LABORATORY EVALUATION OF THE INCO SO_2/AIR CYANIDE REMOVAL PROCESS FOR THE MOUNT NANSEN GOLD PROJECT

Prepared for:

BYG Natural Resources Inc.
#208-3190 St. John's Street
Port Moody, B.C.
V3H 2C7

Prepared by:

Process Research Associates Ltd.
9145 Shaughnessy Street
Vancouver, B.C.
V6P 6R9

Bernhard Klein

Bernhard Klein, Ph.D.
Senior Process Metallurgist

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1 SUMMARY

Process Research Associates Ltd received 178 samples of pulverized drill core from the Mount Nansen property in the Yukon Territory which were combined to create a composite weighing 33 kg. A 20 kg split of the sample was subjected to CIP cyanide leaching and the barren pulp was treated using the Inco SO_2/air cyanide removal process.

The gold and silver grades of the material were determined to be 6.34 g/t and 65.1 g/t, respectively. Cyanide leaching extracted 80.8% of the gold and 38.2% of the silver.

The main process variables for the SO_2/air treatment process are the SO_2/CN_T ratio (SO_2 was added as an aqueous $Na_2S_2O_5$ solution), the copper dosage, the dissolved oxygen level, the pH and the reactor retention time. Based on the level of dissolved copper in the barren solution (83 mg/L), no copper addition was required for the process. The pH controller was set at 8.5, however even after 9 hours of continuous operation, the pH did not drop below the set point and therefore no lime addition was required.

An SO_2/CN_T ratio of 4.2/1 with a reactor retention time of 60 minutes reduced picric acid cyanide (CN_P) levels from 109 mg/L to as low as 0.06 mg/L and CN_T levels from 98.5 mg/L to 0.09 mg/L. At a lower ratio of 3.7/1 the best CN_P achieved was 1.6 mg/L. Decreasing the retention time to 30 minutes resulted in a CN_P level of only 8.0 mg/L. Further testing is required to optimize the SO_2 dosage.

Aging the treated effluent for 7 days reduced the CN_T level to 0.005 mg/L.

SO_2/air treatment reduced the copper concentration from 83 mg/L to 0.8 mg/L. Aging for seven days reduced the copper level to the 0.2 to 0.3 mg/L range. The SO_2/air treatment caused arsenic to dissolve increasing the concentration from 1.95 mg/L to 4.85 mg/L. Aging for up to 14 days did not reduce As levels which increased slightly during this period to 5.6 mg/L.

An acid base accounting test performed on the treated effluent residue revealed that the material contained 0.59 % sulphide sulphur and the net neutralization potential (NNP) was -5.61. Despite the negative NNP, it is not expected that acid rock drainage would be a problem since the sulphide sulphur content is very low.

2 INTRODUCTION

BYG Natural Resources Inc. commissioned Process Research Associates Ltd to conduct testing for the detoxification of cyanidation effluent for the Mount Nansen Gold project. The testwork was performed on an ore sample which was cyanide leached (CIP) to produce the barren cyanidation effluent sample for testing. This report describes the procedures and summarizes the results of the test program.

The SO_2/air cyanide removal process is patented by Inco and is used commercially at numerous locations under license.

3 EXPERIMENTAL PROCEDURES

A composite sample of Mount Nansen ore was leached with cyanide and the barren solution was used in subsequent cyanide removal testwork. The following describes testing procedures that were used.

3.1 Sample Preparation

A total of 178 pulverized diamond drill hole samples weighing between 50 g and 350 g each were combined to produce a composite. The sample numbers, reported gold grades and weights are presented in Appendix I. Approximately 20 kg was riffled from the 33 kg composite sample for cyanide leaching. A representative split was obtained and assayed for gold, silver and ICP metals.

3.2 Cyanidation leaching

The 20 kg composite sample was subjected to carbon in pulp (CIP) cyanide leaching to produce barren slurry for SO_2/air detoxification testwork. The cyanide leach conditions established by Melis[1] were used and are as follows:

Grind (% -200 mesh)	70.0
pH	10.5 - 11.0
Solids content (%)	50.0
Cyanide concentration, g NaCN/L	0.3
Leach retention time, hours	24
Carbon adsorption retention time, hours	5
Carbon pulp loading, g/L	20

A sieve analysis of the composite sample revealed that 80.9% of the material was finer than 200 mesh which is finer than the target grind of 70% -200 mesh. As a result, the sample was not ground prior to cyanide leaching. Cyanide leaching was performed in a 100 L overhead stirred tank reactor.

