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VANGORDA  
MINES LTD.  
PRELIMINARY  
MINING and COST  
STUDY

*Maps not correct.*

*original taken  
to CAME*

*Lawyer. re Vangorda Court Action*

GENERAL ENGINEERING COMPANY LIMITED  
MONTREAL TORONTO VANCOUVER

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July 2, 1964.

Kerr Addison Mines Limited,  
44 King Street West,  
Toronto 1, Ontario.

Attention: Mr. W. S. Row, President

VANGORDA MINES LTD.  
PRELIMINARY MINING AND COST STUDY

Gentlemen:

In accordance with the instructions received from Mr. Row on April 22 we are pleased to submit our Preliminary Mining and Cost Study on the Vangorda situation.

We have had the advantage of all the information in your Toronto and Vancouver offices. Our senior plant engineer and one of our senior mining engineers visited the property briefly while it was still covered with snow. We also received the results of the preliminary metallurgical investigations on core samples of Vangorda ore carried out by Noranda Mines Ltd.

Our investigations have been largely directed towards a study of the mining problem. They have included a detailed examination of all the available data and the preparation of preliminary ore reserve estimates, of pit development plans and of mining methods.

From the limited metallurgical data available we have made a preliminary evaluation of the possible grades of concentrates and recoveries of metals. This was done largely to ensure that our assumptions in the mining study and cost estimating were valid. It is presented for your information. We have also shown some smelter terms for bulk concentrates which are indicative of the market situation.

This is not a formal feasibility report, our objective having been to arrive at costs for the purpose of negotiation with possible buyers. We



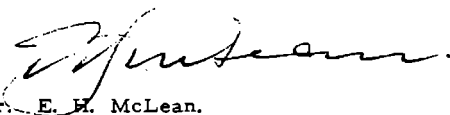
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feel, however, from our investigations, that the economic picture might be improved by:

1. Provision of fresh ore samples for further metallurgical testing and further investigation of selective flotation.
2. Discussion with public and other bodies with a view to obtaining assistance in the provision of services and consequent reduction in capital expenditure.
3. Continued efforts to increase the local ore reserves.

Respectfully submitted,

GENERAL ENGINEERING COMPANY LIMITED.



per. E. H. McLean.



MONTREAL • TORONTO • VANCOUVER

VANGORDA MINES LTD.  
PRELIMINARY MINING AND COST STUDY:

Prepared for

KERR ADDISON MINES LIMITED

by

GENERAL ENGINEERING COMPANY LIMITED

Toronto, Ontario.

July 2, 1964.

## SUMMARY

1. The Vangorda deposit, a series of flat sulphide lenses in metamorphosed sedimentary rocks, is located just north of the Pelly River on Vangorda Creek. It is about 125 air miles northeast of Whitehorse, Y. T.
2. The deposit, near surface, can be mined as an open pit, and a preliminary pit design and mining method have been developed.
3. Some preliminary metallurgical testing has been done by Noranda Mines Ltd. This testing has shown that only a bulk lead-zinc concentrate can be produced. This concentrate, however, appears to be a saleable product as feed for an Imperial Smelter Furnace.
4. Some calculations of the concentrate and ore values have been made on the basis of currently known smelter terms for this type of concentrate and of current metal prices.
5. The factors of location and climate have been considered insofar as they are related to the necessary services which must be provided to develop the Vangorda deposit into an operating mine.
6. Preliminary estimates of capital and operating costs have been worked out on the basis of the currently known data and on the basis of experience elsewhere under related conditions.
7. The following conclusions have been developed in this Preliminary Mining and Cost Study:
  - a. Probable diluted grade of ore:

i. Lead	2.963%
ii. Zinc	4.863%
iii. Copper	0.252%
iv. Silver	1.613 ozs.
v. Gold	0.024 ozs.
  - b. Probable ore reserve 6,200,000 short tons (10% dilution)
  - c. Probable grade and recovery of concentrates:

i. Lead	19% at 80% recovery
ii. Zinc	33% at 85% recovery
iii. Copper	1.4% at 70% recovery
iv. Silver	7 oz. at 70% recovery
v. Gold	0.09 oz. at 60% recovery

- d. Probable value of concentrate f. a. s. receiving port at current metal prices \$63.20 per short dry ton.
- e. Probable value of ore at current metal prices \$4.40 per short ton.
- f. Preliminary estimate of capital necessary to bring the mine into production \$9.7 million.
- g. Preliminary estimate of direct operating costs \$3.60 per short ton.

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## ILLUSTRATIONS - See Back Cover

- A - One Book - 200 ft./in., comprising front page and seven plans.
- B - Plan of Successive Pit Bottom Benches.
- C - Ultimate Pit Plan.
- D - One Book - 100 ft./in., comprising front page and 14 pit vertical cross-sections.

## GENERAL DESCRIPTION

### History

1. The Vangorda Creek sulphide deposit was found in July, 1953 by a prospector, A. Kulan, of Whitehorse, Yukon Territory. E. C. Chisholm of Prospectors Airways Co. Ltd. examined the showing immediately after its discovery and optioned 48 claims around the showing. During the summer, a group of 238 contiguous claims was staked around the original 48 and work was begun in the vicinity of the showing.
2. Extensive work has since been done on the property as follows:
  - a. Geochemical survey.
  - b. Geophysical surveys including, gravity, magnetic, electrical and electromagnetic.
  - c. Diamond drilling, which defined the sulphide body of interest.
3. In addition, a ten mile road was constructed from the Pelly River to the property; an airstrip was constructed at the river and camps were built.

### Location and Access

4. Vangorda Creek is a tributary of the Pelly River and joins it about 36 miles downstream from the Canol Road crossing at Ross River Post.

The property straddles Vangorda Creek seven miles upstream from its confluence with the Pelly. It is located in the Whitehorse Mining Division of the Yukon Territory and is about 125 air miles Northeast of Whitehorse.

5. Access to the property may be gained from Whitehorse by float plane in the summer and ski plane in the winter by landing on a small lake on the south boundary of the claim group about 1-1/2 miles from the camp. Overland routes of some difficulty are also available.

Proposed new road construction would make access easier.

6. No mines are in the area, and it is very sparsely populated. The nearest small settlement is at Ross River post some 35 miles from the property.

### General Geology

7. Outcrop in the area of the deposit consists largely of metamorphosed sedimentary rocks which are now schists and gneisses carrying sericite, graphite, garnet, staurolite and other minerals indicative of intense metamorphism. These rocks have been intruded by granites and gabbros, none of which, however, are found in the vicinity of the sulphide deposit.

8. Regionally, the rocks strike to the northwest and dip about 25° to the southwest. There is some reason, however, for believing that the metasedimentary units form a gentle syncline and that the schistosity in the vicinity of the sulphide deposit is almost horizontal. As planar elements in the cores are reported almost normal to the core length,

and as Kerr Addison reports refer to the sulphide bodies as horizontal, they have been so considered in calculations embodied herein. However, in a few small pieces of core seen in the Toronto offices of Kerr Addison, the planar elements dip at about 30 degrees or as the regional geology.

