

SGS Lakefield Research Limited
An Investigation of
**GOLD RECOVERY FROM
NORTH STAR PROJECT SAMPLES**
for
Foran Mining Corporation
LR10572-002 - Progress Report No. 1

NOTE:

This report refers to the samples as received.

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Lakefield Research

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Executive Summary

In this second phase of testwork on the North Star property ore, the various options available for gravity concentration were examined. The program was initiated through contact with Gekko Systems, and focussed initially on the completion of their particular amenability tests for the InLine Pressure Jig (IPJ) and the InLine Leach Reactor (ILR). Subsequent to the completion of those tests, the potential for enhancing gold recovery was evaluated through the application of centrifugal bowl type concentrators. The Falcon concentrator was tested in continuous discharge mode. A full gravity recoverable gold (GRG) test was completed using a Knelson concentrator under the direction of Knelson personnel.

Gold recovery by gravity separation was predictably high in all tests. Knelson's GRG test indicated that the gravity recoverable gold was coarser, and the relative gold recovery was higher, than in most ores that they have tested.

Intensive cyanide leaching of gravity concentrates generated by the Gekko Systems IPJ test, indicated that the concentrate was highly amenable to the process, with a gold extraction of almost 98% applying standard test conditions.

Typical results, from tests completed in this program, are compared to the previously completed testwork in the following table.

Table i. A Comparison of Overall Test Results

Flowsheet	Phase 1 Testwork ¹			Phase 2 Testwork ²		
	Feed Grade g/t Au	% Au Recovery	Final Tailing Grade g/t Au	Feed Grade g/t Au	% Au Recovery	Final Tailing Grade g/t Au
Gravity Separation	12.1	66.2	4.09	13.4	85.9	2.19
Gravity + Rougher Flotation	4.06	95.8	0.53	--	--	--
Gravity + Tailing Cyanidation	3.87	97.2	0.32	--	--	--
Gravity + Concentrate Cyanidation	--	--	--	73.4	84.0	2.11 ⁽³⁾

¹ All results are presented as weighted averages. ² These results are from the Gekko IPJ and ILR testwork.

⁽³⁾ Refers to the final combined Gravity + CN leach tailing grade.

In purely metallurgical terms, the optimum processing route may be:

1. Grind to $P_{80} \leq 100 \mu\text{m}$,
2. Batch Knelson (or Falcon) concentration to yield a high grade, low mass product,
3. Cyanidation of the entire gravity tailing stream,
4. Final gold recovery from such a circuit would be ~97%.

Considering the subsequent cyanide detoxification requirements, along with the environmental and permitting implications, it may be equally attractive to eliminate the large scale cyanidation circuit in favour of a rougher flotation plant. The rougher flotation concentrate would require further processing, likely in the form of intensive cyanide leaching. Recovery loss would probably be held to much less than 2% overall, meaning an overall gold recovery of ~95%.

In spite of these very positive metallurgical scenarios, the choice of processing route will be made based on overall project economics. With that in mind, the gravity recovery (continuous discharge, Gekko, Knelson or Falcon) followed by concentrate cyanidation in an intensive leach reactor may be the economic optimum processing route.

SGS Lakefield Research Limited does not represent the manufacturers of or agents for the various processes or equipment tested in this program. Our role was to independently test the processes on behalf of Foran Mining Corporation. We make no recommendations regarding process selection based on project economics.

Introduction

This report presents results from testwork completed for Foran Mining Corporation, on a composite sample representing the North Star project, located in northern Manitoba. The program was intended to determine the maximum potential gold recovery that might be anticipated applying a gravity only scenario.

The program was directed by Mr. Steve Masson, of Foran Mining Corporation. Ms. Jennifer Abols, of Gekko Systems Inc., and Mr. Mike Fullam, of Knelson Gravity Solutions, were instrumental in the design and interpretation of the testwork program. Results were regularly discussed with and sent to Mr. Masson, as available, throughout the program. Specific test data was also shared with Gekko and Knelson personnel, as deemed appropriate by Mr. Masson throughout the program.

