National Exams May 2019

09-MMP-A4, Mine Valuation and Mineral Resource Estimation

3 hours duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.
2. This is a Closed Book Exam. One aid sheet 8.5 x 11 inch, hand written both sides containing notes and formulae is allowed in the exam. A Casio or Sharp approved calculator is permitted.
3. Compulsory Question 1 and THREE (3) other questions constitute a complete exam paper. Only question 1 and the first three optional questions as they appear in the answer book will be marked. You must select three questions from the "optional" Questions 2 to 6.
4. Compulsory Question 1 is worth 40 marks. Each optional question is of equal value (20 marks). Three optional questions plus Question 1 constitute a complete exam paper.
5. Many questions require an answer in essay format. Clarity and organization of the answer are important.
6. Always use large (½ page or larger) neat sketches and drawings to illustrate your answers. This is important in obtaining good marks.

09-MMP-A4 Mine Valuation and Mineral Resource Estimation

Suggested Timing: 30 minutes to read the exam and consider answers. Allow an hour for Question 1. Choose 3 of 5 multiple choice questions. Three multiple choice questions chosen from the five (Q 2 to 6), should take 30 minutes per question, 1.5 hours in all. Total 3 hours.

Q1.1 *Syllabus - Aspects of geological conditions and control relating to mineral resource estimation.* *Compulsory* *worth 8 marks*

1.1.1 Identify and describe the three major types of geological fault and define the terms "graben" and "horst". Describe each of the five types/terms with a sketch to aid your answer. 2 marks

1.1.2 In both underground and open in mining operations, what effects might these faults have on the ability to physically mine deposits with the types of fault in 1.1.1. 2 marks

1.1.3 What effects do each of the fault types have on the quantity (and sometimes value) of "ore" in the vicinity of such faults. 2 marks

1.1.4 What do you understand by en-echelon folding and inflexion. 2 marks

Total 8 marks

Q1.2 *Syllabus - Principles of mineral resource estimation using conventional and geostatistical methods* *Compulsory* *worth 8 marks*

1.2.1 How is the structure of a deposit found and quantified using the variogram. (more correctly "semi-variogram", but "variogram" is used throughout this exam). What do you understand by "included angle" and "band width". 2 marks

1.2.2 Is the variogram at azimuth 035, dip 0 the same as that for azimuth 215, dip 0, and is the variogram at azimuth 060, dip -55 the same as that for azimuth 240, dip -55 (numbers are in "degrees"). 2 marks

1.2.3 Various lengths of drill core have been assayed and the raw results used to develop an "omni-directional" variogram. Discuss the expediency of using such a "raw" variogram when estimating the grade of a mineral deposit. 1 mark

1.2.4 Discuss how the drill core in such a case (1.2.3) is logged from the perspective of geological features affecting mineralisation (economic, sub-economic and controlling), and from the perspective of a uniform core length estimated by combining adjacent cores and part cores as a weighted average grade over uniform lengths. 1 mark

1.2.5 How will the omni-directional variogram for raw data in 1.2.3 above differ from that for a uniform core length in 1.2.4. How will this affect how epithermal and porphyry bulk mining methods (usually open pit or mass block cave) on the one hand, and rich compact mineralisation (vein/lens type and VMS deposits for example) often mined by underground methods on the other, be treated from the perspective of developing a data set for variogram analysis. 2 marks

Total 8 marks

Q1.3 *Syllabus – Aspects of mine valuation - assessment of market conditions - capital and operating cost estimation, Estimation of revenue including - cash flow, sensitivity and risk analyses.* *Compulsory worth 8 marks*

1.3.1 In the context of the mining industry, define Net Present Value (NPV) 2 marks

1.3.2 Calculate the project NPV given the following (dollars in millions) 3 marks

Initial investment	$100	
Project life		10 years
Salvage value	$ 20	
Annual income	$ 40	
Annual costs	$ 22	
Minimum discount rate acceptable		12%

1.3.3 What are the conclusions to be made from the calculated NPV. 2 marks

1.3.4 When comparing the mining industry with other ventures, should the mining NPV be raised or lowered to account for the differences in mining timelines and certainty of meeting the stated valuations. 1 mark

Two values you may or may not find of use in answering question 1.3

The compound interest factor for 12% at 10 years is 3.106

The present worth factor (present value of an annuity) for 12% at 10 years is 5.650

Q 1.4 *Syllabus - Aspects of mine valuation (assessment of market conditions), Economic optimization of mine development.* *Compulsory* *worth 8 marks*

There are several simple methods that an investor can use in deciding to invest in a mining company, among others Enterprise Value (EV) is one.

1.4.1 In simple terms, EV is the value the market puts on physical assets only and is comprised of three parts. What are the three parts, and how is EV estimated from these parts. 2 marks

1.4.2 In examining the value of gold mines and gold mining companies, EV can be modified in two ways, producing values for EVO and TVO. How are these two modifications estimated, and what conclusions can be drawn from the values. 2 marks

1.4.3 The following is a published reserve of a Canadian owned gold mine operating in the United States (Nevada);

Reserves	'000 tons	ozs./ton	'000 ozs.
Measured	152,600	0.02418	3,689.87
Indicated	1,207,700	0.02532	30,578.96
Measured + Indicated	1,360,300	0.02519	34,268.83
Inferred	442,600	0.03154	13,959.60

A further figure of

91,800,000 ozs. proven + probable

is listed in the publication.

Comment on this published data 2 marks

1.4.4 Another publication attempts to analyse several gold operations in assessing a particular target graphically as shown below;

