98	0.068
10	1.2	<0.04	< 0.02	0.096	0.009	259	0.065	0.08	0.011	0.08	< 0.05	28.5	0.75	< 0.02	2.85	NA	NA	0.069

APPENDIX 10

SOXHLET EXTRACTION TEST DATA

LEACHING OF MINE WASTES: SOXHLET EXTRACTION TEST METHOD

DATE: August 22, 1988

BY: Dr. L.M. Lavkulich and Bill Price
Department of Soil Science, UBC

REPORT TO: Coastech Research Inc.
80 Niobe Street
North Vancouver, B.C.
V7J 2C9

ATTENTION: Linda Broughton

1. SOXHLET METHODS TESTED

METHOD I: Acetic Acid in Singleton and Lavkulich (1978) soxhlet with free draining chamber.

Leachate - 0.05 m Acetic Acid, pH 2.49
- 200 ml replaced weekly
- leaching rate 1 litre/day
- temperature in extraction chamber 135°F

Run for 3 weeks

METHOD II: Distilled Water in Singleton and Lavkulich (1978) soxhlet with free draining chamber.

Leachate - distilled water, pH 8.2
- 200 ml replaced weekly
- leaching rate 1 litre/day
- temperature in extraction chamber 135°F.

Run for 3 weeks

METHOD III: Distilled Water in Sullivan and Sobek (1982) soxhlet

Leachate - distilled water, pH 8.2
- 200 ml replaced weekly
- leaching rate 1 litre/day
- temperature in extraction chamber 80°F

Run for 3 weeks

SAMPLE PRETREATMENT

Leachate:

Cool to room temperature and measure pH and electrical conductivity. Add 4 ml HF to soxhlet flask. Leave until all precipitated material is either in suspension or solution. Shake well and take 20 ml subsample. Add 4 ml HF and 2 ml aqua regia (4 parts HC:1 part HNO_3). Heat at 80°C for 2 hours in water bath. Add 4.6 g boric acid. Heat at 80°C for 1 hour or until clears, in a water bath. Cool and make up to 100 ml. Ship to A.S.L. for analysis. Measure volume of leachate remaining in soxhlet flask.

Residue:

Air dry (approximately 1 week), weigh and then sieve to remove teflon beads. Store in plastic viles for shipping.

RESULTS

Weight of material recovered in leachate equals

$$\left\{ \text{mg/litre in sample} - \text{mg/litre in control} \right\} \times \text{ASL dilution factor} \times \text{initial leachate volume} \times \frac{100 \text{ ml}}{20 \text{ ml}}$$

NOTE: controls were labeled blank or 13

e.g. for I 1.1 Aluminum

$$\left\{ 122 \frac{\text{mg}}{\text{L}} - 0 \frac{\text{mg}}{\text{L}} \right\} \times 10 \times 163 \text{ ml} \times 5 \times 10^{-3} \frac{\text{L}}{\text{ml}} = 994.3 \text{ mg}$$

PROBLEMS ENCOUNTERED

1. precipitation of material from leachate prior to it reaching collection flask, and disolution of the same in subsequent weeks.

2. getting precipitate in collection flask into suspension in order to take a representative subsample.

3. maintaining a constant leaching rate.

Soxhlet Mine Waste Study for Coastech

ACETIC ACID Singleton + Lavkulich 1978

WEEK#1 VOL. ml	pH	EC mhos	WEEK#2 VOL. ml	pH	EC mhos	WEEK#3 VOL. ml	pH	EC mhos
163	4.4	11.8	200	3.4	3.5	198	3.2	4.2
167	3.9	8.0	199	3.6	5.5	190	3.3	5.2
152	4.3	13.4	200	3.0	3.2	192	2.7	2.8
166	3.7	6.1	199	3.2	2.9	192	2.9	3.4
165	4.4	12.7	196	2.9	1.8	196	2.5	1.9
173	3.0	2.7	199	2.5	1.2	196	2.2	1.3
155	4.0	7.9	200	3.4	3.3	196	3.3	4.7
166	4.0	7.8	198	3.2	2.0	196	3.0	2.7
168	2.9	7.4	200	2.4	3.3	194	1.9	5.0
155	3.7	6.4	198	2.4	2.6	196	2.1	3.5
156	4.0	7.2	198	3.4	3.0	196	3.2	3.4
173	4.7	–	200	3.4	4.8	190	2.8	4.2
	2.5	0.9						

DISTILLED WATER Singleton + Lavkulich 1978

WEEK#1 VOL. ml	pH	EC mhos	WEEK#2 VOL. ml	pH	EC mhos	WEEK#3 VOL. ml	pH	EC mhos
152	2.5	3.2	194	2.0	3.1	200	2.0	3.2
145	9.2	3.0	198	9.4	0.8	197	9.4	0.6
152	1.8	12.8	196	1.8	7.0	196	1.6	7.6
151	3.2	4.4	198	3.2	1.6	198	2.5	2.1
155	3.1	4.0	196	2.2	3.3	197	1.7	4.6
154	9.2	2.6	199	7.2	1.0	199	4.0	2.1
153	9.3	2.0	198	9.4	0.9	200	9.2	0.9
156	9.1	1.4	194	5.5	1.7	196	4.5	0.5
158	4.0	2.8	198	2.0	4.2	197	1.6	5.0
147	9.2	1.7	197	9.3	0.8	196	9.3	0.9
149	9.3	2.3	198	9.4	0.9	196	8.7	1.0
158	8.5	1.9	197	3.2	0.3	200	2.3	0.8
	8.2	0.0			0.0			0.0

DISTILLED WATER Sullivan + Sobek 1982

WEEK#1 VOL. ml	pH	EC mhos	WEEK#2 VOL. ml	pH	EC mhos	WEEK#3 VOL. ml	pH	EC mhos
124	9.1	1.1	170	8.4	0.3	186	6.2	0.5
122	6.6	3.0	192	3.9	1.3	206	2.5	1.8
164	8.7	1.5	186	8.5	0.1	226	4.3	0.1
98	2.5	3.4	147	2.4	1.8	276	2.3	2.4
105	8.8	2.1	164	9.4	0.6	226	9.0	0.6
103	9.3	3.0	195	9.2	1.8	225	9.4	0.5
96	9.1	2.0	158	9.4	0.8	213	9.1	0.9
126	2.0	13.5	156	1.9	5.8	213	1.9	6.6
93	2.1	7.2	133	2.1	3.0	159	2.3	3.0
124	9.2	0.6	182	8.9	0.7	219	8.6	0.6
111	2.4	1.8	162	2.3	2.5	169	2.4	2.9
112	9.5	1.6	151	9.3	0.6	177	9.3	0.5

APPENDIX 11

CARBONATE PRESSURE ANALYSIS REPORT

Soxhlet Mine Waste Study for Coastech

ACETIC ACID Singleton + Lavkulich 1978

soxh.#	sample	INITIAL SAMPLE WT (g)	INITIAL TOTAL WT (g)	FINAL TOTAL WT (g)	WT.LOSS (g)	%WT.LOSS %
1	CU-WR	50.00	116.57	109.94	6.63	13.26
2	WA-T	50.00	116.85	111.72	5.13	10.26
3	KL-T	50.00	116.53	99.77	16.76	33.52
4	ES-WR	50.00	115.61	111.98	3.63	7.26
5	NB-T	50.00	116.69	112.53	4.16	8.32
6	EL-T	50.00	116.18	115.00	1.18	2.36
7	IN-WR	50.00	117.56	113.60	3.96	7.92
8	ES-T	50.00	116.41	113.16	3.25	6.50
9	HS-T	50.00	117.17	111.51	5.66	11.32
10	WM-T	50.00	118.31	115.00	3.31	6.62
11	HS-WR	50.00	118.20	114.98	3.22	6.44
12	CU-T	50.00	117.08	109.63	7.45	14.90
	blank					

DISTILLED WATER Singleton + Lavkulich 1978

soxh.#	sample	INITIAL SAMPLE WT (g)	INITIAL TOTAL WT (g)	FINAL TOTAL WT (g)	WT.LOSS (g)	%WT.LOSS %
1	ES-WR	50.01	118.32	117.43	0.89	1.78
2	KL-T	50.01	117.38	109.62	7.76	15.52
3	HS-T	50.01	117.53	113.01	4.52	9.04
4	WA-T	50.00	118.26	117.53	0.73	1.46
5	CU-T	50.00	117.34	115.93	1.41	2.82
6	HS-WR	50.00	117.64	116.91	0.73	1.46
7	NB-T	50.00	118.26	116.94	1.32	2.64
8	IN-WR	50.00	117.53	117.28	0.25	0.50
9	WM-T	50.00	116.91	115.07	1.84	3.68
10	CU-WR	50.00	118.71	117.43	1.28	2.56
11	ES-T	50.00	118.20	117.10	1.10	2.20
12	EL-T	50.00	117.82	116.94	0.88	1.76
	blank					