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Summary

1 Sample Description

Equal proportions of the samples used in the previous phase of testing, (received on April 2, 2003) were composited and prepared for use in the current test program. Details of that shipment can be found in the report issued on June 23, 2003 (Project 10572-001). The resulting – 10 mesh composite was labelled ABC Comp.

1.1 Sample Preparation and Head Analysis

The ABC composite sample was blended well and a sample was riffled out for a standard Bond ball mill grindability test. The balance was crushed to pass 20 mesh, in accordance with the Gekko Systems Inc. testing protocol. Two, 1,000g test charges were extracted by rotary splitting. These were submitted for head analyses applying a screened metallics protocol. The remainder of the minus 20 mesh composite was rotary split into 10 kg charges. The screened metallics gold analyses are given in Table 1.

Table 1. Screened Metallics Analysis for Au Results

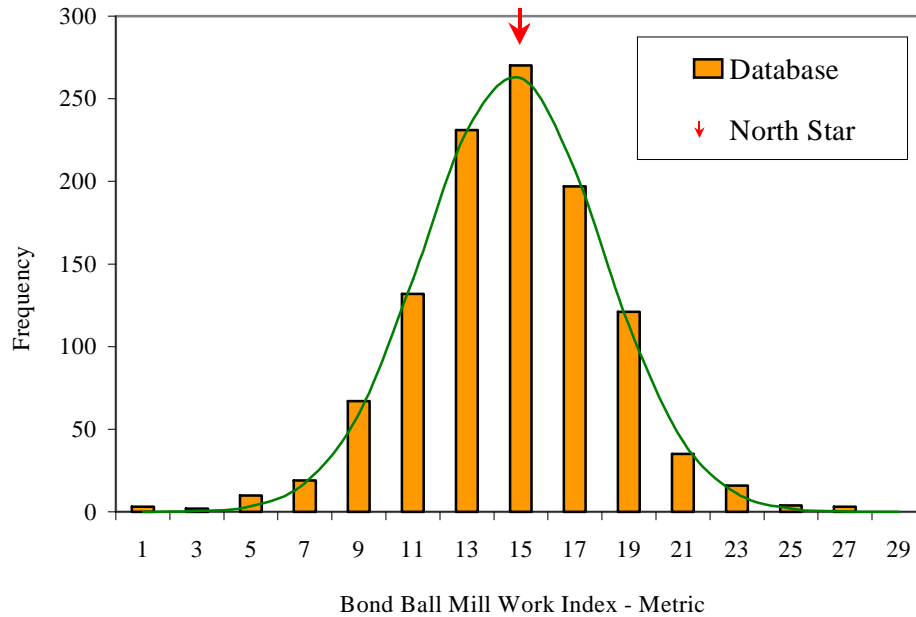
Overall Calc. Head, g/t Au	Calculated Head Au, g/t	+150 Mesh		-150 Mesh		% Au Distribution	
		Mass %	Au g/t	Mass %	Au g/t	+150 Mesh	-150 Mesh
12.9	12.4	2.98	150	97.02	8.20	36.0	64.0
	13.4	2.77	248	97.23	6.80	50.9	49.1

1.2 Crushing Testwork

A standard Bond ball mill grindability tests was completed on the –10 mesh ore. The results are shown in Table 2. Figure 1 compares the North Star ore with the A.R. MacPherson (grinding specialists) data base.

Table 2. ABC Composite Grinding Work Index Results

Feed Size (F ₈₀), µm	Closing Screen Size, µm	Product Size (F ₈₀), µm	Bond Work Index	
			Imperial	Metric
1161	150	123	13.4	14.8

Figure 1. North Star ABC Composite Compared to the A.R. MacPherson Data Base

At the 51st percentile, the North Star Composite would be considered an ore of medium hardness. There are 1,110 Bond ball mill tests represented in the data presented in Figure 1.