## II

### MINING

#### The Orebody

1. The main ore zone has been delineated by diamond drilling along a length of 3,000 feet across a general width of 400 feet which bulges to more than 600 feet at the northwest end. The strike of the zone is northwest-southeast.
2. Diamond drill holes spaced at 200 feet centres form a grid pattern on the main zone. In the (1954) initial pattern, 78 holes were drilled vertically to an average depth of 350 feet. Eleven holes were drilled outside the pattern. A later drill program (1955) filled in spacing to 100 feet on alternate cross-sections every 400 feet along the strike length of the main zone with the objective of clarifying the continuity of ore lenses not apparent from drill holes spaced at 200 feet.
3. The main mineralized zone disclosed by drilling is a series of flat lying overlapping lenses of sulphide minerals made up mostly of pyrite with irregular concentrations of galena and sphalerite with some chalcopryrite. The overlying stratum is predominantly sericite schist and the underlying stratum graphite schist. The sulphides appear to be a high temperature replacement of a quartzitic horizon that formerly existed between the two. Remnants of this are present within the ore zone.
4. The main ore minerals are iron-rich sphalerite and galena with minor chalcopryrite. Other minerals are pyrite (very abundant),

arsenopyrite, magnetite, pyrrhotite, marcasite, and very small amounts of tennantite, covellite, and three undetermined minerals, two of which resemble polybasite and cobaltite.

5. Gangue minerals are quartz, actinolite, barite, witherite, celestite, with calcite and other carbonates. The ore is fine-grained, and grinding to minus 100 mesh size is necessary to achieve separation.

6. Lenses of sulphide minerals containing irregular streaks and patches of galena and sphalerite enrichment are best developed in the northwest end of the zone where lenses are thickest and deepest. The best continuous ore intersection is in hole number 10 which is 115 feet thick and bottoms at a depth of 338 feet. Progressing to the southeast mineralized lenses become thinner and lie closer to the surface. It is noticeable that the lead-zinc enrichment of the sulphide lenses forms a layer on the upper parts of the lenses.

### Pit Design

7. All intersections of ore encountered in drilling could not be included within the limits of an economic open pit design. Many were too low grade, or too isolated and deep-seated to warrant consideration.

8. A preliminary trial pit design was based on the premise of mining the deepest and thickest lenses in the northwest portion of the ore zone which contain 64 per cent of the total ore. These lenses were shown in drill holes 10 and 33 to bottom at an elevation of 3,680 feet, about 370 feet below the general surface contour which would form the perimeter

of an open pit. The 3,680 feet elevation was used as the base for the pit, and benches designed upward at a slope of 57 degrees in a series of benches 33.3 feet deep. Rising from the lowest bench the higher benches were extended to include - lenses of ore considered to be within economic limits determined by ratios of waste to ore. The design resolved itself into a pit layout with benches elongating to the southeast to embrace the shallowest lying lenses.

9. A detailed explanation of the step-by-step design of the pit is given in Appendix A of this report along with seven plan illustrations showing surface contours, ledge contours, location of diamond drill holes collars and their nomenclature, three classifications of diamond drill holes, and a pit location sketch.

10. From the pit plans fourteen pit sections have been drawn which are illustrated in a book form in the Appendix to this Report. The cross sections show the pit, the surface contours, and the rock ledge. All relevant drill holes are shown with delineations of waste rock and sulphide ore lenses with their differentiations of ore grade material.

#### Measurement of Pit Material Volumes

11. The areas of each category of material in the pit, overburden, waste rock, total sulphides, ore differentiations and the volumes are recorded on each cross-section of the pit. A summary is given in Table One.

Table OnePit Quantities and Distribution

Overburden	=	4,100,000 cu. yds.	-	38.0%
Waste Rock	=	2,670,000 cu. yds.	-	25.3%
Massive Sulphides	=	<u>3,830,000</u> cu. yds.	-	<u>36.1%</u>
Total		10,600,000 cu. yds.	-	100.0%

Massive sulphide are divided into barren sulphides and ore grade sulphides.

Barren or low grade sulphides	=	1,780,000 cu. yds.	-	46.5%
Ore grade sulphides	=	<u>2,050,000</u> cu. yds.	-	<u>53.5%</u>
Total sulphides	=	3,830,000 cu. yds.	-	100.0%

Ore Reserves

12. Cut-off grade for ore was taken at 4 per cent combined lead and zinc metals. Specific gravity was taken at 3.6 for calculation of ore tonnage. This was given as an average specific gravity by Noranda Mines laboratory. (it is to be noted that Prospectors Airways used a specific gravity of 4.0 in earlier calculations, and that two core samples of typical looking ore measured recently at the University of Toronto showed specific gravities of 4.28 and 4.42 respectively).

13. Areas of ore on each cross-section were checked by planimeter measurements and by calculations of drill hole intersections extended half way to the adjoining drill holes or to the sides of the pit. Volumes

were calculated by extending areas of each section half way to the next section with the end sections, 2 and 14, being extended half way to the pit limits taken to be 50 feet. Dilution of ore was arbitrarily taken to be 10 per cent waste rock at nil grade.

14.

Table TwoSummary of Ore Reserve Calculations

	<u>Calculated</u>	<u>Diluted 10%</u>
Tonnage (short tons)	5,640,000	6,200,000
Grade:		
Lead %	= 3.256	2.963
Zinc %	= 5.344	4.863
Copper %	= 0.277	0.252
Silver, ozs.	= 1.773	1.613
Gold, ozs.	= 0.026	0.024

The tonnage given above corresponds to the tonnage figures recorded on the cross-section diagrams.

Pit Refinement

15. As has been stated, the ultimate pit design used in this study is subject to adjustment in final detail. Some waste sulphides on lower benches may be eliminated and the pit shrunk somewhat as a result. Similarly some upper benches may be extended at the southeast end to mine the sulphide lens indicated in diamond drill hole No. 81. Adjustments, however, will not appreciably affect the basic pit design or the

volumes and calculations of costs as set out. For this reason a refinement of pit design has not been considered necessary for the purposes of this preliminary cost study. .

### Mining Method

16. The pit design is a layout for a standard open-cut benching operation using shovels for loading and trucks for haulage of overburden, waste and ore. Details of equipment to be used will depend on the scale of operations. Benches are designed for a depth of 33.3 feet with rock slopes of 3 to 1 plus a horizontal berm of 25-35 feet at each bench elevation. The finished pit will have a bottom floor at 370 feet below the elevation of 4,050 feet on the road entering the pit. Ramp grade is 8.5 per cent and completed length 4,800 feet. Width of ramp is 55 feet tapering up 40 feet at the pit bottom.

17. Waste material of sericite or graphite schist will be easily distinguishable visually from the sulphide ore and may be broken and loaded separately for haulage to spoil. Sulphides, however, have an assay cut-off which will require a system of grade control guided by drill hole or bench sampling.

### Mining Costs

18. The level of operations is taken as 3,000 tons of ore per day or 1,050,000 tons per year.

19. Preliminary cost figures have been developed by taking average costs for stripping and mining of similar type operations in Canada and applying an increment of 14 per cent to take care of added costs likely to be experienced in the remote location of the project, and a further increment of 6 per cent for contingencies. Costs include all operating expenses properly distributable to the mine, but do not include head office, taxes, or capital write-offs.

20. Basic Costs per Cubic Yard:

<u>For</u>	<u>Overburden</u>	<u>Rock and Sulphides including Ore</u>
Any pit in a not too remote location	\$ 0.42	\$ 1.29
Vangorda location add + 14%	<u>0.06</u>	<u>0.18</u>
Possible minimum cost	0.48	1.47
Contingency + 6%	<u>0.03</u>	<u>0.09</u>
Estimate Used	\$ 0.51	\$ 1.56

21. Total Cost for Pit

	<u>Cu. Yds.</u>	<u>Cost per Cu. Yd.</u>
Overburden	4,100,000 @	\$ 0.51 = \$2,091,000
Waste Rock	2,670,000 @	1.56 = 4,165,000
Sulphides	<u>3,830,000 @</u>	1.56 = <u>5,975,000</u>
Total	10,600,000	\$12,231,000
Cost per ton of ore (6,200,000 tons)	=\$ 1.97	

The estimate for volume of waste rock is subject to some adjustment in further detailed planning for production. The pit may be shrunk somewhat and adjusted to a degree to eliminate waste rock and stripping. It seems possible that a minimum cost of about \$1.75 per ton of ore may be attainable.

