Appendix D  2006 Water Quality and Ecological Assessment
Sustainable Energy Limited

Nadarivatu Hydropower Project

FRESHWATER ECOLOGICAL AND WATER QUALITY MONITORING SURVEY (JULY 2006)

Final
September 2006
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<th>Revision type</th>
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<td>24 - 08 - 06</td>
<td>Pene Burns</td>
<td>Luke Gowing</td>
<td>28 -08 - 06</td>
<td>Practice and professional review. Provided a list of edits.</td>
</tr>
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<td>20 - 09 - 06</td>
<td>Pene Burns</td>
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Distribution of copies

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Printed: 20 September 2006
Last saved: 20 September 2006 01:37 PM
File name: I:\Aenv\Projects\AE02809\Deliverables\Final\EIA\Appendix D Nadarivatu Biological Survey Report july 06.doc
Author: Luke Gowing
Project manager: Pene Burns
Name of organisation: Sustainable Energy Limited
Name of project: Nadarivatu Hydropower Project
Name of document: Results of July 2006 Round of Ecological and Water Quality Monitoring
Document version: Final
Project number: AE02809 / LT00884
1. Introduction

1.1 Background
The Fiji Electricity Authority (FEA) propose to construct a hydropower scheme which will divert water from the headwaters of the Sigatoka River (Qaliwana, Nadala and Nukunuku Creek tributaries) to the Ba River, through a power station located on the bank of the Ba River near Buyabuya.

Past studies assessing the ecological and water quality of watercourses in the vicinity of the proposed development and streams potentially affected consist of the following:

- USP undertook the first round of specific baseline water quality and ecological monitoring in 2004.
- A second round of baseline water quality and ecological monitoring was undertaken by SKM in February 2005 (see SKM 2005).
- Investigations undertaken by the Fiji Institute of Technology (FIT) at sites in streams in the vicinity of the current streams of interest as part of a Fiji – wide water quality monitoring programme using macroinvertebrates.
- Investigations undertaken by the IAS at sites in the current streams of interest between 25 and 31 August 2004 as part of background investigations (IAS 2004).

This data is addressed in detail in SKM (2005).

1.2 Scope of Report
This report documents the results of the July 2006 baseline assessment of aquatic macroinvertebrates, and habitat and water quality in watercourses potentially effected as a result of the construction and operation of the proposed hydro power scheme development, and compares this data with that collected during the February 2005 round undertaken by SKM.

The July 2006 round of monitoring was conducted to provide information on the natural seasonal variation in water quality and ecological data to further describe the baseline condition prevailing in the watercourses potentially affected by development.

Note that the design of the monitoring programme has changed in light of the changes to the design of the scheme.
2. Methods

2.1 Introduction
This section of the report presents the methods used by SKM to describe the aquatic resources (macroinvertebrate communities), habitat and water quality present in the watercourses potentially affected as a result of the construction and operation of the proposed hydro power scheme.

The first round of monitoring was conducted in February 2005. The fieldwork for this round of monitoring was conducted on 5 and 6 July 2006.

2.2 Sampling Sites
Figure 2-1 presents the locations of the sampling sites used for the collection of macroinvertebrate, instream habitat and water quality samples and Table 2-1 describes the site locations used. In the 2006 survey the majority of sites were revisited and an additional site (Site 9) sampled based on a change in scheme design. Appendix 1 presents photographs of the sites.