2 Metallurgical Testwork

The initial goal of this phase of metallurgical testing was to determine the maximum gold recovery that might be expected from a gravity only flowsheet. Previous testwork had established that greater than 90% gold recovery was possible utilizing a conventional, gravity + flotation, flowsheet. In that process, it was clear that a significant proportion of the gold content was intimately associated with the sulphide components of the ore and thus was recoverable by flotation. The present testwork endeavoured to determine whether a significant part of the sulphide hosted gold could be won from the ore via gravity separation. Gravity processes designed to recover significantly more mass than is typically recoverable

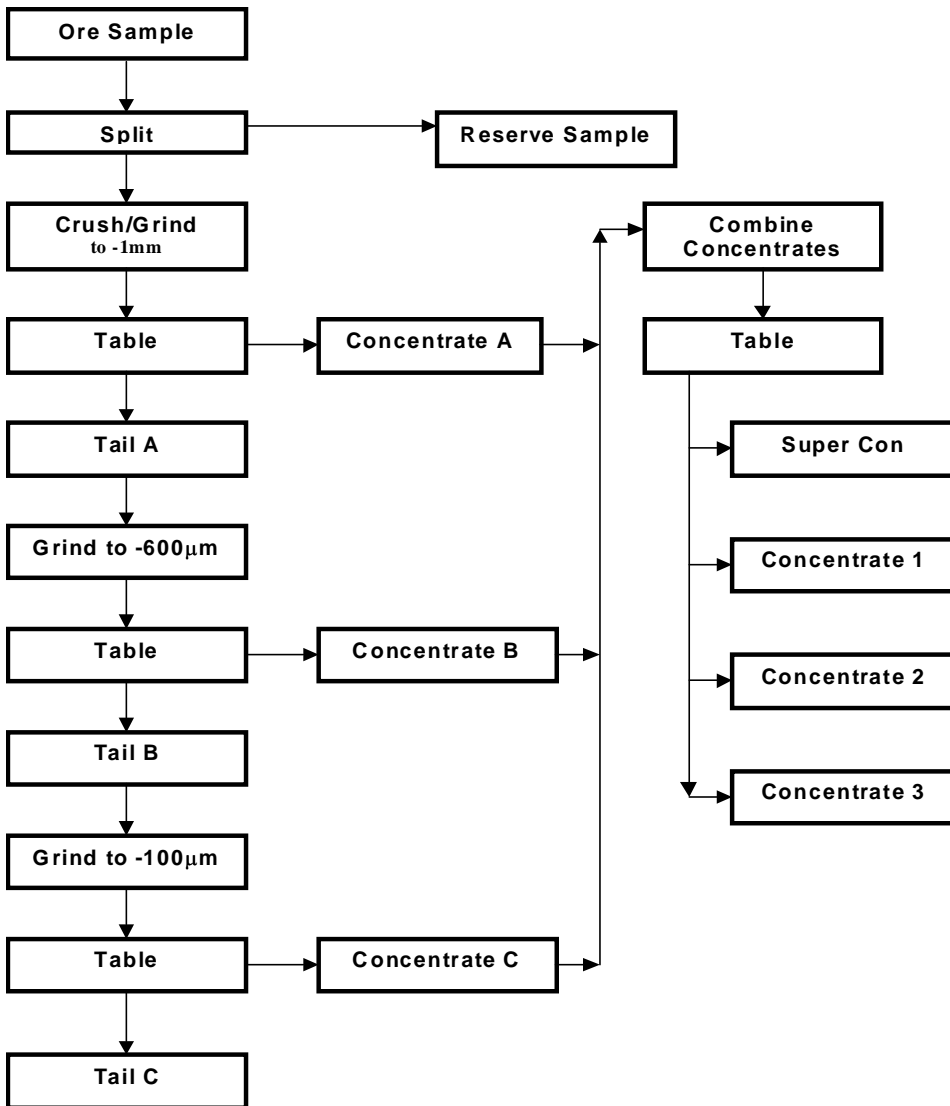
by a conventional Knelson or Falcon type separator were therefore the focus of this investigation.

2.1 Gravity Separation

2.1.1 Gekko InLine Pressure Jig Amenability Testing

The standard, InLine Pressure Jig (IPJ), amenability test protocol was provided to SGS Lakefield Research by Gekko personnel. The general test procedure is illustrated in Figure 2. The complete procedure is described in the Details of Tests section of this report. The test procedure uses a standard laboratory Wilfley shaking table as the concentration device.

