Ministry of Infrastructure and Transport

PRE FEASIBILITY REPORT

NUKULOA MICRO HYDRO POWER PROJECT

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Table of Contents

Nukuloa MICRO HYDRO POWER PROJECT [MHPP]

Summary

This technical report prepared for the village of Nukuloa located in the Lomaiviti Province 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 distance to the nearest town and main road. 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 result can be summarized as follows:

- Nukuloa can be classified as a "traditional Fijian Village "
- Relatively, the income of the households can be classified as 'average'
- The villagers are very interested in receiving adequate electricity supply by MHPP.
- The villagers have already had electricity by a diesel generator capacity of 45kw. This generator is available only during 6pm to 10 pm. The villagers want to use electricity for 24 hours. Also the maintenance cost of the generator is going to affect the villager's finance due to recent growing fuel price. Therefore they

would like to use the MHPP substitute for the diesel generation.

- Based on the income of the villagers, the proposed MHPP will be affordable to the villagers. The lifetime of MHPP is estimated to be 30-50 years.
- The social impact of the project on the villages 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 250W (inclusive of 2*20W florescent tube and a 10A GPO) per household is available for the village based on 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 0.088 m^3/s is available for 99% of the time for electricity generation - no other water uses are made on this creek.

SECTION 5-Description of the Nukuloa MHPP scheme.

This section describes in detail the layout of the MHPP, the design of hydraulic and civil structures penstock and the powerhouse with tailrace canal. Furthermore, the access required as well as the distribution network are described. The result favors a pelton turbine with an installed capacity of 33 kW using a flow of 0.088 m3/s at a gross head of 56.0m. 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 reports

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. Geographical Location and General Aspects

Nukuloa village belong to the Sawaieke Tikina of the Lomaiviti province and is located to the west of Gau Island.

Nukuloa village is located about 30 minutes from Nausori to Gau by airplane and about 30 minutes from Gau airport to Nukuloa village by car. This village has a population of 138 people and 38 houses. The village has a nursing station, a community hall, a school and 2 churches.

General analysis of the site

Waivadela creek

The water flow rate at the Waivadela creek is 0.088 m^3/s. The gross head is about 56.0m (in height from a forebay to the proposed powerhouse site.)The maximum power generated therefore is approximately 33 kW. The length of penstock from the forebay site to the powerhouse is approximately 800m.

The proposed MHPP will be a diversion/run-off-river type with an installed capacity of 33kW. 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 Nukuloa MHPP as the most suitable turbine type for the given site conditions.

There is an existing 25 kVA Diesel Generator in Nukuloa village with underground reticulation to the houses. A transition box is located near the powerhouse, which is intended to be used for the MHPP. The transition box is just outside the village proper boundaries. Therefore it is

intended that the existing transmission line from this box be used for the MHPP. Transmission to the village is based on a 415/240 V low voltage distribution system.

The operation of the Nukuloa MHPP is not in conflict with any irrigation or domestic water use. Only minor negative environmental effects are to be expected during the construction of the MHPP. It is envisaged that after sometime, there negative environmental effects will normalize.

2. Socio-Economic Analysis

2.1 Results of Field Survey

2.1.1 Village Characteristics

Nukuloa village consist of 38 houses, a nursing station, a school and two churches.

The houses in each village are mostly of concrete foundation with wood and iron walls.

2.1.2 Village wealth and Income

Villager sells cash crops for example Dalo, Cassava and Yaqona (Grog. The crops are carried to Suva and sold in a market. The average household income is estimated at about $100~$200/month.

2.1.3 Project Acceptance

The entire village expressed their interest in the project and their keenness to receive electricity by MHPP as soon as possible in spite of the fact that they already have a diesel generator. This is due to recent high cost of fuel and the limitation of use, which is now available only during 6pm to 10pm.

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 of, understand the REU policy and are willing to abide by it, when the DOE was discussing the above project with them.

In the discussion, the villagers were informed of their required contributions and responsibilities for project's well-being.

2.1.5 Project Risks

Nearest Electricity Supply

The nearest national FEA transmission line of the National Grid is approximately 150 across the ocean on the mainland . FEA does not have any plan to extend their transmission line to Nukuloa.