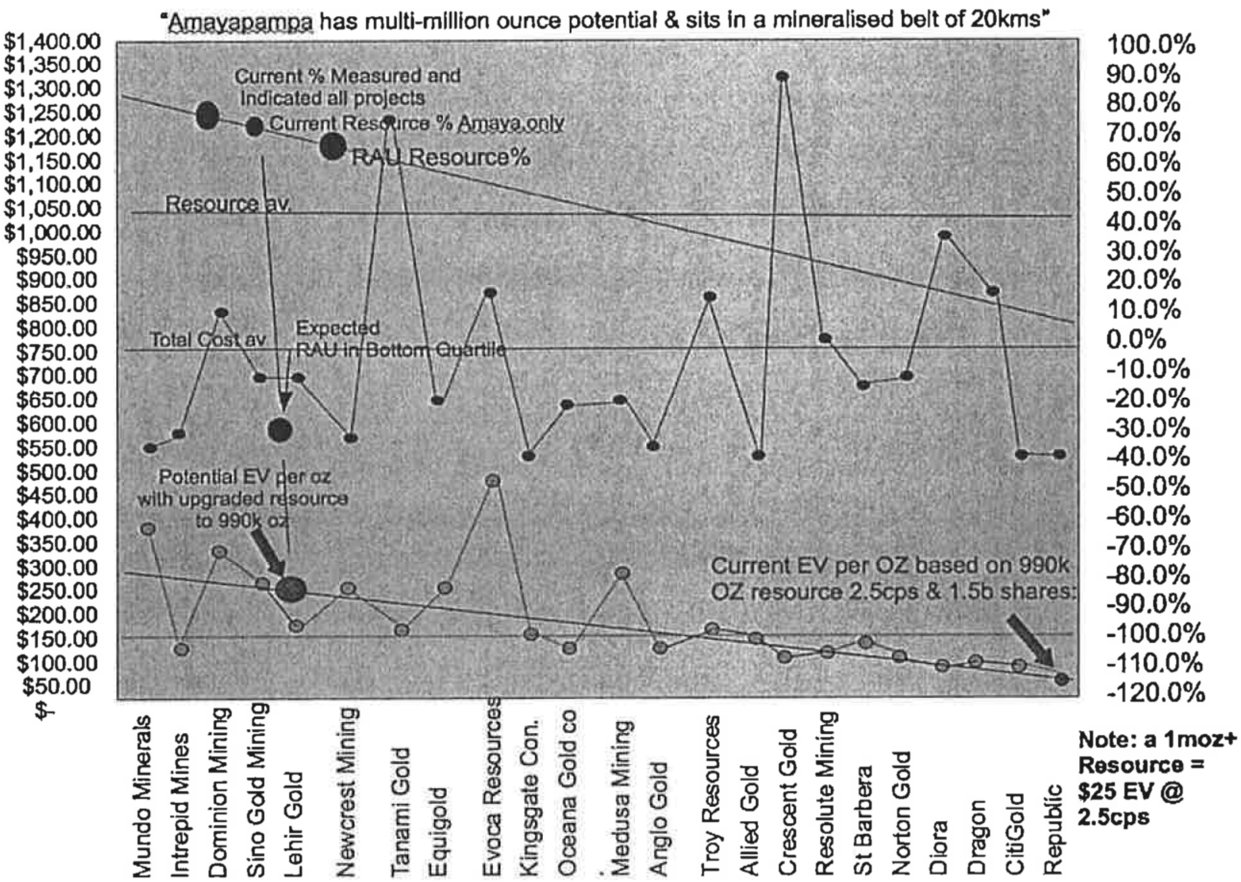

Figure 1.4.4 EV, EVO and TVO analysis of several gold mining operations

Comment briefly on the efficacy of such an analysis shown above 2 marks

Total 8 marks

Q 1.5 *Syllabus - Principles of mineral resource estimation, Aspects of mine valuation, Economic optimization of mine development.* *Compulsory* *worth 8 marks*

There are two major concerns with defining "ore reserves" for investment decision making.

The mining investor must understand the worth of what is being advertised as an investment and the assuredness that what is being offered really exists. Along with published product (metal, coal etc.) prices and suitable technologies plus parts 1.1, 1.2, 1.3 and 1.4 above, determinations of potential worth can be made. This material is mainly objective and with due diligence can be based on hard facts.

The likelihood that the product the investment is based on exists as advertised is far more problematic to predict, and can be described as subjective, involving the opinions and processes of others who are trained in the business and provide professional advice.

1.5.1 In the early 1970's McKelvey produced a box diagram relating "Increasing degree of feasibility of recovery" to "Increasing degree of geological assurance" for the US Geological Survey. Make a sketch of the McKelvey diagram including the various classifications of mineral resources and reserves within it. 2 marks

In Canada, National Instrument 43-101 (and others) provides some assurance that mining projects will perform as stated, subject to the stipulations stated by the professional mining engineer/geologist (e.g. P.Eng.) in reporting on the mining investment. Other jurisdictions outside Canada have adopted NI 43-101, or have similar legislation.

1.5.2 Describe the classification of "reserves" typically used in NI 43-101 to satisfy the limitations of 1.5.1 above. 2 marks

1.5.3 What is the definition of a "qualified person" in NI 43-101. 2 marks

1.5.4 How does the person in 1.5.3 ensure that the product (grade) data available is of a quality suitable for purpose. 2 marks

Q 2 *Syllabus - Aspects of geological conditions and control relating to mineral resource estimation.* *Optional question* *Total 20 marks*

2.1 Describe volcanogenic massive sulphide (VMS) deposits,

2.1.1 How are they formed — 2 marks

2.1.2 What host rock types enclose such deposits — 1 mark

2.1.3 What economic minerals are found in the sulphides — 2 marks

2.1.4 Give at least 2 examples of such deposits — 2 marks

Figure 2 shows a section of a typical VMS orebody. Original diamond drilling from surface found the deposit, but the true location could not be accurately determined as "de-survey" of the drilling was inaccurate. The findings from the drilling indicated a deposit of some value, and an exploration shaft and drifts were excavated, and the orebody delineated from drilling conducted in fans from the drifts, Figure 2 left. The orebody extended some 500 meters in depth, was relatively narrow and had a substantial strike length.

The massive sulphides were located and an economic orebody outlined within. The vein/lens like structure did have some geologic feature in the centre shown in the box on the left hand side of Figure 2. This area is expanded/exploded on the right hand side of Figure 2, and the economic sulphides shown as cylinders where the cylinder diameter indicates the total dollar value of the economic minerals in the intersection.

2.2 The interpretation of the economic sulphide orebody at the geologic feature was a matter of conjecture. The interpretations can be summarized as;

2.2.1 A very conservative outline such that an overinterpretation is most unlikely, ensuring that the mining corporation would be protected from loss. — 2 marks

2.2.2 An overly optimistic outline of economic sulphides suited to an on-site management desire to build a mine regardless. — 2 marks

2.2.3 A realistic outline based on a "best interpretation" of the facts as shown in the section on the right, Figure 2. — 3 marks

You are provided with Figure 2, page __ plus three attached copies (Appendices 2A, 2B and 2C pages __, __ and __) to outline your Interpretation of 2.2.1, 2.2.2 and 2.2.3. You may use just one of the Figures Appendix 2A, 2B and 2C and/or Figure 2 below and show the three outlines on one page provided you clearly indicate which is which, and show your outlines as colored or as dashed/dotted lines.

You will receive no marks if your outlines are not clear and unambiguous. Neatness and clarity are essential. Marks are shown in 2.2.1, 2 and 3 above.