DISTILLED WATER Sullivan + Sobek 1982

soxh.#	sample	INITIAL SAMPLE WT (g)	INITIAL TOTAL WT (g)	FINAL TOTAL WT (g)	WT.LOSS (g)	%WT.LOSS %
1	IN-WR	50.00	88.23	88.42	-0.19	-0.22
2	WM-T	50.00	87.85	86.88	0.97	1.10
3	EL-T	50.00	88.02	87.49	0.53	0.60
4	ES-WR	50.00	86.94	86.84	0.10	0.12
5	NB-T	50.00	86.72	86.42	0.30	0.35
6	KL-T	50.00	86.11	74.88	11.23	13.04
7	CU-WR	50.00	87.32	86.92	0.40	0.46
8	HS-T	50.00	87.46	84.30	3.16	3.61
9	WA-T	50.00	86.93	86.71	0.22	0.25
10	HS-WR	50.00	86.67	87.00	-0.33	-0.38
11	CU-T	50.00	87.59	86.50	1.09	1.24
12	ES-T	50.00	86.57	86.39	0.18	0.21

Results of the manometric analysis of the tailing samples and waste rock samples

V. P. Evangelou

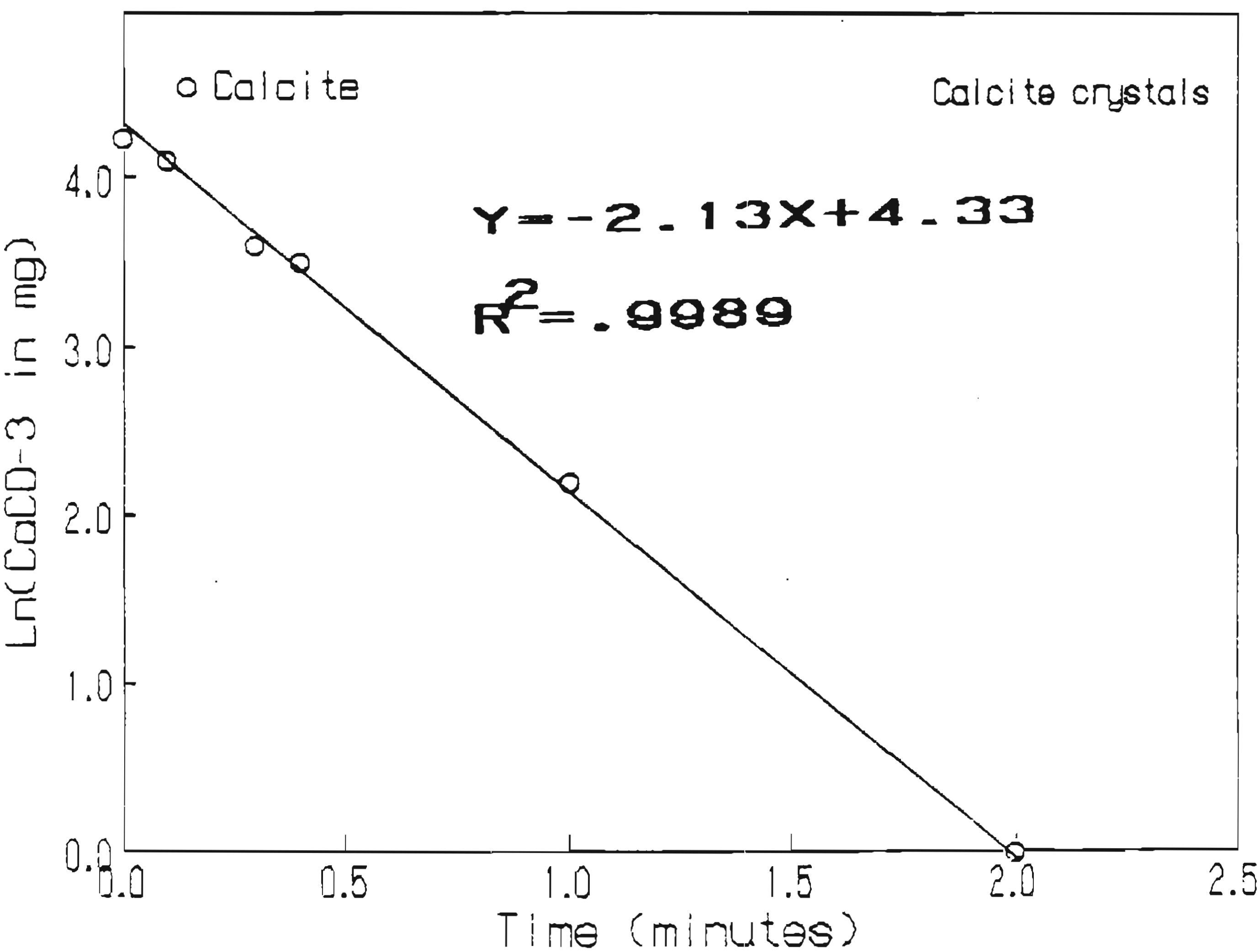
The results of the manometric analysis of the tailing samples and waste rock samples are shown in detail in Table 1. Some additional clarification of these analyses are needed.

The manometric analysis does not directly identify calcite, dolomite and siderite. This direct identification can only be carried out by x-ray diffraction. The manometric technique simply demonstrates the rate constants for the carbonate dissolution in 5 N HCl. These rate constants are then compared to the rate constants of the reference minerals. As is shown in Table 1, some of the samples exhibit rate constants very close to those of the reference minerals while other samples are not in close agreement.

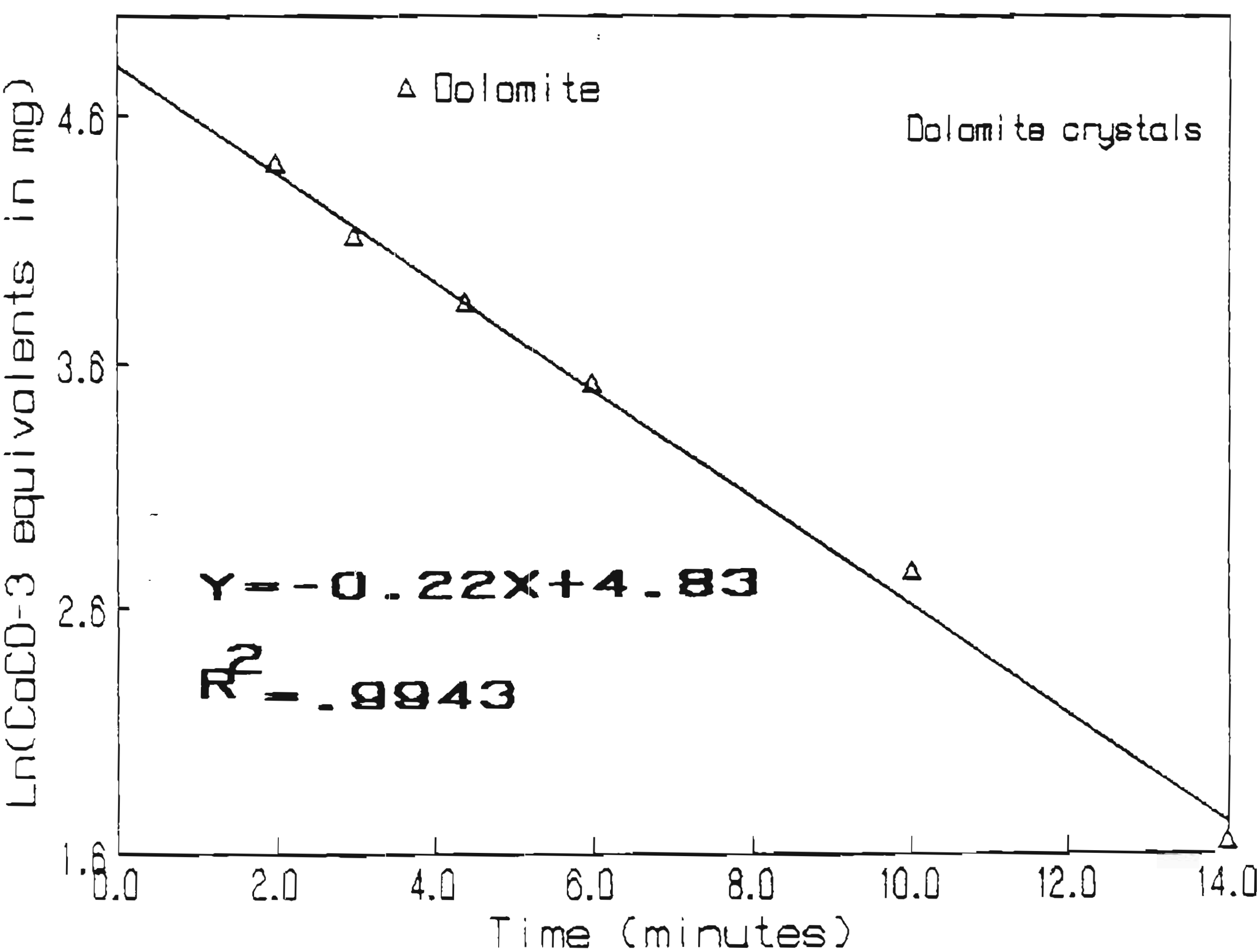
The manometric analysis demonstrates the reactivity of the carbonates present in these samples. The rate constants of the geologic samples shown in Table 1 may or may not represent the pure minerals. For example, iron oxide, manganese oxide and clay mineral coatings may inhibit the reactivity of calcite and its kinetics may resemble kinetics of dolomite or siderite ($FeCO_3$). In any case, one may argue that the most important information in terms of environmental issues is knowledge of the kind of reactivity (rate constants, k_n) the residual carbonates display and not necessarily the identity of each carbonate in the sample(s). For example, the manometric technique might identify a sample as being siderite ($FeCO_3$) when in fact it may be calcite coated with manganese oxide. However, coated calcite would have limited if any neutralization value. This would not differ from true siderite, which based on its acid-base stoichiometry would have no neutralization value either.