Figure 2. Gekko Systems IPJ Amenability Test Procedure



All final concentrates were assayed in duplicate for gold. The final tailing was sampled and assayed four times. The results from the IPJ test are given in Table 3.

Table 3. IPJ Amenability Test Results

Product	Weight %	Assays Au, g/t (Avg.)	% Au Distribution
<i>Super Concentrate</i>	3.6	265	70.6
Super Conc + Conc 1	6.3	171	81.1
Super Conc + Conc 1 - 2	13.7	84.2	85.9
Super Conc + Conc 1 - 3	23.5	51.1	89.6
Table Tailing	76.5	1.82	10.4
Head (calc.)	100.0	13.4	100.0

The results indicated that approximately 86% of the gold could be recovered in 13.7% of the ore mass (Super Concentrate + Concentrates 1 and 2). The tailing grade at that recovery level would be 2.19 g/t Au. Increasing the mass recovery to 23.5% yielded another 3.7% gold recovery. The tailing grade at that level of gold/mass recovery would be as indicated in Table 3 above (i.e., 1.82 g/t Au).

2.1.2 Falcon C Amenability Test

Compared to the previously established, conventional gravity + flotation circuit gold recovery, the recovery achieved in the IPJ amenability test was relatively low. Due to the comparatively low mass pull required to achieve the higher gold recovery in the gravity + flotation circuit (~96% gold recovery in <5% mass), it was felt that the gold bearing sulphides must be reasonably liberated. Based on this supposition, it was believed that there might be some merit in testing a continuous discharge type centrifugal concentrator, in that the fine liberated sulphides would likely be more amenable to recovery by gravity separation in that environment. To explore that possibility, a Falcon C (continuous) test was completed.

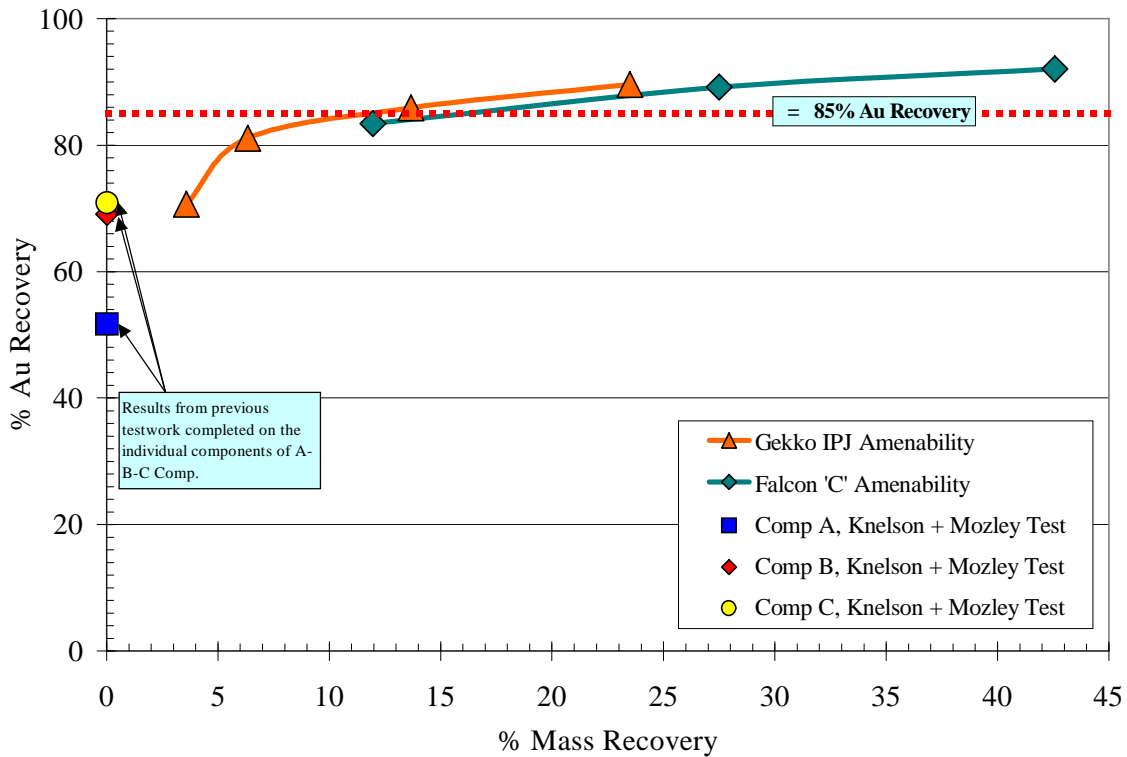
The Falcon C amenability test uses a small quantity of ore ground only once (i.e., to the terminal grind size). The ground charge was passed through a standard Falcon SB4