2.3 Examining the width of the economic sulphide veins/lenses, their dip and the surrounding host rocks (mainly the hanging wall), discuss underground mining methods which might be suitable in this case. 3 marks

2.4 Discuss the importance of Canadian and international VMS deposits in the supply of base and associated metals in the supply of these commodities. 3 marks

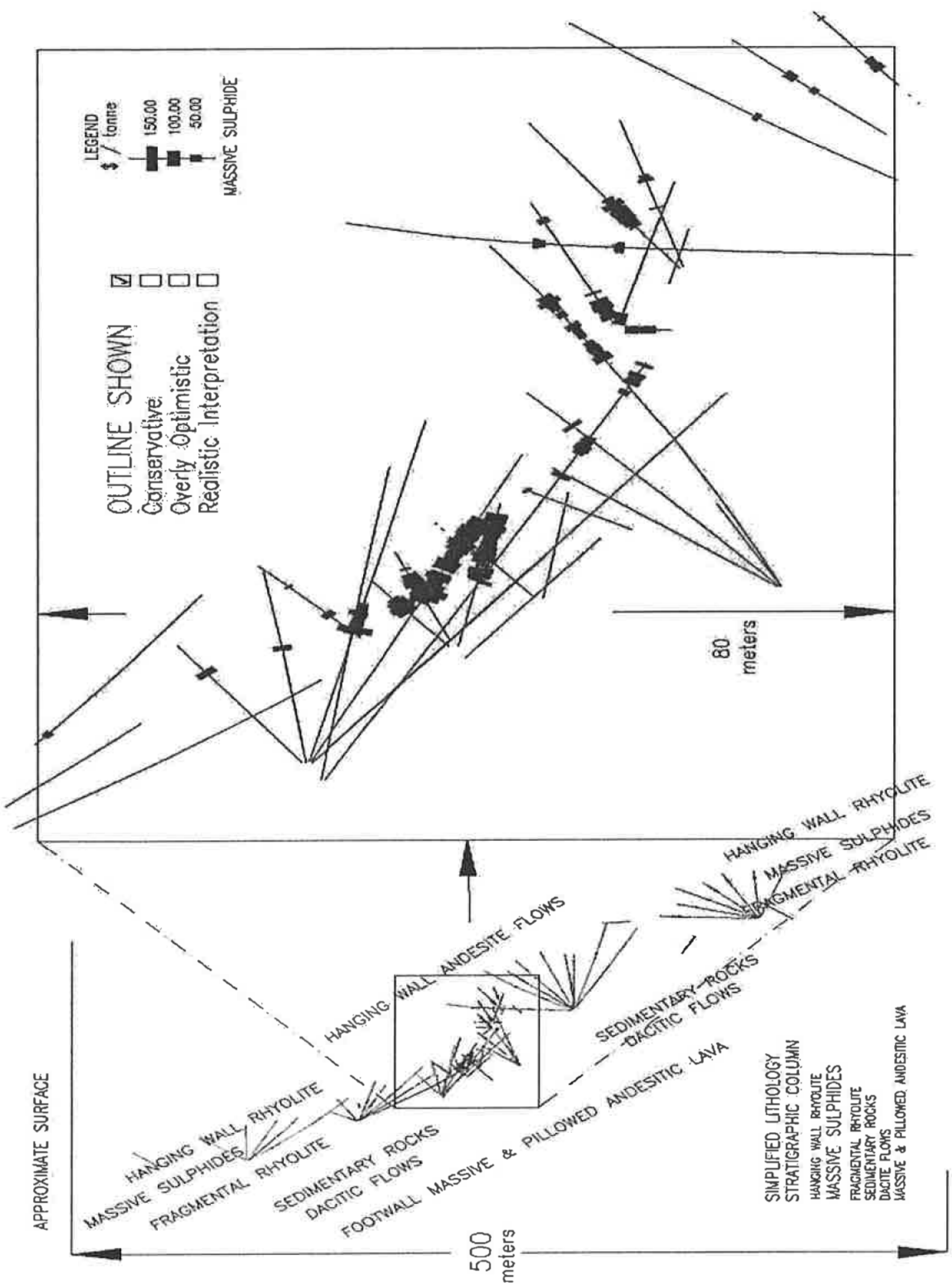

FIGURE 2 Diamond Drilling from Surface and Underground Drifts on Left

Simplified Lithology/Stratigraphy on 500 meter Deep Section Looking East

Expanded/Exploded View Valuable Drill Intersections as Cylinders Along Strike Right

Q 3 *Syllabus - Principles of mineral resource estimation using conventional and geostatistical methods.* *Optimal question* *Total 20 marks*

3.1 An essential analytical tool in geostatistics is the semi-variogram, commonly termed "variogram".

3.1.1 How is each individual variance value calculated in preparation for constructing an experimental variogram. 1 mark

3.1.2 How are these values combined to make an individual data point on a variogram, and should the number of values used from 3.1.1 be stored as an indication of the reliability of the data point. 1 mark

3.1.3 What are the values represented by the usual conventional variogram axes, x and y, and what are the units in each case. 1 mark

3.1.3 Describe the 3 main values estimated by the variogram and what each represents. 1 mark

3.1.4 How can a variogram consisting of very differing uneven values for adjacent data points (a "sawtooth") be "smoothed", and what information is lost in the resulting variogram. 1 mark

3.2 Given the power of modern computers, the variogram need not be modelled. However, a model of a variogram is helpful in quickly estimating many values used in geostatistical analysis.

3.2.1 The "spherical" variogram model has proven to be the most useful. Describe a spherical variogram in mathematical terms, and draw a sketch of such a variogram showing the three main values from 3.1.3 above. 1 mark

3.2.2 Unfortunately the model from 3.2.1 above does not well replicate the data from 3.1.2 above and a "nested" structure model is preferred. Such a nested spherical variogram has the following description,

	Variogram Value	Range (meters)
Nugget	0.1	
Structure (1)	0.5	30
Structure (2)	0.4	150

Draw a neat sketch of this variogram to approximate scale. 1 mark

3.2.3 Calculate the variogram (γ) value at the following distances,

3.2.3.1	0 m	1 mark
3.2.3.2	15 m	1 mark
3.2.3.3	100 m	1 mark
3.2.3.4	200 m	1 mark

Total 4 marks

3.2.3 The values in 3.2.2 above represent a relative variogram. Relative to what, and how would this variogram help where areas of a deposit have changes in variance.
1 mark

3.3 The volume/variance relationship is essential to an understanding of geostatistics.

3.3.1 Given two blocks of very different sizes but with dimensions less than the range, explain the volume/variance relationship. 1 mark