Table 1. Results of the manometric analysis of the tailing samples and waste rock samples.

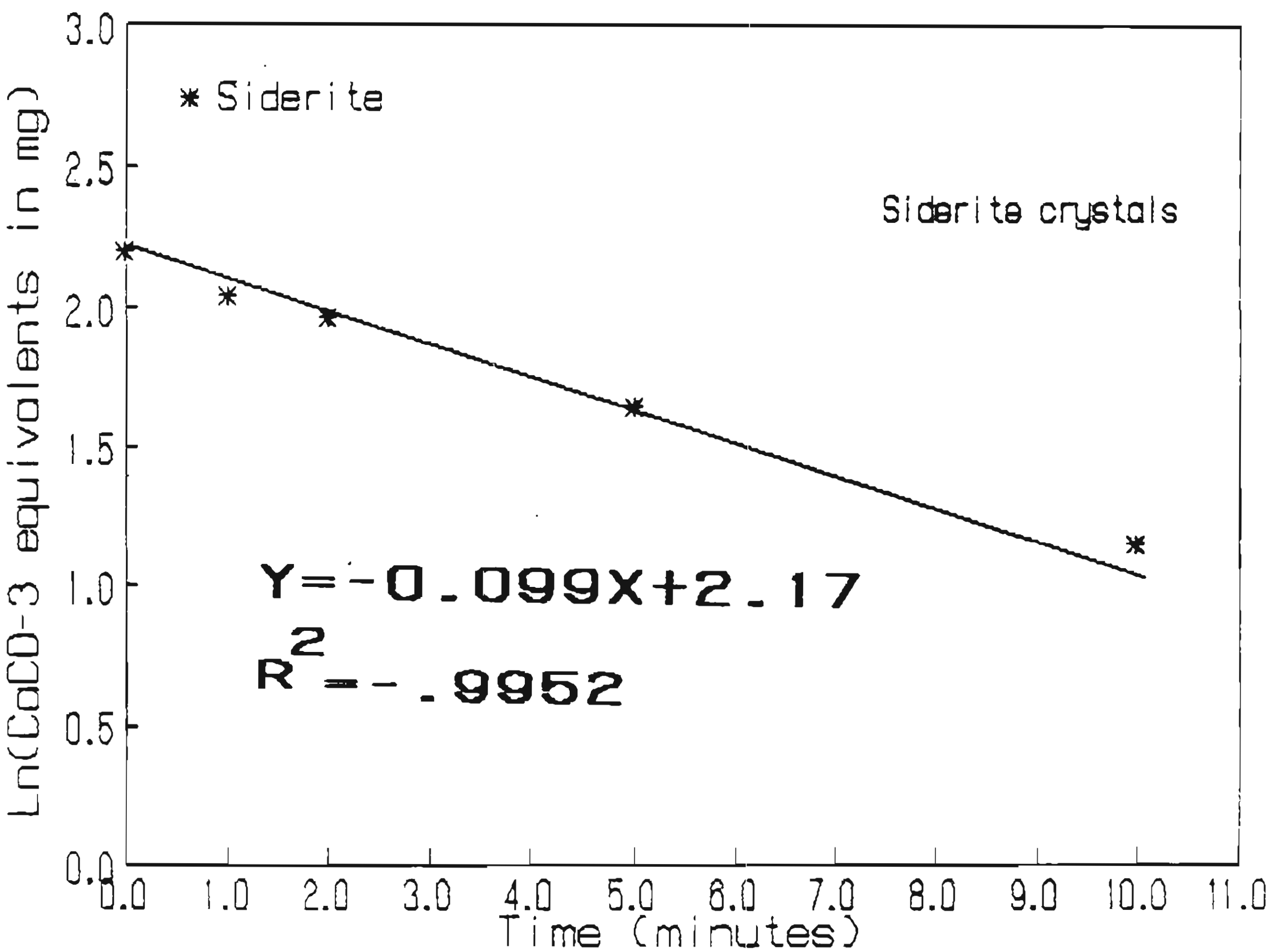
Sample identification	Calcite in $CaCO_3$ equivalents	Dolomite in $CaCO_3$ equivalents	Siderite in $CaCO_3$ equivalents	Dissolution rate constants k_1 Calcite	k_2 Dolomite	k_3 Siderite
	- - - - - - - grams/kilogram of sample		- - - - - - - - - -	- rate constants, K_n $(min)^{-1}$ -		
Reference minerals	-	-	-	2.13	0.22	0.099
1 HSWR	0	32.0	0	-	0.55	-
2 ELT	0	0	0	-	-	-
3 CUWR	17.5	0	35.0	0.80	-	0.08
4 EST	20.1	0	0	1.53	-	-
5 NBT	43.5	26.0	0	0.71	0.23	-
6 CUT	0	25.9	82.02	-	0.11	0.06
7 WMT	15.5	0	0	3.04	-	-
8 KLT	3.9	0	0	1.96	-	-
9 ESWR	2.1	0	1.6	2.0	-	0.04
10 WAT	0	0	0	-	-	-
11 HST	0	2.3	0	-	0.14	-
12 INWR	3.6	0	0	1.77	-	-



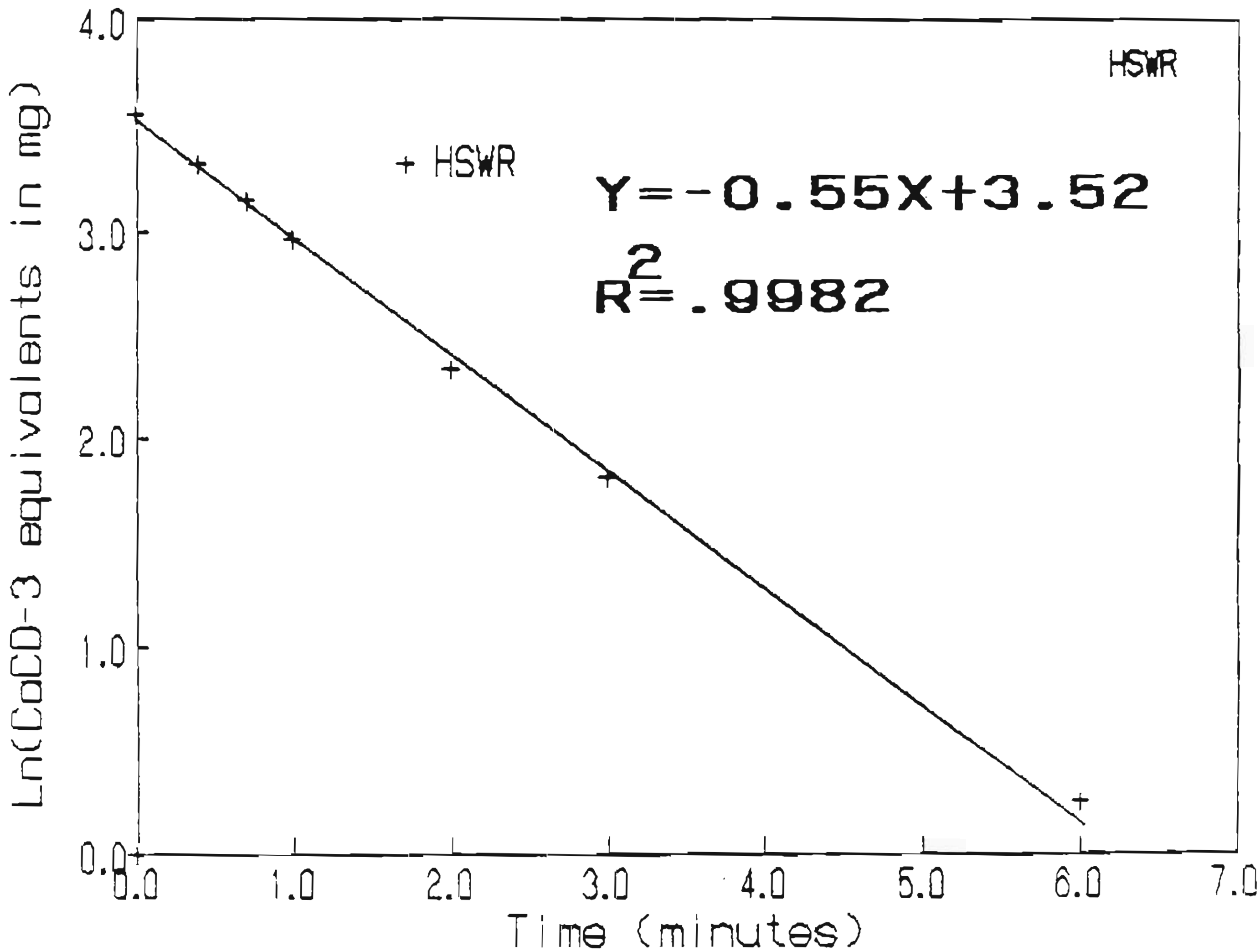
o Calcite
Calcite crystals
Y=-2.13X+4.33
R2=.9989
Ln(CaCO-3 in mg)
4.0
3.0
2.0
1.0
0.0
0.0
0.5
1.0
1.5
2.0
2.5
Time (minutes)



