Ministry of Works, Telecommunication, Energy, Road Transport and Shipping
Government of the Republic of Fiji Islands

PRE FEASIBILITY REPORT
Buca MICRO HYDRO POWER PROJECT

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[DOE]

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Buca MICRO HYDRO POWER PROJECT [MHPP]

SUMMARY

This technical report prepared for the village of Buca, Tukavesi villages and Tukavesi government station in Cakaudrove consists of 7 sections, the contents of which can be summarized as follows:

Section 1 - Geographical Locations and General Aspects

This section describes in brief the geographical location of the villages, its environment as well as the distances to the nearest town. Furthermore, the source of water that will supply the micro hydro plant is described. Attached to this section is the project location map and project data sheet where all essential data for the project are shown.

Section 2 - Socio-economic Analysis

This section deals with the socio-economic aspects of the project. The results can be summarized as follows:

- Buca and Tukavesi can be classified as a "traditional Fijian Villages".
- Relatively, the income of the households can be classified as "average".
- The villagers are very interested in receiving adequate electricity supply (in accordance with the 1993 Rural Electrification Policy).
- Based on the income of the villagers, the proposed MHPP will be affordable to the villagers. The lifetime of MHPP is estimated to be 30 - 35 years.

- The social impact of the project on the village can be assessed as positive as in the cases of other constructed hydro schemes.

Section 3 - Electricity Demand Analysis

This section deals with the analysis of the electricity demand. It concludes that a connection of 250 W (inclusive of 2*20W florescent tube and a 10A GPO) per household is adequate for the villages based on the power potential at the site.

Section 4 - Water Resources Analysis

This section describes in detail the availability of water resources and the flow analysis of the creek. The result of this study is that a discharge of 0.031 m^3/s is available for 90% of the time for electricity generation - no other water uses are made on this creek. Furthermore, the environmental aspects of the project have been assessed and the results indicate that only minor negative environmental impacts can be expected.

Section 5 - Description of the Buca MHPP Scheme

This section describes in detail the layout of the MHPP, the geology, the design of hydraulic and civil structures, penstock and the powerhouse with tailrace canal. Furthermore, the access possibilities, the necessary mechanical and electrical equipment required as well as the distribution network are described. The result favors a pelton turbine with an installed capacity of 30 kW using a flow of 0.031 m^3/s at a net head of 73.81 m. The distribution system consists of a 415/240 V low and medium voltage system.

Section 6 - Economic and Financial Analysis

Not included in the technical report.

Section 7 - Conclusion and Recommendation

This section contains the conclusion and recommendations, which have been made by the engineer in accordance with the findings of the previous sections. It is recommended that a detailed design of the project should be carried out to facilitate full development of the hydro project.

Annexes

This section of the technical report contains calculations and assessments that have been made to arrive at the figures quoted herein.

1. GEOGRAPHIC LOCATION AND GENERAL ASPECTS

Buca and Tukaevsi villages belongs to Cakaudrove province and front the Buca Bay in Fiji. These villages are approximately 70 km from Savusavu town. Buca village has a population of 430 ndividuals, with 68 households, which is exclusive of 3 churches and 1 community hall. Tukavesi village has .There are government station in Tukavesi, which include DO office, police post, health center and primary school.

General Analysis of the site

Koronikaivesi creek

The water flow rate at the Koronikaivesi is 0.031 m^3/s [cubic meters per second]. The gross head is about 73.81 m [meters] in height from a intake to the proposed powerhouse site. The maximum power generated therefore is approximately 30 kW [kilowatts]. The length of penstock from the intake site to the powerhouse is approximately 220 m.

The proposed MHPP will be a diversion/run-off-river type with an installed capacity of 30 kW. The main components such as the weir, intake, headrace, forebay and powerhouse, local materials and labor have been considered for the site development.

A pelton turbine has been selected for the Buca MHPP as the most suitable turbine type for the given site conditions.

As the powerhouse is at the bottom of the waterfall, the electrification of the village is based on a 415/240 V low voltage distribution system.

The operation of the Buca MHPP is not in conflict with any irrigation or domestic water uses. Only minor negative environmental effects are to be expected during the construction of the MHPP - it is envisaged that after sometime, these negative environmental effects will normalize.

The (i)Project Location Map, (ii)Project Data Sheet are provided as Annex 1.

2. Socio - Economic Analysis

2.1 **Results of Field Surveys**

2.1.1 **Village and government station characteristics**

Buca village consists of 68 houses, 3 churches and a community hall. Tukavesi village consists of . Tukavesi government station has DO office, police post, health center and school. Each facility has a diesel generator and total power supply is 25kW.

