Analysis of the Final Feasibility Study and Environmental Impact Assessment for the Proposed Chalillo Dam

Prepared for The Belize Alliance of Conservation Non-Government Organizations

by

Conservation Strategy Fund

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Executive Summary

This report contains an analysis of the Final Feasibility Study and Environmental Impact Assessment (EIA) for the Macal River Upstream Storage Facility, also known as the proposed Chalillo dam. We examine the economic net benefits of the Chalillo project, as well as the adequacy of environmental mitigation plans detailed in the EIA. This report follows a September 1999 study, also by the Conservation Strategy Fund (CSF), on an earlier version of the Feasibility Study. This analysis was done on behalf of the Belize Alliance of Conservation Non-Government Organizations, in collaboration with hydrology consultants Philip Williams & Associates and with economist Dr. Linwood Pendleton. PWA and Dr. Pendleton have produced separate reports, which are supporting documents to this report.

Economic viability of the Chalillo dam

We conclude that the project is not economically viable. <u>The mean net present value (NPV) for the project is estimated at -$4.5 million</u>.[1] Given large uncertainties associated with the project, a point estimate for the NPV is not sufficient to evaluate the project. Therefore, we performed a risk analysis to determine the *probability* of economic viability. <u>Using plausible ranges for key variables, the risk analysis indicates that Chalillo would have a 32 percent probability of economic viability</u>.

Consumers would not see a dramatic change in their bills resulting from the Chalillo project. Rates could go up by around 7 percent initially, which translates to an increase of around $1.60 (B$3.20) on the average monthly residential electricity bill. Over time, though, the difference in rates between a scenario with Chalillo and the no-Chalillo scenario would diminish (as the dam replaced progressively more expensive sources of electricity).

These conclusions differ from findings of BEL consultants, AGRA CI Power (ACIP). The differences stem from three important differences between our assumptions and those of ACIP. The first and most decisive has to do with the estimation of project benefits. ACIP assumes that the value of electricity produced by the project would be between US$0.06-0.07 per kilowatt-hour (kWh). This is roughly double the figure used in past ACIP and CSF analyses, which both based the avoided-cost figure on the price of imported Mexican electricity. At the date of this writing we have not been provided with the methodology that guides ACIP's avoided-cost calculation. Our approach is as follows:

For peak power, which represents less than 10 percent of Chalillo's production, we assume that Mexican power sets the avoided cost figure. For off-peak electricity associated with Chalillo, we assume that, in the absence of Chalillo, BEL would maximize purchases of Mexican power, priced at around $0.03 – between a half and a third of the cost of diesel generation. We assume that any off-peak demand in excess of the 70 percent of the capacity of Mollejon and Mexican imports would be covered with

[1] Monetary figures in this report are in year 1999 US$ unless otherwise noted.

diesel generation. If there is currently some bottleneck to the reduction of off-peak diesel use, that bottleneck will not be solved by Chalillo, so Chalillo cannot be initially credited with substantially avoiding diesel use. In our calculation, the avoided alternative power is therefore initially composed of 97 percent Mexican electricity. As demand grows over time, the figure incorporates more and more of the higher cost diesel, up to 82 percent at the end of 40 years. The 40-year average for this off-peak avoided cost figure is $0.057/kWh.

The second difference between our assumptions and those of ACIP comes in the way we estimate external costs; ACIP does not include external costs in their economic analysis. Without external costs, the project has a negative NPV even before considering cost overruns. The true economic project cost could be US$4 million higher than estimated if one considers the potential impacts on transport, forestry and tourism, meaning that the NPV could go to -$8.5 million. We also examine a very optimistic scenario in which external impacts are actually positive and lead to a maximum external benefit of $1.5 million. In this scenario, the NPV would rise to -$3 million; still far below the minimum threshold for economic feasibility. This limited subset of external costs does not include many of the 44 line items in the EIA's environmental management plan. It also excludes many of the difficult-to-quantify items such as losses of wildlife, cultural resources and a variety of downstream uses.

The Feasibility study affirms that a 10 percent cost overrun would render the project infeasible. World Bank research has established that the average hydro project in a developing country goes 27 percent over budget. A cost overrun in this amount would result in a construction cost of over $35 million and a NPV of around -$12 million. This sort of miscalculation becomes less likely as the Chalillo site and design are studied in more detail.

The third difference between our analysis and that of ACIP is that the ACIP Feasibility study rests on very uncertain hydrological information. Hydropower generation depends on flow, and mean flows at the two sites could be substantially higher or lower than the means calculated from the incomplete data that are available from the relatively short period of records. It is important to note that uncertainty is largely biased towards less production rather than more. While lower flows could reduce generation well below the estimated 72.9 gigawatt-hours (GWh), the scale of the dam limits additional generation from higher flows. Further, uncertainty over peak flows raises the possibility that the dam may need to be built to withstand a significantly (60 percent) larger flood than is now foreseen in the project plans.

Environmental Impact Assessment

Our main objective in reviewing the Environmental Impact Assessment is to ascertain whether the emphasis in the environmental mitigation plans matches the most important and irreversible impacts the Chalillo dam would cause. On the way to that objective we examine issues of site selection, the consideration of alternatives, cumulative environmental impacts, integration of the EIA with the Feasibility Study, the emphasis of the mitigation plan, suggested mitigation priorities, and an issue of process.

Site selection: The EIA contains a useful application of criteria developed by George Ledec, Juan David Quintero and Maria Mejia, of the World Bank for dam site selection. The EIA concludes that Chalillo is a better site than the alternative site at Rubber Camp. The World Bank criteria are intended not only for site selection in a given watershed, but also for the determination of whether the best site in the watershed is socially and environmentally acceptable.

Applying the World Bank criteria highlights the fact that, unless they are very large, dams either have large direct impacts on people or large impacts on natural habitats, but not both. The remote valley Chalillo would flood has no human inhabitants, no infrastructure and no crops. Its human uses in recent decades have been limited to research, military exercises, and logging. The notable direct impacts associated with the Chalillo reservoir would be the loss of critical natural habitat. The 953-hectare Chalillo reservoir would be small in absolute terms. Relative to the power likely to be generated, however, the flooded area is large. Ledec and his colleagues consider dams flooding more than 50 hectares per MW installed capacity as environmentally "bad" (WB authors' term). Chalillo would submerge 114 hectares of relatively rare habitat per MW of new capacity.

Consideration of alternatives: The EIA's consideration of alternatives is limited to a comparison of Chalillo to one alternative Macal dam site, called Rubber Camp. The purpose of the Chalillo proposal is not to dam the Macal River; it is to supply electricity. Therefore, a consideration of alternatives should weigh the environmental impacts of Chalillo against other options for supplying electricity.