The pH was adjusted to 10.5 by adding lime. Cyanide was added at 0.3 g NaCN/L. The pH and NaCN concentration were monitored and controlled to maintain the target levels. Following 24 hours of leaching, 20 g/L of activated carbon was added to the reactor to absorb the gold. Extraction with carbon was continued for 5 hours.

The carbon, leach residue and barren leach solution were assayed for gold and silver. The solution was also analyzed for copper, iron, nickel, zinc, total cyanide, thiocyanate, weak acid dissociable cyanide, picric cyanide, ammonia, nitrate, nitrite, sulphate, sulphide and ICP metals. The remaining pulp was used for SO_2/air detoxification testing.

Foot Note: 1. Report Melis Engineering Ltd., January 1992, "Mount Nansen Gold Project Mill and Surface Facilities Feasibility Study".

3.3 SO_2/Air Detoxification

Batch and continuous SO_2/air detoxification testing was performed. The batch test was performed to check calculated reagent dosages. Continuous testing was performed to evaluate the effect of retention time and reagent dosage on the levels of cyanide species and dissolved metals.

The equipment set-up for the tests is illustrated in Figure 1. The equipment consisted of a baffled single stage glass reactor with a working volume of 1.23 litres. The dissolved oxygen content of the slurry was maintained above 4 ppm by sparging air into the bottom of the reactor. A variable speed overhead stirrer provided mixing.

The pH was controlled automatically using a pH controller and slurried lime. The ORP (Ag/Cl reference electrode) was recorded regularly during testing. Metabisulphite solution was added via a fixed speed peristaltic pump; dosages were controlled by adjusting the strength of the solution. During continuous testing, the slurry feed was added with a variable speed peristaltic pump. Treated slurry overflowed the reactor via a glass tube into a beaker.

For the batch test, 1.23 litres of barren pulp with approximately 50% solids by weight was added to the reactor. An aqueous solution with 17.4 g $Na_2S_2O_5$/L was added at a rate of 1.4 mL per minute. The pH controller was set at pH 8.5. During testing the pH, redox potential, copper and weak acid dissociable cyanide (picric acid method) levels were monitored. The test was operated for one hour.

For continuous testing, the slurry feed rate was set at 1.2 litre per hour. Aqueous $Na_2S_2O_5$ solution was fed to the reactor at 1.41 mL per minute. During the test, the pH, redox potential, copper and weak acid dissociable cyanide (picric method) were monitored. Samples were obtained for analyses of cyanide species, nitrogen species and dissolved metals. Samples of treated effluent were stored for periods of 7 days and 14 days under both open and closed conditions. Following storage the samples were analyzed for total cyanide and dissolved metals.