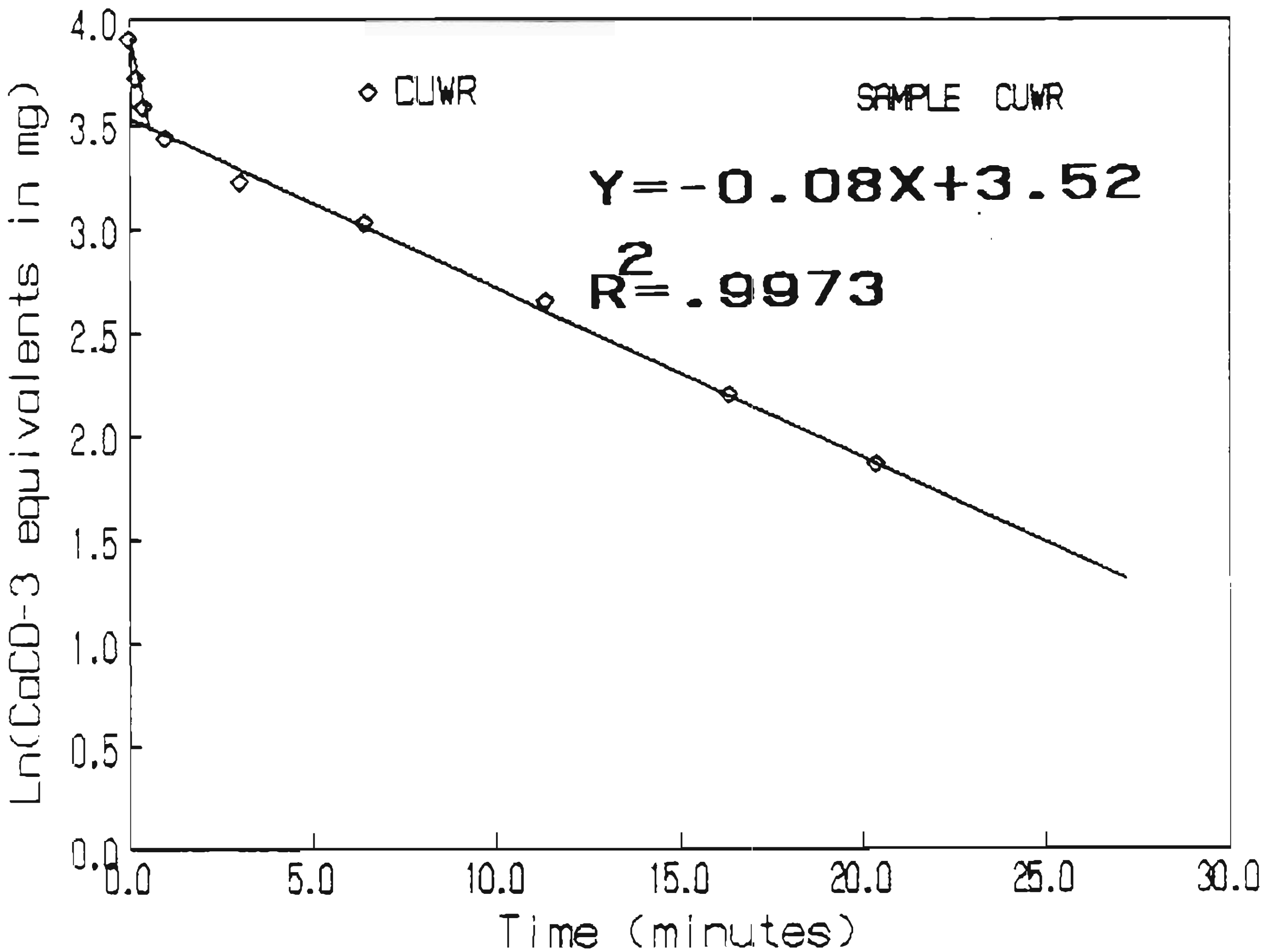
Dolomite
Dolomite crystals
Y=-0.22X+4.83
R2=.9943
Ln(CaCO-3 equivalents in mg)
4.6
3.6
2.6
1.6
0.0
2.0
4.0
6.0
8.0
10.0
12.0
14.0
Time (minutes)



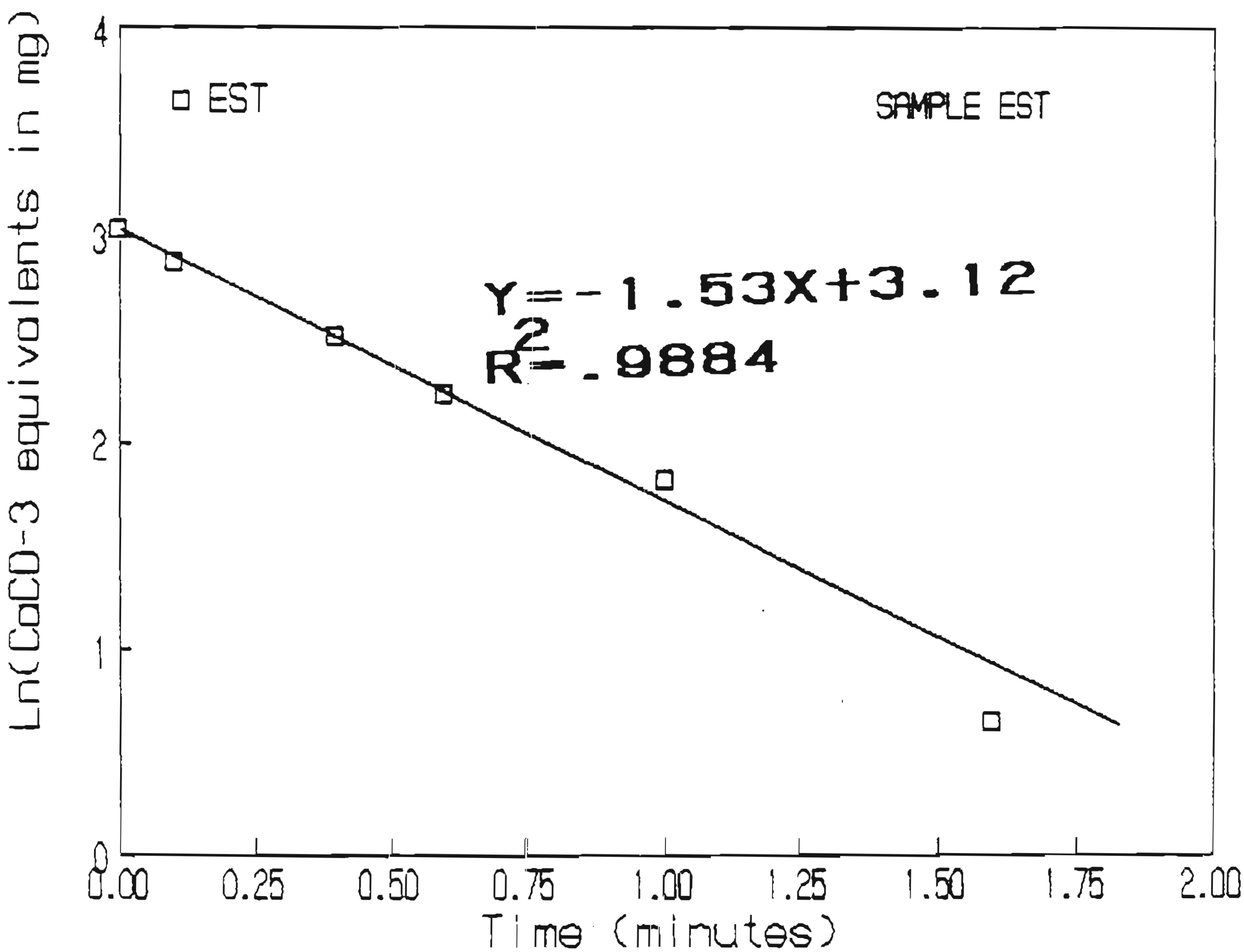
* Siderite
Siderite crystals
Y=-0.099X+2.17
R^2=-.9952
Ln(CaCO-3 equivalents in mg)
Time (minutes)
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
10.0
11.0