There are several alternatives that probably have fewer impacts than the Chalillo projects – primarily Mexican imports and bagasse (or other biomass now burned). Environmental costs associated with the production of Mexican power are borne by Mexico. Bagasse energy would have limited new impacts since its main impact is air pollution and much of the bagasse is already burned without generating electricity. There are also alternatives that would have significant impacts that are very different from Chalillo's impacts. New diesels would cause both noise and air pollution. Windmills might have negative impacts on scenery and birds. It is very difficult to make a direct comparison of these impacts to those that would be caused by the Chalillo scheme. Nevertheless, this is the charge of the EIA team and a comparison of alternatives is normally considered a requisite component of the EIA.

Emphasis of mitigation: While reasonably thorough treatment is given to many of the direct physical impacts of the project, ecological impacts are not adequately addressed. The Executive Summary (p.1) states that information on wildlife is "insufficient and inconclusive." To fill the gap on wildlife, Appendix 3 of the report contains terms of reference for a literature review limited to three species. We question the adequacy of an assessment of overall wildlife impacts that limits its scope to three species and does not include any field investigation.

Process: The EIA should not be considered complete until all sections – including the wildlife study and mitigation plan – are included in the report, and until the complete report and all supporting documents are publicly available at the Department of Environment office in Belmopan.

Recommended mitigation/compensation: We suggest that special emphasis be placed in two areas to avoid and compensate for the least reversible of potential environmental impacts:

1. Compensate for the loss of natural habitat. When impacts on ecosystems cannot be avoided, the next best option is to compensate for them with offsetting conservation investments elsewhere. Offsetting protected areas should ideally support similar species as the area affected by the dam. In the event that no such area exists within the country, the World Bank authors cited above affirm that the dam should probably be rejected altogether on environmental grounds.

   In choosing a compensatory protected area, there are several other important considerations: First, the offsetting protected area should be of a similar size as the dam's area of influence, not of the inundated area alone. Second, a valid form of compensatory protection is to provide funds for legally established protected areas, which are at risk because they lack funds for on-the-ground implementation. If a new area is purchased for protection purposes, funds should be provided at least for establishment and operation over the short-term. Finally, funds provided for the purpose of offsetting protection should be placed in a special trust fund, separate from other government accounts, even if such accounts are also used for nature protection purposes.

Prevent settlement in the Mountain Pine Ridge and Chiquibul Forest Reserves, the Chiquibul National Park and the Caracol Natural Monument Reservation. This goal will require 24-hour control of access to the area.

Introduction

In December 1999, Belize Electricity Limited (BEL) released a Final Feasibility Study and Environmental Impact Assessment for the construction of the Chalillo hydroelectric dam on the Macal River in western Belize. The Chalillo scheme consists of a 46-meter-tall storage dam to supply water to the Mollejon run-of-the river dam, 13 kilometers downstream. The existing Mollejon dam, commissioned in 1995, was built and is operated by a private company, Belize Electric Company Limited (BECOL), owned by USA-based Duke Energy. The new dam would store water during the rainy season and then release it during the dry season to power the turbines of the Mollejon facility. The preferred configuration for Chalillo includes a power plant at the toe of the new dam.

This proposal comes amid continued changes in Belize's electricity sector. The last 15 years have seen dramatic increases in electricity consumption, fundamental shifts in supply, the establishment of an interconnected grid, and changes in corporate and regulatory aspects of the electric power sector. From 1987 to 1993, total electricity consumption grew at 12 percent per year. Part of the rapid growth in this period was due to an aggressive rural electrification program, which brought the proportion of electrified households to 80 percent. Between 1989 and 1993 the government paid for electrification of 131 villages at a cost of $13 million (World Bank 1994). [2]

Between the fiscal years 1993/1994 and 1997/1998 growth slowed to an average of 5.6 percent (BEL 1999). Even during that period there were high growth years, due in part to the Second Power Development Project. This $37 million project spurred sales by connecting isolated commercial and industrial users, which had formerly produced their own energy with diesel generators. The so-called "Power II" project enabled Belize to replace some of its diesel generation with new sources of energy: electricity imports from Mexico and hydropower from the Mollejon dam.

Over this period, Belize's electric utility has transformed from the Belize Electricity Board (BEB) to Belize Electricity Limited (BEL). In October 1999, the majority state-owned company became private by selling over 40 percent of its shares to the Canadian company, Fortis Incorporated. This move necessitated a change in the country's regulatory framework, which included the creation of a public utilities commission to oversee the privatized electricity distribution system.

In January of2000, The Belize Alliance of Conservation Non-Government Organizations (BACONGO) retained the Conservation Strategy Fund (CSF) to interpret and analyze the final Feasibility Study and EIA. (CSF was also hired in July of 1999 to analyze the Stage 1 report of the Feasibility Study.) This report, the fulfillment of the agreement between BACONGO and CSF, begins by examining differences between the Stage 1 and Final Feasibility reports produced by AGRA Power CI (ACIP). We then examine the main assumptions underlying the results of the final report. Next we calculate the probability of economic viability under alternative scenarios. Finally, we turn to the dam's EIA, and analyze the adequacy of its mitigation recommendations.

[2] All figures in this report are in US dollars, unless otherwise noted.

Feasibility Study

Review of Stage 1 Feasibility Study

The Stage 1 Feasibility Study is so called because it did not include some of the more costly elements of a full feasibility study, such as geotechnical surveys. The Stage 1 study was conducted to ascertain whether the Chalillo proposal was worth further investigation. The economic conclusion of the study was that the Chalillo dam with a toe-of-dam powerhouse would have a net present value (NPV) of -$3.5 million. A project needs to have an NPV of zero or greater in order to be economically viable, meaning that that option was not economically viable. The one configuration that returned a positive NPV was a scheme with a powerhouse at the end of a long tunnel; the tunnel alternative has been discarded, apparently because of its high capital cost. The second important finding of the Stage 1 Study was that it would be advantageous for BEL to purchase the Mollejon dam for the minimum buyout price of $75 million, regardless of whether Chalillo was built.

CSF's analysis concurred with the Stage 1 study's finding on the project's viability, but differed on the conclusion that BEL should buy Mollejon. The CSF analysis indicated that Chalillo would have a NPV of -$5.4 million. The higher losses estimated by CSF were due to the fact that the Stage 1 study assumed that the price of the alternative power supply, Mexican imports, would be slightly higher than they have actually turned out to be. On the question of the Mollejon purchase, we found that the $75 million would buy only $64.6 million worth of electricity (in present value terms.) The Stage 1 report calculated that the benefits would be $76.64 million, based on production of 112 gigawatt-hours (GWh) per year. Based on our meetings with BEL staff and management at the Mollejon plant, we assumed annual production of 90 GWh per year. Output of 108 GWh per year would be needed to make the Mollejon purchase advantageous (95.8 GWh per year is now assumed in the Final Feasibility Study).

Reid et al. (1999) found that building the Chalillo dam would have only a slight impact on retail electricity rates. A rise of around five percent in rates was considered most likely, and a drop of at most two percent possible. A decline in electricity rates drop would depend on Chalillo displacing all of the country's consumption of diesel power – an unlikely scenario.

