SECTION 5 : PROJECT OVERVIEW

5.1 INTRODUCTION

The background of the project and the reasons for investigating the potential of constructing a hydro power plant on the Okavango River upstream of the Popa Falls are given in Section 1 of this Report and need not be repeated here.

The project provides for the possible construction of a low to medium head run-of-the-river hydro power plant at a suitable location upstream of the Popa Falls. A low head plant is operates at a head of 6 m or less whilst a medium head plant would operate at heads between 6 m and 25 m. A run-of-the-river hydro power plant operates at a constant head for most of the year providing a constant power output. During low flow periods the head, and as a consequence, the power generated, would drop. A run of the river hydro power plant is designed to operate continuously at maximum power output.

Due to the ecological and environmental sensitivity of the Okavango Swamps and islands in the Okavango River with unique and rear habitat, it was essential that weir heights, and hence impoundments be minimised whilst at the same time striving to maximise power output. A further essential restriction placed on the project was that sediment transport may not be disrupted as this could result in severe channel scouring and removal of sediments downstream of the weir.

5.2 DESIGN REQUIREMENTS

5.2.1 POWER OUTPUT

The underlying principle of the design of the hydro power plant is to maximise power out for a given weir height, which should ideally lie between 20 and 25 MW. This process of optimisation therefore gave consideration to the use of conventional bulb turbines and Hydromatrix turbines.

In this study two main types of turbines were investigated, namely the conventional Bulb Turbines and the Hydromatrix Turbines. The Bulb Turbines are generally mounted horizontally but can also be mounted vertically, in which case they are called Pit Turbines. For hydro power stations with low heads it is often more economic to use the pit turbine/generator concept which has the advantage that a step-up gearbox can be used to increase the speed of the generator to make the installation more compact and therefore less costly. Such installations are generally more feasible in the ultra low head range, i.e. less than 6 m.

Hydromatrix turbines are a relatively new concept of hydraulic energy generation which combines the advantage of proven technology and low cost installation. These turbines are easily integrated into existing dam structures or weir. The Hydromatrix design utilises a factory assembled module of small propeller turbine-generator units (± 0.75 MW each) which are easily installed into existing gates incorporated into the spillway structure. Both types of turbines have been considered in this study.

5.2.2 ENGINEERING REQUIREMENTS

The weir heights considered for the Popa Falls application range from 6,5 m to 11.5 m with the higher limit being investigated to determine the sensitivity of weir height on the economic viability of the project. For the purpose of this study, practical weir heights were limited to between 6.6 m and 9.75 m in order to limit impacts resulting from impoundment.

To ensure that the hydro power plant can operate at maximum power output for as long a period as the river flow allows, it was essential that spillway gates be provided that would automatically open gradually as the discharge over the weir increases beyond a certain pre-defined overflow depth, to prevent flooding upstream of the weir. These gates, which have been patented in South Africa by Flowgate Projects, would close automatically as the flood recedes thereby ensuring that the turbines operate continuously at maximum power output. Similar gates have recently been installed in the Avis Dam spillway in Windhoek, Namibia.

The weir, irrespective of its height, incorporates twelve 10 m wide spillway gates and nine 7 m wide Hydromatrix Turbine Modules. The number of spillway gates required was defined by the sluicing requirements, which provided for the rapid drawdown of the water level in the impoundment for the purpose of removing the accumulated sediments in the weir basin. The positions the spillway gates and Hydromatrix Modules are alternated as best as possible over the length of the weir to ensure an even flow discharge across the width of the river to minimise possible scour effects in the river channel downstream of the weir.

A sediment by-pass system was also investigated whereby sediment transported down the river are trapped at the head of the basin and channelled into a pump sump and pump station located on the river bank from where it is then pumped to discharge back into the river immediately downstream of the weir. Such a system would not only prevent the accumulation of sediment within the weir impoundment but would also eliminate the scouring effects downstream of the weir. In the case of this option, the number spillway gates can be reduced to 6.

The flank walls of the weir will be either mass gravity concrete walls or earth embankments with a clay core.

5.3 ENVIRONMENTAL REQUIREMENTS

In order to fulfil the requirements of sustainable development, a project should try and optimise the financial, technical, social and environmental components, i.e. to ensure that the project can proceed at the lowest cost financially, socially and environmentally. This is sometimes difficult to estimate, measure and achieve and compromises have to be made. However, it is important to set goals from the outset and then strive to achieve them within the cost and technical constraints of the project. The technical and financial goals are set out above and the social and environmental objectives for the project are listed below:

- The site for the weir should be chosen on the basis that the area of inundation will have the minimum impact on: rare island habitats, riverine vegetation, important faunal breeding areas, Red Data Book species, archaeological and cultural sites e.g. graves, dwellings, institutions, businesses, infrastructure, agriculture, rural livelihoods and tourism activities.

- The natural flow in the river should be interrupted as little as possible, because the seasonal cycles in the hydrograph trigger an unknown number of complex ecological processes downstream. A collapse of one component of the foodweb could have far-reaching consequences in the ecology of the Okavango River and Delta (see the PEA Report). This is especially important given that the Okavango Delta is a Ramsar site i.e. an area internationally recognised in terms of the Ramsar Convention as being important for waterfowl. The rich biodiversity of the Delta is the basis for the lucrative tourism business in Botswana, which is currently the fastest growing economic sector in the country (SAIEA, 2003). The actual minimum flow requirement is not yet known, but it should not be a single flow volume, constant throughout the year, but rather if there are to be any flow disruptions, then the minimum flow should be expressed as a percentage of the hydrograph.

- As discussed in **Section 5,** the movement of sediment should not be interrupted at all because of the predicted impacts on the geomorphology of the Okavango River and Delta. This means that a method needs to be found to ensure that there is a constant flow of sediment through or round the impoundment.

In summary, therefore, the main environmental objective is to minimise the negative impacts of the proposed development and to maximise the benefits to ensure the long-term sustainability of the scheme.