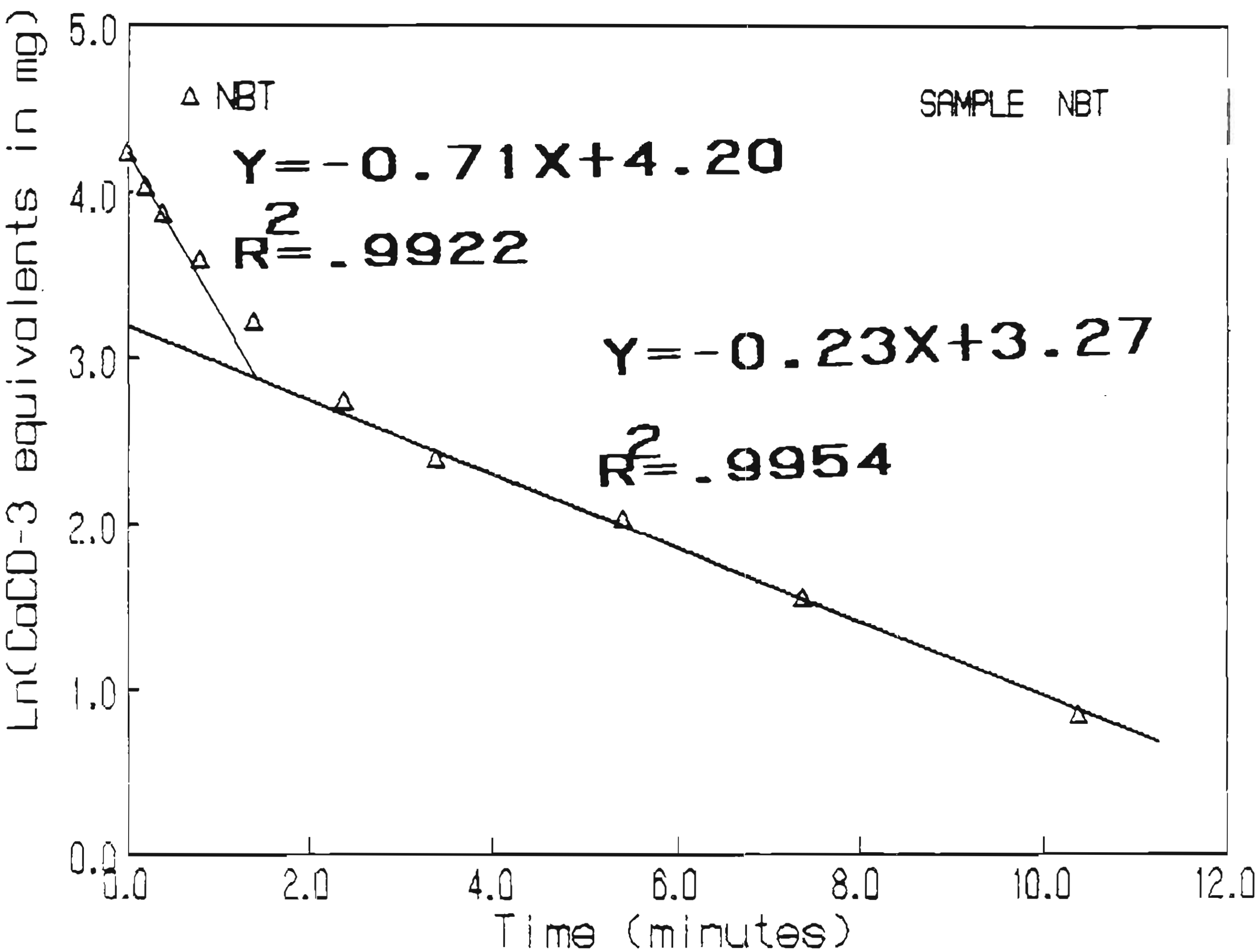
HSWR
+ HSWR
Y=-0.55X+3.52
R2=.9982
Ln(CaCO-3 equivalents in mg)
4.0
3.0
2.0
1.0
0.0
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
Time (minutes)

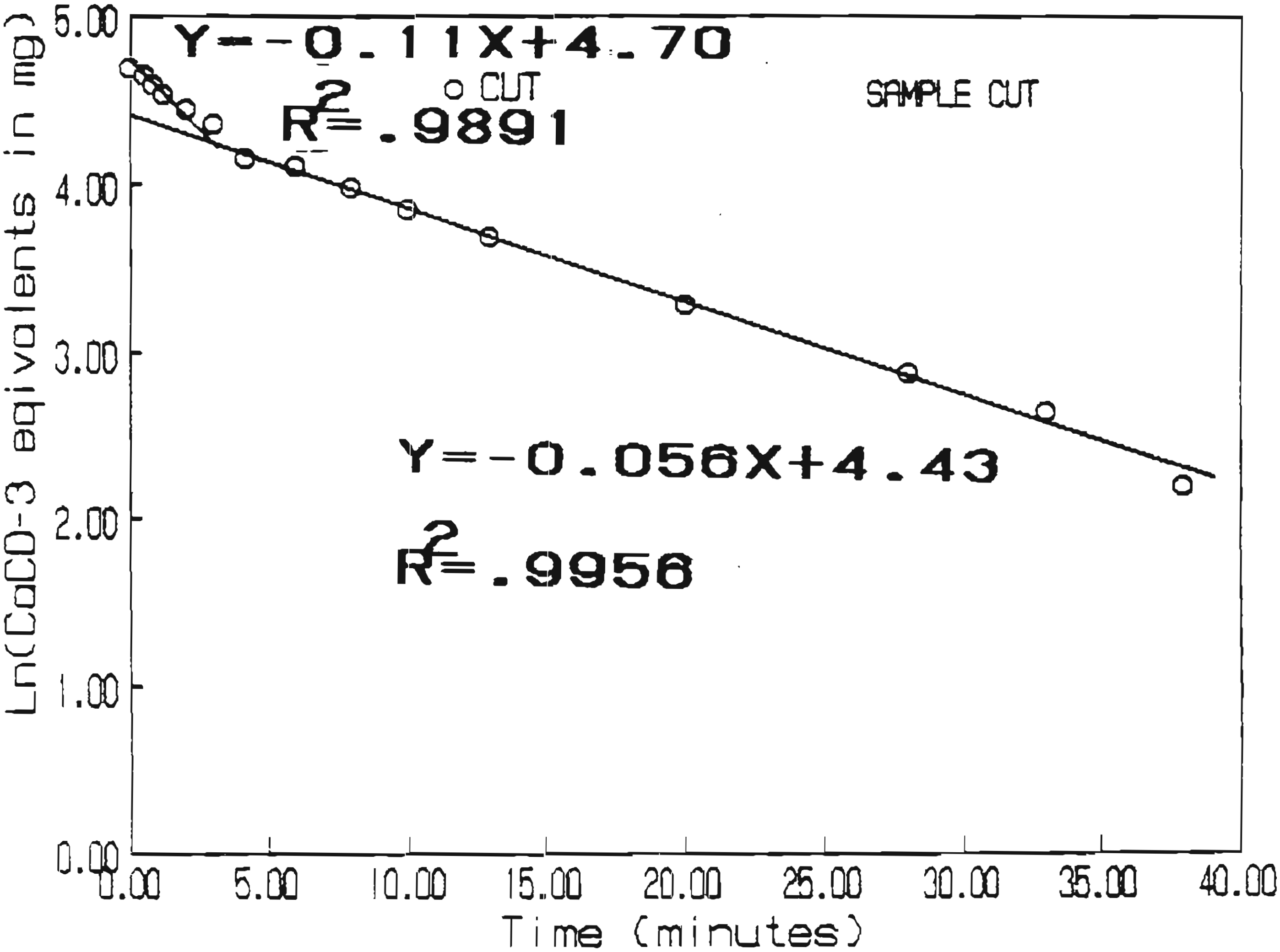


◇ CUWR
SAMPLE CUWR
Y=-0.08X+3.52
R²=.9973
Ln(CaCO-3 equivalents in mg)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0.0
5.0
10.0
15.0
20.0
25.0
30.0
Time (minutes)