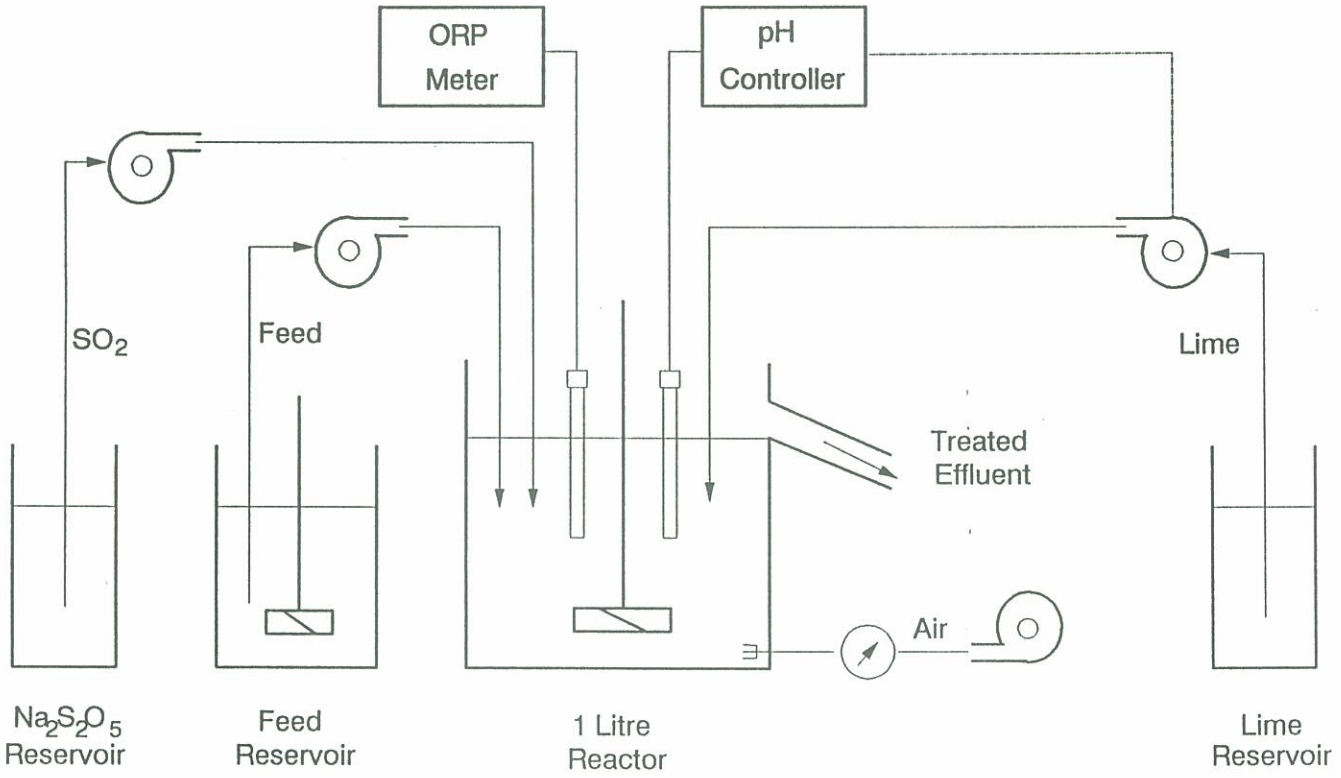
3.3.3 Analytical Procedures

During testing it was important to monitor the cyanide and copper concentrations in the treated solution. Slurry samples were filtered through 0.45 μm filter paper and analyzed for weak acid dissociable cyanide by the picric method and for copper, iron, zinc and nickel by atomic absorption. The picric method for cyanide analysis is suitable for process control but is subject to interference and is therefore not suitable for presenting final results.

The composite ore sample was analyzed for gold and silver by fire assay and the metals content was determined by multi-element ICP. The untreated and treated effluents were analyzed for total cyanide, thiocyanate, weak acid dissociable cyanide, cyanate, ammonia, nitrate, nitrite, sulphate, sulphide and ICP metals.

The effect of aging the samples under both open and closed conditions was also tested. Samples were aged for 7 days and 14 days and then analyzed for total cyanide and ICP metals.

FIGURE 1. LABORATORY ONE STAGE CONTINUOUS SET UP



4 RESULTS

The results of the cyanide leaching and detoxification testwork are as follows.

4.1 Head Sample Analysis and Cyanide Leaching

The gold and silver grades of the head sample were 6.34 g/t and 65.1 g/t, respectively. The metal result, presented in Appendix II, show that the sample contained high levels of arsenic (6,237 ppm), antimony (542 ppm), lead (4,307 ppm), copper (496 ppm) and iron (5.88%).

As mentioned above, the CIL cyanide leaching procedures proposed in the feasibility study by Melis (1992) were followed. The test results are presented in Appendix III. Gold and silver extractions of 80.8% and 38.1% were achieved. The cyanide level, maintained at 0.3 g/t for the entire leach, resulted in a total NaCN consumption of 0.7 kg/t. Controlling the pH at 10.5 for the leach consumed 7.8 kg lime/t as $Ca(OH)_2$.

The calculated gold head grade was lower than the measured grade (6.09 g/t versus 6.34 g/t). There is no obvious explanation for the discrepancy. The residue gold and silver grades were 1.12 g/t and 48 g/t, respectively.

The barren leach solution was stored in sealed 20 litre buckets for subsequent detoxification testwork.

4.3 SO_2/Air Cyanide Removal

The results of analyses for the barren cyanide leach solution are presented in Appendix VI along with the analyses of the treated effluent. The solution contained 98.5 mg/L CN_T, 1.95 mg/L As, 13.5 mg/L Cu and less than 0.03 mg/L Fe.

Theoretical reagent dosages were calculated based on the following preliminary analyses of the barren solution:

CN_p	(mg/L)	109
Cu	A.A. (mg/L)	83
Fe	A.A. (mg/L)	<0.1
Ni	A.A. (mg/L)	<0.1
Zn	A.A. (mg/L)	0.1

The estimated levels of reagents are lower than proposed by Melis (feasibility report, 1992). Copper levels were sufficiently high so that no copper was required. The required $Na_2S_2O_5$ dosage was estimated to be 600 mg/L which corresponds to a SO_2/CN_T ratio of 3.7/1. A retention time 0.5 hours was estimated to be more than sufficient for kinetic considerations. The recommended pH level was 8.5.