3.3.2 In estimating block variance "pseudo samples" are used. What do you understand by a pseudo sample, and their layout in a given block. 1 mark

3.3.3 What essential information is necessary to estimate variance between pseudo samples. 1 mark

3.4 Geostatistics has its advocates and detractors. Explain the following from their differing viewpoints.

3.4.1 Geostatistics is best suited to porphyry and epithermal deposits, not lenticular or vein mineralization. 1 mark

3.4.2 When the drill hole spacing greatly exceeds the size of a block representing a shift, days, weeks etc. production, there is little estimated grade differentiation between adjacent blocks. 1 mark

3.4.3 When the drill spacing is large (see 3.4.2 above), there is little difference between inverse distance power (IDP) estimates and kriged estimates. In these cases, the high value selective mining units (SMU's) are missed in the estimation procedure, leading to inaccurate "mineable" estimates and less likelihood of developing a mine. 1 mark

3.4.4 Geostatistics provides many more valid options and methods than IDP, which only produces point estimates which are essentially the same in the surrounding (SMU) area. 1 mark

3.4.5 The application of geostatistics including "turning bands" and simulation of grades offers a substantially better realization of the SMU grade variability, leading to "probabilistic" SMU grades. 1 mark

Q 4 *Syllabus - Economic optimization of mine development and extraction variables including sequencing, cut-off grade, installed capacity and utilization.*

Optimal question *Total 20 marks*

This question involves copper porphyry and epithermal gold deposits mined with an initial pit and followed by surrounding or partially surrounding expansions, often called push-backs, phases or shells. Often the expansions are started before the previous excavation has been completed, and are scheduled to maintain ore production while maintaining such as safety, stripping ratios and truck utilization/hours.

This can cause mining of the later phase to blast rock down onto the previous phase which is the source of high-grade ore and safety considerations. Where trucking capacity (truck hours) are fixed this also forms a constraint on the process of mine planning. Some thought and planning are necessary to maintain ore production and truck utilization (no parked truck capital), and the stripping ratio, in a timely and practical manner.

In Figure 4.1.1 mine ore production is prepared for scheduling. (Working Figures 4.1.1 and 4.2.1 are attached at the end of the exam as Appendices 4.1 and 4.2 in case you need them.)

In this operation there is a start-up period shown as (end of year) -1 and (end of year) 0 where the mine is stripping waste to expose Phase 1 ore (the initial pit, Figure 4.1.1) while the mill is under construction. Loaders and trucks are also under construction during periods -1 and 0.

Elev-Ation	Phase 1 Ore	Phase 2 Ore	Year Phase One						Year Phase Two				
			-1	0	1	2	3	4	4	5	6	7	8
2000	0	0											
1985	0	0											
1970	5	2											
1955	9	4											
1940	6	6											
1925	3	5											
1910	1	4											
1895	0	3											
1880	0	2											
Totals	24	26											

Figure 4.1.1 Ore Schedule 7 million tonnes per year starting Year One to completion

At the end of year one, 7 million tons of ore have been mined (5 from 1970e elevation and 2 from 1955e, leaving 7 on 1955e) and ore scheduled annually until the ore is exhausted. First Phase 1, and on completion of Phase 1, the sequence moves on to Phase 2, Figure 4.1.1 and Appendix 4.1.

The year shown at the top of the figure refers to the end of the year. For example, year "0" ends at the start of the ore mining and mill operations which have been under construction during years "-1" and "0". Year "1" is material mined from mill start-up and lasting for one year.

The mine operates in 2 Phases and management demands the "ore' production remain at 7 million per year. Normally Phase 1 ore will be mined out before moving to Phase 2 ore. The critical objective of the mine is to produce 7 million tons of ore annually starting in year 1 and continuing each year until ore depletion and end of mine, (or development of a Phase 3 etc. if economics are positive).

During these early years (-1 and 0) no ore is mined, and if any is inadvertently encountered it would be stockpiled for mining at the end of mine life.

Note the nomenclature of the mining year in Figures 4.1.1 and 4.2.1. At the end of the first start-up pre-production year (called minus 1) the waste stripping of 6 million tons is completed with one or two loaders and sufficient trucks.

At the start of year 0, waste pre-production stripping of 12 million tonnes with at least one extra loader and suitable truck fleet(s) is started and a further loader and truck fleet are under construction to mine ore, but no ore is mined as yet, Figure 4.2.1. (Appendix 4.2)

Elev-Ation	Phase 1 Waste	Phase 2 Waste	Year One Phase						Year Two Phase				
			-1	0	1	2	3	4	3	4	5	6	7
2000	5	2											
1985	8	4											
1970	11	5											
1955	9	11											
1940	7	8											
1925	3	7											
1910	0	3											
1895	0	1											
1880	0	0											
Totals	43	41											

Waste Schedule
6 million tonnes per year in first pre-production Year -1 (minus One)
12 million tonnes per year second pre-production Year 0 (zero)
Up to 12 million tonnes of waste mined per year thereafter (1, 2, . . ?)

Figure 4.2.1

In the Figures 4.1.1 and 4.2.1 (and Appendices 4.1 and 4.2) the simple "North West Corner" scheduling method (moving right or down to the next period or next bench when no more material is required or available) is used as a guide to mine planning and scheduling. This ensures an orderly operation, starting at the highest working elevation in the earliest period. The method works down to fulfil the production quota for the period, then right to the next mining period and down until the period quota has been met. Eventually all the benches will be mined out and the production quotas for the mining period completed.

When mining ore, the bench(es) above should have removed enough waste to uncover the ore to make the ore available as required. To ensure waste is not removed too early, incurring a cost which could -have been delayed and improving profits, the rules are that in any given year, the amount of waste removed on a bench should not exceed the amount of ore removed. The rules on mining waste neither too late nor too early are the responsibility of the mine planner/scheduler. First the pre-requisite ore schedule must be constructed which mines 7 million tons per year starting in year one mining the first phase, and then moving onto the second phase. The choice of moving ore from both phases when the first phase is near completion is again the responsibility of the mine planner/scheduler.

4.1.1 In Figure 4.1.1, complete the ore schedule (use Appendix 4.1 to tabulate your answer if you wish to provide a neater copy) for both phases 1 and 2. Be sure to include your name/number on the page __ and/or Appendix 4.1 and hand in with your ---exam paper. If you make major errors on the exam page __, you can use the Appendix copy attached on the end of the exam. Be sure to include your name/number on the relevant page(s) and hand in with your exam paper.
2 marks

4.1.2 What relative grade values would be mined as the ore becomes deeper and more constricted towards the core of the orebody. Make a sketch graph of grade (y) versus life-of-mine time (x) to show this. Draw conclusions. 1 mark

4.1.3 What total truck hours would be required to mine ore during the life cycle of phases 1 and 2. In reality, the truck hours per ton per meter of depth would be included in any mine planning. The examples, Figures 4.1.1 and 4.2.1, assume that truck productivity is constant. Include your conclusions as part of your answer. Make a sketch graph of total relative ore truck hours (y) versus life-of-mine time (x) to show this. 1 mark

Clear, neat and large sketch diagrams are expected throughout your answers, and untidy thumbnail sketches will receive no marks.