III

METALLURGY

Test Work

1. Preliminary metallurgical test work has been carried out by Noranda Mines Ltd. at their laboratories in Noranda, Quebec. To date this testing, as reported to GECO by Kerr Addison and Noranda, has been confined to a series of bench tests done on one composite sample made up from the drill cores of several holes.
2. Initially, attempts were made to produce selective lead and zinc concentrates but with little success both grades and recoveries being unsatisfactory. Representatives of Noranda have verbally advised GECO that in their opinion selective concentrates cannot be produced if the sample received by them is representative of the Vangorda ore. Consequently efforts have been directed toward bulk concentration.
3. The results of this test work by Noranda are presented in Table Three. From this test work the following may be concluded:
  - a. Minimum acceptable grades of concentrate were achieved.
  - b. The indicated recoveries of lead and zinc are comparable with those of bulk concentrates produced elsewhere.

Table Three  
Summary of Bulk Flotation Tests  
Carried out by Noranda Mines, 1964.

Concentrate Assays

<u>Test</u>	<u>Percent Wt.</u>	<u>oz. Au</u>	<u>oz. Ag</u>	<u>% Cu</u>	<u>% Zn</u>	<u>% Pb</u>	<u>% Fe</u>	<u>% Pb+Zn</u>
Pa 71	13.3	.095	7.4	1.08	28.9	20.2	13.7	49.1
72	13.5	.088	7.4	1.30	28.7	20.1	14.3	48.8
73	12.7	.10	7.6	1.36	28.4	21.1	14.1	49.5
74	9.5	.057	6.2	2.10	27.3	27.1	11.6	54.4
75	9.4	.13	9.5	1.38	28.8	26.5	10.3	55.3
76	<u>12.8</u>	<u>.099</u>	<u>7.5</u>	<u>1.60</u>	<u>28.7</u>	<u>19.8</u>	<u>13.7</u>	<u>48.5</u>
Average	11.9	.096	7.5	1.4	28.5	22.0	13.1	50.5

Ore Grade

100	0.02	1.27	0.24	4.0	3.1	-	7.1
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Distribution

<u>Test</u>	<u>% Au</u>	<u>% Ag</u>	<u>% Cu</u>	<u>% Zn</u>	<u>% Pb</u>	<u>% Fe</u>
Pa 71	60.0	71.7	67.7	89.5	90.6	-
72	66.9	80.0	86.2	90.0	89.2	8.4
73	57.6	76.0	73.3	90.0	85.5	7.8
74	58.7	58.7	66.7	64.6	86.5	4.9
75	80.0	68.2	67.6	68.2	83.2	4.3
76	<u>85.0</u>	<u>74.5</u>	<u>77.7</u>	<u>89.5</u>	<u>77.8</u>	<u>7.5</u>
	67.3	73.0	72.3	82.1	85.7	6.6

Table Four  
Details of Test No. Pa 73

Assays

	Wt %	Au oz	Ag oz	Cu%	Pb%	Zn%	Pb+Zn%
4 Cleaner conc	7.5	0.14	10.06	1.91	28.7	33.5	62.1
4 Cleaner tail	3.0	0.04	5.46	0.74	14.4	30.2	
3 Cleaner conc	10.5	0.11	8.74	1.56	24.6	32.5	57.1
3 Cleaner tail	2.2	0.06	2.10	0.41	4.36	9.71	
2 Cleaner conc	12.7	0.10	7.6	1.36	21.1	28.4	49.5
2 Cleaner tail	2.8	0.08	1.42	0.29	2.54	1.96	
1 Cleaner conc	15.5	0.10	6.5	1.17	17.7	23.7	41.4
1 Cleaner tail	23.1	0.01	0.47	0.08	0.51	0.48	
Rougher conc	38.6	0.045	2.88	0.52	7.4	9.8	17.2
Flot tail	61.4	0.008	0.24	0.06	0.42	0.39	
Head	100.0	0.02	1.27	0.24	3.1	4.0	7.1

Distribution Percent

	Au	Ag	Cu	Pb	Zn
4 Cleaner Conc	46.8	59.5	60.6	68.6	62.1
4 Cleaner tail	5.4	12.9	8.9	13.7	22.7
3 Cleaner con	52.2	72.4	69.5	82.3	84.8
3 Cleaner tail	5.4	3.6	3.8	3.2	5.2
2 Cleaner conc	57.6	76.0	73.3	85.5	90.0
2 Cleaner tail	9.8	3.0	3.4	2.3	1.2
1 Cleaner conc	67.4	79.0	76.7	87.8	91.2
1 Cleaner tail	10.3	8.5	7.6	3.8	2.8
Rougher conc	7.8	87.5	84.3	91.6	94.0
Flot tail	22.3	12.5	15.7	8.4	6.0
Head	100.0	100.0	100.0	100.0	100.0

4. Efforts to improve concentrate grades were reported by Noranda. The results of 4 stages of cleaning on Sample No. Pa 73 are reported in Table Four. This test work shows that for a bulk concentrate good grades and acceptable recoveries may be possible with three stages of cleaning. Even at reduced recoveries the significance of this improved concentrate grade shows in the net smelter returns and value of the ore. At current metal prices the No. 2 cleaner concentrate under a typical smelter contract would be valued at \$108. per ton f. a. s. receiving port; under the same terms the No. 3 cleaner concentrate would be valued at \$126. per ton. This in turn, taking into account shipping and handling costs, represents an increase in head values of 74 cents from \$4.33 to \$5.07 per ton in spite of the reduced metal recoveries. (See also IV - Value of Ore and Concentrates.)

5. The indicated recoveries of copper, gold and silver are about what can be expected for this type of concentrate. The copper content of the concentrate is just at the payable level and thus is of marginal value. This, however, would depend somewhat on the terms of the smelter contract. No data is available on the penalty metals, if any, in the ore.

6. Test Nos. 71, 72 and 73 were carried out on fresh ore and gave quite good recoveries and grades, the latter being close to the desirable minimum of 50 per cent combined lead and zinc. Tests Nos. 74, 75 and 76 were done some time later and the earlier results could not be duplicated. This is attributed to the aging of the sample and consequent oxidation of the particle surfaces. Test No. 76 was done at a higher

pH than Nos. 74 and 75 with improved zinc recovery, but with reduced lead recovery.

7. Noranda metallurgists report that pH control may offer some difficulties requiring compromise values to achieve satisfactory recoveries of both lead and zinc.

8. The grade of concentrate, desirably, should be kept above 50 per cent combined lead and zinc. Imperial Smelting type furnaces will accept lower grades and concentrates may be upgraded by blending, but below the 50 per cent level, penalties can generally be expected to be added. Also, below this level, shipping costs, which will be critical at Vangorda, will be increased appreciably.

9. From the limited test work done to date any forecast of probable grades of concentrates and probable metal recoveries must be very preliminary. From the data available and with particular reference to test No. Pa 73 which showed the most promising results, a reasonable metallurgical target for grades and recovery would appear to be:

- a. For a concentrate grade of 52 per cent combined lead and zinc.
- b. For a lead recovery of better than 80 per cent.
- c. For a zinc recovery of better than 85 per cent.

10. Assuming an average grade of ore to be 2.96 per cent lead and 4.86 per cent zinc the above targets would result in a concentrate grade of 19.0 per cent lead and 33.0 per cent zinc. This would give a ratio of concentration of 8:1.