It takes 1 km along the Buca Bay road from Buca to Tukavesi. The houses in Buca and Tukavesi villages are concentrated on a diameter of about 200 m and are mostly of concrete foundation with wood and iron walls.

2.1.2 **Village Wealth and Income**

Villagers sell cash crops for example yaqona and dalo. The crops are carried to Savusavu and sold in the market.
The average household income is estimated at about $400/month.

2.1.3 **Project Acceptance**

The entire village expressed their interest in the project and expressed their keenness to receive electricity as soon as possible. All villagers agreed to sign an MOU with the Rural Electrification Unit (REU) to undertake the operation and maintenance of the MHPP as per REU guidelines.

The villagers intend to use electricity for social application, which will better the socio-economic standards of the village.

2.1.4 **Affordability and Willingness to Pay**

The villagers are aware, understand the REU policy and are willing to abide by it, when the above project was being discussed with them by the DOE. In the discussions, the villagers were informed of their required contributions and responsibilities for project's well being.

2.2 **Social Aspects**

2.2.1 **Project Risks**

Nearest Electricity supply

The nearest transmission line is approximately 70 km from the village to Savusavu. Tukavesi government station and Tukavesi village have diesel generators. But since diesel generator need very high running cost and provide carbon dioxide, they request economical and environmental hydro power. Given the low population density and far from Savusavu town to Buca area, there is no plan to extend their transmission lines to Buca and Tukavesi.

Village Disputes

Although the villagers are willing to adopt the REU policy in ensuring the sustainability of the scheme, lack of cooperation and local disputes amongst themselves will undermine the scheme sustainability. An example is the village not paying their arrears for the sustainability of the scheme once it is installed. Land use compensation can also be an issue in this project.

In order to overcome the above risks it is proposed that a Memorandum of Understanding (MOU) is signed between the Fiji Department of Energy and the village representatives prohibiting them taking any such actions as mentioned above that could cause threat to the hydro scheme sustainability.

3. Electricity Demand Analysis

Although the available hydro potential from the Koronikaivesi creek will allow a higher supply capacity [30 kW], the households will receive a maximum of 250 W. This amount per household is sufficient to meet a family's electrical needs living in a typical Fijian village like Buca and Tukavesi.

A copy of the electricity demand analysis is attached as *Annex 2*.

4. Water Resource Analysis

4.1 Catchment

The planned Buca MHPP is located on the Koronikaivesi Creek. The catchment area of the MHPP [at the location of the intake] is 2 km^2. The catchment area is mostly covered with bush; jungle and talasiga grassland.

The main elevations in the catchment are:

- altitude of intake site : 98.00m a.s.l.

- altitude of forebay site : 81.12m a.s.l
- altitude of powerhouse site: 7.31m a.s.l.

4.2 **Available Hydrological Data**

The catchment is in a region which is located mainly above 98 m a.s.l. The initial survey at the site was undertaken in 1999, followed by the installation of hydrological monitoring equipment. The hydrological equipment had a data logging system, which recorded water level at the site on a daily basis. This creek was monitored for approximately 3 years. Stream gauging was also manually undertaken on the site on a monthly basis during the monitoring period.

A rainfall gauge installed at Vunisea for about 11 years in an adjacent catchment recorded an average rainfall of approximately 2300 mm per year. A copy of the rainfall data obtained is attached as *Annex 3*.

Next

4.3 **Flow analysis**

Elementary hydrological information were obtained from the 3- year monitoring period. Detailed analysis of the flow is attached as *Annex 4.*

The flow characteristics are as follows:

- Minimum Discharge [100% exceedance] 0.027 m^3/s
- Minimum Discharge [97% exceedance] 0.030 m^3/s
- Normal Discharge [50% exceedance] 0.033 m^3/s
- Estimated Maximum flood Discharge 0.046 m^3/s
- Design Discharge [90% exceedance] 0.031 m^3/s

4.4 **Water uses in the Catchment**

No other water uses exists in this catchment.

4.5 **Available flow for electricity generation**

Design Discharge [90% exceedance]	0.031 m^3/s
Water uses for irrigation purposes	0.000 m^3/s
Water uses for any other purposes	0.000 m^3/s
Available flow for electricity generation	0.031 m^3/s

Optimized design discharge 0.031 m^3/s

5. **Description of the MHPP Scheme**

5.1 **Layout of the MHPP and Geology**

The hydropower plant will consist of the following main components:

- concrete weir and intake structure
- headrace
- forebay
- penstock
- Powerhouse and tailrace

A detailed Topographical, Longitudinal Sectional survey of the site has been undertaken. Details of the survey are provided as *Annex 5.*

5.2 **Hydraulic and Civil Structures**

Diversion Structure:

The diversion weir is located obliquely across the Wainavana creek, approximately 10 m up from the juncture truck and the creek.