laboratory separator. The entire concentrate was recovered from the unit and the tailing was reprocessed. This cycle was repeated a total of three times. The three concentrates and the final tailing were weighed and assayed in duplicate for gold content. The results from the Falcon C test are given in Table 4 and are compared to the IPJ amenability test in Figure 3. Gravity separation results from the previous phase of testing are included for comparison.

Table 4. Falcon C Amenity Test Results

Product	Weight %	Assays Au, g/t (Avg.)	% Au Distribution
Concentrate 1	12.0	97.5	83.4
Concentrate 1 - 2	27.5	45.3	89.1
Concentrate 1 - 3	42.6	30.2	92.0
Falcon Tailing	57.4	1.94	8.0
Head (calc.)	100.0	14.0	100.0

Figure 3. Mass versus Gold Recovery IPJ and Falcon C Tests



Comparing the IPJ and Falcon C test results does not indicate a fundamental difference in the nature of the gold recovered. Specifically, it does not appear that very fine gold or gold

in association with sulphide ore components has been recovered to a significantly higher degree in the Falcon C test. The mass versus recovery curves, plotted in Figure 2, are virtually the same and essentially overlay each other. The slight apparent differences in the curves are likely more due to differences in the individual calculated heads than any physical factor.

2.1.3 Gravity Recoverable Gold Test

As recommended following the previous test program, a full gravity recoverable gold (GRG) test was conducted to generate data for full scale circuit modelling. The Knelson test protocol was applied and all test data and tabulated results were forwarded to Knelson as well as to Foran Mining. The data modelling and interpretation was completed by Knelson. Their report was issued directly to Foran Mining and is therefore not included in this document. The test procedure is described as follows:

In stage 1, 20 kg of -20 mesh Comp A-B-C was passed through the Knelson concentrator, collecting a concentrate and tailings sample. The Knelson concentrate and tailing samples were filtered and submitted for size-fractional Au analysis. The remainder of the tail was decanted to ~65% solids, split into two equal parts and each half ground in a 10 kg ball mill for 4 minutes. For stage 2, the gravity separation, sampling, and size fractional assaying procedure was repeated. Stage 2 Knelson tail was split into two equal parts and each part ground at ~65% solids in the 10 kg ball mill for 45 minutes. Stage 3 gravity separation was performed as per the above stages repeating the gravity separation, sampling, and size fractional assaying procedure.

The summarized results from the GRG test are given in the following table and figures. The complete test data sheets are contained in the details of tests section of this report.

Table 5. Summarized GRG Test Results

Grind Size	Product	Mass %	Assay Au, g/t	% Au Distribution
P ₈₀ = 536µm	Stage 1 Concentrate	0.47	1,771	61.0
P ₈₀ = 354µm	Stage 2 Concentrate	0.48	357	12.6
P ₈₀ = 74µm	Stage 3 Concentrate	0.47	312	10.7
	Final Tailing	96.8	2.13	15.1
	Total (Head)	100	13.7	100
	Combined Knelson Conc.	1.42	809	84.3