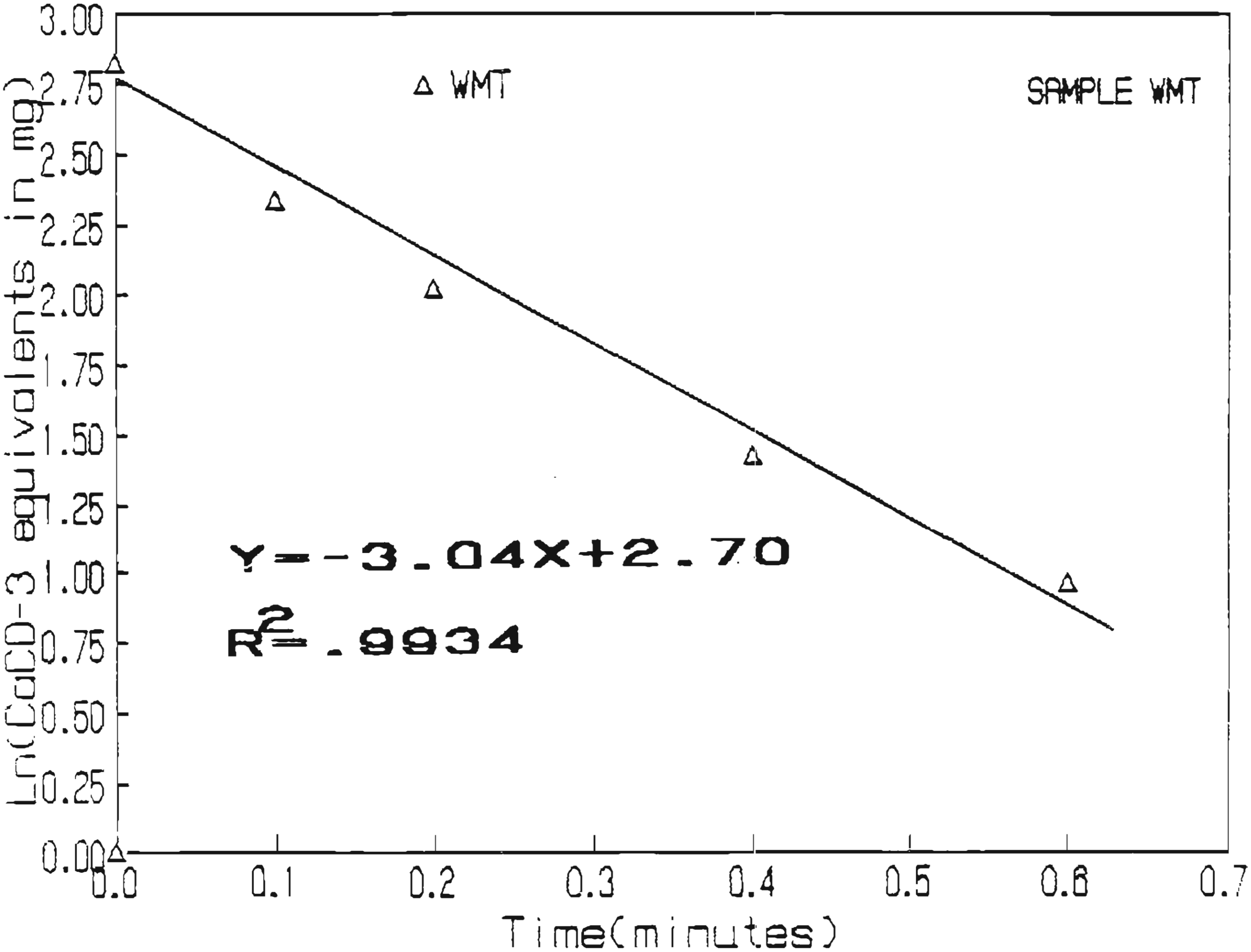


EST
SAMPLE EST
Y=-1.53X+3.12
R2=.9884
Ln(CaCO-3 equivalents in mg)
Time (minutes)
0
1
2
3
4
0.00
0.25
0.50
0.75
1.00
1.25
1.50
1.75
2.00

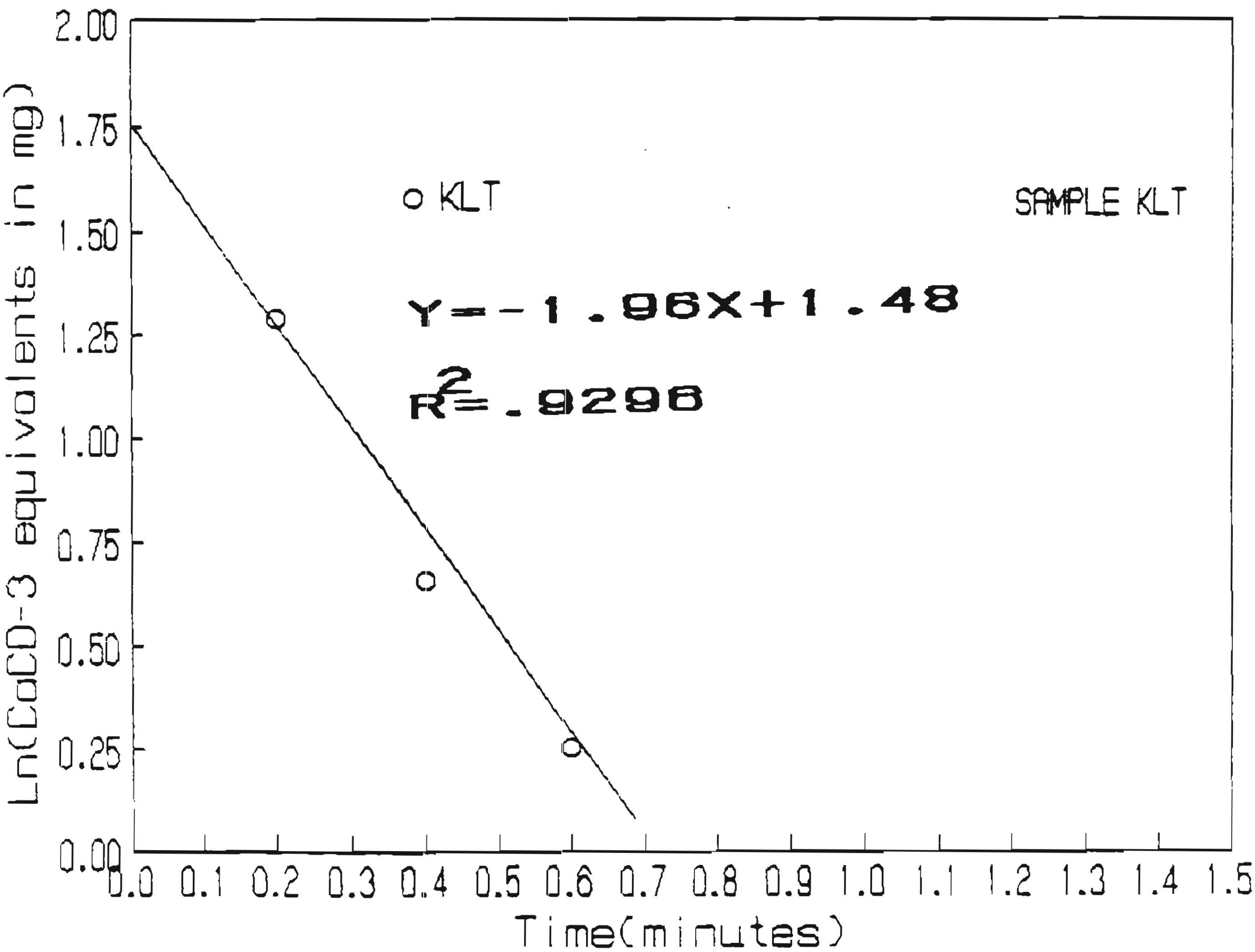

Ln(CaCO-3 equivalents in mg)
Time (minutes)
NBT
SAMPLE NBT
Y=-0.71X+4.20
R2=.9922
Y=-0.23X+3.27
R2=.9954
0.0
1.0
2.0
3.0
4.0
5.0
0.0
2.0
4.0
6.0
8.0
10.0
12.0

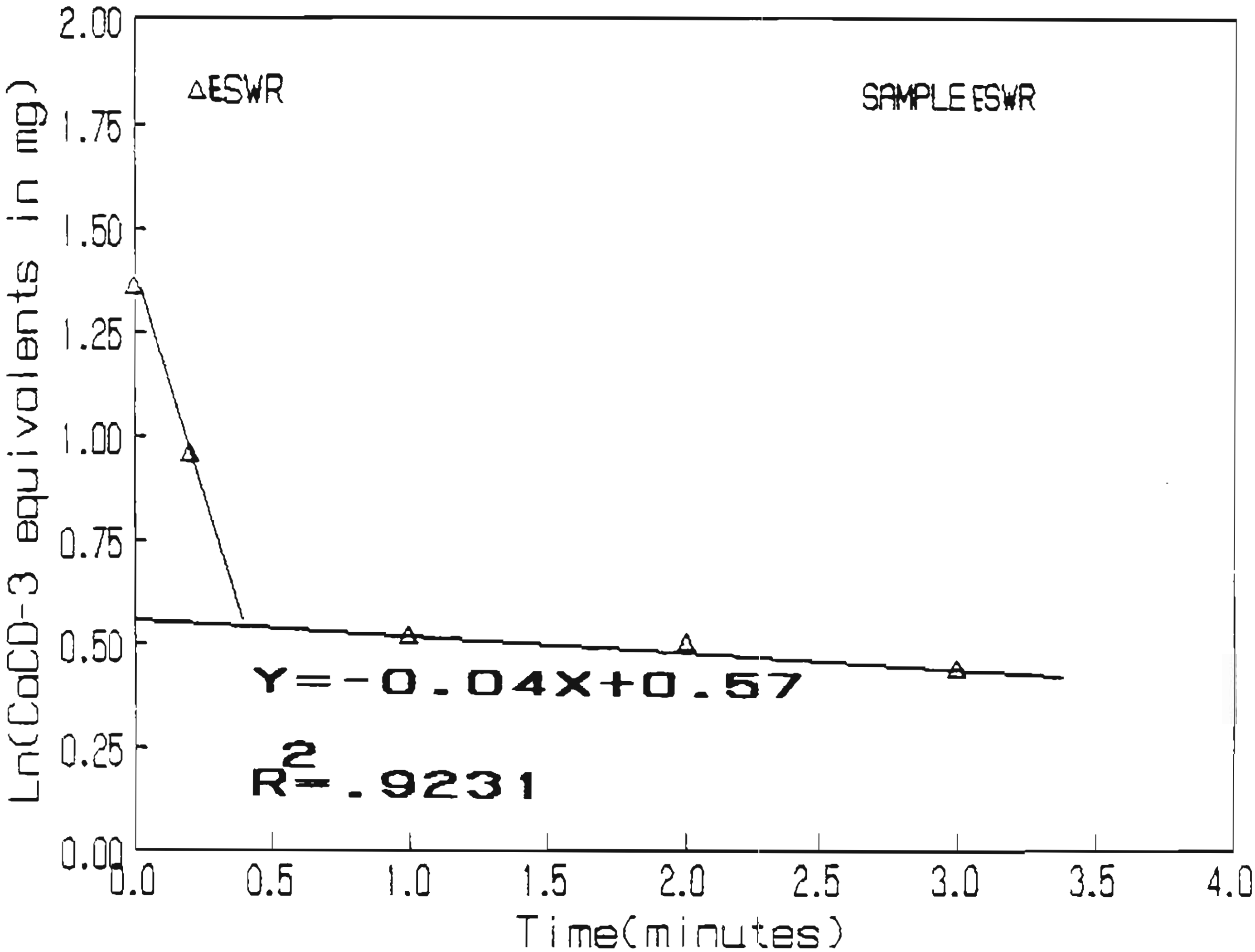


Y=-0.11X+4.70
R2=.9891
o CUT
SAMPLE CUT
Y=-0.056X+4.43
R2=.9956
Ln(CaCO-3 eqivalents in mg)
5.00
4.00
3.00
2.00
1.00
0.00
0.00
5.00
10.00
15.00
20.00
25.00
30.00
35.00
40.00
Time (minutes)