Changes in Final Feasibility Study

The Final Feasibility Study, performed by the same consultants, Agra CI Power (ACIP), reaches a different conclusion than the Stage 1 report on the question of Chalillo's viability (the Mollejon purchase is not addressed in the final version of the Feasibility Study). The ACIP Final Feasibility study concludes that Chalillo would have a *positive* NPV of $3.2 million. In this section, we will explain changes in ACIP's analysis that account for this difference.

Value of Chalillo Output: The economic value of the power attributed to the Chalillo facility is equal to the cost of the alternative power sources Belize can substitute for Chalillo if the dam is not built (Black et al. 1998). In the ACIP Stage 1 study, it was assumed that Chalillo would enable Belize to avoid imports of electricity from Mexico (the next best alternative power source.) The value of the dam's generation was therefore set at the import price of Mexican power. More than 90 percent of the additional generation from Chalillo would be during off-peak periods, during which the Mexican price is around $0.03 per kWh. The logic of avoided-cost pricing is that if Belize does not have the Chalillo dam, it will use the cheapest source of alternative power for the electricity that Chalillo would have provided. In the new analysis the price of avoided alternative power sources is assumed to be more than $0.06 per kWh. In other words, the assumed unit value of the new generation in the ACIP Final Feasibility Study is roughly double the value assumed in the earlier study, though the rationale for the change is still unclear.

Output: The estimated total amount that the two dams would produce has increased from 162.4 GWh/year to 168.9 GWh/year. Further, Mollejon's assumed long-term average production has been reduced from 112 GWh/year to 95.8, meaning that a greater share of the total production is now attributed to the Chalillo project. In absolute terms, Chalillo's predicted production has increased from 49.9 GWh to 72.9 GWh/year, an increase of 46 percent over the previous study. In the simplest terms, the ACIP Feasibility study attributes the increased output to the fact that the Macal River is subject to larger flows at higher flow frequency (more flooding) than was originally supposed. Those floods are thought to now be spilling over the Mollejon dam, and would be captured and stored by the Chalillo facility.

Construction Cost: In the Stage 1 Study the construction cost for the dam was put at $20.4 million. The final Feasibility report estimates that the dam will cost $27.8 million. That change is presumably due to the more detailed studies and design work the consultants have now completed.

These are the three most important variables in the analysis, and all three have changed substantially since the Stage 1 report. The 46 percent increase in estimated generation, combined with the near doubling of the assumed value of generation adds approximately $16 million to the projected benefits . The 36 percent increase in predicted construction expenditures adds around $8 million (including higher maintenance expenses) to costs. The net effect after discounting is that the ACIP Feasibility shows a project with a positive NPV – an increase of $6.7 million.

Examination of key variables

Avoided thermal cost: As noted above, the energy expenditures BEL avoids by building Chalillo represent the direct economic benefits of the project. The two potential alternative sources for the Chalillo generation are electricity from Mexico, and power produced by BEL's approximately 26-30 MW of interconnected diesel-powered generators (30 MW capacity figure from www.bel.com.bz, February 10, 2000; 26 MW from BEL 1999 Annual Report).

As mentioned above, in the Stage 1 study the cost of Mexican power determined the avoided-cost price for both peak and off-peak power. In the ACIP Feasibility Study, it appears as if a combination of Mexican and diesel prices is used for at least the off-peak avoided cost figure. The question is, what is the correct avoided-cost price? To answer that question, one must ask, "in the absence of the Chalillo project, what sources will supply Belize's power during peak and off-peak periods?"

During peak periods, BEL should maximize purchases from Mollejon, where the firm capacity is 21.3 MW. In theory, diesels should be able to supply all the remaining peak needs for several years at a unit cost of around $0.08/kWh. In practice, Belize is already importing small amounts of Mexican peak power, 5-7 GWh per year at a unit cost of around $0.21/kWh (Lynn Young and Joseph Sukhnandan, personal communication, July 1999). For peak generation added by Chalillo, we adopt the Mexican peak price because, although these imports are in theory avoidable without Chalillo, they will not be avoidable in several years when peak demand exceeds the capacity of Mollejon plus the diesels. This assumption favors Chalillo economically.

For off-peak energy, BEL should use remaining capacity at Mollejon, up to the amount it is required by contract to purchase. After that, BEL should purchase up to the negotiated maximum 25 MW of Mexican power, at $0.03/kWh. We assume that any off-peak demand in excess of the 70 percent of the capacity of Mollejon and Mexican imports would be covered with diesel generation. In the short-run, Mollejon and imports should be able to cover all off-peak consumption. If non-isolated diesels[3] are now being used extensively during off-peak hours, they should be idled in favor of Mexican power *regardless of whether Chalillo is built*. Given Belize's present electricity sector configuration, diesel generation should be used to provide peak power; Chalilloshould provide off-peak power.

Our calculation indicates that initially 97 percent of the off-peak avoided alternative electricity would be from Mexican power. As demand grows from the current average load of around 23-25 MW, diesel use (or other sources) would increase, and comprise a greater portion of the avoided cost figure. The 40-year average for this avoided cost figure is $0.057/kWh. Diesel would account for 82 percent of the avoided cost figure by the end of 40 years.

This estimate obviously cannot account for every future scenario and all the intricacies involved in BEL's management of available power sources. For instance, more diesel plants could be built for peaking needs, more power could be obtained from Mexico, the price of Mexican power could go up or down in a future contract, and/or other renewables could come into use in Belize. The estimate does, however, represent the principle that Belize should use cheaper power sooner and more expensive power later, where it has the flexibility to do so.

[3] Around 4 MW of isolated diesels serve areas not yet connected to the grid.

Output

Potential power generation at Mollejon and the proposed site at Chalillo depends upon the available flow in the Macal River. Philip Williams & Associates (PWA) undertook a review and analysis of available hydrology information as part of this report and came to the following conclusions regarding the hydrological aspects of the Chalillo project (PWA's full report, Bowles et al. 2000, is a supporting document provided to BACONGO with this report).

The uncertainties associated with the existing hydrologic analyses in the Macal River basin mean that power generation estimates are subject to a high degree of uncertainty. Faced with such uncertainties in power generation estimates it is prudent to take into account the statistical confidence interval in flow estimates to estimate reliable power generation. The ACIP power generation estimates are presently based solely on average values and hence no estimate of the uncertainty of the calculations has been provided by ACIP.

Generally, only small discrepancies were observed for the 15-year averages for flows at Cristo Rey, Mollejon and Chalillo between the analyses of PWA and ACIP. Nonetheless, the length of time over which records are provided for Cristo Rey is insufficient to predict reliably the long-term average flows or the range of flows that could be expected on the Macal River. The period of records available amounts to 15 years of incomplete, non-continuous data. Large uncertainties are associated with the methods employed by ACIP for the calculation of 15-year average flows and these uncertainties are accentuated with reduced periods of correlation data used for statistical generation of records particularly at Mollejon and Chalillo.