Figure 4. GRG Test Results, Stage by Stage Au Recovery

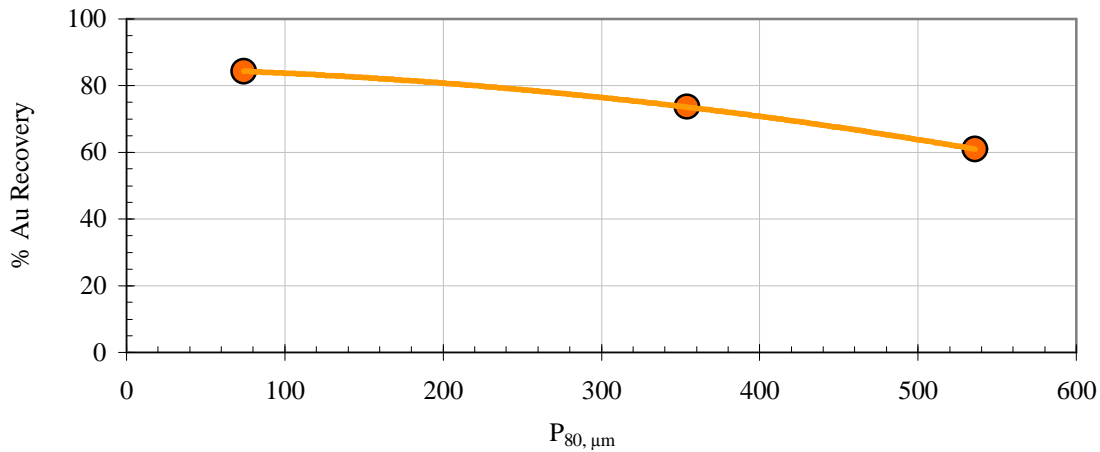
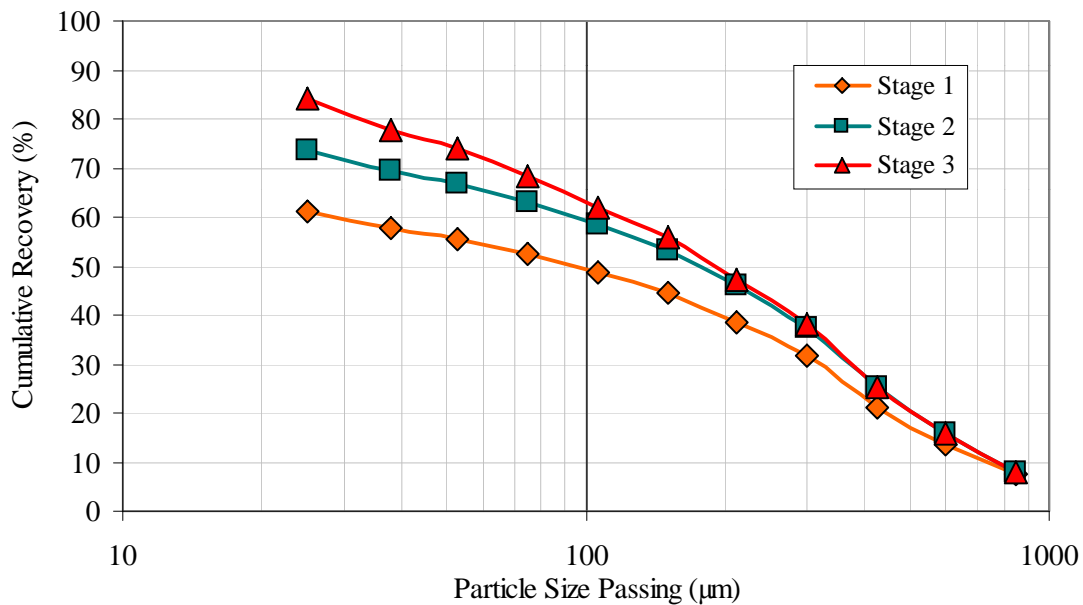


Figure 5. GRG Test Results, Au Particle Size versus Stage Recovery



As expected, based on all previous test data, the results indicated that the sample was highly amenable to gold recovery by gravity separation. A GRG value of 84.3% would likely be among the higher values in the Knelson database. The flat curve shown in Figure 4 indicates that a very high proportion of the gravity recoverable gold present is quite coarse and is therefore recoverable with relatively coarse grinding. Note that the tailing gold grade, at 2.13 g/t Au, is similar to the grades generated in the previous IPJ and Falcon C tests.