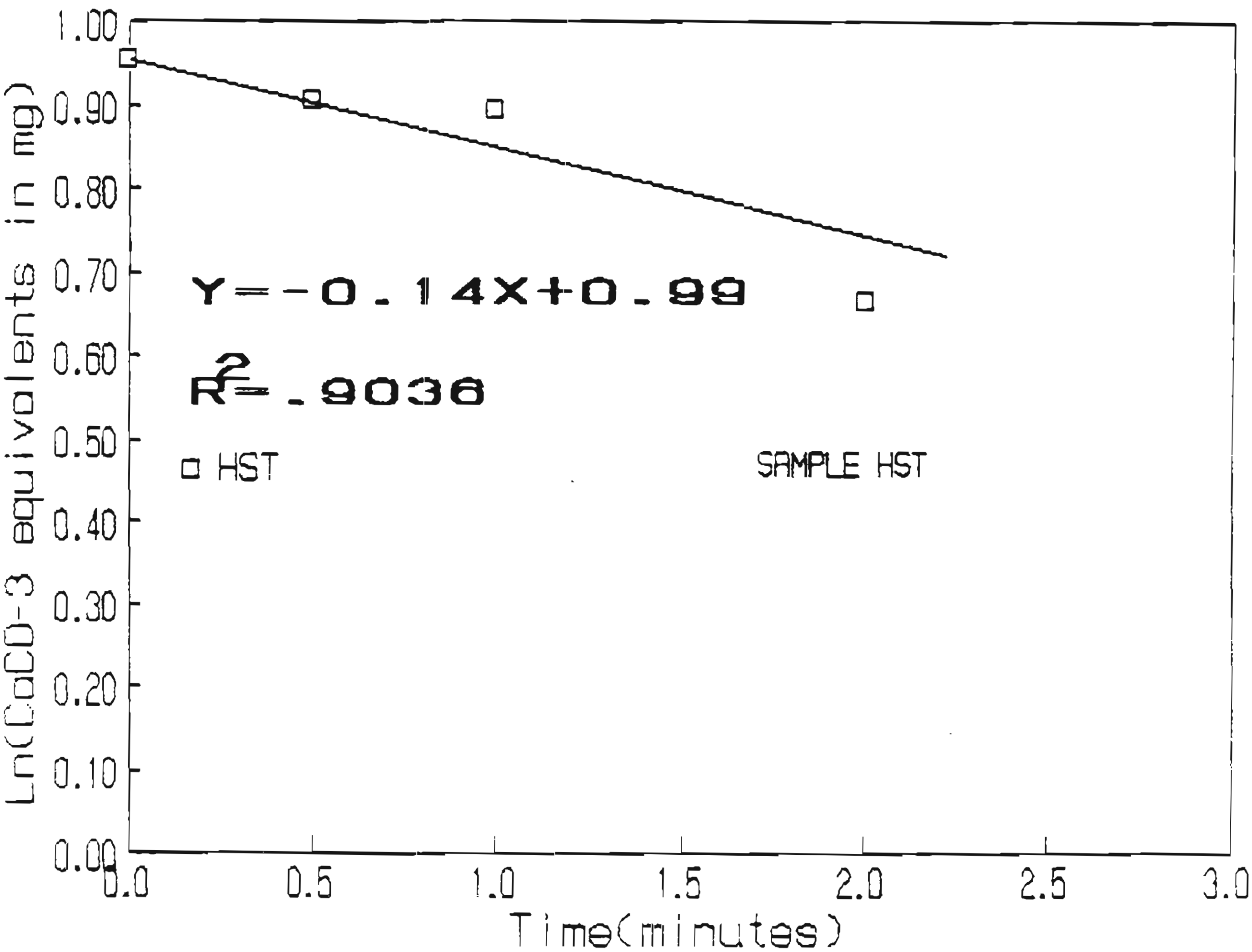


3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Ln(CaCO-3 equivalents in mg)
WMT
SAMPLE WMT
Y=-3.04X+2.70
R2=.9934
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Time(minutes)

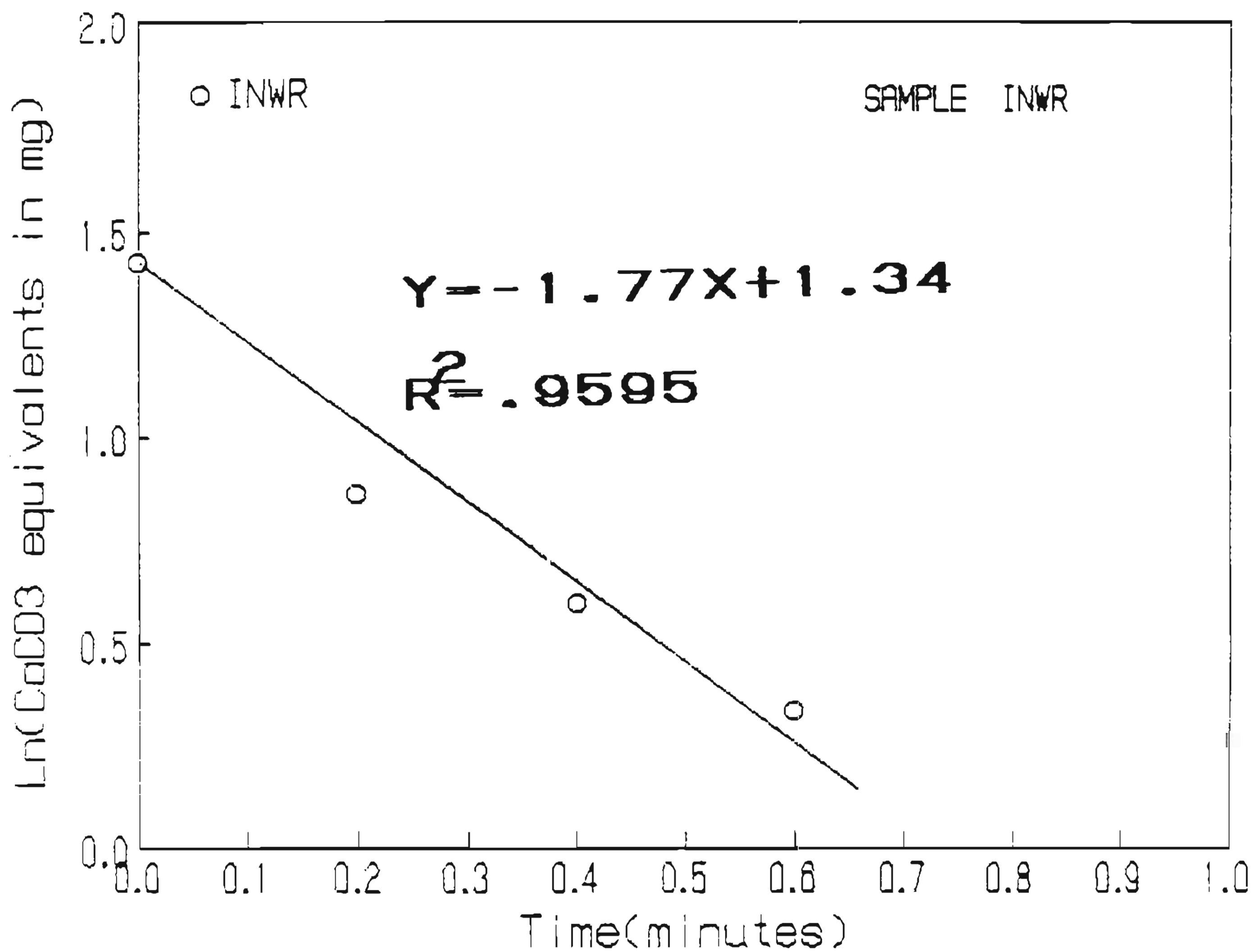

2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
Ln(CaCO-3 equivalents in mg)
o KLT
SAMPLE KLT
Y=-1.96X+1.48
R2=.9296
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 1.1 1.2 1.3 1.4 1.5
Time(minutes)



ΔESWR
SAMPLE ESWR
Y=-0.04X+0.57
R2=.9231
Ln(CaCO-3 equivalents in mg)
Time(minutes)
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0



1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0.0
0.5
1.0
1.5
2.0
2.5
3.0
Ln(CaCO-3 equivalents in mg)
Time(minutes)
Y=-0.14X+0.99
R2=.9036
HST
SAMPLE HST



2.0
1.5
1.0
0.5
0.0
o INWR
SAMPLE INWR
Y=-1.77X+1.34
R^2=.9595
Ln(CaCO3 equivalents in mg)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
Time(minutes)

APPENDIX 12

QUESTIONNAIRE SENT TO, AND FIELD DATA FROM PARTICIPATING MINING COMPANIES

THE UNIVERSITY OF BRITISH COLUMBIA
DEPT. OF MINING AND MINERAL PROCESS ENGINEERING
6350 STORES ROAD
VANCOUVER, B.C., CANADA
V6T 1W5

Telephone: (604) 228 - 3981 Fax: (604) 228 - 5599

June 7, 1988

Dear Participant:

Re: Acid Mine Drainage Prediction Contract, No. 23440-7-9+78

General Objective: To investigate advantages and disadvantages of current techniques used for the prediction of acid mine drainage.