### Table 2-1 Location of sites for macroinvertebrate, habitat and water quality sampling

<table>
<thead>
<tr>
<th>Area</th>
<th>Site</th>
<th>Description</th>
<th>Study 2005</th>
<th>Study 2006</th>
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<tr>
<td>Ba River</td>
<td>1</td>
<td>Marou Village (above proposed powerstation)</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Drala Village (below proposed powerstation)</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Nukunuku Creek</td>
<td>3</td>
<td>Above hydrological station (approximately 1km above proposed weir and intake)</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>50m below hydrological station</td>
<td>√</td>
<td>-</td>
</tr>
<tr>
<td>Nadala Creek</td>
<td>5</td>
<td>Nadala village</td>
<td>√</td>
<td>-</td>
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<tr>
<td>Qaliwana Creek</td>
<td>6</td>
<td>Nabuyasa village</td>
<td>√</td>
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<td></td>
<td>7</td>
<td>50m above hydrological recording station (approximately 1km above proposed weir and intake)</td>
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<td>√</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>Below confluence with Nukunuku Creek (approximately 200m below proposed weir and intake)</td>
<td>-</td>
<td>√</td>
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<tr>
<td>Savatu Creek</td>
<td>8</td>
<td>Savatu Creek access from Drala Village (control site)</td>
<td>√</td>
<td>√</td>
</tr>
</tbody>
</table>

Notes: - = Sites not sampled as they will no longer be directly affected by the Nadarivatu scheme.

As well as selecting a control site (Savatu River) in a stream with similar physical and hydrological characteristics, sites were located in the watercourses above and below the location of the various proposed development activities in each catchment. The control and upstream sites will allow comparisons to be made to determine whether any observed changes that occur during and post construction are the result of the activity or are due to natural variability. Further detail on site selection is provided in SKM (2005).
2.3 Habitat Assessment
Habitat assessments were undertaken over representative 100 m stream reaches at each site. A suite of instream and riparian habitat characteristics were visually assessed using habitat assessment protocols adopted by a number of Regional Councils in New Zealand for high gradient streams (Appendix 2 provides an example of the field sheet). Each habitat parameter was assessed by scoring it a value between 0 and 20 based on a defined set of criteria, where scores between 0-5 represented poor quality, 6-10 marginal quality, 11-15 suboptimal quality and 16-20 optimal quality. Further detail on habitat assessment process is provided in SKM (2005).
2.4 Macroinvertebrate Communities

2.4.1 Introduction
In New Zealand, macroinvertebrate communities have been shown to respond readily to changes in their surrounding environment and are thus used extensively to indicate instream habitat quality (Stark 1985, 1993; Winterbourn 1981). In light of this, a monitoring programme has been implemented to describe the baseline environment and allow the assessment of any potential changes that may occur in the macroinvertebrate communities as a result of the proposed development.

2.4.2 Sample Collection
The sampling methodology and protocols detailed in the New Zealand MfE guidelines (Stark et al. 2001) were used in the current investigations. More specifically the protocols for collecting quantitative samples from hard-bottomed streams were adopted.

Samples were collected from riffle / run habitat where macroinvertebrate diversity and density is considered to be greatest (Pridmore & Roper 1985). This type of habitat was chosen as it best represents the macroinvertebrate communities present and allows comparisons to be made across sites as similar habitat conditions were sampled.

At each site five 0.1m$^2$ surber samples (0.5 mm mesh) were collected from within each riffle. Each surber sample was collected by placing the sampler on the substrate and the cobble-sized material, to a depth of 100 mm, was scrubbed to remove macroinvertebrates. Samples were preserved in methylated spirits, placed in ice and delivered to Fiji Institute of Technology (FIT) for sorting and identification. The macroinvertebrates were identified to the lowest practical level, usually genus.

2.4.3 Data Analysis
The following ecological indices, as well as descriptive analysis, were used in the examination of the macroinvertebrate data:

- **Taxa richness** which is a measure of the number of types of organisms (taxa) present in each sample. As a general rule, the "richer" a community, the "healthier" the stream environment (Plafkin et al. 1989).

- **Density** which measures the total number of organisms per unit area. In this investigation density refers to the number of macroinvertebrates per 0.1 m$^2$. As with richness, density loosely correlates with the health of the stream environment. In extremely degraded environments the density of organisms tends to be lower than in higher quality environments. However, this cannot be taken as a hard-and-fast rule, and depends to a large extent on the types of species present.
Quantitative Macroinvertebrate Community Index (MCI) which was developed largely for the purposes of determining the tolerance of macroinvertebrate communities in New Zealand stony streams to organic enrichment, but is now commonly used as a general indicator of water and habitat quality (Stark 1993). The MCI is based on macroinvertebrate taxa being assigned a score between 1 and 10 reflecting their sensitivity to pollution, 1 representing taxa with high tolerance to organic pollution such as worms and snails, and 10 representing taxa highly sensitive to organic pollution such as most mayflies and stoneflies. Scores for all organisms collected are then combined and averaged to provide an estimate of water/habitat quality, with higher MCI scores indicating higher stream health (refer Table 2-2) (Stark 1993).