Based on the data presented in the Knelson report to Foran Mining and the Gekko and Falcon C tests, the following general comments and comparisons may be made:

1. With a GRG number of 84.3% at a grind of (P_{80}) 74 μ m, the North Star material is considered to be highly amenable to gold recovery by gravity separation.
2. Coarsening the grind to (P_{80}) 200 μ m, would result in a slight downward shift in the GRG value, to ~81%. The implication of this slight reduction is that the majority of the gold is quite coarse and easily won via gravity separation.
3. Based on a comparison of the various gravity recovery methods tested as part of this program, relatively high recovery should be expected regardless of the method/equipment applied.
4. Both the Gekko IPJ and Falcon C concentrators would yield a relatively low grade – high mass concentrate compared to the batch type Knelson unit.
5. Gold recovery by the Knelson would likely be in the 70-80% range (depending on a number of specific parameters and the actual circuit configuration). This would likely be slightly lower than would be achieved via the Gekko or Falcon units. The mass requiring further processing however would be far less than 0.5% of the Mill feed. At a feed rate of approximately 250 tpd, less than 1 t of concentrate would require additional processing.
6. To achieve a similar gold recovery approximately 5% mass would be required to be recovered by the Gekko IPJ. Based on a comparison of the mass versus recovery curves generated from the Gekko and Falcon data (Figure 3), it is likely that a similar mass would be generated by the Falcon C. At a feed rate of approximately 250 tpd, more than 12 t of concentrate would require further processing.

2.2 Intensive Cyanidation

Tests were completed on the concentrate generated from the Gekko IPJ test, in order to evaluate the amenability of the material to the Gekko Systems InLine Leach Reactor. The procedure was provided by Gekko Systems. The concentrate tested was a proportionally reconstituted blend of Super Conc + Conc 1 and Conc 2. The test conditions applied were as follows:

Pulp Density	=	10% solids (w/w)
Pulp pH	=	10.5 – 11 (maintained with lime)
Cyanide Concentration	=	20 g/L NaCN (maintained)
Dissolved Oxygen	=	+20 mg/L (maintained with oxygen and/or peroxide)
Retention Time	=	24 hours

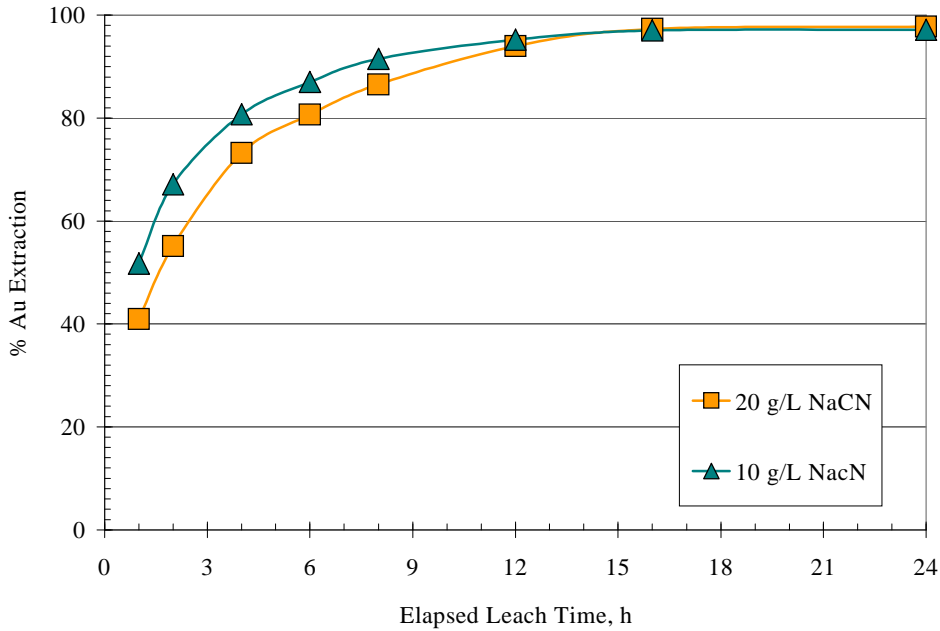
The pregnant leach solution was sub-sampled and assayed for gold after 1, 2, 4, 6, 8, 12, 16 and 24 hours. All final test products were assayed for gold. A second test was conducted with the cyanide level reduced by half.