Statistical generation of 15 years of records at Mollejon is unreliable since it is based on only 32 months of incomplete and non-continuous data from Mollejon power logs. Statistical generation of 15 years of records at Chalillo is also unreliable since it is based on assumptions derived solely on catchment ratios and 5 sets of low-flow measurements made by ACIP in May and June 1999. No comparisons of the data to the long-term climatic regime in Belize have been made by ACIP. Tables 1 and 2 show the ranges of possible mean flows using 50, 70 and 95 percent confidence intervals.

Table 1 - Mollejon 15-Year Averages

Site	**Mean** (m^3/s)	**95%** (m^3/s)	**70%** (m^3/s)	**50%** (m^3/s)
ACIP Mollejon	21.3 (21.1)[1]	N/A	N/A	N/A
PWA Mollejon	20.5			
PWA Mollejon + Confidence Limit		69.0	37.5	31.3
PWA Mollejon – Confidence Limit		6.2	11.2	13.4

[1] 15-year average calculated by ACIP = 21.1m^3/s, compared to 21.3 m^3/s calculated by PWA using ACIP data.

Table 2 - Challillo 15-Year Averages

Site	Mean (m^3/s)	95% (m^3/s)	70% (m^3/s)	50% (m^3/s)
ACIP Chalillo	17.9 (17.7)[1]	N/A	N/A	N/A
PWA Chalillo	17.2			
PWA Chalillo + Confidence Limit		67.3	36.4	30.2
PWA Chalillo – Confidence Limit		4.9	9.0	11.0

[1] 15-year average calculated by ACIP = 17.7m^3/s, compared to 17.9 m^3/s calculated by PWA using ACIP data.

Using a 50 percent confidence limit instead of the mean flow used by ACIP would result in a *reliable* power generation of approximately 45.2 GWh instead of 72.9. In our calculation of economic feasibility, we still use the mean figure – 72.9 GWh – but merely note the significant risk that generation could be far lower.

If development of the upper Macal basin continues to be considered, PWA recommend that an intensive program of flow measurements be undertaken including the installation of a long term gauge at the Chalillo site, in order to reduce the uncertainty of average flows estimates.

The data provided by ACIP also are inadequate to accurately estimate flood flows for the Macal River. To minimize the possibility of dam failure, flood return periods based on the "Expected Probability Method" should be considered. The Expected Probability method weights estimates based on the statistical period for which records are available. For traditional flood flow calculations, 15 years of records constitute a relatively short period and hence the Expected Probability for the 100-year flood differs by up to 60% from the 100-year flood calculated by ACIP. The column labeled "Chalillo Expected Probability" shows peak return flows adjusted using the method described in the WRC Guidelines (WRC, 1981).

Table 3 - Chalillo Peak Return Period Flows

Return Period (Years)	Chalillo – ACIP (m^3/s)	Chalillo – PWA (m^3/s)	Chalillo Expected Probability (m^3/s)	Chalillo – 5% Confidence (m^3/s)	Chalillo – 95% Confidence (m^3/s)
2	530	530	530	765	363
5	1130	1102	1158	1832	765
10	1710	1664	1853	3173	1102
20	2410	2387	2857	5195	1495
50	3590	3650	4956	9407	2120
100	4690	4893	7511	14180	2682

PWA recommends that to conservatively design the structures at Chalillo, the Expected Probability peak return period flows should be adopted. For the side cofferdam, the design value of the 1:20 year flood of 2857m^3/s should be considered, a flow 18 percent greater than the design flow used by ACIP. Similarly, for the design of the main spillway, the 1:100 year flood of 7511m^3/s should be considered, a flow 60 percent greater than the design flow used by ACIP.

Taken together, uncertainty about mean flows and floods should compel developers of a dam at the Chalillo site to build the dam to withstand greater floods than are foreseen in the ACIP report, but to be prepared to run the facility profitably on flows much smaller than the means flows used by ACIP.

For related information – on sedimentation, geomorphology, and other environmental impacts – please see the full PWA report (Bowles et al. 2000).

Project costs

External costs

Large public works projects, such as dams, can generate impacts that do not directly affect project participants, but may have lasting and sizable impacts on the public at large (e.g. surrounding communities, ecosystems, and even national economies.) To begin accounting for these impacts, most prudent feasibility analyses include thorough Environmental Impact Assessments (EIA) that offer detailed descriptions of the most important of these impacts. While the direct physical nature, longevity, and regional dimensions of these impacts are described in the EIA, the economic costs and benefits of these impacts are rarely quantified and traditionally are omitted from both the EIA and the Economic Analysis required in Feasibility Studies. Because these economic impacts are seen as being outside the focus of the project and the feasibility analysis, they are referred to as external costs and benefits.

Public works projects, whether publicly or privately provided, represent an investment by society and should be treated like any other investment. The sum of all costs and benefits should be considered, especially if the project is to be undertaken on the public's behalf. Even a profitable project may create more costs than benefits when external costs are considered. Unfortunately, adding external costs and benefits to project costs and revenues is a difficult proposition. There often is a great deal of uncertainty involved in the identification and quantification of external costs and benefits. Chief among the causes of these difficulties are

- the lack of data about probable impacts and their costs/benefits
- the difficulty in valuing impacts that fall outside the "market"
- the difficulty in predicting the performance of the project (and the promises made in civil works plans), and
- the difficulty in determining the likelihood of catastrophic events and their impacts on the project (e.g. hurricanes).

Despite the difficulties involved in determining external costs and benefits, these economic impacts are every bit as real as those internal costs included in the cost benefit analysis. Projects that might result in large external costs must show beyond a doubt that the net internal benefits of the project exceed the possible external costs, no matter how difficult these costs are to quantify. This section attempts to examine possible external costs and benefits that could result from the proposed Macal River Upstream Storage Facility and Power Plant (MRUSF). Most of these impacts are outlined in the Environmental Impact Assessment. Table 4 provides a preview of the specific sectors that are mostly likely to be affected by the proposed dam. A more detailed description of the potential costs and benefits associated with these sectors follows.

Table 4 - A Preview of Sectors Considered

Sectors	Agency Impacted	Benefit	Cost	Benefit/Cost Accrued to:
1. Transportation	Ministry of Works		X	Govt. of Belize, drivers, passengers
2. Tourism		X	X	hoteliers, employees, craftsmen, farmers
3. Forestry/Land use	Department of Forestry	X	X	Govt. of Belize, loggers
4. Water Quality	Water and Sewerage Authority	X	X	W.A.S.A., citizens of river communities (from San Ignacio to Belize City)
5. Local Uses			X	fishermen, farmers, washwomen
Difficult to Measure				
1. Loss of Wildlife	Department of Environment		X	people of Belize, global loss
2. Cultural Sites			X	people of Belize, global loss

Table 5, below, summarizes the speculated values of the most important external costs and benefits that might be associated with the construction, impoundment, and operation of the MRUSF at the Chalillo site. For the full text and explanation of calculations, please refer to Pendleton (2000), a supporting document provided to BACONGO with this report. The potential external costs and benefits of the proposed Macal River Upstream Storage Facility could range from a net benefit of just under B$3 million (US$1.5 million) under the most optimistic scenario to a net cost of over B$8 million (US$4 million) under a far less optimistic, yet still conservative, scenario. The most significant costs could accrue to the transportation infrastructure of Belize and to the tourism economy of Cayo. Impacts on forestry, water quality, wildlife and some downstream uses are left out of our calculation due to a lack of data.