A similar scoring system has yet to be developed for the Fijian situation and is currently being investigated (A Suren (NIWA), pers. comm.). For the purposes of this investigation, the same scores given to New Zealand species have been applied to those that were found in Fiji. Where an equivalent species score was not found then either a score for other similar species was used or a score was not assigned (this occurred on the rare occasion).

<table>
<thead>
<tr>
<th>Water / Habitat Quality</th>
<th>QMCI</th>
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</tr>
<tr>
<td>Moderate Quality</td>
<td>5 – 6</td>
</tr>
<tr>
<td>High Quality</td>
<td>6 – 10</td>
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Statistical analyses of the 2005 survey macroinvertebrate data was undertaken using two-way analysis of variance (ANOVA) with JMP software (version 5.0.1.2, SAS Institute). ANOVA is able to detect differences between sites or groups of sites which cannot be explained by inherent variability or randomness.

As the abundance data was determined to be significantly different from normal in the previous round of sampling, it was corrected using a natural logarithmic transformation to satisfy the assumptions of the statistical comparison. Statistical significance was evaluated at the 95% confidence level however biological significance is evaluated in the discussion.

2.5 Water Quality

Water quality data has been collected to assist in describing the baseline environment in streams within the proposed development area. Water samples were collected at the same sites as the macroinvertebrate samples. The data is compared with accepted water quality guidelines to assist in the interpretation of the current status.
At each site, water temperature (°C), dissolved oxygen (mg/L and % saturation), conductivity (S/cm) and pH were measured using a calibrated YSI 556 meter. In addition, water samples were collected at each site, stored on ice and sent to Hills Laboratory in New Zealand for analysis. Appendix 3 presents a list of the parameters determined, the laboratory methods and detection limits.

The results of the analysis are discussed in Section 5.
3. Habitat Characteristics

3.1 Introduction
This section of the report details the habitat characteristics that were determined at each site. Appendix 2 contains an example of the field sheet used to record site details.

3.2 Results
Figure 3-1 and Figure 3-2 compare the proportion of substrate types present at each site for the 2005 and 2006 surveys. Tables 4a – 4d (Appendix 4) present the results of the analysis of the habitat characteristics present at each of the sites investigated. The key points to note are as follows:

- All sites reflect the substrate characteristics targeted to yield the greatest densities and abundances of macroinvertebrates e.g., gravel (2-64mm) and cobble (64-256mm) sized substrates ranged from 40 – 70% of the total size classes. Of all the watercourses in the 2006 survey, cobble – sized substrate are greatest in the Nukunuku Creek, upstream Qaliwana and Savatu Creek sites (50%) and gravels are greatest in the upstream site in the Ba River (30%). This is similar to the 2005 survey.

- At all sites the following characteristics ranged from optimal to sub – optimal: the abundance and diversity of macroinvertebrate habitat, the velocity and depth regimes present, the amount of sediment deposition and channel alteration, the frequency of productive riffle habitat, and the stability of the banks. Marginal levels of the riparian zone width were observed at the upstream site in the Ba River. On the true right bank of the Savatu Creek control site the amount of vegetation protection and width of the riparian zone were marginal. In the 2005 survey the amount of periphyton growth at all sites, with the exception of the Savatu Creek and the upstream (lower) Qaliwana Creek sites (optimal to sub – optimal), was marginal or poor. In the 2006 survey the upstream (lower) Qaliwana Creek site was poor however both Ba River sites had improved to optimal levels.