The results from these tests are given in Table 6.

Table 6. Intensive Cyanide Leach Test Results

Test No.	NaCN		Reagent Consumption		% Au Extraction (hours)								Residue Au, g/t	Head Calc. Au, g/t
	Added kg/t	Maintained g/L	kg/t of CN Feed NaCN	CaO	1	2	4	6	8	12	16	24		
GK(ILR)-2	220	20	33.1	0.00	41	55	73	81	87	94	97	97.8	1.64	73.4
GK(ILR)-3	122	10	28.5	0.00	52	67	81	87	92	95	97	97.2	2.15	77.0

The kinetic extraction data are plotted in Figure 6

Figure 6. Intensive Cyanide Leach Kinetics

The ultimate gold extraction in both cases was very high, ranging from 97.2% at 10 g/L NaCN to 97.8% at 20 g/L NaCN. These recovery rates are typical of those achieved by this process. The slightly slower leach kinetics in the 20 g/L test (GK(ILR)-2) may have been the result of lower oxygen content in the leach solution during the early part of that test. Based on a gold recovery of 85.9% in the gravity separation stage (IPJ amenability test), the overall gold recovery from the ore was 83.5% in the 10 g/L NaCN test and 84.0% in the 20 g/L test.

The approximately 5 kg/t lower cyanide consumption observed in the 10g/L test equates to approximately 0.5 kg/t NaCN based on the whole ore.

3 Conclusions and Recommendations

- The composite sample responded predictably well to the three gravity separation unit processes tested.
- If a continuous discharge unit such as a Gekko IPJ, Falcon C or Knelson's CVD were applied, it is likely that gold recoveries in the 80-85% range would be achieved in a mass representing 10-15% of the total mill feed mass, assuming a grind target of ~75m (P₈₀). *Note that the Knelson CVD unit was not tested within the scope of this program.*
- The balance of the gold, likely in association with fine sulphides, would report to the tailing stream.
- The 10-15% mass would require further processing by intensive cyanidation (e.g., Gekko's ILR or Knelson's Acacia Reactor).
- Intensive cyanide leaching of the concentrates generated in this test program yielded impressive results, with 98% gold extraction being achieved applying Gekko's standard amenability test conditions (Table 3).
- Overall gold recovery from the ore applying a continuous discharge gravity process coupled with an intensive cyanide leach reactor, would therefore be ~84%, considering the gravity recovery achieved in the IPJ amenability test reported in Table 3.
- Applying a batch type gravity recovery unit such as a Knelson concentrator or a Falcon Superbowl would likely result in gold recovery as indicated in the Knelson report to Foran Mining. Approximately 70-80% gold recovery would likely be achieved, depending on several circuit specific parameters, as defined in the Knelson report.

- The batch unit mass recovery would likely be at least an order of magnitude smaller than the mass generated by the continuous discharge units. The intensive leach reactor requirements would be significantly lessened as a result.

Any of the gravity circuits evaluated would recover a significant proportion of the gold content from this ore. It is the author's opinion, that cyanide leaching the entire gravity tailing from the batch Knelson (or Falcon) circuit is likely the optimum "metallurgical" option if a significant proportion of the sulphide hosted gold, lost to the gravity tailing, is to be recovered.

As an alternative, and in many respects a more suitable alternative, batch gravity separation followed by gravity tailing flotation, would achieve an overall gold recovery only marginally lower than the gravity + cyanidation circuit. Based on the previous phase of testing, the gravity + cyanidation circuit recovered 97% of the gold while the gravity + flotation circuit recovered 96%. Subsequent treatment of the flotation concentrate, by intensive cyanide leaching, would likely result in very slight overall gold losses (probably <0.5%). It is anticipated that the combined overall recovery from such a scenario would exceed 95% (refer to Table i, Executive Summary).

The decision as to which processing route is to be selected is, of course, an economic one. The plant design should take into account the additional costs (capitol and operating) inherent in the inclusion of a flotation circuit.

Details of Tests