Table 5 - Potential External Costs and Benefits to Selected Sectors				
			Range of Speculated Economic Impacts (B$)[2]	
Activity	**Dam Phase[1]**	**Benefit or Cost**	**Lowest Cost (highest benefit)**	**Highest Cost (lowest benefit)**
TRANSPORTATION				
1. Construction on Western Highway	**Cn**		**- B$201,000**	**-B$4.65million**
a. Deterioration of road		C	B$0	-B$2million
b. Traffic congestion		C	B$0	-B$1million
c. Traffic accidents			-B$201,000	-B$1.65million
i. Vehicle loss		*C*	*-B$160,000*	*-B$160,000*
ii. Injury		*C*	*-B$8,000*	*-B$1.1million*
iii. Death		*C*	*-B$33,000*	*-B$.39million*
2. Chiquibul Road	**Cn/O**	**B/C?**	**?**	**?**
TOURISM				
1. Traffic and Road Work	**Cn**	**C**	**B$0**	**-B$2.53million**
2. River Flow and Water Quality	**Cn**	**C**	**B$0**	**-B$1.3million**
3. Reputational Impacts	**Cn/I/O**	**C**	**B$0**	**?**
4. Improved Roads	**I/O**	**B**	**?**	**B$0**
5. Moderation of River Flow	**O**	**B**	**+B$1.42million**	**B$0**
FORESTRY AND LANDUSE				
1. Increased Prob. of Forest Fire	**Cn**	**C**	**B$0**	**-B$200,000**
2. D'Silva Forest Camp Rental	**Cn**	**B**	**+B$1.68million**	**0**
3. Road Improvements/Power Line Construction	**Cn/I/O**		**?**	**?**
a. Forest clearance		C	?	?
b. Deterioration of road		C	?	?
c. Improved Access for Logging		B	?	?
WATER QUALITY				
1. Monitoring and Treatment	**Cn/I/O**	**C**	**?**	**?**
WILDLIFE AND ARCHEOLOGICAL LOSS				
1. Submersion of Land	**I/O**	**C**	**?**	**?**
OTHER IMPACTS				
1. Downstream Use	**Cn/I/O**	**C**	**?**	**?**
2. Catastrophe	**O**	**C**	**?**	**????**
3. Avoided Pollution	**O**	**B**	**?**	**?**
Total			*+B$2.89million*	*-B$8.68millliion+*

1: Dam Phase: Cn – Construction I – Impoundment O – Operation
2: All figures are undiscounted except for perpetual benefits from the moderation of river flows. The present value of all other costs and benefits that occur during the two-year construction period can be found by multiplying the two-year figure by .95 (10% discount rate) or .93 (at a 15% discount rate.)

It is one thing to assert that the dam developer should pay the external costs and quite another to ensure that these costs are covered. One way to ensure that the costs of external impacts are adequately covered by the project is to require the posting of performance bonds. Like a security deposit, bonds are posted to ensure that the firm meets certain performance criteria. If performance criteria are met, then the bond plus interest is refunded to the firm. If criteria are not met, then proceeds from the bond are used to help remediate the problem. In the case of the MRUSF, separate bonds could be posted for transportation impacts, water quality management, and even potential impacts on downstream tourism.

See Pendleton (2000) for an expanded discussion of potential external costs and benefits that could result from the proposed Chalillo Dam.

Analysis of Economic Viability

We now turn to the calculation of Chalillo's net present value. First we calculate NPV independent of ownership questions and then look at the implications of its relation to Mollejon.

<u>Net present value and probability of viability</u>

The net present value of Chalillo is simply the discounted stream of benefits minus the discounted stream of costs. In this case we have adopted a 40-year timeline as the economic life of the project. Our first approach at this analysis was to attempt to replicate the results presented by Agra CI Power (Agra CI Power 1999a). We were provided access to some of the parameters needed for this analysis, but did not have access to most information on ACIP's methods and assumptions. The main assumptions provided to us were the following

Total construction cost of the project	$27.8 million
Economic discount rate	13.3%
Construction time	2 years
Additional peak power output	4.6 GWh/year
Additional off-peak power output	68.3 GWh/year

Among the most important information not available to us were the following:

- Avoided cost assumptions (these determine project benefits). The avoided-cost variables were defined as discussed above, under *Examination of key variables:* <u>Avoided thermal cost</u>.
- Probability distribution of power output (range of possibilities). We structure the distribution of generation of peak power as a normal distribution with a standard deviation equal to 10 percent of the mean. The off-peak generation range is much larger and more uncertain. We therefore adapted the confidence intervals from our calculation of flows and applied them to off peak power. This is not a normal distribution, because there is an upper constraint on generation, imposed by the size of the dam and its turbines.

- Annual operation and maintenance costs. Annual operation and maintenance costs are assumed to be 2.5 percent of construction costs. This assumption is adopted from the 1990 Renewable Energy Study (CI Power Services 1990).
- Periodic reinvestment costs. No periodic reinvestment costs have been included due to a lack of information.

A full list of assumptions is given in Annex 1.

Net present value is given by the formula: $\sum_{t=0}^{40} \frac{B_t - C_t}{(1+i)^t}$

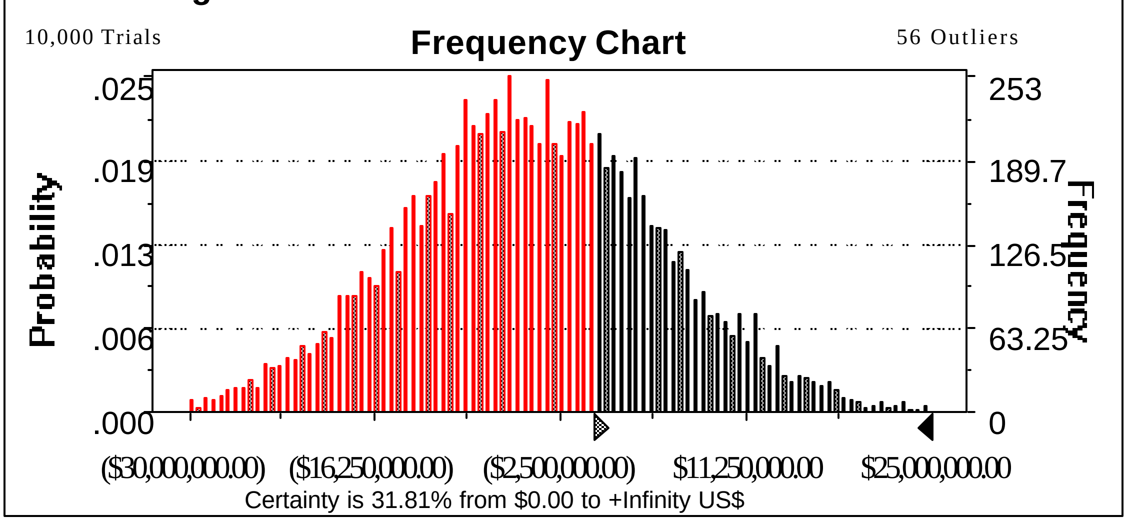
t = Time in years
B = Benefits
C = Costs
i = discount rate

Before considering the probability distributions of variables in the analysis, the mean net present value is -$4.05 million. Incorporating the external cost estimates from above, the NPV could range from $2.5 million to -$8 million. Given that any estimate of this sort involves uncertainty, it is prudent to focus less on this point estimate than on the *probability* that the project will have a net present value greater than zero (the threshold for viability).