- All of the sites in the 2006 survey were dominated by substrate that was: either tightly packed and / or overlapping or moderately packed with some overlap; had less than 24% of the substrate covered by fine sediment with the exception of the Nukunuku Creek site which had between 25 and 49% of the substrate covered; the majority of sites had no algal cover however in the 2005 survey sites mainly ranged from ‘slippery’ to ‘obvious’; and <5% macrophyte cover at nearly all sites in both surveys.
Figure 3-1  Comparison Of Sediment Substrate Composition (%) At Sites Investigated In The 2006 Survey

Figure 3-2  Comparison Of Sediment Substrate Composition (%) At Sites Investigated In The 2005 Survey
3.3 Summary
The analysis of site habitat characteristics has shown that all sites reflect the substrate characteristics targeted to yield the greatest densities and abundances of macroinvertebrates. The gravel and cobble substrates at all sites ranged from 40 – 70% of the substrate. The majority of habitat characteristics can be described as optimal to sub-optimal (e.g., the abundance and diversity of macroinvertebrate and fish habitat, the velocity and depth regimes present). The amount of periphyton growth at the majority of sites in the 2005 survey was marginal or poor. Improvement at some of these sites during the 2006 round was noted. With the exception of the amount of periphyton growth, similar characteristics were observed between surveys for all parameters.
4. **Macroinvertebrates**

4.1 **Introduction**
This section of the report provides a baseline assessment of the macroinvertebrate communities present in the key streams potentially affected by the development of the proposed hydropower scheme.

4.2 **Results and Discussion**

4.2.1 **General Description**
In the 2006 survey, a total of 9,991 individuals representing 33 taxa were collected and identified. In the 2005 survey, a total of 10,630 individuals representing 42 taxa were collected and identified. The 2006 samples included species from the following orders: trichoptera (or caddisflies – 9 species), gastropoda (6 species), diptera (or two-winged flies – 6 species); two species each of odonata (damselflies and dragonflies) and ephemeroptera (mayflies); and one species each of hemiptera (or waterbugs), heteroptera (or true bugs) and crustacea (or shrimps and prawns) and a group of ‘others’ consisting of lepidoptera (moths), hirudinea (leeches), oligochaetae (bristle worms) ostracoda and sufferini. The raw data is presented in Appendix 5.

4.2.2 **Densities and Number of Taxa**
Figure 4-1 and Figure 4-3 presents a summary of the macroinvertebrate data identified during the current survey. The 1995 survey data is provided in Figure 4-2 and Figure 4-4 for comparison.

The following key points can be made:

- Mean macroinvertebrate densities (or abundances) in the 2006 survey ranged from 92 ± 47 at the Nukunuku Creek site to 470 ± 150 at the upstream site in the Ba River. This is the same as the 2005 survey where the upper Nukunuku Creek site had the lowest mean macroinvertebrate densities (201 ± 122) and the upstream site in the Ba River the highest (484 ± 462). The statistical comparison of the two surveys shows that although there is a significant (p < 0.001) difference between sites for both surveys, the overall interaction effect between surveys and sites is not significantly (p > 0.05) different (see Appendix 6).

- Mean number of species in the 2006 survey ranged from 10.6 ± 1.5 at the Nukunuku Creek site to 13.8 ± 1.1 at the downstream site on the Ba River and 13.8 ± 2.0 at the upstream site on the Qaliwana River. For sites in the 2005 survey that were repeated in the 2006 survey, the downstream site on the Ba River had the lowest mean number of species (12.2 ± 1.3) and the Savatu Creek site the highest (15.4 ± 2.1). The statistical comparison of the two surveys shows that there is a significant (p = 0.026) difference between sites for both surveys, with the overall interaction effect between surveys and sites also being significant (p = 0.011) (see Appendix 6) i.e., overall fewer species were identified across all sites in the 2006 survey which is likely to be due to natural seasonal variation.
Figure 4-1  Mean (± 1 SD) Macroinvertebrate Abundance For Sites (n = 5 Replicates Per Site) In The 2006 survey. Sites With No Data Were Not Sampled.