The following summarizes the initial test conditions to evaluate the SO_2/air treatment process:

Tailings discharge density, wt % solids	50.0
SO_2/CN_T ratio	3.7
Retention time, hours	0.5
pH	8.5
Sodium Metabisulphite addition, g $Na_2S_2O_5$/L	0.60
Copper sulphate addition, mg Cu^{2+}/L	0.0

4.3.1 Batch Testing

Calculated reagent conditions were evaluated in a batch test. During the test the pH, redox potential, dissolved oxygen, copper and picric cyanide levels were monitored. A summary of the batch test results are presented in Appendix IV.

During batch testing, the picric cyanide levels dropped from 109 mg/L to 0.52 mg/L within 30 minutes and to 0.26 mg/L after 60 minutes. The copper level dropped from 83 mg/L to 2.0 mg/L at 30 minutes and 0.1 mg/L at 60 minutes. During the test, which lasted one hour, the pH remained above the controller set point of 8.5 and therefore no lime was added.

4.3.2 Continuous Testing

Two sets of continuous tests were performed to evaluate the SO_2/air treatment process. In the first test, an SO_2 /CN_T ratio of 3.7/1 was used at reactor retention periods of 30 minutes and 60 minutes. In the second test, the SO_2 /CN_T ratio was increased to 4.2/1 and the reactor retention time was fixed at 60 minutes. The tests were run for sufficient period of time to obtain samples for analyses (6 hours for test 1 and 9 hours for test 2). The parameter levels monitored during tests are summarized in Appendix V. The results of analyses on the treated effluent are presented in Appendix VI.

During continuous testing, at a SO_2/CN_T ratio of 3.7/1 and a retention time of 30 minutes, the CN_P level was reduced from 109 mg/L to 8.0 mg/L and the copper level was reduced from 83 mg/L to 29.7 mg/L. Using a retention time of 60 minutes, the CN_P was reduced to 1.4 mg/L and the Cu to 4.8 mg/L.

A higher $Na_2S_2O_5$ addition rate, corresponding to a SO_2/CN_T ratio of 4.2/1, decreased the CN_P level to as low as 0.06 mg/L and the copper level to 0.8 mg/L (retention time 60 minutes). A more detailed analysis of the solution determined that the CN_T level was reduced from 98.5 mg/L to 0.090 mg/L and the CN_{WAD} decreased from 67.9 mg/L to 0.087 mg/L. As a result of the treatment the ammonia rose from 0.587 mg/L to 4.47 mg/L and the nitrite from 0.006 mg/L to 0.130 mg/L. The treatment caused more arsenic to dissolve increasing from 1.95 mg/L to 4.85 mg/L.

The results show that the required SO_2 dosage will depend on the effluent quality objectives. A retention time of 60 minutes resulted in significant improvement compared to 30 minutes.

Aging the treated effluent caused the total cyanide level to drop to less than 0.005 mg/L within seven days. The arsenic levels were not effected by aging and remained at levels of 4.86 to 5.6 for at least two weeks following treatment. No discernable difference was observed between samples stored under either open or closed conditions. A more detailed analyses of the aged treated effluent is presented in Appendix VI.

4.3.4 Acid Base Accounting

The residue from the treated effluent was submitted for a standard acid base accounting test. The acid base accounting report is presented in Appendix VII. Despite the negative net neutralization potential of -5.61 tonnes of $CaCO_3$ per 1000 tonnes of material, the low sulphide sulphur content of 0.59% suggests that acid generation should not be a concern with tailings.

APPENDIX I - SAMPLE IDENTIFICATION, WEIGHTS AND GRADES

Sample Number	Weight (g)	Gold Grade (oz/t)
S-01163	267.0	0.74
S-01164	236.7	0.48
S-01165	232.7	0.91
S-01166	244.6	1.37
S-01167	240.9	0.83
S-01168	273.4	0.85
S-01169	256.8	0.96
S-01170	266.4	0.56
S-01171	231.5	1.53
S-01172	245.6	0.91
S-01173	263.4	0.61
S-01174	233.8	0.34
S-01175	225.2	1.05
S-01176	267.3	0.14
S-01177	163.8	1.22
S-01178	241.2	1.44
S-01179	239.3	1.30
S-01180	213.7	0.90
S-01186	248.1	1.22
S-01187	242.0	0.92
S-01188	240.7	1.21
S-01189	219.4	0.92
S-01190	243.5	0.48
S-01191	259.9	0.43
S-01192	241.4	1.53
S-01211	291.6	0.98
S-01212	259.9	0.24
S-01213	241.5	0.31
S-01214	226.9	0.55
S-01215	306.5	0.66
S-01216	227.6	1.53
S-01217	276.2	0.31
S-01218	234.6	0.30
S-01219	244.0	0.60
S-01220	214.0	0.55
S-01221	253.4	0.37
S-01222	80.6	0.92
S-01223	272.6	0.60
S-01224	300.6	1.53
S-01225	258.4	0.61
S-01226	222.8	0.61
S-01227	236.4	1.52
S-01228	241.2	1.22
S-01310	236.0	1.04
S-01311	325.7	0.76
S-01312	213.1	0.46
S-01313	200.4	1.53