11. This grade of concentrate would be saleable in terms of the total lead and zinc content. The typical contract terms outlined in Appendix B call for a minimum of 20 per cent lead but this could be subject to some negotiation. However, the production of bulk concentrate cannot normally be predicted with such accuracy, and the grade may vary from this average very considerably, yet maintaining the combined percentage above 50. The factors affecting this will be:

- a. Head grade
- b. Mineralogy of the ore
- c. Physical characteristics of the ore
- d. Skill of the mill operators

12. To maintain a reasonably constant concentrate grade, the limits of which will very likely be specified in the smelter contract, considerable flexibility must be available in the milling. This can be achieved as follows:

- a. By good grade control
- b. By provision for blending ore
- c. By flexibility in the mill flow sheet.

13. The Vangorda ore is quite constant in grade and ratio of lead to zinc throughout the ore zone. Thus the amount of blending either in the mine or at the mill head will be limited.

14. In the milling the grade of the concentrate may be adjusted by pulling the maximum amount of lead even at some sacrifice of zinc. This of course will depend on the smelter terms and also on how the

precious metals - gold and silver - will report. Another possibility, that of producing some selective concentrates, as well as a bulk concentrate, might adjust the lead-zinc ratio in the bulk flotation feed to bring the bulk concentrate within an acceptable range. To date, however, the possibilities of producing selective concentrates, as mentioned earlier, have not been encouraging.

#### Flow Sheet and Concentrator

15. Again, the preliminary nature of the metallurgical tests must be emphasized. While work has not proceeded far enough to put forward any sort of flowsheet, some comments on this and the plant layout can be offered.

16. Most significantly the testing has indicated the possibility of only producing bulk concentrates. This would result in a simpler plant layout and lower operating costs but at lower revenues. The differences in cost between a single bulk flotation circuit and a complex selective flotation circuit may be as much as 25 per cent in both capital and operating costs. The increased capital cost would result from the additional equipment required in the flotation, dewatering, drying and concentrate shipping sections.

17. Nothing concrete is available at present regarding the hardness of the ore or the crushing and grinding requirements. From visual examination of some core samples and from the mineralogy as reported

in drill logs crushing and grinding should not present any difficulties. The fineness of grind will be important because it will influence the moisture content of the shipped concentrates. The moisture content must be below the maximum acceptable limits for bulk ocean shipment. It must be at a minimum to hold down shipping costs generally, and it must not be so low as to cause a dusting problem. The shipping distances involved and the necessity of ocean shipping make this a question worth very careful study.

IV

VALUE OF ORE AND CONCENTRATES

1. To determine the ore reserve tonnages in the mine, the value of the ore has been calculated on the basis of assumed market conditions which may be considered typical of the Vangorda situation. This valuation has been based on the assumption that only bulk concentrates will be produced.

Markets

2. Bulk concentrates have a restricted number of market outlets either to Imperial Smelter Furnaces or large custom smelters which can blend limited quantities of bulk concentrates with higher grade concentrates to produce satisfactory feeds for zinc smelters. In spite of this, the demand for bulk concentrates is good. This is largely the result of the higher efficiency of the Imperial Smelter Furnace and their ability to accept and desire to use low cost feed.

3. Now operating throughout the world are five Imperial Smelter Furnaces. A further two are expected to come into operation in 1965 and three more in 1966. The ownership and location of these are shown in Table Five.

4. Of these furnaces, the U.K., French, German and Japanese probably would be potential buyers of concentrates.

Table Five  
Imperial Smelter Furnaces  
Location and Ownership

<u>Company</u>	<u>Location</u>
Imperial Smelting Corporation	U. K. - Avonmouth
Imperial Smelting Corporation	U.K. - Swansea - 1961
Sulphide Corporation	Australia-N. S. W. -Cockle Creek 1961
Rhodesia Broken Hill Development	Northern Rhodesia - Broken Hill - 1962
Societe Miniere et Metallurgique de Penarroya	France - Noyelles - Godault - 1962
Rumania	Copsa Mica (1965)
"Berzelices" Metallhutten G. M. B. H.	Federal German Republic - Duisbeerg - (1965)
Poland	Poland - Miasteczko - (1966)
Sumitomo Metal Mining Company	Japan - Near Kobe (1966)
East Coast Smelting and Chemical Company	Canada - New Brunswick (1966)
AMMI S. P. A.	Italy - (option holder)
Mitsui Mining and Smelting Company	Japan - (option holder)

5. In Appendix B some assumed smelter terms are given in some detail. These may be considered typical of terms for bulk concentrates having been in their original form the basis of negotiations with smelters in Europe.

### Shipping

6. The location of Vangorda Mine remote from tidewater or other North American smelters will result in the costs of transportation overland being the highest single item of cost in the proposed scheme.

7. The first of two possible alternate shipping routes to tidewater would be by truck to Carmacks, Haines Junction and Haines, Alaska. This is not a feasible route because the Haines Road section is not a good all season road. Also, to handle concentrates at Haines might offer some difficulties.

8. Based on the experience of the United Keno Hill Mines near Mayo, the second alternate via Carmacks, the Mayo Road to Whitehorse and then to Skagway by the White Pass and Yukon Railway appears to be the most likely shipping route.

### Value of Concentrates

9. The metallurgical testing to date has only shown the possibility of producing bulk concentrates from the Vangorda ore; therefore only the returns from bulk concentrates have been considered.

10. The returns from bulk concentrates are considerably lower than from selective concentrates. The differences show in the smelter charges and the payments for the metals. For example, payment for lead in selective concentrates is 95 per cent of the analytical lead content compared with 90 per cent in bulk concentrates, for zinc it is 85 per cent compared with 75 per cent.

11. On the other hand, bulk concentrates require less plant with only one product to recover, dewater, dry, store, handle and ship.

12. The values of the bulk concentrates as produced in the bench, testing by Noranda are given in Table Six. The two concentrates are the second and third cleaner concentrates of Test No. Pa 73 which is detailed in Table Three. The calculation of these values are given in detail in Appendix C.

Table Six

Values of Concentrates Compared

	<u>No. 2 Cleaner Conc.</u>		<u>No. 3 Cleaner Conc.</u>	
	<u>Current Prices</u>	<u>Lower Prices</u>	<u>Current Prices</u>	<u>Lower Prices</u>
Lead price per pound	\$ 0.11	\$ 0.10	\$ 0.11	\$ 0.10
Zinc price per pound	0.13	0.105	0.13	0.105
Concentrate value f. a. s. receiving port	\$62.06	\$51.16	\$76.11	\$63.04
Shipping cost	<u>28.00</u>	<u>28.00</u>	<u>28.00</u>	<u>28.00</u>
Net Smelter return at mine	\$34.06	\$23.16	\$48.11	\$35.04
Concentrate ratio as a per cent	13.7%	12.7%	10.5%	10.5%
Value of ore per ton	\$ 4.36	\$ 2.94	\$ 5.05	\$ 3.68

13. From Table Six, the effect of reduced metal prices is very evident. The high fixed charges for shipping would result in a reduced smelter return and a very sharp drop in the value of the ore per ton.

14. The effect of increased concentrate grade is very significant. The combined lead-zinc grade in the No. 3 cleaner concentrate is 57.1 per cent compared with 49.5 per cent for the No. 2 cleaner concentrate, and even at reduced recoveries for both lead (85.5 to 82.3 per cent) and zinc (90.0 to 84.8 per cent) the value of the ore per ton would be increased markedly.

15. It must be noted that the values per ton of ore given in Table Six are not the average value of the Vangorda ore. They are the values for the one composite sample on which metallurgical bench tests were run in Noranda.