The geology of the weir site is dominated by solid igneous rocks, coarse river deposits, boulders (diameter up to 150 cm) and pebbles (diameter up to 50 cm). Medium and fine-grained river deposits (gravel, sand) are also found.

Main dimensions of the bottom weir are:

- height of weir h = 1.0 m.
- length of weir crest 1 = 6.0 m

Intake Structure

Directly from the bottom of the intake weir, the headrace conveys the water to the forebay (a settling basin is incorporated in the forebay). The grill of the weir is located on the left- side riverbank, parallel to the flow direction of the river.

Headrace:

The location and the arrangement of the intake structure enables an easy diversion to the headrace, without deep cutting of the riverbank. The headrace does not follow the track sometime to keep the constant incline.

Main characteristics and dimensions of the headrace are:

- PVC pipe
- total length 750 m
- diameter 200 mm
- gradient 2.2 %
- head loss 16.5 m

Forebay

The forebay is located at the top of the first hill from the village. The concrete forebay is equipped with a screen and two gates; a control gate to close the penstock and a flushing gate to clear the forebay from sediments. Downstream of the control gate an air vent pipe is provided to prevent negative pressure within the penstock on closure of the gate under flow.

The forebay is equipped with a spillway to divert excess water during turbine regulation and heavy rainfall. Excess and flushed water can be discharged to the left into a specially prepared flushing canal, which conveys the water back to the river. The excess water canal is formed by gabion mattress which are arranged in steps in order to dissipate energy and to protect the slope from erosion.

Penstock:

From the forebay a HDPE penstock leads to the powerhouse.
The alignment of the uncovered penstock crosses the shrub areas perpendicular to the contour lines as shown on the map.

The characteristics of the penstock are:

- HDPE pipeline diameter 150 mm
- length 690 m
- head loss 30.1m

Power House and Tailrace:

The powerhouse is located near a mango tree near a church.

The powerhouse consists of a concrete foundation and an

incorporated tailrace to a nearby stream perpendicular to the penstock route. The substructure consists of concrete and wooden walls, a corrugated iron roof is supported by wooden griders. A foundation pad and footing for the turbine is built on a box culvert. The box culvert becomes a discharge chute which carries the turbine discharge to the tailrace.

The powerhouse floor is located above the maximum flood level; as to avoid the flooding of mechanical and electrical equipment.

The turbine outflow will be discharged directly into a creek via a short tailrace [length 20 m].

Access:

For the transport of the construction material, as well as the electrical and mechanical equipment, we need to use a boat from Viti Levu to Buca village. There is a track to the sites where the power house, forebay and intake has to be constructed. Transport of heavier equipment and construction material can be arranged by man power.

5.3 **Mechanical and Electrical Equipment**

Due to the available head and discharge a pelton turbine is proposed as the most suitable turbine type for the MHPP. If required, the turbine speed shall be stepped up to the generator speed via a transmission belt.

The generator shall be a 3 phase synchronous type with a rated capacity of 15kVA. For frequency/speed control, an electrical load controller of 50% of the generator terminal capacity, shall be provided. Control, protection and measuring equipment are housed in a steel- made cubicle.

DISTRIBUTION NETWORK

The distance from the MHPP to the most remote consumer of Abaca MHPP is about 1 km. Therefore an electricity transmission system based on 415 V, and a distribution system based on the generator voltage of 240 V is specified.

The transmission and distribution system consists of bundle conductor lines, which are supported by wooden poles between 40 - 65m.

Related to consumer voltage 240 V, the maximum static consumer voltage variation shall not exceed five percent (5%).

6.0 **Economic and Financial Analysis**

Not included in this report.

7.0 **Conclusion and Recommendations**

Buca is located on the center of Cakaudrove Island. There is no immediate or long term plans to electrify Buca because of its remote location.

The operation of the MHPP will not hinder any other water uses either for agriculture or domestic use.

The socio-economic impact on the village by coming on line of the MHPP will be substantial while the environmental effect will be negative, but only during the construction period.

It is therefore recommended that detailed designing of the project be carried out.

ANNEXES

ANNEX 1
Project Data Sheet
Project Location Map

ANNEX 2
Demand Analysis for Buca

ANNEX 3
Buca Rainfall Data

ANNEX 4
Flow Analysis (including rating curve and flow duration curve)

ANNEX 5
Topographical, Longitudinal surveys and basic system plan