

812165

82-E-3

ARCTIC GOLD & SILVER MINES LTD
MICROBIOLOGICAL LEACHING TESTS

THE OLD NICK NICKEL MINERALIZATION
BRIDESVILLE, BRITISH COLUMBIA

ARCTIC GOLD & SILVER MINES LTD.

MICROBIOLOGICAL LEACHING TESTS

ON

THE OLD NICK NICKEL MINERALIZATION

BRIDESVILLE, BRITISH COLUMBIA

by

John S. Vincent, M.Sc., F.G.A.C.,
Vancouver, British Columbia.

APRIL 6th, 1970.

TABLE OF CONTENTS

	<u>Page No.</u>
INTRODUCTION	1
SUMMARY AND CONCLUSIONS	2
SUMMARY AND SIGNIFICANCE OF INITIAL STUDIES	3
British Columbia Research Council Seymour Laboratory Ltd.	
RECOMMENDED TEST PROGRAM	4
Laboratory	
Field Pilot Test	
Drilling and blasting	
Excavation	
Drainage and aeration	
Aeration System	
Pumping and Sprinkler System	
COST ESTIMATE SUMMARY	9
Field Pilot Test	
Laboratory	
Total	
ILLUSTRATIONS	Following Page
Figure 1	6
Figure 2	6
CERTIFICATE	
APPENDIX	
References	

INTRODUCTION

Recent exploration work on the Old Nick Property of Arctic Gold and Silver Mines Ltd., at Bridesville, British Columbia, has indicated nickel mineralization grading 0.20 % to 0.25 % nickel in an altered quartzite band approximately 2600 feet long and 400 feet wide. The fine intergrowth of pentlandite, pyrrhotite, and pyrite is not conducive to economic recovery using conventional metallurgical processes, and the conclusion was reached that;

"Under the present economic conditions, further exploitation of the nickeliferous mineralization occurring in the Bridesville area is not feasible." *

Since that time, Mr. Egil Livgard, of Arctic Gold and Silver Mines Ltd., has investigated and studied the application of bacterial leaching and the possibility of applying these techniques to the Old Nick nickel mineralization. Samples have undergone extensive preliminary testing at the British Columbia Research Council Laboratories to establish the leachability of the material. Results have been encouraging, and more advanced stages of testing have been recommended. Bacterial leaching techniques introduce a new set of economic conditions which warrant study and consideration.

In view of the favourable test results to date, it is the purpose of this report to compile and present the work completed in the initial study, and outline the next stages in the testing program as recommended by the B.C. Research Council. All laboratory work will be carried out at the Council's facilities, and field testing will be done under their supervision.

* Newmont Mining Corporation of Can. Ltd., 1967-68

An appendix has been included to provide the interested reader with copies of the reports from B.C. Research and Seymour Laboratory Ltd.

SUMMARY AND RECOMMENDATIONS

Results of preliminary shake-flask tests on finely ground samples of nickel mineralization from the Old Nick Property show that microbiological leaching is a potential means of recovering the nickel. More advanced testing is warranted to evaluate the economic feasibility of leaching.

The program recommended by B.C. Research consists of column testing on various size fractions of the mineralized material, followed by a field pilot test to study the process on the property.

SUMMARY AND SIGNIFICANCE OF INITIAL STUDIES

British Columbia Research Council

Preliminary studies in the form of shake-flask tests on finely ground material were designed to assess the leachability of the mineralization quickly and economically. The results indicate that microbiological leaching is a potential means of recovery for the nickel(1).

Three samples were chosen to represent the mineralized rock types underlying the property. The nickel grade is not significant as this was not a consideration in their selection. The rock types tested were:

- 1) Meta sediment
 - a) grade 0.13% nickel
 - b) 75% recovery in 66 hours
 - c) an acid producer
- 2) Quartzite
 - a) grade 0.09% nickel
 - b) 99% recovery in 66 hours
 - c) an acid producer
- 3) Basic intrusive
 - a) grade 0.20% nickel
 - b) 73% recovery in 66 hours
 - c) an acid consumer

On the basis of these results the Council recommends that further testing is warranted to determine the economic feasibility of leaching larger mineralized fragments(1).

Preliminary microbiological leaching tests on a concentrate made from the same material showed excellent leachability. At present, however, the concentrate grade is too low to allow an economic rate of recovery, and further metallurgical studies will be required to assess the feasibility of up-grading it.