#### Value of Ore

16. From the tonnage and grade of the ore calculated in Chapter II of this report and from the results of the metallurgical test work reported in Chapter III a very preliminary prediction of the ore value can be made. The average grades of the diluted ore, and probable grades and recoveries of the concentrate are given in Table Seven. The values given are considered to be minimum values in all cases which should show some improvement with further metallurgical testing.

Table Seven

Summary of Average Ore Grade and

Predicted Concentrate Grades

	<u>Weight</u>	<u>Lead</u>	<u>Zinc</u>	<u>Copper</u>	<u>Silver</u>	<u>Gold</u>
Diluted Ore	100%	2.963%	4.863%	0.252%	1.613 oz.	0.024 oz.
Concentrate grade	12.5%	19%	33%	1.4%	7 oz.	0.09 oz.
Concentrate recovery	-	80%	85%	70%	70%	60%
Current Market Prices		\$0.11	\$0.13	\$0.32	\$1.40	\$37.80

Ratio of Concentration 8:1

17. The value of this average concentrate is calculated below for current market prices.

a. Charges:

i. Basic treatment charge	\$14.00
ii. Lead charge 0.33 (19 - 3)	5.28
iii. Zinc charge 0.95 (33 x 0.75)	23.51
iv. Zinc escalator 1.35 (13 - 9)	<u>5.40</u>
v. Total	\$48.19

b. Refining Charges:

i. Silver 0.02 (7 - 1)	0.12
ii. Gold	0.01
iii. Copper $\frac{1.40 - 1.30}{100} \times 130$	<u>0.13</u>
iv. Total	0.26

c. Payments

i.	Lead - $19.3 \times 2000 \times 0.11$	\$ 35.20
ii.	Zinc - $33 \times 0.75 \times 2000 \times 0.13$	64.35
iii.	Copper - $\frac{1.40 - 1.30}{100} \times 2000 \times 0.32$	0.64
iv.	Silver - $1.40 (7 - 1)$	8.40
v.	Gold $0.09 \times 0.90 \times 37.80$	<u>3.06</u>
vi.	Total	\$111.65
d.	Value of concentrate f. a. s. receiving port	\$ 63.20

18. A total cost of shipping these concentrates to some overseas port has been assumed to be \$28.00 per ton of concentrates. This is an approximate figure which includes all trucking, handling and ocean freight costs. (This is discussed in more detail in VI - COSTS). The resulting value of concentrates at the mine would be \$35.20.

19. The metallurgical testing has indicated a concentration ratio of 8:1 which would give an ore value of \$4.40 per short dry ton.

V

AUXILIARY SERVICES

1. The isolated location of the Vangorda property will require that very careful consideration be given to the various essential services to ensure reliable but still economic facilities. The provision of these services will be largely a responsibility of the mining company although some assistance can reasonably be expected from the responsible government agencies. This latter aspect will be of particular importance and undoubtedly will require a great deal of attention to derive the maximum benefit for all parties concerned.

Electric Power

2. Power from a public utility corporation is not available in the area. Diesel generating units are generally used in such locations. However, in this instance, other means may be feasible.

3. Hydro power is in use at Mayo which is 350 miles north of Whitehorse and 125 air miles northwest of the Vangorda site. In the more immediate region of the mine are three possible hydro electric sites have been investigated by the federal government. No indication has yet been given that any of these will be developed but the presence of a mine or mines in the area may provide the necessary impetus to such a development.

4. At Carmacks a coal deposit is currently being mined on a small scale and Yukon Electric have started a study regarding use of this coal for thermal generation. Such a scheme would very likely place the power plant immediately adjacent to the coal field.
5. Both the hydro power and the thermal power schemes would require transmission lines of some length. Alternately a diesel plant would require trucking of fuel either with a long return haul empty or in specially designed tanks on the concentrate hauling trucks. A further possibility might be a coal burning thermal-electric plant at the mine site fuelled by coal from Carmacks or a deposit on the Pelly River closer to the mine site. This could also be hauled at least in part by the returning concentrate trucks but would not require specially designed tanks.
6. Two important factors regarding the electric power supply must be kept in mind when considering its possible source. These are:
  - a. Hydro power with its associated high capital cost can only be written off over a 30 or 40 year period if competitive power costs are to be achieved. Thus, to be of interest to government as a public utilities development, any hydro project will require some long term prospects either in a single project or in the region served by the power plant.
  - b. Diesel power may offer somewhat higher power unit costs but it will have lower capital costs which may be within the capability of the developing company. On this

basis diesel-generated power is best considered as the most suitable alternate in the initial studies of the Vangorda project.

#### Water Supply

7. The water supply requirements were not evaluated in any detail. Present indications are that the process does not require abnormal quantities and that good supplies of water are available within a reasonable radius of the Vangorda property. The Pelly River is only 5 miles distant and would provide a thoroughly reliable source of water.

8. In the event of transporting water some distance by pipeline, careful consideration to frost conditions, re-cycling, mine water and tailings disposal all of which are related to the unit cost of water supplied to the plant would be essential.

#### Access Roads

9. At present the Vangorda property is not accessible by road. The nearest existing roads are the Canol Road at Ross River some 35 miles to the east, and the Whitehorse-Mayo Road at Carmacks about 100 miles to the west. Both these roads connect to the Northwest Highway to the south.

10. The Canol route being the closest could most readily provide immediate access by a tote road along the north bank of the Pelly River. The Canol Road, however, cannot be maintained easily as a year round

road due to heavy snowfall on two summits rising from 2,400 to 4,000 feet along the route. Further, the road is not built for winter traffic, nor is it built for heavy traffic, an 1,800 foot long bridge at Johnson's Crossing being only good for 10 to 15 ton loads.

11. The Whitehorse-Mayo road is a year-round road now being used continuously by United Keno Hill Mines to transport concentrates to railhead at Whitehorse.

12. The location survey and design for the Ross River - Carmacks Road has been completed by the Department of Northern Affairs and National Resources and the expectations are that construction will start on this road within the next two years. This road, located south of the Pelly River, is an extension of the Watson Lake - Ross River trucking road which is scheduled for completion this year. The Vangorda site being about 20 miles north of this Ross River - Carmacks Road will require a ferry at the Pelly River.

13. The network of existing and proposed roads places Vangorda at approximately 240 miles from Whitehorse by road via Carmacks and about 260 miles via Ross River, and approximately 270 miles from Watson Lake.

14. Existing territorial roads policy indicates that the roads required for the development of the Vangorda site will fall into three distinct categories.

a. Ross River to Vangorda site - tote road:

This will provide immediate access to the property and may be eligible for government assistance of up to two-thirds of the capital cost. Maintenance would be the company responsibility.

b. Ross River - Carmacks Area Development Road:

This will be built on the basis of attractiveness of the resources in the area. The capital costs will be the full responsibility of the territorial government; the company will contribute 15 per cent of the maintenance costs.

c. Mine Access Road:

This final access to the property from Ross River Carmacks Road across the Pelly River will be eligible for government assistance of up to two-thirds of the capital cost. The company will be responsible for all maintenance.

Heating

15. The northern location of the Vangorda site makes the demand and reliability requirements for heating critical. The requirement for heating will be in all production, service and accommodation type buildings. Again the remote location makes the need maximum economy of paramount importance.

16. To some extent the heating requirement will be associated with the power and process requirements because waste heat from the power generating plant may be utilized in either the heating requirements or the concentrate drying. However, waste heat will not satisfy the full peak winter heating demand and a heating plant will be required.

17. The type of fuel for the heating should desirably be the same as for the power generating plant in order to reduce shipping, storing and handling costs.

