APPENDIX 4-6 ECONOMIC MODELLING FOR FEASIBILITY STUDIES AND BUSINESS PLANNING

4-6.1 INTRODUCTION

This appendix presents a commonly used method of modelling predicted financial performance of a business or part of a business to support comparative analysis of different commercial courses of action and to allow expected returns on investment and commercial risks to be evaluated. As described in Chapter 6 of the Handbook, commercial risk assessment is an essential component of overall design risk assessment in the quarry design process. The method is based on the building and analysis of cash flows for a project or business as described in the following sections

4-6.2 CASH FLOWS

A cash flow is a simple arithmetic statement of predicted cash inflows (revenues) and outflows (expenditure) over increments of time. An example is given below:

	Period 0[1]	Period 1	Period 2	Totals
Cash inflows (income)	£0	£2,000,000	£2,000,000	£4,000,000
Cash outflows (Costs and Investments)	£1,000,000	£500,000	£500,000	£2,000,000
Cash flow	-£1,000,000	£1,500,000	£1,500,000	£2,000,000

The above cash flow for a notional project shows an outlay (investment) of £1,000,000 by the end of Period 0, during which no income is generated. In Periods 1 and 2, costs are £500,000 per period, giving a total outlay of £200,000,000. Also during Periods 1 and 2, there is a projected income of £2,000,000 per period, giving a total income for the project of £4,000,000. Clearly, by the end of the project period, the investment would have been paid back and a return on the investment of £1,000,000 would have been made; 100% return.

4-6.2.1 Operator's cash flow

For a quarry operator, the revenue stream will include all sources of revenue derived from the operation of the quarry. For an aggregate quarry, this will include sales of the products produced at the quarry, for which there is a market. The level and mix of sales is determined by:

- The properties of the material being quarried (its inherent suitability for various end-uses and product types);
- The rate at which the deposit can be excavated using the plant and techniques selected;
- The capacity and nature of processing plant (crushing and/or screening plant);
- The capacity of the market to accept the products produced and the market prices.

Cash outflows (costs) fall into the following categories:

- Capital investment and one-off project costs (including the cost of land);
- Fixed operating costs (incurred irrespective of production rate); and
- Variable operating costs (i.e. related to each tonne of mineral produced or to each m³ of void space filled).

Generally speaking the majority of capital investment and one-off project costs are incurred in "Year 0" (i.e. before the start of the project). They may include investment in equipment, land and/or other assets, site

1 Period 0 is the period before the project gets underway. For each of these periods, the word 'Period n' is shorthand for 'the end of period n'.

clearance costs and professional advice to get the operation up and running. Operating costs, both fixed and variable, relate to the productive period of the operation, and are entered in the cash flow in the period during which they occur. Fixed costs are such things as wages and salaries for permanent staff, rates, rent, heat, light and power etc. Variable costs are expressed in £/tonne and include items such as fuel, explosives, haulage and excavation costs, and royalties.

The total period represented by the cash flow will equate to the total operational life of the quarry (including any final restoration). The operational life of the quarry is derived from the total recoverable reserve divided by production rate with any final restoration period added at the end. With most quarrying projects, there will be a degree of uncertainty in some of the key assumptions (notably the market for the mineral and void space, but also in relation to geology and planning status). Given this uncertainty, there is normally a range of cashflows that can be generated for an operation, each of which represents an operating scenario to be considered.

Landlord's cash flow

The landlord's cash flow does not include cash outflows. The cash inflows and the total period represented by the cash flow are intimately related to the operator's cash flow in relation to the output of the quarry, the relative proportions of different quarry products, and the life of the reserves and/or void space.

4-6.3 ESTIMATION OF RETURN ON INVESTMENT IN A QUARRY FROM A CASH FLOW

4-6.3.1 Comparison of cash flows

In order to select the most commercially attractive option (and understand the risks and sensitivities attached), it is common practice in business (and particularly the minerals industry) for cash flows to be generated for each scenario and compared.

In the simple example cash flow given above, it is apparent that, for an investment of £1,000,000 a 100% return on investment was made over the project period.

The attractiveness of this return, and therefore the asset value of the business represented by that cash flow is, however, highly dependent on the length of each time period. For example, if each period in the cash flow were 6 months, then the 100% return would have been made in only a year. However, if each period were 10 years, we would have to wait 20 years to achieve the same return, by which time it could look significantly less attractive compared to a 'safe' investment such as a bank or building society.

The key question would be "how much money, received now, is equivalent to the future return that is expected to be generated?" It is clear that, given the choice, it is preferable to have £1M today than the promise of £1M in a few year's time. This is because we have the opportunity to invest the £1M if we have it today. If we decide to wait for the £1M, its real value will have diminished by the time we receive it through the effects of inflation, even before taking into account the lost opportunity to invest the money. In order to calculate how much we need now to compensate for the lost opportunity to benefit from a future income stream, we use an approach which takes into account the 'time value of money'. This involves converting all the individual future cashflows for the project to present values. The present values (PVs) are the amounts of money that would need to be invested today to yield the cashflow expected in a future year.

The following simple example illustrates how PVs are calculated.