Seymour Laboratory Ltd.

Mr. G.A. Ekins, Research Metallurgist, has reviewed the results to date on flotation tests carried out on finely ground samples of the mineralization under consideration. A bulk float and a pyrite depressing float have been produced, but a bulk float followed by a pyrite depressing cleaner float has not been evaluated. Mr. Ekins suggests that most of the gangue material could be cleaned out of the pyrite depressing float and the resulting concentrate would be considerably up-graded(2).

RECOMMENDED TEST PROGRAM

Laboratory

To further assess the feasibility of producing a higher grade concentrate Seymour Laboratory Ltd. has recommended that a limited bench test program be carried out as follows (2,3):

- 1) Produce a bulk float to obtain a maximum recovery.
- 2) Produce a cleaner float to reject the gangue material.
- 3) Study a pyrite-depressing stage to separate bulk concentrate into two products.
- 4) Initiate a smelter evaluation and a bacterial leach test on the higher grade product.
- 5) Initiate bacterial leaching tests on the pyrite product.

The cost given for this laboratory work was estimated at \$800.00.

In addition to the laboratory studies on concentrating the material, Ekins also recommended a pilot scale test on the property to study the results of the leaching process on the broken ore under field conditions.

The recommendations of the Research Council include extensive laboratory testing, and a pilot leaching operation in the field (1).

The next stage in the lab. program consists of column leaching tests to study the effect and reaction rates of the process on various sizes of mineralized fragments. The reader is referred to the appendix and the copy of the B.C. Research report for the detailed outline of these recommendations (1). In general, 3 columns will be required to study leachability on a -2 inch, 4 inch, and 6 inch size fraction. Duplicate columns are set up so that certain variables can be adjusted and the resulting effects measured against the standard or fixed column. Approximately 100 lbs. of material is required for each column, so a total of 600 lbs. will be supplied for this phase of the program.

When the column testing studies are completed the results can be correlated with the shake-flask tests and applied to samples from other areas and depths within the deposit.

The cost estimate provided by B.C. Research for the lab. work was given at \$ 7200.00.

Following discussions with B.C. Research Personnel it was agreed that the pilot leaching operation at the property could operate concurrently with the column tests. The work would be done under the direction of the Council, and results of the column tests could be applied to the field study as warranted. An element of risk must be recognized in undertaking the field pilot test and column test concurrently in that if the latter is unsuccessful the pilot test will be superfluous. However, from a practical point of view considerable time can be saved by telescoping the field and lab studies. The overall test program could be shortened by 12 months with proper initiation and coordination of the two test phases.

B.C. Research has carried out preliminary tests on a low grade concentrate. The major operating expense to be considered here is oxygen consumption, and a series of experiments is recommended to determine the

requirements (1). A cost estimate of \$2600.00 has been submitted.

To summarize, Seymour Laboratory Ltd. has recommended a bench testing program directed towards producing an up-graded nickel concentrate which would then undergo microbiological leach tests.

The British Columbia Research Council has recommended column leaching studies on various size fractions to assess the economic feasibility of leaching broken rock. A field pilot test will be required to study the process on the property and obtain firm data on the feasibility of in-place leaching.

Cost Estimate:

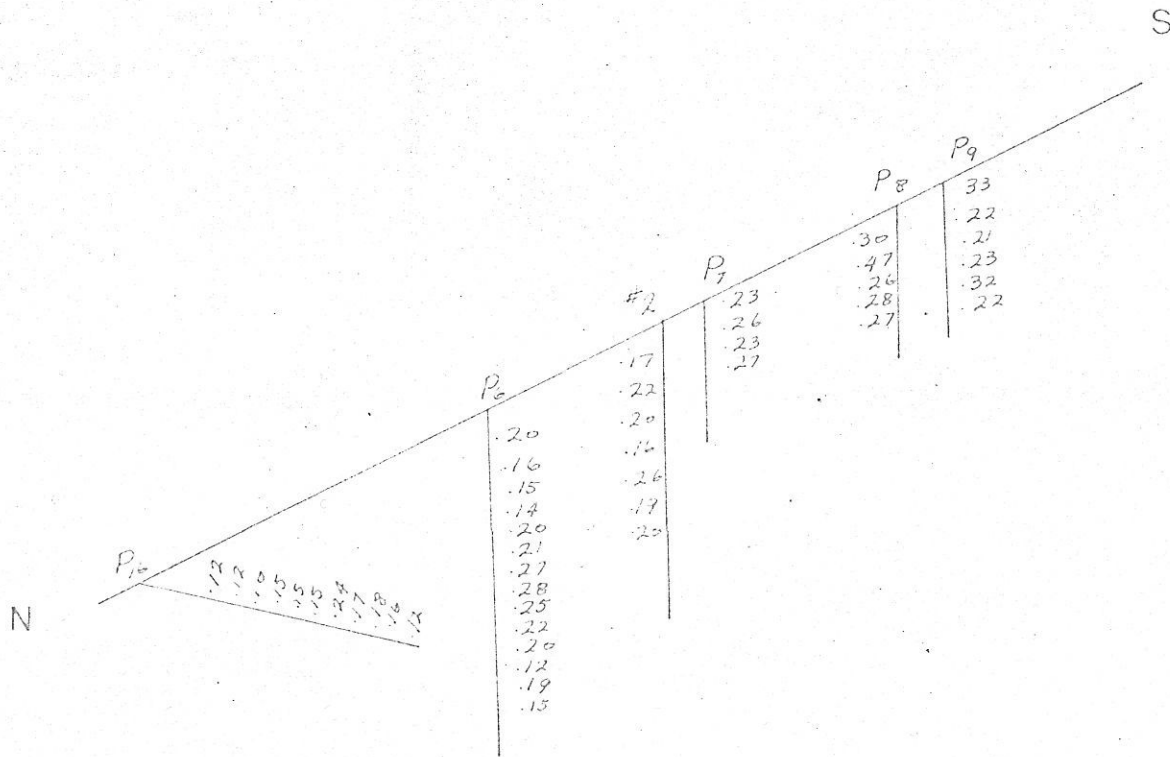
1) Metallurgical bench testing	\$ 800.00
2) Column leaching tests	5700.00
(Shake-flask tests, 4 @ \$300.00)	1200.00
3) Oxygen consumption tests	2000.00
Contingencies @ 10%	970.00
Total (Lab.)	<u>\$10,670.00</u>

Field Pilot Test

The field pilot test site has been located to include bedrock representative of the mineralized material under study. Section 1200 E has had sufficient drilling to provide a reliable indication of continuity and grade of mineralization (Figure 1). Figure 2 illustrates a suggested location and orientation for the test.

It is recommended that the pilot test area have the configuration of a trench 100 feet by 40 feet by 20 feet deep. The long dimension should lie across the strike and be oriented "downhill" as much as possible to facilitate drainage of the pregnant solutions.

Drilling and blasting will be required, and fragmentation to a 4 to 6 inch size will be imperative. The broken material must then be excavated



J.S.VINCENT ——— CONSULTANT

ARCTIC GOLD & SILVER MINES LTD.

OLD NICK PROP.

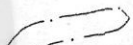
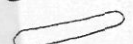
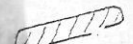
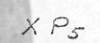
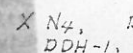
SECTION 1200 E

SC. 1" = 100'

MARCH, 1970

FIG. 1.



-  Geochemical anomaly; 140 ppm + Ni
-  Trench
-  Proposed trench
-  XP₅ Percussion hole
-  XN₄, BH₃, DDH-1 Diamond drill holes

J.S. VINCENT — CONSULTANT		
ARCTIC GOLD & SILVER MINES LTD.		
OLD NICK PROP.		
TRENCH & DRILL SITE LOCATIONS		
SC. 1" = 200'	MARCH, 1970	FIG. 2

and the bottom of the trench sealed to minimize the loss of the solutions through seepage. In order to supply the necessary oxygen to sustain the bacterial processes the Council has suggested the installation of 6 inch perforated pipe on the bottom of the trench. A forced air system would be required initially but as the reaction progresses, and heat is generated, sufficient oxygen should be available through natural convection. The walls of the trench should assist the overall reaction in that much of the heat generated by the process will be retained.

At the lower end of the trench a sump will be required to catch the draining solutions and facilitate sampling and re-circulation.

At present, the design and construction of the field pilot test is under discussion with S.C. Research Personnel. The following preliminary outline is presented to provide the reader with an idea of what is involved, and an estimated cost of establishing the project.