Sample Number	Weight (g)	Gold Grade (oz/t)
S-01314	243.6	0.81
S-01315	152.7	0.35
S-01316	217.1	0.36
S-01317	259.3	0.94
S-01318	204.3	0.59
S-01319	190.2	0.91
S-01320	207.9	0.50
S-01321	284.5	0.72
S-01322	279.5	0.88
S-01323	237.8	0.34
S-01324	285.5	0.96
S-01325	281.8	0.56
S-01326	230.6	0.69
S-01327	245.9	0.60
S-01328	206.7	0.24
S-01329	223.5	0.41
S-01330	343.1	0.85
S-01331	275.2	0.26
S-01332	263.4	0.34
S-01333	302.5	0.60
S-01334	247.8	0.58
S-01495	204.4	0.91
S-01496	155.5	1.10
S-01497	73.9	0.42
S-01498	142.9	0.38
S-01499	90.2	1.14
S-01500	145.0	0.16
S-01527	106.5	0.50
S-01528	87.1	0.87
S-01529	60.1	0.23
S-01530	117.5	0.53
S-01531	107.2	0.47
S-01532	125.1	0.29
S-01533	120.1	1.11
S-01534	149.7	0.42
S-01535	114.8	0.98
S-01536	169.8	0.54
S-01537	152.2	0.26
S-01538	165.8	0.90
S-01539	133.1	0.36
S-01734	156.1	1.53
S-01735	152.5	0.51
S-01736	143.4	1.01
S-01737	187.5	0.24
S-01738	211.0	0.75
S-01739	216.2	0.49
S-01753	143.2	0.92

Sample Number	Weight (g)	Gold Grade (oz/t)
S-01754	119.5	1.52
S-01755	99.0	1.04
S-01756	139.3	0.18
S-01757	154.9	0.92
S-01758	137.4	0.45
S-01759	160.6	0.40
S-01810	175.5	0.84
S-01811	194.7	0.69
S-01812	101.9	1.22
S-01813	140.1	1.37
S-01814	106.2	0.52
S-01815	183.9	0.55
S-01816	173.9	0.35
S-01817	121.7	0.56
S-01818	83.5	1.14
S-01819	160.8	0.38
S-01820	269.8	1.53
S-01842	207.4	1.53
S-01843	232.0	0.68
S-01844	128.1	0.84
S-01845	197.0	1.52
S-01846	165.8	0.49
S-01847	189.9	0.65
S-01848	215.3	0.39
S-01849	207.4	1.52
S-01850	197.9	0.89
S-01851	136.6	0.64
S-01852	138.1	0.11
S-01853	178.4	0.91
S-01854	146.9	0.20
S-01855	222.9	0.89
S-01912	182.6	1.52
S-01913	205.7	1.15
S-01914	61.9	0.37
S-01915	86.3	0.58
S-01916	149.3	0.30
S-01917	196.4	0.65
S-01918	190.1	0.85
S-01919	94.6	0.67
S-01920	147.6	0.63
S-01921	160.4	0.30
S-01922	33.6	0.60
S-01923	86.2	0.60
S-01924	192.7	0.92
S-01925	158.5	0.63
S-01940	110.6	1.81
S-01941	91.2	0.65

Sample Number	Weight (g)	Gold Grade (oz/t)
S-01942	2.7	1.53
S-01943	100.8	0.33
S-01944	147.0	0.98
S-01945	107.5	1.13
S-04373	164.9	0.91
S-04374	5.0	0.50
S-04375	91.1	1.02
S-04376	162.6	0.92
S-04377	94.3	0.61
S-04378	94.3	1.22
S-04525	215.6	0.70
S-04526	211.8	0.82
S-04527	162.6	0.58
S-04528	146.9	0.94
S-04529	233.9	0.54
S-04530	212.9	0.99
S-04531	210.7	0.37
S-04532	243.7	0.26
S-04533	254.1	0.38
S-04534	236.2	0.51
S-04553	247.5	0.61
S-04554	244.9	0.92
S-04555	172.3	0.95
S-04556	178.2	0.57
S-04557	242.7	0.33
S-04558	187.1	0.55
S-04559	225.2	0.35
S-04560	165.0	0.29
S-04561	181.4	0.36
S-04562	212.5	0.75
S-04563	240.1	0.42
S-04564	205.1	0.76
S-04571	175.9	1.52
S-04572	125.5	1.53
S-04573	123.2	0.15
S-04574	185.1	1.07
S-04575	236.3	1.06