4.2.1 In Figure 4.2.1 (and use Appendix 4.2 if necessary), complete the waste mining schedule based on the production expected and the completed ore schedule in Figure 4.1.1. Ensure that the rules governing waste mining are followed (i.e. waste is not mined ahead of ore). Be sure to include your name/number on the relevant page or Appendix 4.2, and hand in with your exam paper. If you make major errors on the page __ copy, you can use the Appendix copy, and be sure to include your name/number on the relevant page/Appendix and hand in with your exam paper. 3 marks

4.2.2 What total truck hours would be required to mine waste during the life cycle of phases 1 and 2. In reality, the truck hours per ton per meter of depth would be

included in any mine planning. The examples, Figures 4.1.1 and 4.2.1, assume that truck productivity is constant, but it decreases rapidly with depth, and costs increase with depth. Include your conclusions as part of your answer.
Make a sketch graph of total relative waste truck hours (y) versus time (x) which include these effects. 1 mark

Again, clear, neat and large sketch diagrams are expected throughout your answers, and untidy thumbnail sketches will receive no marks.

4.3.1 Draw a plot the relative trucking cost for ore mining which is dependent on fuel and tire consumption, and the need for more hours/ton at depth. Note that for simplicity in the exam question the reduction in waste production with depth is ignored. Would the purchase/rental of used trucks help any problems envisaged. Include your conclusions as part of your answer.
In reality, the truck hours per ton per meter of depth would be included in any mine planning. The examples, Figures 4.1.1 and 4.2.1, assume that truck productivity is constant. Include your conclusions as part of your answer.
2 marks

4.3.2 Draw a plot of the relative truck costs for waste removal which is dependent on fuel and tire consumption costs. Include your conclusions as part of your answer.
1 mark

4.3.3 Draw a plot the relative total mining cost of ore plus waste. Include your conclusions as part of your answer. 1 mark

4.4 The stripping ratio (waste tons/ore tons) is a typical measure used in evaluating mines. Values are generally 1:1 and up to 5:1 or more, and ratios below 1:1 (say 0.5:1) are indicative of a low cost mining operation. Ensuring that waste is not mined ahead of ore (keeping waste mined lower than ore mined on any particular bench elevation) is an essential part of practical mine planning and ensures costs are moved to the future whenever possible.

4.4.1 What is the maximum and minimum annual stripping ratio, and describe how this knowledge will help your attempt to maintain constant truck hours. 2 marks

4.4.2 Are there any year(s) where waste mining is started/completed before ore is mined. What rule in open pit mining is broken in this event. 1 mark

4.4.3 Will your schedule have mining on the upper levels of Phase 2 working above ore or waste loaders and trucks working in Phase 1. Draw a mine plan at this juncture and explain how safety and productivity can be assured in this instance. 1 mark

4.4.4 What if commodity prices decrease or increase with the business cycle. On your total cost and grade mined graphs conduct an analysis of the effects on corporate profits and stock market share value of the important changes, and discuss how you would continue operations when, for example, the business cycle is low when grade mined is low and costs are high. The converse is also a potential outcome. Include discussion of what to do with excess profits in this later event. 1 mark

4.4.5 In your opinion, has the simple mine scheduler been successful in giving the short/medium/long term planning engineer a solid background to make short term scheduling through long term planning scenarios. 1 mark

4.5 If "waste mining" could be replaced by "mine development", would it be possible to base an underground mine planning and scheduling methodology on the open pit practice above. Discuss potential application to the various underground mining methods in use in mines.

2 marks

Q 5 *Syllabus - Estimation of revenue including, taxation, cash flow.*

Optional question *Total 20 marks*

5.1.1 What do you understand by the term "depreciation", and what is its purpose. How does depreciation affect the tax paid by a mining corporation. 1 mark

5.1.2 From a taxation perspective describe how the following depreciation methods are calculated using the following example. Provide the annual amount in each case where appropriate.

An item worth $100k is being depreciated over 5 years and will have a salvage value of $5k. What is the annual depreciation, Total 3 marks

- 5.1.2.1 full expensing, 100% depreciation
- 5.1.2.2 straight line depreciation
- 5.1.2.3 units of production
- 5.1.2.4 declining balance (use 30% as an example)
- 5.1.2.5 tax depreciation

A formula which may or may not be of use $100\left(1 - \sqrt[n]{\frac{S}{C}}\right)$

5.3 The following are typical of abbreviations used in the Federal and Ontario tax codes. What are they and what is their effect on taxes paid. Total 3 marks

- 5.3.1 CCA
- 5.3.2 CI 41(a)
- 5.3.3 CDE
- 5.3.4 CEE
- 5.3.5 CCEE
- 5.3.6 ITC
- 5.3.7 E&D
- 5.3.8 CMT

5.4 Using the province of Ontario as an example (and which has a similar tax administration as many other Canadian provinces). Total 4 marks

5.4.1 What three sets of taxation regulations are applicable to metal mining operations.

5.4.2 Briefly describe the main points of each of the regulations as they impact the tax payable and the associated reductions in revenue and profitability of mining companies

5.4.3 What tax reductions apply to mines in very remote locations.

5.4.4 How does the taxation of diamond mining companies differ from that for metal mines

5.5 The tax data for year 7 of an Ontario mine is given below. Where necessary, data for years 5 and 6 have been given to aid the calculation of year 7 data.

The order format of the accounting spreadsheet has been amended so that you can better answer the question.

Fill in the missing values shown as ________| e.g. 123.456|

Total 7 marks

A copy of Question 5.5 is attached as Appendices 5.5 parts 1, 2 and 3 in case you need it.