1) Drilling and Blasting:

When the final size and configuration of the test has been established Dupont and C.I.L. will be asked to provide technical assistance in determining drilling and powder requirements to achieve 4 to 6 inch fragmentation.

Cost estimate (Preliminary) \$ 10,000.00

2) Excavation:

Following blasting the material will be removed, the bottom of the excavation sealed, and aeration pipes installed. A quantity of the blasted material will be taken for the previously outlined laboratory test programs.

Cost estimate; 200 hrs. @ \$25.00 \$ 5,000.00
(Model 977 track loader with a 2 yd. bucket
and ripper--Personal comm. with Mr. Edwards
of Finning Cat.)

The 200 hours estimated includes the replacement of the muck after the bottom work has been completed.

3) Drainage and Aeration:

Following excavation the bottom will be "evened up" with gravel and 2 layers of 10 ml. poly sheeting layed down across the trench. The sheets should lap on the down-grade side at least 1 foot. (Another method of sealing the bottom which should be considered would be with roofing tar.)

To provide the aeration requirements 6 inch perforated pipe would be placed on the poly sheeting at 5 foot centers. A further 12 to 18 inches of gravel would then be required to protect the pipe.

Cost estimate;

a) Gravel; pit run 200 yds @ \$1.00	\$ 200.00
b) Poly Sheeting; 15 x 100 ft. rolls, 8 rolls @ \$25.00	200.00
c) Pipe; 6 inch perforated No-Co-Rade 1000 ft. @ \$1.00	<u>1000.00</u>
	\$ 1400.00

(Pers. comm. with Mr. Ried of Deeks-Lafarge)

4) Aeration System:

When oxygen requirements have been established a suitable blower will be required.

Cost estimate (Preliminary) \$500.00

5) Pumping and Sprinkler System:

A circulation pump and sprinkler system will be required to circulate and re-apply the solutions. Further studies are required at B.C. Research to establish the volumes of solution and the timing cycle which will apply the solution.

Cost estimate (Preliminary) \$2000.00

COST ESTIMATE SUMMARY

I Field Pilot Test

Drilling and Blasting	\$ 10,000.00
Excavation	5,000.00
Drainage and Aeration	1,400.00
Aeration System	500.00
Pumping and Sprinkler Systems	2,000.00
Labour estimated at 1600 man hours, \$2.50 / hr.	4,000.00
Contingencies @ 15%	<u>3,735.00</u>
	\$ 26,635.00

II Laboratory Testing

B.C. Research consulting services	<u>2,000.00</u>
-----------------------------------	-----------------

Total Estimate \$ 39,305.00

No cost allowance has been made in the above estimate for road building, power line installation, or construction of any buildings which may be required.

Respectfully submitted,

John S. Vincent

John S. Vincent, M.Sc., F.G.A.C.,
Vancouver, B.C.

CERTIFICATE

April 6th, 1970.

I, John S. Vincent, with business and residential addresses in Vancouver, British Columbia, do hereby certify that:

1. I am a consulting mining geologist.
2. I am a graduate of Queen's University, B.Sc., 1959, Geological Sciences, and of McGill University, M.Sc., 1962, Economic Geology.
3. I am a Fellow of the Geological Association of Canada, and I have applied for registration in the Association of Professional Engineers of the Province of British Columbia.
4. From 1962 until 1969, I was engaged as a mine exploration geologist with the International Nickel Co. of Canada Ltd. in Thompson, Manitoba.
5. I have not received, nor do I expect to receive any interest, directly or indirectly, in the properties or securities of Arctic Gold & Silver Mines, or of any associated company.

Respectfully submitted,



John S. Vincent, M.Sc., F.G.A.C.,
Vancouver, B.C.