APPENDIX II - HEAD SAMPLE ANALYSES

Analysis of Mount Nansen Project Composite Ore Sample

Fire assay	
Au (g/t)	6.34
Ag (oz/t)	65.1
ICP Analysis	
Ag (ppm)	64.7
Al (%)	0.36
As (ppm)	6237
Au (ppm)	9
B (ppm)	3
Be (ppm)	60
Bi (ppm)	33
Ca (%)	0.59
Cd (ppm)	17.9
Co (ppm)	1
Cr (ppm)	32
Cu (ppm)	496
Fe (%)	5.88
K (%)	0.41
La (ppm)	4
Mg (%)	0.09
Mn (ppm)	968
Mo (ppm)	1
Na (%)	0.01
Ni (ppm)	2
P (ppm)	0.041
Pb (ppm)	4307
Sb (ppm)	542
Sr (ppm)	57
Th (ppm)	2
Ti (%)	< 0.01
U (ppm)	< 5
V (ppm)	16
W (ppm)_	< 1
Zn (ppm)	1335

APPENDIX III - CYANIDATION TEST RESULTS

CYANIDATION TEST REPORT

Project no : 94-043 Date : 18-Jul-94
Test no : C1
Sample description: Composite of the as-recieved sample
Procedure: Carbon-in-pulp cyanidation with carbon addition at 24 hour.

INITIAL CONDITIONS

Feed solids weight :	19930 g	NaCN :	0.3 g/L
Water weight :	19930 g	pH :	10.5
% solids :	50.0 %	Carbon :	20 g/L

TEST PROGRESS

Time (hr)	NaCN [g/L]	NaCN (g)	Ca(OH)2 [g/L]	Ca(OH)2 (mL)	Initial pH	Final pH	dO2 [mg/L]
0.0	0.30	5.91	109.50		5.7	10.5	8.2
1.0	0.10	3.99	17.10		9.9	10.7	
3.0	0.20	1.99	22.10		10.2	11.0	7.9
4.0	0.30					10.7	
5.0	0.18	2.39				10.5	
21.0	0.18	2.39	6.90				
24.0					10.1	10.5	
29.0	0.10					10.2	7.2

Reagent consumption

NaCN = 0.8 kg/t
Lime Ca(OH)2 = 7.8 kg/t

Reducing power

RP = 140 mL of N/10 KMnO4 per litre solution

EXTRACTION PROFILE

	Time (hr)	Assay (mg/L) Au	Assay (mg/L) Ag	Distribution (%) Au	Distribution (%) Ag
Solution	24	0.08	0.04	1.5	0.1
Carbon		8.75	56.00	79.3	38.1
Residue		1.17	48.00	19.2	61.9
				100.0	100.1
		Total Extraction =		80.8	38.2

	Au (g/t)	Ag (g/t)	Au (oz/ton)	Ag (oz/ton)
Calculated Head	6.09	77.6	0.178	2.26
Measured Head	6.35	65.2	0.185	1.90

Process Research Associates Ltd.

APPENDIX IV - INCO SO2/AIR BATCH TEST RESULTS

SO_2/AIR DETOXIFICATION OF THE MOUNT NANSEN TAILINGS

BATCH TEST SUMMARY

Time	$Na_2S_2O_5$ Dos. (mL/min)	pH	ORP (mV)	Diss. O_2 (ppm)	CN_P (ppm)	Fe (ppm)	Cu (ppm)
0	1.41	9.8	113	6.4	109	<0.1	83
2		9.7	89				
5		9.5	71				
10		9.1	39				
15		9.0	31				
20		8.8	28				
30		8.7	34	6.8	0.52	<0.1	2.0
40		8.5	69				
50		8.7	64				
60		8.5	73		0.26	<0.1	0.1

Notes: $Na_2S_2O_5$ feed solution concentration, 17.4 g/L
$Na_2S_2O_5$ flow rate, 1.41 mL/min
ORP measured using Ag/AgCl reference electrode
Reactor volume, 1.23 L
Pulp density, 50% solids by weight
Temperature, 20°C

Batch reagent consumptions
$Na_2S_2O_5$ - 30 minutes, 594 mg/L
- 60 minutes, 1,188 mg/L
$CuSO_4$, 0.0 g/L
CaO, 0.0 g/L