Consider an investment (I) of £1 in a fixed interest account at a fixed rate of interest of i%, its future value (FV) at year n is:

$$FV=I(1+i)^n \qquad \text{Equation 1}$$

Clearly, an investor, knowing he will need to realise £1,000, in some years time will invest less than this now on the basis that his money will grow over the period.

Consider now a desire to have £FV in the fixed interest account at the end of year n, with a fixed interest rate i. What is the sum to be invested now to achieve that? This is simply calculated by rearranging equation 1:

$$I = \frac{FV}{(1+i)^n} \qquad \text{Equation 2}$$

I is known as the 'present value (PV)' of the investment at year n.

4-6.3.2 A discounted cash flow model for a quarry project

A quarry cash flow is far more complex than a fixed interest account because the expected returns are not simply dependent upon the rate of interest being paid; they depend upon the performance of a complicated business and on external factors (notably related to the market and regulatory environments). However, the principles are the same and are applied as follows:

i. A 'cash flow' (costs and revenues over time) is built up for the project, taking into account inflation in predicting costs and revenues.

ii. Each item in the cash flow is translated into a PV using a notional interest rate called the 'discount rate' and the formula in Equation 2. The discount rate will be chosen by the company having regard to the company cost of capital (interest on debt and dividends on equity) and the nature of the risks associated with the project. This adjusted cash flow is called a 'discounted cash flow' (DCF).

iii. By adding all the individual PVs in the DCF, we derive the 'Net Present Value' (NPV) (net inflow or outflow of cash at present values over the project period). This would be an amount that could be paid today in compensation for losing the opportunity to benefit from future cash flows (i.e. it might be the basis for a decision as to how much to offer to buy a site or how much we might accept if selling a site). An NPV of 0 indicates that a return on investment equal to the discount rate will be made (i.e. the outcome will be equivalent to making the initial investment at a rate of interest equal to the discount rate). If NPV is negative, then the expected outcome is that there will be a negative return on investment, compared with a ‘safe’ investment at the discount rate (or, more usually, compared with the cost of borrowing the money to invest). If the NPV is positive, then the expected outcome is that the return on investment will exceed the required threshold represented by the discount rate.

Some examples are given below; illustrating the effect of the period of the investment.

Returning to the simple cash flow given paragraph 4-6.2 above, we can calculate the present value of the return at the end of the period (known as the net present value or NPV) and vary the period to look at the effect.

Using Equation 2, and assuming a discount (interest) rate of 10%, the NPV of the project summarised in the cash flow has been calculated assuming a total duration of 20 years, 10 years, and 5 years:-

Cash flows equally spaced over 20 years

	Year 0	Year 10	Year 20	NPV
Cashflows	-£1,000,000	£1,500,000	£1,500,000	
Discount factor[2]	1	0.3855	0.1486	
Present Values (PVs)	-£1,000,000	£578,250	£222,900	-£198,850
Cumulative PV	-£1,000,000	-£421,750	-£198,850	

2 See equation 2 above.

Cash flows equally spaced over 10 years

	Year 0	Year 5	Year 10	NPV
Cash flow	-£1,000,000	£1,500,000	£1,500,000	
Discount factor	1	0.6209	0.3855	
Present Values (PVs)	-£1,000,000	£931,350	£578,250	£509,600
Cumulative PV	£1,000,000	-£68,650	£509,600	

Cash flows equally spaced over 5 years

	Year 0	Year 2.5	Year 5	NPV
Cash flow	-£1,000,000	£1,500,000	£1,500,000	
Discount factor	1	0.7880	0.6209	
Present Values (PVs)	-£1,000,000	£1,182,000	£931,350	£1,113,350
Cumulative PV	-£1,000,000	£182,000	£1,113,350	

In the first example, if the original investment capital of £1M had been borrowed for 20 years at an interest rate of 10%, the project would lose money and the project would not appear attractive to an investor.

The second example shows that the return on investment will exceed the cost of capital over 10 years but that we have to wait for more than 5 years to start generating a positive return. The appropriate investment (or asset value) in this case would be £509,600.

In the third example, a positive return is generated before the end of the first 2.5 year period and the NPV at the conclusion of the period is £1.113M.

For a ‘full blown’ quarry cash flow, sensitivity analysis is an important part of this type of exercise. The sensitivity of all cost and marketing assumptions is tested as is the sensitivity to the discount rate chosen. The sensitivity of the NPV to key assumptions helps the investor to determine the risks associated with the investment opportunity and informs his decision in respect of whether those risks are acceptable or not. In general terms, the higher the risk, the greater the required return on investment. Clearly, identification of key variables and associated sensitivity analyses will be critical in assessing appropriate asset values or compensation for loss of working rights, especially in the event of a dispute.

Normally, for a quarry project, the periods in the cashflow will be one year or less. They may be less at the initial stages of the project where significant investments are being made and there is a need to understand cash flows in great detail in order to plan cash requirements. Where less than a year, they are simply expressed as decimal fractions of a year (e.g. 1.25 years) and used in the formula as with whole years.

Although discounted cash flow models for rental and royalty income streams are less complex than operational models, the principles are precisely the same.