### Housing

18. The housing requirements at this site will be considerable because of the remote location, and will involve development of a fully integrated townsite either immediately adjacent to the mine or perhaps at Ross River on the Canol Road. This will depend, to some extent, upon government policy with regard to developing company townsites in the territory.

19. The housing requirement will break down into the following three distinct phases.

- a. Construction camp
- b. Initial start-up and operating period
- c. Long term operating period

In the first phase only bunk houses will be required for the exclusively single status construction worker. The second phase will see a few

married personnel particularly in the staff level and the third phase will see a transition to predominately married personnel.

20. Because of the high cost of construction at the site, maximum utilization of facilities should be the objective. With the bunk houses for construction they should be built in such a durable style as to withstand the heavy abuse of the construction group, but yet so designed as to be convertible to firstly operating crew bunkhouses and finally into apartments for married personnel.

21. In addition to bunk houses, a cafeteria will be required immediately and ultimately the townsite will have to develop to include such ammenities as a recreation centre, shopping centre, schools, and churches. The full extent of these will depend upon the type and number of employees, the final location of the townsite, other developments in the area and accessability to the larger centre - Whitehorse. Also, some of the cost burden of these might be relieved by government assistance.

22. A final factor which might influence the extent and type of the housing might be the method of mining the open-pit. If this work is contracted, the responsibility for accom<sup>o</sup>modating the mine crew might be placed with the contractor.

VI

COSTS

1. The location of the Vangorda property some 250 miles from Whitehorse - the nearest supply centre, which itself suffers from high costs because of location - will contribute the most toward increasing capital costs and operating costs. Transportation will add appreciably to the cost of materials and supplies. Also, some premium on wages for the isolated location may add to the labour costs, depending upon the available ammenities at the site and upon the regional labour market.

Capital Costs

2. Cold weather, the length of the winter season, the spring break-up and the winter freeze-up will all impose critical restrictions and they will require careful consideration in the scheduling of the project.

This will be particularly true of the break-up and freeze-up because they each will prevent access to the site for a period of up to one month.

3. Apart from the factors of location which will be uncontrollable, and of weather, the effects of which can be reduced by careful planning, and by the use of modern winter construction methods, the Vangorda site should offer no particularly difficult problems which would increase construction costs. The site is not in an area of permafrost; details of soils and foundation conditions are not available but nothing so far has suggested serious problems in this regard.

4. The cost of cement in the Yukon is an example of the effect of the location factor. In Vancouver it costs \$1.22 per bag; in Whitehorse it costs \$2.92 per bag; and at the Vangorda site it would cost \$3.47 per bag.

5. Basic data required to estimate capital costs of services and production facilities is only available in rough form at this point. It will be subject to considerable refinement as more metallurgical testing is done thus enabling more accurate determination of requirements.

6. The capital costs have been estimated for a plant capacity of 3,000 tons per day this figure having been used to develop the pit layout and the mine costs. Sufficient data is not yet available to determine if this is the optimum capacity. Although the low grade of the ore and the relatively high probable costs due to location suggest a fairly high daily capacity, on this first examination it appears to be of the correct order of magnitude.

7. Because its extent is not known, no allowance has been made for government assistance which may be given, except that the Ross River - Carmacks Road has been assumed to be a government responsibility.

8. A preliminary estimate of capital costs is summarized in Table Eight. These costs were largely based on experience elsewhere, on average unit costs and on requirements for other mines of similar size, all of which were adjusted to suit the conditions which might be encountered at Vangorda. The figures would be subject to considerable adjustment particularly in the light of later policy decisions which may be made by the company to meet any existing conditions.

Table EightPreliminary Estimate of Capital Costs

Roads	\$ 500,000
Construction Buildings	200,000
Administration and Service Buildings	500,000
Service Equipment	250,000
Power, Water and Sewage	1,000,000
Permanent Accomodation	750,000
Mine Equipment	1,500,000
Concentrator	4,000,000
Other	<u>1,000,000</u>
	\$9,700,000

9. Being a preliminary estimate, the costs given tend to be conservative thus some room for reducing the capital costs should exist. Also, the size of the Vangorda deposit does not warrant any elaborate facilities and efforts should be directed towards achieving the minimum possible capital costs commensurate with sound operating practices.

The extent to which capital cost savings can be carried will depend on the method of mining, on the necessary metallurgy and on the policy of the company regarding transportation and housing.

10. The following factors were considered while preparing the estimate:

- a. Roads: Allowance was made for 20 miles of access and service roads including the mine access road across the

Pelly River and service roads in the vicinity of the mine.

No allowance was made for a bridge across the Pelly River but provision was made for obtaining a ferry at some reduced cost from the territorial government.

- b. Construction Buildings: The estimate included for all offices, stores, shops, bunkhouses and cookhouses necessary for the construction phase. It was based on a peak construction force of 200 men.
- c. Administration and Service Buildings: This allowed for office, shop and store facilities with some of the construction buildings being adapted to this use.
- d. Service Equipment: In this item allowance was made for all equipment and accessories for the shops, stores and offices and for administrative transport.
- e. Power, Water and Sewage: The bulk of the cost here was for a power plant including central heating boilers and the estimate was based on a 5000 KW diesel installation. The cost included allowances for all plant, pumps, piping and related buildings.
- f. Permanent Accommodation: Provision for a minimum of family housing was made. No allowance was made for concentrate truckers who will locate in Whitehorse. Because of the indicated short life of the property, a high proportion of single-status employees was assumed. The estimate was based on providing for 100 employees.

g. Mine Equipment: The major items of mine equipment include:

- i. 2 4-1/2 cu. yd. shovels
- ii. 1 2-1/2 cu. yd. shovel
- iii. 8 32 cu. yd. haul units
- iv. 2 rotary drills
- v. 2 600 cfm compressors
- vi. 3 D-8 tractors

This item also included all maintenance vehicles and equipment required in the pit and a powder magazine.

h. Concentrator: Allowance was made for producing only bulk concentrates, thus reducing the flotation, dewatering and drying requirements. No provision was made for concentrate trucks this being assumed to be provided by contract. A modest provision for tailings disposal was also made.

i. Other: Any additional costs such as stores, inventory and spare parts were included here.

11. Further details of current capital costs as applied to Vangorda are given in Appendix D.

#### Operating Costs

12. The operating costs will be influenced by the same external factors of location and climate as the capital costs will be influenced.

13. The shipping of concentrate will be seriously affected by the break-up and freeze periods when crossing the Pelly River will be impossible for up to one month at each period. This will result in some stockpiling and re-handling of concentrates as well as delays in revenues.

14. The cost of shipping concentrates has not been included in the operating costs at the mine but has been included as a charge against the concentrates. In IV - VALUE OF ORE AND CONCENTRATES, an assumed shipping cost of \$28 per short dry ton of concentrates from the mine to the receiving port was used. This cost had been used in earlier calculations and subsequent investigations have shown it to be still valid. The White Pass and Yukon Route have tentatively quoted a rate of \$17 per short ton (wet weight) for shipping concentrates from the mine to the ship at Skagway and including loading. This, however, has some qualifications regarding cold weather handling and moisture content in addition to not mentioning the method of handling, that is, in bulk, or in containers all of which could materially increase the cost. Furthermore, the expected short life of the property will force any contractor to write off quickly any specialty concentrate trucks and this was not considered in detail at the time of the White Pass and Yukon quotation. Assuming ocean shipping costs of \$6 per ton, then, this quotation at \$19 per short dry ton of concentrate (assuming 8% moisture content) allows \$3 leeway between it and the assumed shipping cost of \$28 per short dry ton to cover these qualifications.

15. The operating costs of mining have been estimated in some detail and are discussed in II MINING. Final adjustments to pit planning have not yet been made, and this cost may be reduced by 10% in the final analysis.