APPENDIX V - INCO SO2/AIR CONTINUOUS TEST RESULTS

SO_2/AIR DETOXIFICATION OF THE MOUNT NANSEN TAILINGS
CONTINUOUS TEST 1 SUMMARY

Time	Feed Rate (mL/min)		pH	ORP	Diss. O_2	CN_P	Cu
	Pulp	$Na_2S_2O_5$		(mV)	(ppm)	(ppm)	(ppm)
0	41.0	1.4	10.1	54		109	83
15			9.5	39			
30			9.2	22	5.1		
60	20.5	1.5	9.0	14	5.6	8.0	29.7
120			9.0	40		3.8	12.3
180		1.5	8.9	48		3.4	9.3
240		1.5	8.8	56	5.5	1.4	4.8
300			8.8	56		1.6	5.0
360			8.9	53		3.0	7.9

Notes:
$Na_2S_2O_5$ feed solution concentration (<60 min), 17.4 g/L
$Na_2S_2O_5$ feed solution concentration (>60 min), 8.7 g/L
$Na_2S_2O_5$ flow rate, 1.41 mL/min
ORP measured using Ag/AgCl reference electrode
Reactor volume, 1.23 L
Pulp density, 50% solids by weight
Temperature, 20°C

Reagent consumptions
$Na_2S_2O_5$, 600 mg/L
$CuSO_4$, 0.0 g/L
CaO, 0.0 g/L

SO_2/AIR DETOXIFICATION OF THE MOUNT NANSEN TAILINGS
CONTINUOUS TEST 2 SUMMARY

Time	Feed Rate (mL/min)		pH	ORP	Diss. O_2	CN_P	Cu
	Pulp	$Na_2S_2O_5$		(mV)	(ppm)	(ppm)	(ppm)
0	20.5	1.41	8.90	67	6.3	109	83
15		1.46	8.80	58			
30		1.54	8.68	53			
60		1.51	8.57	66		0.44	3.2
90		1.50	8.52	72		0.36	1.7
120	20.5	1.51	8.51	68	5.4	0.32	1.5
150		0.5	8.59	70		2.0	4.9
180		1.48	8.53	73		0.22	0.8
240		1.47	8.50	72	5.2	0.40	1.7
300			8.50	73		0.12	1.0
360			8.50	75		0.06	1.4
420	21.8	1.46	8.50	76	5.3	0.30	1.3
480	20.0	1.47	8.47	78	5.3	0.28	0.8
540	20.2	1.45	8.45	79	5.1	0.38	1.4

Notes: $Na_2S_2O_5$ feed solution concentration, 9.85 g/L
$Na_2S_2O_5$ flow rate, 1.41 mL/min
ORP measured using Ag/AgCl reference electrode
Reactor volume, 1.23 L
Pulp density, 50% solids by weight

Batch reagent consumptions
$Na_2S_2O_5$ 680 mg/L
$CuSO_4$, 0.0 g/L
CaO, 0.0 g/L
Temperature, 20°C

SO_2/AIR DETOXIFICATION OF THE MOUNT NANSEN TAILINGS
SUMMARY OF EFFLUENT ANALYSES

Species (mg/L)		Untreated Solution	Treated Product	7 day Open	7 day closed	14 day open	14 day closed
Total cyanide	CN_T	98.5	0.090	<0.005	<0.005	<0.008	<0.008
Cyanate	CNO	40.4	164				
Thiocyanate	SCN	95.0	101				
WAD cyanide	CN_{WAD}	67.9	0.087				
Ammonia	N	0.587	4.47				
Nitrate	N	0.467	0.599				
Nitrite	N	0.006	0.130				
Sulphate	SO_4	1940	2220				
Sulphide	S	<0.02	<0.02				