Ontario – Model

	Year 7
Summary Part One	1 mark
Gross revenue	210,000
Operating costs	(100,000)
Reclamation costs	
Internal expense at 8%	
Pre-tax cash flow from operations	_______|

Mining taxes (Ontario – Model)	2 marks
Pre=tax cash flow from operations	_______|
Add back interest expense	
Tax depreciation	
Mining	(500)
Processing	(7,500)
Pre-production	
E&D	(1.000)
	_______|
Processing allowance	(15,150)
	_______|
Exempt amount	
Basic exemption	(500)
Taxable income for mining tax	_______|
Mining tax	_______|
ITC deduction	
Total mining tax	_______|

Federal Tax (Ontario – Model) 2 marks

Income Taxes	**Year 5**	**Year 6**	**Year 7**
Pre-tax cash flow from operations			110,000
Deduct Crown Charges			_______
Less CCA			
Standard			(315)
Supp. Cl 41(a)			
Income from mines			_______
Add back interest expense			
Resource profits			_______
Deduct interest expense			
CDE	(1,801)	(1,261)	_______
CEE			(900)
			_______
Non-capital loss (claim)			
Taxable income for income taxes			_______
Federal tax - basic			_______
Less CCEE ITC			(100)
Total federal tax			_______
Provincial tax – basic			_______
Less ITC claim			(4,394)
Provincial CMT (credit)			
Total provincial tax			_______

	Year 7
Summary part two	2 marks
Income taxes	
Federal	_______|
Provincial	_______|
Mining taxes	_______|
Total taxes	_______|
Net cash flow from operations	_______|
Capital costs	(1,500)
Net cash flow	_______|
Working capital loan (repayment)	
Equity (deficit)	_______|

5.6 The share of pre-tax earnings over the life of mine (13 years) is as follows,

Share of Pre-Tax Earnings over the Life of the Mine

Ontario tax	133,759	13.5%
Federal tax	161,685	16.3%
Shareholders	696,445	70.2%

Comment on this division of pre-tax earnings given the costs of finding suitable mineral properties, the risk taken in constructing a mine, the uncertainties of mining methods, ground control, operating costs and product (e.g. metal) prices. 2 marks

Q 6 *Syllabus - Estimation of revenue including, smelter contracts.*

Optional question *Total 20 marks*

6.1 With respect to typical standard smelter contracts for base and precious metal mines (copper, zinc, gold etc), succinctly discuss/describe the following in a sentence or two each with examples where applicable. (1 mark each, total 12 marks)

6.1.1 When and how product prices are determined
6.1.2 Method of payment
6.1.3 Charges for smelting and refining
6.1.4 Additional charges when power, labour, fuel and environmental costs increase
6.1.5 Weights and measures including abbreviations
6.1.6 Approximate content of product concentrates
6.1.7 Types of container (rail/truck/ship) to be used for transportation
6.1.8 Weighing and sampling detail
6.1.9 Splitting limits with choice of sample and sampling umpires
6.1.10 By products paid for
6.1.11 Impurities (all the deleterious substances) and penalties
6.1.12 Sharing large product price swings

6.2 Define and differentiate between Net Smelter Value (NSV) and Net Smelter Return (NSR) and give the range of units each could be expressed in. 2 marks

6.3 Estimate the NSV per metric ton of concentrate in Canadian dollars for a base metal (copper) mine given the following; 2 marks

Head Grade (copper)	0.2%
Grade of concentrate (M)	28%
Concentrator Recovery	60%
Unit Deduction (D)	1 unit
Exchange Rate	1.00 US$ = 1.10 CDN$
Metal Price (P)	US$ 1.80/lb
Refining Charge (r)	USc9.0/lb
Treatment Charge (T)	US$100.00/DMT metal
Credits for Precious Metals (C)	US$40.00/DMT metal

6.4 Estimate the NSR (%) (based on Canadian $) for the example given in (6.3) 3 marks

6.5 If the concentrate contains 7% by weight water and costs CDN$125.00/WMT to transport from mine to smelter, what is the NSR for the mine for the example given in (6.4).

1 mark

END OF EXAM

DO NOT FORGET TO PLACE YOUR <u>NAME/NUMBER</u> ON EXAM PARTS AND APPENDICES WHERE APPLICABLE OR WHERE SOMETHING YOU WROTE DOWN WOULD INDICATE YOU WERE APPROACHING THE ANSWER CORRECTLY.