Private Power Plants

There is no private power plant in Nukuloa village.

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. Should land become an issue, we could get the village to lease the land for NLTB.

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 threaten the hydro scheme sustainability.

2.2 Social Aspects

3. Electricity Demand Analysis

Although the available hydro potential from the Waivadela creek will allow a high supply capacity of 33kW, the households will receive a maximum of 250W.This amount per household is sufficient to meet a family's electrical needs living in a typical Fijian village like Nukuloa.

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

4. Water Resource Analysis

4.1 Catchment

The planned Nukuloa MHPP is located on the Waivadela creek. The catchment area of the MHPP [at the location of the intake] is about 2km^2.The catchment area is mostly covered with bush, jungle and talasiga grassland.

4.2 Available Hydrological Data

The catchment is located 56 m above powerhouse location. The initial survey at the site was undertaken in 1999 followed by another survey in 2006. The monitoring system consisting of a v-notch weir and staff gauge was installed with data acquired from the 5th of December 2007 to the 31st of December, 2010.

With the staff gauge, a villager has recorded water level on a daily basis. Measurement of the stream flow also has been undertaken by a current meter on the site on a monthly basis for 1 year. We used correlations between the flow data, which had been measured monthly by current meter, and the water surface level, which had been measured daily to estimate the flow.

4.3 Flow analysis

Elementary hydrological information was obtained from the 3-year monitoring period. We chose 0.088 m3/s (99%exceedance) for design discharge from safety aspects. Detailed analysis of the flow is attached as Annex .
The flow characteristics are as follows:

- Minimum Discharge [100% exceedance] 0.080 m3/s
- Minimum Discharge [97% exceedance] 0.090 m3/s
- Normal Discharge [50% exceedance] 0.108 m3/s
- Estimated Maximum Flood Discharge 0.300 m3/s
- Design Discharge [99% exceedance] **0.088 m3/s**

4.4 Water uses in the Catchment

No other water uses exist for this catchment.

4.5 Available flow for electricity generation

- Water uses for irrigation purposes 0.000 m3/s
- Water uses for any other purposes 0.000 m3/s
- Available flow for electricity generation 0.088 m3/s
- Design Discharge [99%exceedance] 0.088 m3/s
- Optimized design discharge 0.088 m3/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

5.2 Hydraulic and Civil Structures

Diversion structure:

The diversion weir is located obliquely across the Waivadela creek.

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

Main dimensions of the bottom weir are:

- Height of weir h= .50m
- Length of weir crest l= 5.0m

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 of the riverbank, parallel to the flow direction of the river.

Headrace:

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

Main characteristics and dimensions of the headrace are:

- Hume pipe
- Total length n/a
- Diameter 200mm
- Gradient 2.2%
- Head loss 0.1m

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 mattresses, which are arranged in steps in order to dissipate energy and to protect the slope from erosion.

Penstock:

From the forebay a MDPE 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:

- MDPE pipeline diameter 200 mm
- Length 800 m
- Head loss 4.2 m

Power House and Tailrace:

The powerhouse is located 10m away from the existing electric transform box.
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 and a corrugated iron roof supported by wooden girders. 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 equipment. The turbine outflow will be discharged directly into a creek via a short tailrace.

Access:

For the transport of the construction material, as well as the electrical and mechanical equipment, an existing road is available to Nukuloa village. But there is no track to the forebay and intake. Therefore the access to these sites has to be constructed. Transport of light equipment and construction material to the dam site and along penstock route can be carried by horses or villagers.

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 40 kVA. 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 Nukuloa village is about 100m. 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 consist 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. Economic and Financial Analysis

Not included in this report.

7. Conclusion and recommendation

Nukuloa village belongs to the Lomaiviti province and is located to the west of Gau Island. It takes about 1 and a half hour from Suva to Nukuloa village by plane and car.

There is no immediate or long term plans to electrify

Nukuloa village through the FEA power grid 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 villages by the coming on line of the MHPP will be substantial while the environment effect will be negative, but only during the construction period.

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

8. Annexes

a. Project Data Sheet
b. Electricity Demand Analysis
C. Flow Duration Curve

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