SO_2/AIR DETOXIFICATION OF THE MOUNT NANSEN TAILINGS
SUMMARY OF EFFLUENT ANALYSES

Metals (mg/L)		Untreated Solution	Treated Product	7 day Open	7 day Closed	14 day Open	14 day Closed
Aluminum	Al	<0.20	<0.20	<0.20	<0.20		
Antimony	Sb	0.61	0.88	0.84	0.84		
Arsenic	As	1.95	4.85	4.86	5.15	5.6	5.6
Barium	Ba	0.016	0.022	0.019	0.016		
Beryllium	Be	<0.005	<0.005	<0.005	<0.005		
Bismuth	Bi	<0.10	<0.10	<0.10	<0.10		
Boron	B	<0.10	<0.10	<0.10	<0.10		
Cadmium	Cd	<0.010	<0.010	<0.010	<0.010		
Calcium	Ca	682	621	598	608		
Chromium	Cr	<0.015	<0.015	<0.015	<0.015		
Cobalt	Co	0.03	0.039	0.042	0.042		
Copper	Cu	13.5	0.746	0.217	0.290		
Iron	Fe	<0.030	0.05	0.058	0.035		
Lead	Pb	<0.050	<0.050	<0.050	<0.050		
Lithium	Li	<0.015	<0.015	<0.015	<0.015		
Magnesium	Mg	2.39	7.04	9.16	9.09		
Manganese	Mn	0.014	0.037	0.046	0.042		
Molybdenum	Mo	<0.030	<0.030	<0.030	<0.030		
Nickel	Ni	<0.020	<0.020	<0.020	<0.020		
Phosphorous	P	<0.30	<0.30	<0.30	<0.30		
Potassium	K	69.1	82.4	71.3	73.3		
Selenium	Se	<0.20	<0.20	<0.20	<0.20		
Silicon	Si	5.25	9.48	8.58	8.80		
Silver	Ag	0.018	0.038	0.049	0.048		
Sodium	Na	218	437	411	417		
Strontium	Sr	1.41	1.37	1.32	1.35		
Thallium	Tl	<0.10	<0.10	<0.10	<0.10		
Tin	Sn	<0.30	<0.30	<0.30	<0.30		
Titanium	Ti	<0.010	<0.010	<0.010	<0.010		
Tungsten	W	<0.10	<0.10	<0.10	<0.10		
Vanadium	V	<0.030	<0.030	<0.030	<0.030		
Zinc	Zn	0.069	0.009	0.027	0.005		

APPENDIX VII - ACID/BASE ACCOUNTING TEST RESULTS

ACID BASE ACCOUNTING TEST REPORT

Project No: 94-043
Sample: Treated cyanidation effluent
Date: Aug.16, 1994

Item	Quantity
S (tot) %	1.70
S (S=) %	0.59
S (SO4) %	1.11
Paste pH	8.5
NP	12.8
MPA	18.4
Net NP	-5.61

Notes:

1. Analytical methods employed here are described in "Field and Laboratory Methods Applicable to Overburden and Minesoils", EPA 600/2-78-054, pp.45-55, 1978.
2. NP = Neutralization Potential as determined by acid consumption test
   MPA = Maximum Potential Acidity (%S(as sulphide) x 31.25)
   Net NP = NP - MPA
3. NP, MPA and Net NP are expressed in tonnes CaCO3 equiv. per 1000 tonnes sample.
4. Samples with negative Net NP are potential acid producers.

T.W. Higgs Associates Ltd

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Tom Higgs , M.E.Sc., P.Eng.

CHEMICAL PROCESS ENGINEERING, 9145 SHAUGHNESSY, VANCOUVER, V6P 6R9
FAX (604) 322-4907, **TEL (604) 322-3525**

September 16, 1994

Lois Craig
Environment & Lands Claims
DIAND
345-300 Main Street
Whitehorse, Yukon
Y1A 2B5

Dear Lois,

Re: Mount Nansen Project - Cyanide Destruction Testwork

Enclosed are 10 copies of the Laboratory Testwork Report conducted to evaluate the Inco SO_2 Air process for the treatment of CIP tailings from the proposed Mount Nansen mill. The preliminary results from this work were presented in our meeting of Aug. 3, 1994. As demonstrated in the report, the process successfully reduced CN_T to acceptable limits. Copper initially was above discharge limits but dropped to the 0.2 to 0.3 mg/L range with aging. It should be noted, that based on experience at other sites using the Inco SO_2 Air process for mill tailings treatment, we do not anticipate being able to achieve the same level of cyanide treatment efficiency during operation as was achieved during the bench tests. The tailings pond may contain cyanide and arsenic at levels above current discharge limits. Some arsenic was brought into solution during cyanidation and not subsequently removed by the SO_2 Air process, as anticipated. Additional tests are underway on arsenic removal using direct ferric sulphate addition to the mill tailings as a means of reducing the concentration of arsenic in the tailings pond effluent. For planning purposes, however, it is assumed that a secondary treatment system will be installed to treat excess reclaimed water for cyanide and arsenic prior to discharge. A discharge may be necessary at some point during operation or at closure to maintain water balance in the tailings pond. Please distribute this report to the RERC and inform us if additional copies are required.

Yours truly,

Tom Higgs

T.W. Higgs, M.E.Sc. P.Eng.

c.c Jim Smith, B.Y.G.