Appendix 2A

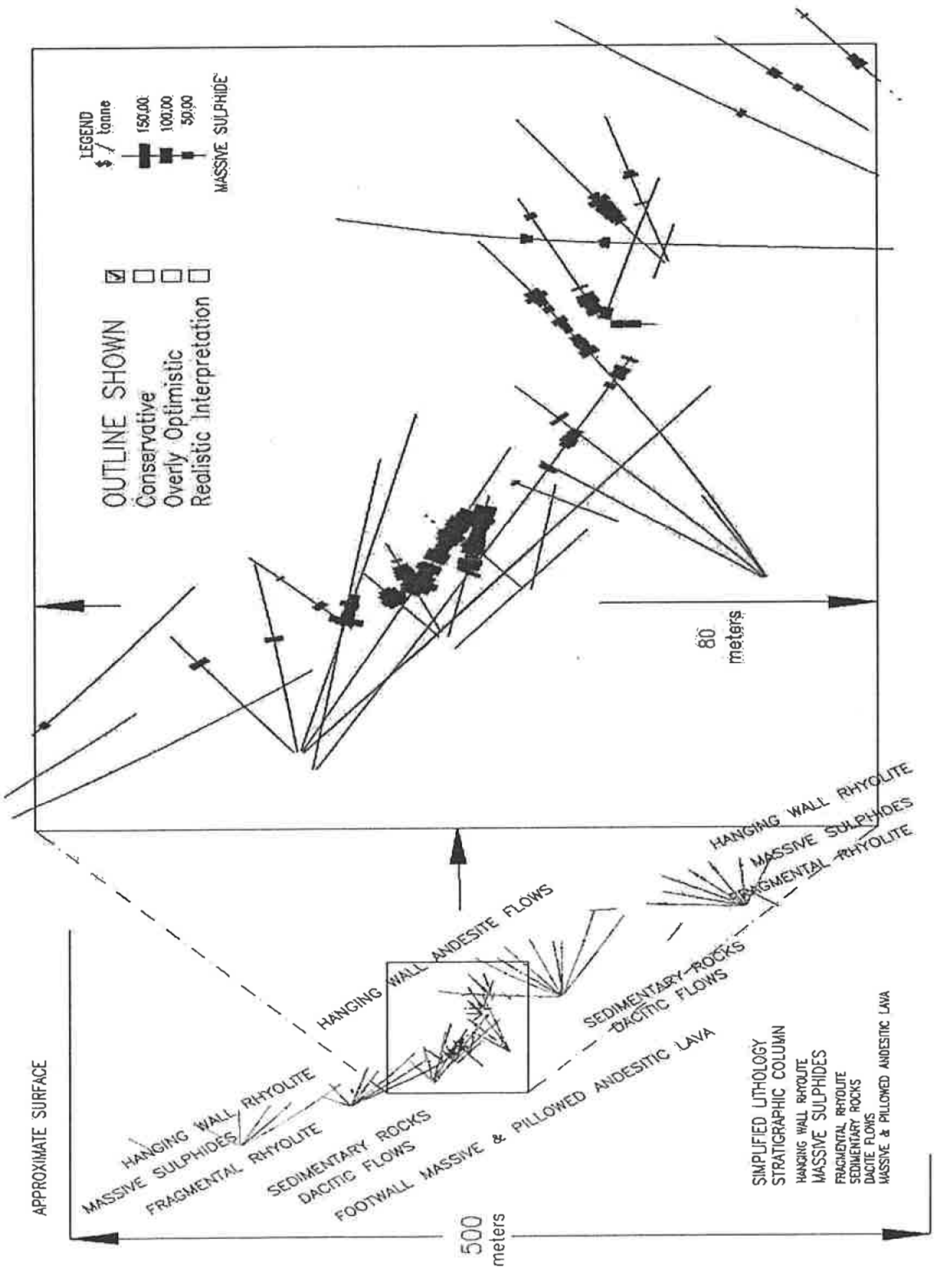

FIGURE 2 Diamond Drilling from Surface and Underground Drifts on Left

Simplified Lithology/Stratigraphy on 500 meter Deep Section Looking East

Expanded/Exploded View Valuable Drill Intersections as Cylinders Along Strike Right

Appendix 2B

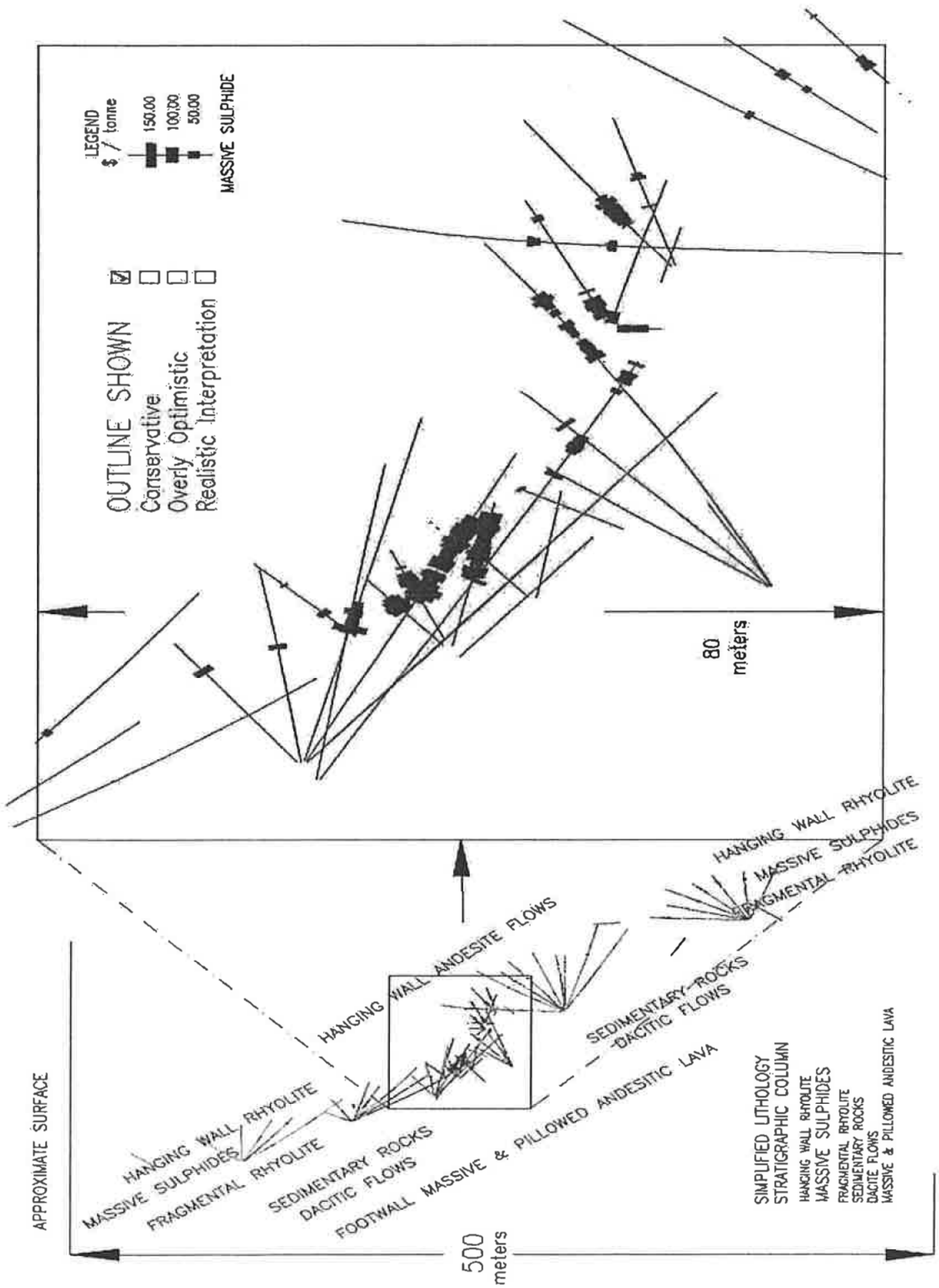

FIGURE 2 Diamond Drilling from Surface and Underground Drifts on Left
Simplified Lithology/Stratigraphy on 500 meter Deep Section Looking East
Expanded/Exploded View Valuable Drill Intersections as Cylinders Along Strike Right