16. The operating cost for milling is an approximate figure based on a concentrator producing a single lead-zinc bulk concentrate only. The production of selective concentrates would increase this cost as labour, reagent and maintenance costs would be increased. This might increase the milling costs 25% or more. The costs contain all direct charges including supervision for processing the ore from the run-of-mine bin to the product in the trucks and to the tailings dam.

17. The following labour force will be required to operate the property:

a. Mining	44
b. Milling	34
c. Service and administration	<u>22</u>
Total	100

This includes all supervisory staff but no provision for management.

Table Nine

Preliminary Estimate of Operating Costs

Mining, including stripping	\$1.95 per ton of ore
Milling	1.15
Surface and Services	.15
Administration and general	<u>.35</u>
Total operating cost	\$3.60 per ton of ore

APPENDIX A

The Layout of the Ultimate Pit Plan - 100 feet/inch

1. The Successive Elevation Plan, drawn on a scale of 100 feet/inch, shows elevations and benches determined for the pit. The lowest pit bench elevation is chosen at 3,680 feet elevation at the base of the lower sulphide intersections encountered by holes 10 and 33 at that horizon. Accordingly, a toe (dotted) of oval shape is drawn around these two holes. To the south of hole 10, not too much ground should be taken in, because if the toe is extended too far from the hole in this direction, the ultimate wall of the pit, raised from this location to surface, would entail too much waste. A crest line (plain) surrounds this toe at 3,700 elevation.

2. From this elevation, upward, the succession of bench elevations have been taken at 33.3 feet vertical intervals as a convenient choice to match the even elevations at 3800; 3900; 4000.

3. The next hole considered is number 115. Its sulphide intersection bottoms at 3,700. The surrounding toe drawn around it on the north side must be taken very close to this hole at the risk of leaving some ore. Here, again, the pit wall to be raised to surface will affect the shape of a 90° hemicycle rising against a steep hill (see contour plan). Should the toe surrounding hole 115 be set at too liberal a distance the resulting increment of waste would more than offset the economic advantage of winning any additional ore. The 3,700 toe is completed by circling the crest line at the same elevation.

4. The same procedures and reasonings are pursued for holes 119, 15 and 95. Since hole 16 (half moon) is "close at hand" it is included in the next 3733 bench, the toe of the 3733 bench being thereby assessed as to location by these four holes.

5. The optimum contours of the next 8 benches, 3766 to 4000, are determined in a similar manner by local determination of the stripping ratios involved in mining a given quantity of ore at each hole location. This plan is completed by a sweep of arrows on each bench suggesting a line of sight along which the Vangorda sulphide deposit dips north-westward at a very low angle and ends in a bulge, between Section 6 and 3, where 64 per cent of the total volume of ore is located.

6. At the rock ledge the pit crest is protected by a berm varying between 25 and 35 feet in width to prevent overburden sloughing into the rock pit.

7. The haulage access ramp is shown on the ultimate pit plan. It is designed to negotiate the vertical distance of 370 feet from the pit bottom bench to the surface contour at a maximum slope of 8.5 per cent. This slope is chosen as a maximum that may be readily negotiated by loaded trucks under wet conditions. The ramp has been designed to fit within the predetermined pit area in such a way as to affect as little additional stripping as possible. This has entailed a design location that avoids cutting into pit walls and which twists up the bench floors in a series of six hairpin turns. "Flats" at turns, implemented for ease

in manoeuvring trucks, add 450 feet to a straight slope distance but is justified by minimizing excess stripping. The ramp width is 55 feet at the top, tapering to 40 feet at the pit bottom. Its total length is 4800 feet from the bottom to the pit access point. Slopes for overburden are cut at  $42^{\circ}$  -  $46^{\circ}$ .

8. The pit plan shows elevations at the top of the surface berm with two digit figures. All elevations are under 4000 feet on the south side between section lines 2 and 8 while the remainder of the pit perimeter is over 4000 feet. Contour elevations at surface are shown all around.

APPENDIX B

Representative Smelter Terms for Bulk Concentrates

1. The smelter terms outlined below are similar to those recently negotiated with smelters in Europe who are operating Imperial Smelter Furnaces.

2. Grade of Concentrate: Grade shall be better than 50 per cent combined lead and zinc. The lead content shall not be less than 20 per cent and the zinc content shall be between the limits of 20 and 35 per cent.

3. Price: In general, prices of metals shall be the official average prices of the London Metal Exchange for Standard (mean) and Three Months (mean). The following payments for metals shall be made:

- a. Lead: 90 per cent of the analytical lead content  
(minimum deduction 3 units)
- b. Zinc: 75 per cent of the analytical zinc content  
(minimum deduction 5 units)
- c. Copper: The analytical copper content less 1.3 units
- d. Silver: 98 per cent of the analytical silver content  
(minimum deduction one ounce per short ton net dry weight of concentrates delivered) at the London price as quoted by Sharps Pixley
- e. Gold: 90 per cent of the analytical gold content if more than 0.02 ounces per short ton net dry weight of concentrates delivered at the Canadian Mint price.

4. Charges: All charges shall be in Canadian funds and all weights shall be in short dry tons (SDT). The following charges shall be made:
- a. Basic Treatment Charge: \$14.00 per SDT.
  - b. Lead Treatment Charge: 33 cents per unit of payable lead content.
  - c. Zinc Treatment Charge: 95 cents per unit of payable zinc content.
  - d. Zinc Escalator Charge: The basic treatment charge is based on a zinc price of 9 cents per pound and it shall be increased or decreased by \$1.35 for each one cent increase or decrease from the base price.
  - e. Moisture Content: The basic treatment charge is based on a water content of 8 per cent and it shall be increased by 10 cents per SDT per unit of water above 8 per cent.
  - f. Refining Charges:
    - i. 2 cents per ounce of payable silver content.
    - ii. 5 cents per ounce of payable gold content.
    - iii. \$130. per short ton of payable copper content.
5. Shipment: Delivery shall be made about equally spread over the year. Shipments shall be made in full cargoes of 4,000 to 5,000 tons.
6. Delivery: Concentrates shall be delivered by the seller f. a. s. the receiving port with unloading by the buyers gear.

APPENDIX C

Estimated Value of Concentrates

1. To illustrate the probable value of the ore under varying conditions of both concentrate grades and recoveries and changing metal prices, two concentrates have been priced at two different sets of metal prices.

	<u>% Wt.</u>	<u>Lead</u>	<u>Zinc</u>	<u>Copper</u>	<u>Silver</u>	<u>Gold</u>
Head Grade	100%	3.1%	4.0%	0.24%	1.27 oz.	0.2 oz.
No. 1 Concentrate	12.7%					
(a) Grade		21.1	28.4	1.36	7.6	0.1
(b) Recovery		85.5	90.0	73.3	76.0	57.6%
No. 2 Concentrate	10.5%					
(a) Grade		24.2	32.5	1.56	8.74	0.11
(b) Recovery		82.3	84.8			-
Current metal prices		\$0.11	\$0.13	\$0.32	\$1.40	\$37.80
Depressed metal prices		\$0.10	\$0.105	\$0.30	\$1.40	\$37.80