Risk analysis

Risk analysis is the tool for measuring this probability. In this analysis we specify a range of likely values for some of the more important variables. Probability distributions are assigned around the mean values for each variable. Risk software generates different combinations of these values and shows the range of possible NPVs. We ran 10,000 combinations of the variables in order to arrive at this range of possible NPVs.

Figure 1 – Forecast of Challillo: Economic NPV



The risk analysis chart above indicates that there is a 32 percent chance that the project will be economically viable, before counting any external costs. The mean NPV in the risk analysis is -\$4.47 million. We artificially assume a normal distribution for power production. The actual distribution would be truncated on the upper end, since the design flow imposes a limit on how much power can be produced. That means our assumption overestimates the NPV. We have also assume a normal distribution for construction costs, with an equal possibility of cost savings and cost overruns, despite the fact that the typical hydroelectric dam project in developing country goes 27 percent over budget (Bacon et al. 1996). An overrun of this size would drive Chalillo's NPV to less than –\$12 million. This sort of miscalculation becomes less likely as the Chalillo site and design are studied in more detail.

Projected change in retail electricity bills

Consumers would not see a dramatic change in their electricity bills resulting directly from the Chalillo project. If Chalillo's output met ACIP's predictions, rates could initially go up by a maximum of around 7 percent, or 2.2 Belize cents per kWh. For the average residential consumer, who buys 148 kWh per month, the monthly bill would go up by B\$3.26. If the dam under-produced, the increase would be greater. Over time, though, the difference in rates between a scenario with Chalillo and the no-Chalillo scenario would diminish (as the dam replaced progressively more expensive sources of electricity).

The simple calculation for the rate change is as follows: $\frac{C_2 - C_1}{P}$

C_1 = The unit cost of electricity to BEL in 2001/2002, without Chalillo
C_2 = The unit cost of electricity to BEL in 2001/2002, with Chalillo
P = The current unit cost of electricity to a residential consumer buying the average of 148 kWh per month

The figures in this calculation are: (.0860-.0755)/.156 = .067

Relation to Mollejon: If Duke Energy, owner of the Mollejon plant built Chalillo, the economic analysis performed above is sufficient. If however, BEL elected to purchase Mollejon, build Chalillo, and operate the two dams, additional analysis is needed to assess the unit cost of power. Since Mollejon has already been built, it would required a complicated avoided-cost analysis to place a unit value on its output (by value we mean economic value here, not the financial value, which is determined by the actual payments made for Mollejon power). Instead we merely calculate the unit cost of the Mollejon + Chalillo electricity, assuming two alternative buyout prices for Mollejon.

Buyout price 1 = \$75 million (minimum value per BEL/BECOL contract)
Buyout price 2 = \$69 million, (value of 95.8 GWh/year under BEL/BECOL contract)

At a buyout price of $75 million, the unit cost of Mollejon power would be $0.104 per kWh. This figure is arrived at by taking an annual payment of capital and interest on the construction cost of Chalillo plus the buyout cost of Mollejon, based on 40-year amortization at 13.3 percent, adding the operation and maintenance cost, diving by kWh produced in a year and adding 1.5 US cents for profit. At $69 million, if such a price could be negotiated, the unit cost would be $0.099. Both figures are above the projected $0.081 unit cost of Chalillo's production and above the financial unit cost of buying Mollejon power (assuming that Mollejon averages above the minimum 85 GWh annual take over the long run). What does that mean? From BEL's perspective, it means that buying Mollejon in order to build Chalillo only makes sense if low-interest credit can be obtained for that purchase, or if the buyout price can be renegotiated to a lower level. Otherwise BEL is better off letting BECOL (Duke) retain ownership of Mollejon. From Belize's perspective, *as a nation*, however, buying Mollejon with low-cost credit would only be beneficial if the loan were subsidized by a non-Belizean source *and* could not have been put to more productive use in another investment.

The third scenario, in which the two dams are owned separately and operated under a revenue-sharing agreement, is not analyzed here. We can only point out that this arrangement would be inherently complicated, since there is very little history on which to estimate Mollejon's long-term production without Chalillo, and therefore little basis to establish Chalillo's contribution of additional power. Though CI Agra Power predicts that Mollejon will produce a long-term average of 95.8 GWh per year, the facility has yet to approach that figure. Last year's production was 67.9 GWh. The average over three full years of operation is 67.4 GWh. Further, even if this information were known, the Mollejon owner would probably have to share in additional revenues, even though they would bear no additional costs. Otherwise, they would have no economic incentive to optimize the use of the additional water provided by Chalillo.