CERTIFICATE

I, John S. Vincent, of 4859 - 12A Avenue, Delta, in the Province of British Columbia, do hereby certify that:

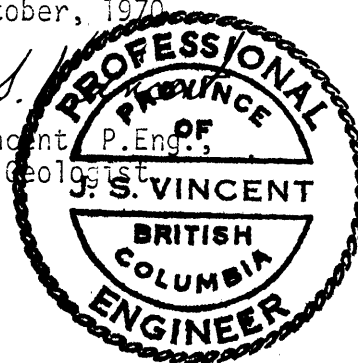
1. I am a consulting geologist.
2. I am a graduate of Queen's University, B.Sc. 1959, Geological Sciences and of McGill University, M.Sc. 1962, Economic Geology.
3. I am a Fellow of the Geological Association of Canada, and a member of the Association of Professional Engineers, in the Province of British Columbia.
4. From 1962 until 1969 I was engaged as a mine exploration geologist with the International Nickel Company of Canada Ltd. in Thompson, Manitoba, and since 1969 I have practised my profession as a consulting mining geologist.
5. I have not directly or indirectly received nor do I expect to receive any interest, direct or indirect, in the property of Arctic Gold & Silver Mines Ltd. or of any affiliate company.
6. The following report relating to the Old Nick Property is based on information made available to me from geological reports and maps in the files of Arctic Gold & Silver Mines Ltd., and from Government publications.

Dated at Vancouver, B.C. this

30th

day of October, 1970

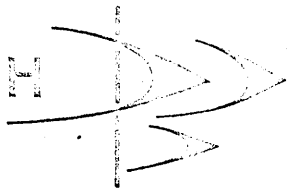
John S.
John S. Vincent, P.Eng.,
Consulting Geologist



REFERENCES

1. B.C. Research, Dr. D.W. Duncan, February 26, 1970.
2. Seymour Laboratory Ltd., Mr. G.A. Ekins, February 19, 1970.
3. Seymour Laboratory Ltd., Mr. G.A. Ekins, February 27, 1970.

B.C. RESEARCH



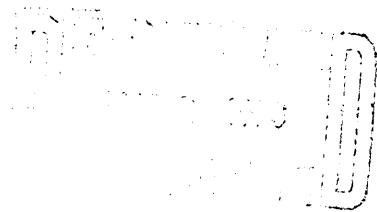
3650 Westbrook Crescent, Vancouver 167, Canada.

Phone (604) 224-4331 • Cable 'RESEARCHBC' • Telex 04-597748

February 26, 1970

Our file: 1310

Mr. Egil Livgard
S & N Mine Management Consultants
1300 Marine Building
355 Burrard Street
Vancouver 1.



Dear Egil:

The results of studies carried out on three samples from the nickel property of Arctic Gold & Silver Mines Ltd., as reported to your company on October 28, 1969, indicated that microbiological leaching was a potential means of treating the mineralization. The initial experiments used finely-ground material and were designed to quickly and economically assess the leachability.

The report recommended column leaching studies using larger sizes of mineralization in order to assess the economic feasibility of leaching. In reply to your request for an outline and cost estimate of such work we propose the following.

1. Column leaching studies should be conducted on drill core or other bulk samples from at least four areas of the deposit. The exact locations to be decided after consultation between B.C. Research and Arctic, taking into consideration other exploration activities. The studies should be in duplicate and so approximately 250-lb samples would be required. The results will provide an estimate of leachability and acid production at the -2" particle size.
2. A large bulk sample (approximately 2000 lb) should be selected from one of the above sites so that duplicate column studies can be run on 4" and 6" material. These results will provide data on the effect of particle size on leachability and acid production and permit an estimation of the blasting requirements.
3. After the correlation between shake-flask and column tests has been established, additional shake-flask studies should be undertaken on samples from other areas and various depths of the deposit to confirm their leachability.

....

February 26, 1970

4. Depending on the results obtained from Items 1 and 2 above, set up a pilot leaching operation on the deposit to develop firm economic data and operating experience.

The cost of Item 1 will be \$4,500. Item 2 will be \$1,500 if done in conjunction with Item 1, \$2,500 if set up later. The cost of Item 3 will depend on the number of samples examined but will range from a high of \$575 for one individual sample down to \$300 per sample for four or more examined at the same time.

As required, the services of B.C. Research will be available to assist on a consulting basis with Item 4. The rate will range from \$65 to \$150 per day plus expenses, depending on the people involved.

Our preliminary microbiological leaching results with a concentrate made from mineralization taken from the same property were reported to you on November 12, 1969. The report showed excellent leachability, but due to the low nickel concentration in the concentrate our economic evaluation of a 100-ton-per-day concentrate leaching system was not encouraging. You felt, however, that for a much larger plant the fixed cost would decrease to such an extent that concentrate leaching would become economically feasible, with the major operating expense being oxygen consumption.