Research on the subject contract involving sample(s) that you submitted to Gilles Tremblay of CANMET in Ottawa is well underway. Enclosed please find a short summary of the predictive tests being evaluated on your samples and samples received from eight other operating mines across Canada.

One objective of this project is to learn from you, relevant field-operating data and experiences to compare with the predictive lab-test results.

Your supply of field data on these samples would greatly contribute to the success and meaning of this research project. We will ensure that, in return, you will each receive copies of the final report.

To assist in your supplying relevant information on your waste/tailing sample behavior, we have included a short questionnaire for you to fill out. We ask that you also supply any additional information (publications etc.) that you perceive to be relevant to this research effort.

If you have questions prior to supplying this information please telephone me at (604) 228 - 3981 or Dr. R.W. Lawrence or Ms. Linda Broughton at Coastech Research Inc. (604) 980 - 5992.

Thank you for your assistance! We hope this project will be very meaningful for those of us attempting to deal successfully with the problem of acid drainage.

Sincerely,

George W. Poling
Professor of Mineral Process Engineering

/ml

Encls.

cc: Dr. R.W. Lawrence, Coastech Research Inc.
Ms. L. Broughton, Coastech Research Inc.

ws2:3gwp-72

ACID MINE DRAINAGE PREDICTION CONTRACT
NO. 23440-7-9+78
PARTICIPATING MINES QUESTIONNAIRE

TAILING/WASTE ROCK SAMPLE DESCRIPTION

1. **Where was sample taken from?**

   1.1 **Supply Site map, if available, showing sampling location(s).**

   1.2 **Type of sample - surface**

   - pit (size and depth)

   - **subaqueous**

   1.3 **Describe detail of any sample preparation and handling for sending to CANMET, i.e., was it filtered or dried etc.**

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2. History of sample:

   2.1 Date sampled.

   2.2 How long was sample exposed to weathering? Under what conditions?

   2.3 Have any overbasing or neutralizing ingredients been added? Detail condition of tailings at discharge.

   2.4 For tailing - does sample represent whole tailing or cycloned or beach - classified fraction or slime fraction?

   2.5 For tailing sample, please supply a flowsheet of concentrator generating this tailing - including reagents used, dosages and their expected dispositions [to concentrate or to tailing (solids and liquids) or to air].

   2.6 What was the lag time between initial deposition and appearance (if any) of acid drainage?

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3. Can sample be related directly to existing pond or seepage or pore water conditions?

3.1 What are those conditions?

3.2 Details of pond, seepage or prewater chemistry and bio-chemistry, i.e., dissolved SO_4, heavy metals, alkalinity, pH, flow rates versus time, etc.

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4. Can you supply detailed mineralogy on the sample(s) supplied or expected approximate mineralogy of the sample supplied?

4.1 Has the extent of sulphide particle oxidation been established microscopically on your tailing/waste material?

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5. Has your tailing/waste sample or seepage problem been subjected to any waste management in an attempt to stop or to minimize acid generation? i.e., has the sample been blended in any way?

6. Have any prediction methods been previously applied to the material? If so, by what methods and what were the results?

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SUMMARY OF REPLIES FROM FIELD DATA QUESTIONNAIRE

CURRAGH RESOURCES

Location:	20 km N.W. of Faro, Yukon
Mine Type:	Open pit - Pb/Zn, 9200 tpd, 1969 - 1982 as Cypress Anvil Mining Corp; restarted May 1986 as Curragh Resources.
Tailings Ponds:	see Figure 1969 original pond : 27 ha, 6 x 10^6 m^3 1974 second pond : 40 ha, 5 x 10^6 m^3 1981 down valley scheme : 128 ha, 42 X 10^6 m^3 capacity
Tailing (CUT):	Cut from tailing discharge June 8, 1987. Sulphides : 50% of tailing, pyrite and pyrrhotite, mainly free, 5 - 200 um. Host Rock: Quartz, feldspar, sericite, chlorite with minor carbonate. Tailing surface generated AMD in few warm summer months due to chemical oxidation. No evidence of biological catalysis.
Waste Rock (CUWR):	Sulphides : 11% of waste rock, pyrite, 50-1000um. Host Rock: Crystalline schist, quartz, plagioclase, biotite, muscovite, minor carbonate. Waste rock generates some AMD.

EQUITY SILVER MINES LTD

Location:	37 km SE of Houston, B.C.
Mine Type:	Open Pit, Ag/Cu
Tailing Pond:	see figure
Tailing (EST):	sampled directly from spigotted beach; coarse fraction, 1 month old Sulphides: 7% of sample, pyrite, free, 5-75 um. Host Rock: primarily sericitized schists. No sign of AMD generation at site. Reclaim water quality : pH 7.3.

Equity Silver continued:

Waste Rock (ESWR):	fresh from south end of main zone pit @ 1270m. Sulphides: >50% pyrite and pyrrhotite, mostly massive, 100 - 3000 um laths; some 5 - 50 um disseminated. Host Rock: Sericitized felsite, trace of carbonate. Waste rock generates AMD after 6 months to 1 year.

HEATH STEELE MINES LTD

Location:	Newcastle, New Brunswick
Mine Type:	Underground and open pit
Tailing Pond:	See Figure
Tailing (HST):	taken from approx. 6" under existing hardpan in tailing pond, Nov 1987, 25 y old. Sulphides: 80% of sample pyrite and altered pyrrhotite, free, 5 - 50 um. Tailings generate AMD on site.
Waste Rock (HSWR):	Taken from waste rock dump next to #1 shaft. Sulphides: ~7% of waste rock, pyrite, pyrrhotite and sphalerite (intergrowths), 5 - 100 um. Host Rock: plagioclase, felsite, quartz, sericite, and chlorite. Waste rock 30 y old, generates AMD.

KEY LAKE MINING CORP

Location:	Key Lake, Saskatchewan, 57°N Lat.
Mine Type:	Open Pit, uranium, since Oct. 1983
Tailing Pond:	~800 m x 500 m
Tailings (KLT):	Sample taken from tailing pipeline, last

Key Lake continued:

week of July, 1987. Tailing limed to pH 10 as neutralized product from acid leach process.
Sulphides: ~1% of sample, Ni arsenides and pyrite.
Host Rock: mainly quartz and gypsum precipitate.

No evidence of AMD at site

NORANDA MINERALS INC

Location:	Granisle, British Columbia
MIne Type:	Open pit, Cu
Tailing Pond:	on island in Babine Lake
Tailing Sample:	taken directly from tailing pump box, Oct 20-22, 1987. Mill feed is limed to pH 9.0, grind 55% -200 mesh. Sulphides: ~4% of sample pyrite + trace chalcopyrite, bornite, free, 5 - 120 um. Host Rock: mainly quartz, sericite, plagioclase, with ~5% carbonate content. Reclaim water pH = 7.5.

No AMD generated at site.

WAITE AMULET

Location:	20 km N of Noranda, Quebec.
Mine Type:	Underground, Cu/Zn. Began 1928, ceased 1962.
Tailing Pond:	41 ha with 5.9 x 10^6 tonnes in elevated impoundment. See figures.
Tailing (WAT):	Sample taken from old tailing pond early July, 1987. Sulphides: ~21% pyrite + pyrrhotite, free, 30 - 250 um. Host Rock: mainly quartz, feldspar, amphibole, muscovite, epidote, and chlorite.

Tailing produces AMD at site above water table. Minimal sulphate reducing bacteria below water table.

WESTMIN RESOURCES LTD

Location:	Southern end of Buttle Lake, Vancouver Island, British Columbia.
Mine Type:	Underground, Cu/Zn
Tailing (WMT):	Sample taken mid November, 1987, from relatively fresh area (< 1 month old) of beach in S.W. corner of tailing deposition area II. Sulphides: ~40% of sample pyrite, free, 2-70 um. Host Rock: mostly quartz, feldspar, and sericite with ~2% carbonate. Tailings develop AMD at surface ~1 year after deposition.

INCO LTD

Location:	Sudbury, Ontario
Mine Type:	Underground, Ni
Waste Rock:	Sample taken Aug 6, 1987 Sulphides: ~2% as pyrrhotite, pyrite, chalcopyrite, free, 10 - 300 um. Host Rock: mainly plagioclase, quartz, pyroxene, hornblend, and biotite. Waste rock does generate AMD.