Appendix 2C

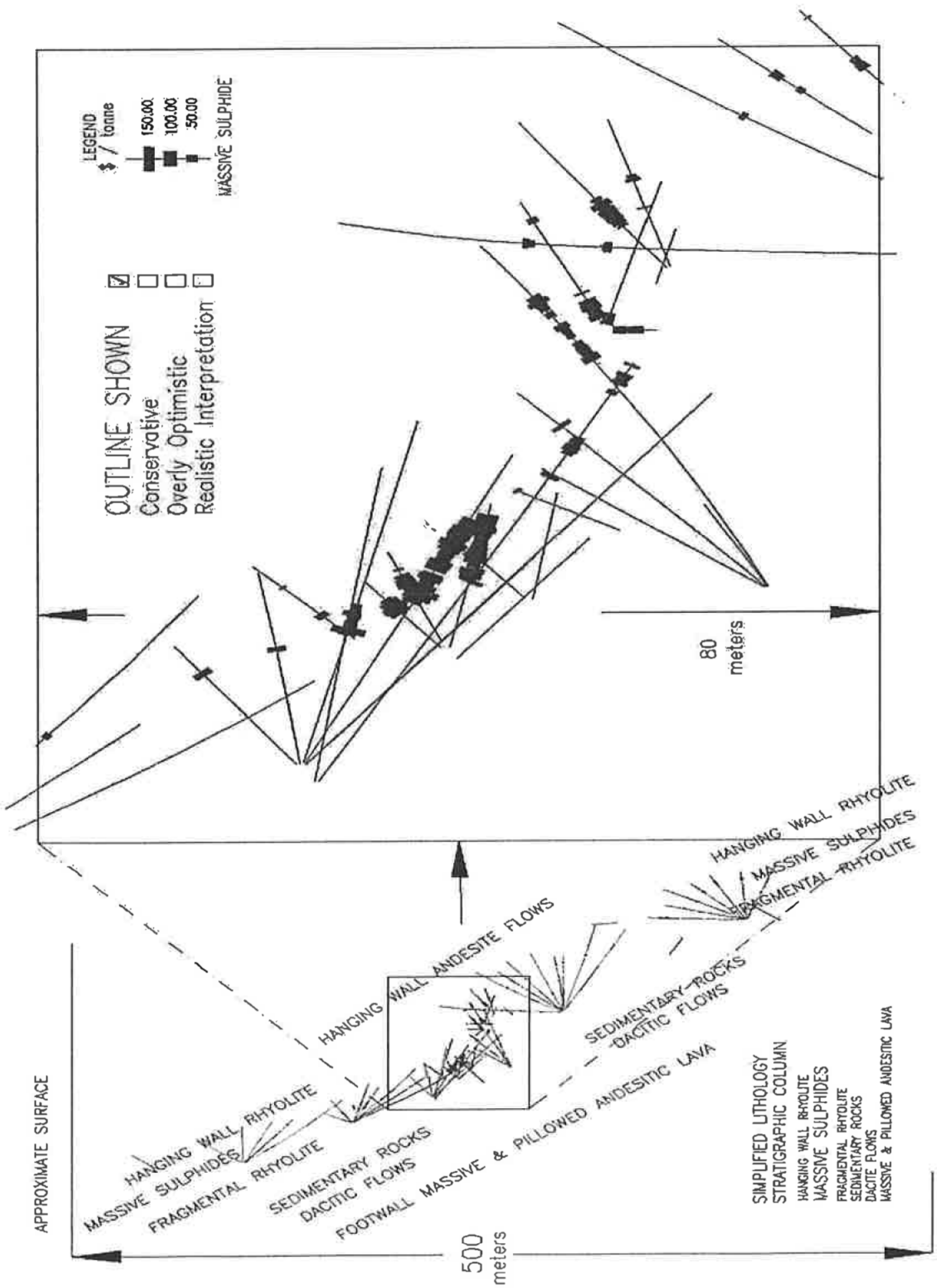

FIGURE 2 Diamond Drilling from Surface and Underground Drifts on Left

Simplified Lithology/Stratigraphy on 500 meter Deep Section Looking East

Expanded/Exploded View Valuable Drill Intersections as Cylinders Along Strike Right

Appendices 4.1 and 4.2

Appendix 4.1 *Figure 4.1.1*

Elev-Ation	Phase 1 Ore	Phase 2 Ore	Year Phase One -1	0	1	2	3	4	Year Phase Two 4	5	6	7	8
2000	0	0											
1985	0	0											
1970	5	2											
1955	9	4											
1940	6	6											
1925	3	5											
1910	1	4											
1895	0	3											
1880	0	2											
Totals	24	26											

Figure 4.1.1 Ore Schedule 7 million tonnes per year starting Year One to completion

Appendix 4.2 *Figure 4.2.1*

Elev-Ation	Phase 1 Waste	Phase 2 Waste	Year One Phase -1	0	1	2	3	4	Year Two Phase 3	4	5	6	7
2000	5	2											
1985	8	4											
1970	11	5											
1955	9	11											
1940	7	8											
1925	3	7											
1910	0	3											
1895	0	1											
1880	0	0											
Totals	43	41											

Figure 4.2.1 Waste Schedule

6 million tonnes per year in first pre-production Year -1 (minus One)

12 million tonnes per year second pre-production Year 0 (zero)

Up to 12 million tonnes of waste mined per year thereafter (1, 2, . . ?)

Appendices 4.1 and 4.2

Appendix 4.1 *Figure 4.1.1*

Elev-Ation	Phase 1 Ore	Phase 2 Ore	Year Phase One						Year Phase Two				
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6 million tonnes per year in first pre-production Year -1 (minus One)

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Up to 12 million tonnes of waste mined per year thereafter (1, 2, . . ?)

Appendix 5.5 Part1

Ontario – Model

	Year 7
Summary Part One	1 mark
Gross revenue	210,000
Operating costs	(100,000)
Reclamation costs	
Internal expense at 8%	
Pre-tax cash flow from operations	_______|
Mining taxes (Ontario – Model)	2 marks
Pre=tax cash flow from operations	_______|
Add back interest expense	
Tax depreciation	
Mining	(500)
Processing	(7,500)
Pre-production	
E&D	(1.000)
	_______|
Processing allowance	(15,150)
	_______|
Exempt amount	
Basic exemption	(500)
Taxable income for mining tax	_______|
Mining tax	_______|
ITC deduction	
Total mining tax	_______|

Appendix 5.5 Part 2

Federal Tax (Ontario – Model) 2 marks

Income Taxes	**Year 5**	**Year 6**	**Year 7**
Pre-tax cash flow from operations			110,000
Deduct Crown Charges			______
Less CCA			
Standard			(315)
Supp. Cl 41(a)			
Income from mines			______
Add back interest expense			
Resource profits			______
Deduct interest expense			
CDE	(1,801)	(1,261)	______
CEE			(900)
			______
Non-capital loss (claim)			
Taxable income for income taxes			______
Federal tax - basic			______
Less CCEE ITC			(100)
Total federal tax			______
Provincial tax – basic			______
Less ITC claim			(4,394)
Provincial CMT (credit)			
Total provincial tax			______

Appendix 5.5 Part 3

Summary part two	**Year 7** 2 marks
Income taxes	
Federal	________
Provincial	________
Mining taxes	________
Total taxes	________
Net cash flow from operations	________
Capital costs	(1,500)
Net cash flow	________
Working capital loan (repayment)	
Equity (deficit)	________

LAST PAGE OF APPENDICES

LAST PAGE OF EXAM