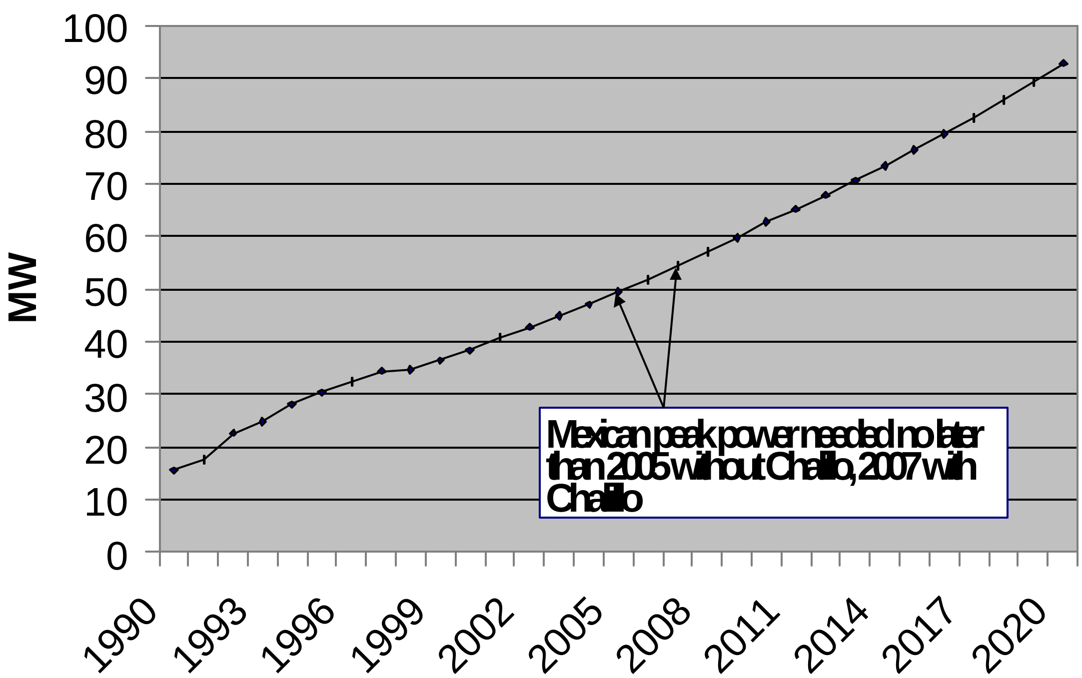
Emergency and energy independence value

One common reason for installing domestic generating capacity is to reduce reliance on foreign sources of energy. In this context, in particular, it has been argued the Chalillo project can avoid the need to buy electricity from Mexico at exorbitant prices. Chalillo's value for this purpose depends on how much peak power it would supply and how soon that power would be needed to prevent imports.

According to BEL, the utility has 30 MW of interconnected diesel capacity, and 4 MW of isolated diesels (www.bel.com.bz, February 10, 2000), in addition to the 21.3 MW firm capacity at Mollejon. Peak demand is estimated at around 35 MW. If the diesels could operate at 80 percent of capacity during peak periods, Belize could conceivably do without Mexican peak power until the year 2005. With Chalillo, Belize would be compelled to buy some Mexican peak power no later than 2007. Chalillo delays the need for Mexican peak power by two years. This timing is based on peak demand growth of 4.9 percent over the next ten years and 4 percent thereafter, as projected by the World Bank (1994). BEL projects a 6.5 percent rate for the coming years. (Lynn Young, Joseph Sukhnandan, personal communication, July 1999). Using that rate, the absolute need for

Mexican peak power would occur a year earlier – no later than 2004 without Chalillo and 2006 with the project.

Figure 2 - Belize Peak Demand



The question of peak power aside, it has been argued that Chalillo is good insurance against the chance that Mexican power could be cut off entirely, either for a short time, by some emergency, or for an extended time due to a decision taken by Mexico's power distribution authority. Another possibility is that prices charged by CFE could rise substantially. In our judgement, Chalillo is ill suited as insurance against temporary disaster. For one reason, some of the more common disasters that might sever Belize's link to Mexico, earthquakes or hurricanes, could very well cut off Mollejon and Chalillo at the same time. Second, there are already diesel plants in various parts of the country that might play the same insurance role. Third, a back-up system should have a low capital costs and high variable cost, the inverse of Chalillo.

On the more serious question of Mexican supply, there is uncertainty about the tendencies of the Mexican market. As a whole, Mexico is facing power shortages if the pace of capacity growth does not quicken. This trend is not true of all regions however. The industrial north is threatened with shortage, and is seeking to address the problem in part with additional electricity imports from the United States. Meanwhile the less-developed and gas-rich south has the prospect for electricity surplus (US Department of Energy – www.eia.doe.gov, January 20, 2000). Sales to Belize and, eventually, the Central American grid are likely to play a role in the disposition of this surplus. At the same time, a trend towards diminished state intervention in electricity markets could reduce subsidies to the energy sector. From these considerations, there is no clear trend we can discern in the future prices Mexico will charge its neighbors for electricity.

Environmental Impact Assessment

What follows is not an exhaustive critique of the Environmental Impact Assessment. Our main objective here is to ascertain whether the emphasis in the environmental mitigation plan matches the most important impacts the Chalillo dam would cause. On the way to that objective we examine issues of site selection, the consideration of alternatives, cumulative environmental impacts, integration of the EIA with the Feasibility Study, the emphasis of the mitigation plan, suggested mitigation programs, and an issue of process. Please also consult the two supporting documents – Bowles et al. (2000) and Pendleton (2000) – for discussions of environmental impacts.

Site selection

The EIA begins with a useful application of criteria developed by George Ledec, Juan David Quintero and Maria Mejia, of the World Bank, for dam site selection. In their paper, "Good Dams and Bad Dams: Environmental and Social Criteria for Choosing Hydroelectric Project Sites" (1999) – the authors present indicators to determine whether a site will be environmentally and socially "good" or "bad" for a dam. The EIA uses the criteria to determine that Chalillo is a better site than the alternative site at Rubber Camp.

The World Bank criteria are intended not only for site selection in a given watershed, but also for a determination of whether the best site in the watershed is "good" or "bad." The following tables present Ledec et al's top 7 and additional 9 criteria applied to Chalillo.

Table 6 – Seven Key Indicators of Social and Environmental Impacts		
	Chalillo	Good/Bad
Reservoir area (Hectares/MW)	114	-
Persons requiring resettlement (per MW)	0	++
Water retention time in reservoir	83 days	+
Biomass flooded (tons/hectare)	>100>300	+/-
Length of river impounded (km/MW)	10.3	--
Number of downstream tributaries	Many	+
Access roads through forest	4 km new, 50 km rehab	-

Table 7 – Nine Additional Indicators of Social and Environmental Impacts		
	Chalillo	Good/Bad
Critical natural habitats affected	Unique riparian forest	--
Persons economically disadvantaged	Moderate negative impacts in Cayo	-
Fish diversity	Negative impacts added to Mollejón	-
Length of river left dry	Impact depends on adequacy of 1 M^3/s environmental flow?	?
Cultural Property Affected	Mayan sites	--
Likelihood of reservoir stratification	Depends on effectiveness of lower outlet releases	?
Useful life of reservoir	Long (though sedimentation information not available)	++
Lost infrastructure	None	++
Lost land-based production	None	++

These tables highlight the fact that most reservoirs, unless they are very large, either have large impacts on people or on natural habitats, but not both. The remote valley Chalillo would flood has no human inhabitants, no infrastructure and no crops. Its human uses in recent decades have been limited to research, military exercises, and logging.

The notable direct impacts associated with the Chalillo reservoir would be of the latter variety – the loss of natural habitat. In absolute terms the 953-haectare Chalillo reservoir would not be large. Relative to the power likely to be generated, however, the flooded area is large. Ledec, et al (1999) consider dams flooding more than 50 hectares per MW installed capacity as "bad." At 114 hectares/MW, Chalillo would be well above the median (39 hectares/MW) of the 47 dams studied by the authors. A further consideration is that footprint of the dam stretches along 86 kilometers of the Macal and tributaries, eliminating riparian habitat that is uncommon in Belize and in neighboring areas of Guatemala and Mexico.