2. Value of No. 1 Concentrate - Current Prices:

a. Charges

i. Basic treatment charge	\$ 14.00	
ii. Lead charge 0.33 (21.1 - 3)	5.97	
iii. Zinc charge 0.95 (0.75 x 28.4)	20.23	
iv. Zinc escalator 1.35 (13 - 9)	<u>5.40</u>	
v. Total		\$ 45.60

b. Refining Charges

i.	Silver 0.02 (7.6 - 1)	\$ 0.13
ii.	Gold 0.01 x 0.05	<u>0.01</u>
iii.	Total	\$ 0.14

c. Payments

i.	Lead $\frac{21.1 - 3}{100} \times 2000 \times 0.11$	\$ 39.82
ii.	Zinc 28.4 x 0.75 x 2000 x 0.13	55.38
iii.	Silver (7.6 - 1) 1.40	9.24
iv.	Gold 0.1 x 0.90 x 37.80	<u>3.40</u>
v.	Total	\$107.84

d. Value of concentrate f. a. s. receiving port \$ 62.10

3. Value of No. 1 Concentrate - Depressed Prices:

a. Charges:

i.	Basic treatment charge	\$ 14.00
ii.	Lead charge	5.97
iii.	Zinc charge	20.23
iv.	Zinc escalator 1.35 (10.5 - 9)	<u>2.03</u>
v.	Total	\$ 42.23

b. Refining Charges \$ 0.14

c. Payments

i.	Lead 21.1 - 3 x 2000 x 10	\$ 36.20
ii.	Zinc $\frac{28.4 \times 0.75}{100} \times 2000 \times 10.5$	44.73

iii.	Silver	\$ 9.24
iv.	Gold	<u>3.40</u>
v.	Total	\$ 93.57
d.	<u>Value of concentrate f. a. s. receiving port</u>	\$ 51.20

4. Value of No. 2 Concentrate - Current Prices:

a. Charges

i.	Basic treatment charge	\$ 14.00
ii.	Lead charge $0.33 (24.2 - 3)$	7.00
iii.	Zinc charge $0.95 \times 0.75 \times 32.5$	23.16
iv.	Zinc escalator	<u>5.40</u>
v.	Total	\$ 49.56

b. Refining Charges

i.	Copper $\frac{1.56 - 1.30}{100} \times 130$	\$ 0.34
ii.	Silver $0.02 (8.74 - 1)$	0.15
iii.	Gold	<u>0.01</u>
iv.	Total	\$ 0.50

c. Payments

i.	Lead $\frac{24.2 - 3}{100} \times 2000 \times 0.11$	\$ 46.64
ii.	Zinc $\frac{32.5 \times 0.75}{100} \times 2000 \times 0.13$	63.44
iii.	Copper $\frac{1.56 - 1.30}{100} \times 2000 \times 0.32$	1.66
iv.	Silver $(8.74 - 1) 1.40$	10.84

v.	Gold $0.11 \times 0.90 \times 37.80$	<u>\$ 3.74</u>
vi.	Total	\$126.12
d.	<u>Value of concentrate f. a. s. receiving port</u>	\$ 76.16

5. Value of No. 2 Concentrate - Depressed Prices

a. Charges

i.	Basic treatment charge	\$ 14.00
ii.	Lead charge	7.00
iii.	Zinc charge	23.16
iv.	Zinc escalator	<u>2.03</u>
v.	Total	\$ 46.19

b. Refining Charges

i.	Copper	\$ 0.34
ii.	Silver	0.15
iii.	Gold	<u>0.01</u>
iv.	Total	\$ 0.50

c. Payments

i.	Lead $\frac{24.2 - 3}{100} \times 2000 \times 0.10$	\$ 42.40
ii.	Zinc $\frac{32.5 \times 0.75}{100} \times 2000 \times 0.105$	51.24
iii.	Copper $\frac{1.56 - 1.30}{100} \times 2000 \times 0.30$	1.56
iv.	Silver	10.84
v.	Gold	<u>3.74</u>
vi.	Total	\$109.78

d.	Value of concentrate f. a. s. receiving port	\$ 63.09
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APPENDIX D

Some Detailed Capital Costs Applicable to Vangorda

1. Mining Equipment:

- a. 4-1/2 cu. yd. diesel powered face shovel \$250,000
- b. 2-1/2 cu. yd. diesel powered face shovel 110,000
- c. 27 cu. yd. haul unit 60,000
- d. D-8 tractor with blade 70,000
- e. ATD 3100 drill 25,000
- f. 600 cfm portable compressor 25,000

2. Roads: Roads of the mine access standard as defined by the territorial government having a gravelled carriageway of 22 feet wide will cost an average of \$20,000 per mile.

3. Power Plant: 5000 KW capacity diesel generating plant consisting of four 1270 KW capacity, 2,300 volt 60 cycle diesel generator sets complete with all accessories such as platforms, guard rails, fuel tanks, heat exchangers, silencers and auxiliaries but excluding

foundations, cooling water supply and housing - \$510,000 f. o. b.  
Whitehorse

4. Permanent Accommodation:

- a. Family dwellings \$15,000 ea.
- b. Permanent bunkhouses \$15 per sq. ft.

5. Service and Administration Buildings: The following unit costs will provide this type of building complete with all essential services:

- a. Shops and stores buildings \$ 8.00 per sq. ft.
- b. Office building \$15.00 per sq. ft.

6. Construction Materials:

- a. Cement f. o. b. minesite \$3.47 per bag
- b. Lumber - (local) f. o. b. Whitehorse \$65-\$85/M
- c. Lumber - (B. C.) f. o. b. minesite \$130-\$150/M
- d. Aggregates - available locally at approximately \$1.25 cubic yard

7. Transportation Costs

- a. Trucking costs in Yukon Territory 3.9¢ to 5.7¢ per ton mile
- b. Shipping costs - Vancouver to mine:
  - i. Cement \$2.25 per cwt
  - ii. Lumber and plywood 2.25 per cwt
  - iii. Structural steel 2.50 per cwt
  - iv. Mining machinery 2.50 per cwt
  - v. General freight 3.25 per cwt

APPENDIX E

Some Detailed Operating Costs Applicable to Vangorda

1. Petroleum Products:

- a. Diesel oil (including sales tax) f. o. b. minesite 28¢ per gal.
- b. Furnace oil f. o. b. minesite 26.3¢ per gal.
- c. Bunker "A", light fuel oil f. o. b. minesite 23¢ per gal.

2. Coal: This fuel is available in limited quantities at Carmacks. The Geological Survey of Canada indicates reserves of about 10 - 20 million tons of 11-12,000 BTU coal with about 7% ash content. Cost f. o. b. Carmacks - \$10 to \$15 per ton.

3. Electric Power Costs: The direct operating cost per KWH from a 5000 KVA diesel generating plant would be:

i. Fuel	0.78¢
ii. Labour	0.20¢
iii. Spare parts and maintenance	0.06¢
iv. Miscellaneous	<u>0.11¢</u>
Total	1.15¢ per KWH

4. Transportation Costs:

- a. Shipping costs Vancouver to minesite:
  - i. Mill operating supplies 2.75 per cwt (average)
  - ii. General freight - including food supplies 3.25 per cwt

b. Trucking costs in the Yukon Territory -

3.9¢ to 5.7¢ per ton mile

4. Labour Costs: The following hourly wage rates are currently in force at United Keno Hill Mines Ltd., Elsa, Y. T. and are generally applicable to Vangorda.

a. Miner	\$2.16
b. Underground labourer	1.90
c. Flotation operator	2.16
d. Ball Mill operator	2.04
e. Crusherman	2.02
f. Mill labourer	1.90
g. Bulldozer operator	2.19
h. Truck driver (heavy)	2.19
j. Tradesmen	2.32

5. Representative Milling Costs:

a. Bethlehem Copper Corporation Ltd. (July 1963 - 3000 f. p. d.)	\$0.91 per ton
b. Tilt Cove Mine (1959 costs - 2000 f. p. d.)	1.24 per ton
c. Wilroy Mines Ltd. (1963 costs - 1400 t. p. d.)	1.18 per ton