In order to evaluate this process it will be necessary to determine the oxygen consumption of the nickel and iron sulfides. This consumption is a function of the horsepower input, bacterial activity and percentage of solids in suspension. We recommend that a series of experiments be designed to determine optimum horsepower requirement and the rate of oxygen consumption. For these experiments we would require approximately 20 lb of concentrate and would expect the cost of such a study to be about \$2,000.

The above experiments will firmly establish the commercial feasibility of leaching the ore and/or the concentrate from the Arctic property. We look forward to being of service to you again in the near future.

Yours very truly,

B. C. RESEARCH



D. W. Duncan
Group Leader, Mineral Microbiology
Division of Applied Biology

DWD:l

C.M.

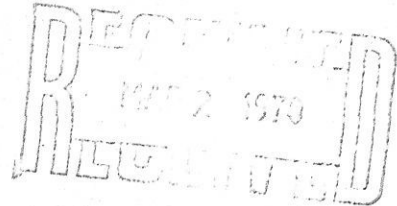
SEYMOUR LABORATORY LTD.
147 RIVERSIDE DRIVE, NORTH VANCOUVER, B.C., CANADA
TELEPHONE (604) 929-2228

February 27, 1970
Dict. Feb. 23/70.

TO: S & N Management Consultants
355 Burrard Street
Vancouver 1, B.C.

ATTN: Egil Livgard

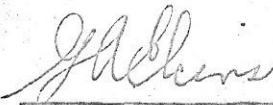
FROM: G.A. Ekins, Seymour Laboratory Ltd.



SUBJECT: Summary of my letters of January 16th, and February 16, 1970 - re "Old Nick" property.

Recommendations:

- 1 - That a pilot scale test be conducted on the property to determine the nickel recovery that could be expected from bacterial leaching of the broken ore. If this phase is successful then it should be followed by laboratory testing to determine the most economical way to recover the nickel from solution.
- 2 - That a limited bench test program be carried out to determine -
 - (a) If overall recovery can be improved.
 - (b) If the concentrate could be split into a high grade product and a lower grade high pyrite product, which then could be processed separately.


G.A. Ekins, B.Sc.

GAE/mv

SEYMOUR LABORATORY LTD.

147 RIVERSIDE DRIVE, NORTH VANCOUVER, B.C., CANADA

TELEPHONE (604) 929-2228

February 19, 1970
Dict. Feb. 16/70

To: S & N Managment Consultants
355 Burrard Street
VANCOUVER 1, B.C.

Attn: Egil Livgard

From: G.A. Ekins, Seymour Laboratory Ltd.

Subject: "Old Nick" Property

Further to our recent discussion and a second look at the flotation test work that has been done:

1 - Bulk floats and pyrite depressing floats were carried out, but apparently a bulk float followed by a pyrite depressing cleaner float was not done. It is reasonable to assume that this could be done fairly simply and you would expect to produce two products similar to (b) and (c) in the calculated table below:

	<u>Concentrate</u>	<u>% Wt</u>	<u>% Ni</u>	<u>% Ni Rec'y</u>
(a)	Bulk Float	20.0	0.61	75
(b)	Pyrite depressing float	8.0	1.0	50
(c)	"Theoretical" Pyrite Conc't	12.0	0.33	25

Assuming that most of the gangue could be cleaned out of conc't (b) you could possibly make a conc't of 4% Wt. and 2.0% Ni or maybe even better. This concentrate could then be given a standard treatment or a quick bacterial leach for extraction of nickel. Concentrate (c) then could be bacterial heap leached.

Recommendation:

That a limited bench test program be carried out to follow the above discussion through, i.e:

- (a) A bulk float to obtain maximum recovery.
- (b) A cleaner float to reject gangue.

Page #2 of 2
February 19, 1970

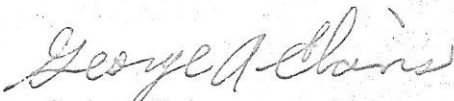
To: S & N Managment Consultants (Cont'd.)

- (c) A pyrite depressing stage to separate bulk conc't into two products.
- (d) A smelter evaluation and a bacterial leach test on the high grade product.
- (e) A bacterial leach test on the pyrite product.

Cost of the bench test work to produce the two products for further evaluation would be approximately eight hundred dollars (\$800.00) -

Yours truly,

SEYMOUR LABORATORY LTD.


G.A. Ekins

GAE/mv
Encl. (1)