Consideration of alternatives

The EIA's consideration of alternatives is limited to a comparison of Chalillo to one alternative Macal dam site, called Rubber Camp. The purpose of the Chalillo proposal is not to dam the Macal River, but rather to supply electricity. Therefore, a consideration of alternatives should weigh the environmental impacts of Chalillo against other options for supplying electricity. The leading options for generating electricity are shown in Table 8 with comments on their environmental impacts:

Table 8 – Electricity Alternatives and Environmental Impact	
Source	Comparison to Challilo
Purchase additional power from Mexico	No environmental impacts for Belize
Increase use of diesel at new/existing plants	▪ More noise pollution ▪ More air pollution ▪ Less impacts on water, wildlife, and transportation infrastructure
Bagasse	Very limited, if any, new environmental impacts, because bagasse already is burned
Other biomass	New air pollution if biomass is not currently burned for disposal
Wind	▪ Scenic impacts ▪ Possible impacts on birds

This table makes it clear that there are several alternatives that probably have fewer impacts than the Chalillo projects – primarily Mexican imports and bagasse (or other biomass now burned). Environmental costs associated with the production of Mexican power are borne by Mexico. Bagasse energy would have limited new impacts since the bagasse is already burned without generating any electricity. There are also alternatives that would have significant impacts that are very different from Chalillo's impacts. New diesels would cause both noise and air pollution. Windmills might have negative impacts on scenery and birds. It is difficult, if not impossible to make a direct comparison of these impacts to those that would be caused by the Chalillo scheme.

Cumulative environmental impacts

If BEL has any intention of further development of the Macal river and its tributaries, Chalillo's EIA should take those future plans into account in an assessment of cumulative impacts. If no further dams are contemplated, that should be stated to verify that cumulative impacts are not a relevant issue.

Integration of EIA and Feasibility Study

It is helpful to have feasibility analysis and environmental assessment done concurrently, as was the case with CI Agra Power's work on the Chalillo project. This approach affords an opportunity to detail environmental impacts based on the specifics of the dam's design. Also it allows the consultants to integrate the mitigation plans into the feasibility analysis. The consultants could have taken fuller advantage of these opportunities. A small example is the aggregate quarry proposed for the right bank of the river, downstream of the dam. Impacts of the quarry are not mentioned in the EIA.

More importantly, though, is the fact that environmental mitigation measures from the EIA are excluded from the economic analysis of the project. These are real costs and should be incorporated into the dam's cost estimate. There are two environmental management plans, one for "civil works" and one for "watershed and wildlife enhancement." (EIA, Tables 5.10, 5.11). Though vague on some points, these plans do direct the project developer to "Make sure financial resources are available to cover cost [sic] of" 44 specific items. Some of these items are surely folded into larger cost categories in the project budget, but many are clearly excluded. (Agra CI Power, 1999a, Appendix G).

Emphasis of mitigation plans

Application of the World Bank "good dams, bad dams" screens above makes it abundantly clear that the most irreversible environmental risk involved in the Chalillo project is that posed to wildlife and their ecosystems in the upper Macal and its tributaries. While reasonably thorough treatment is given to many of the direct physical impacts of the project, ecological impacts are not adequately addressed. The Executive Summary (p.1) states that information on wildlife is "insufficient and inconclusive." To remedy this gap, it says that "scientific research will be concentrated in the coming months on endangered species such as the Scarlet Macaw, Baird's Tapir and Morelet's Crocodile." In the body of the report, several pages are dedicated to aquatic ecology, and one page to terrestrial vegetation. There is no text at all on wildlife.

To fill the gap on wildlife, Appendix 3 of the report contains terms of reference for a literature review limited to the three species mentioned in the executive summary. We question the adequacy of an assessment of overall wildlife impacts that limits its scope to three species and does not include any field investigation.

Recommended mitigation priorities

The EIA recommends a variety of measures to mitigate environmental impacts. We suggest that special emphasis be placed in two areas, to avoid and compensate for the least reversible of environmental impacts:

1. Compensate for the loss of natural habitat
2. Prevent settlement in the Mountain Pine Ridge and Chiquibul Forest Reserves, the Chiquibul National Park and the Caracol Natural Monument Reservation

<u>Compensate for the loss of natural habitat</u>: When impacts on ecosystems cannot be avoided, the next best option is to compensate for them with offsetting conservation investments elsewhere. Ledec et al. (1999) state the common-sense principle that offsetting protected areas should support similar species as the area affected by the dam. In the event that no such area exists within the country, the World Bank authors affirm that the dam should probably be rejected altogether on environmental grounds.

In choosing a compensatory protected area, there are several other important considerations: First, the offsetting protected area should be of a similar size as the dam's area of influence, not of the inundated area alone. Second, a valid form of compensatory protection is to provide funds for legally established protected areas at risk because they have lacked funds for on-the-ground implementation. If a new area is purchased for protection purposes, funds should be provided at least for establishment and operation over the short-term. Finally, funds provided for the purpose of offsetting protection should be placed in a special trust fund, separate from other government accounts, even if such accounts are also used for nature protection purposes.

Preventing settlement: Infrastructure projects often have very slight direct impacts on natural ecosystems, but have large indirect impacts as new roads, transmission lines, pipelines or other linear installations provide access to formerly remote areas. The road improvements and transmission lines in the Chalillo project need to be accompanied by continuous vigilance to ensure they are not leading to permanent settlements in the various protected areas that comprise the upper Macal, Raspaculo and Monkey Branch watersheds. To this end, we recommend that the Chiquibul road be gated at an appropriate point, with passage controlled on a 24-hour basis.

Process

The Environmental Impact Assessment should not be considered complete until all sections – including the wildlife study and mitigation plan – are included in the report, and until the complete report and all supporting documents are publicly available at the Department of Environment.

Supporting documents

Bowles, C.B, P.B. Williams and J. Haltiner, 2000. Chalillo Hydropower Feasibility Assessment. Report to the Belize Alliance of Conservation Non-Government Organizations. Corte Madera, CA: Philip Williams & Associates.

Pendleton, L.H., 2000. The Potential External Costs and Benefits of the Proposed Chalillo Dam (Macal River Upstream Storage Facility) in Cayo, Belize: A Preliminary Report. Los Angeles, CA: L.H. Pendleton.

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Annex 1: Key variables and assumptions in economic analysis

Parameter	Quantity	Units
Construction Cost	27,750,000	US$
Construction Cost + IDC	33,300,000	US$
External Costs	-1.5 -+4 million	US$
Construction Time	2	years
O&M Cost	693,750	US$/year
Reinvestment		
Discount Rate	13.3%	
Economic Time Horizon	40	years
Avoided cost unit prices		
Mexican Peak	0.21	US$/kWh
Mexican Non-Peak Average	0.03	US$/kWh
Diesel	0.08	US$/kWh
Generation		
Peak	4.6	GWh
Off Peak	68.3	GWh
Total	72.9	
First year prod/long-term average	0.75	
Utilization of off-peak capacity	0.7	
Demand growth		
2000-2010	4.9%	
Beyond 2010	4.0%	
Mexican capacity + Mollejon off peak	34.8	MW
Initial (2000) off-peak load	25	MW