Figure 4-2  Mean (± 1 SD) Macroinvertebrate Abundance For Sites (n = 5 Replicates Per Site) In The 2005 Survey. Sites With No Data Were Not Sampled.
Figure 4-3  Mean (± 1 SD) Number Of Macroinvertebrate Taxa At Sites Surveyed (n = 5) In The 2006 Survey. Sites With No Data Were Not Sampled.

![Graph of mean number of taxa](image)

Figure 4-4  Mean (± 1 SD) Number Of Macroinvertebrate Taxa At Sites Surveyed (n = 5) In The 2005 Survey. Sites With No Data Were Not Sampled.

![Graph of mean number of taxa](image)
4.2.3 Relative Abundance

The relative abundances of the major macroinvertebrate groups identified at sites in the 2006 and 2005 surveys are summarised in Figure 4-5 and Figure 4-6. The key points to note are as follows:

- The proportion of ephemopteran and trichopteran species in the 2006 survey which are typically amongst the most sensitive to changes in water and habitat quality were greatest at the upstream and downstream sites in the Ba River and the control site on the Savatu Creek comprising between 86 and 89% of the total taxa present. Overall, there has been a notable increase in the proportion of these taxa at all sites compared with the 2005 survey, with the exception of the Nukunuku Creek site which has remained relatively consistent.

- The proportion of dipterans (especially chironomidae), gastropods (snails) and species classified as ‘other’ such as lepidoptera (moths), hirudinea (leeches) and oligochaetae(worms), which tend to be the most tolerant to changes in water and habitat quality, was greatest at the Nukunuku Creek site (34.5%). This is similar to the results of the 2005 survey where 45.2% of the total taxa present at this site were represented by these taxa.

As expected, the types of species present are largely determined by habitat conditions. The sites with a high proportion of ephemoptera and trichoptera were characterised by what was considered to be optimal to sub-optimal conditions in relation to habitat (see Section 3 for more detail). On the other hand, the sites with a high proportion of diptera and other more tolerant species were characterised by what was considered to be sub-optimal to marginal or poor conditions in relation to habitat quality particularly the amount of periphyton growth and fine sediment present.
- **Figure 4-5** Relative Abundance (%) of key Macroinvertebrate Groups Identified In Samples From The 2006 Survey. Sites With No Data Were Not Sampled.

- **Figure 4-6** Relative Abundance (%) Of Key Macroinvertebrate Groups Identified In Samples From The 2005 Survey. Sites With No Data Were Not Sampled.
4.2.4 QMCI
As indicated in Section 2.4.3, the QMCI scoring system devised for New Zealand stony streams and rivers has been applied to the Fijian species data. The QMCI data is presented in Figure 4-7 and Figure 4-8. The key points to note are as follows:

- Mean QMCI ranged in the 2006 survey ranged from 2.4 ± 0.8 at the downstream site in the Ba River to 3.6 ± 0.7 at the control site in Savatu Creek. In the 2005 survey, for sites repeated in the 2006 survey, mean QMCI ranged from 3.3 ± 0.6 at the upstream site in the Ba River to 5.3 ± 0.4 at the control site in Savatu Creek. The statistical comparison between surveys and sites shows that the interaction effect is significant difference (p = 0.04).

- All of the sites have habitat conditions that are considered to be ‘degraded’ (see Table 2-2) based on the types of species present. In the 2005 survey the Qaliwana and Savatu Creek sites were described as having habitat conditions of ‘moderate quality’.

4.3 Summary
The analysis of macroinvertebrate samples collected in the 2006 survey from the watercourses potentially effected by the proposed development has shown that densities and number of taxa overall are moderately high. A statistically significant difference was observed between site and surveys for macroinvertebrate density and QMCI score which is likely to be due to natural seasonal variation. Where habitat conditions are optimal, such as at sites in Qaliwana Creek and Savatu Creek (control site), the fauna is dominated by trichopteran (mayflies) and ephemopteran (caddisflies) taxa which are typically most sensitive to changes in habitat and water quality. Where habitat conditions were sub optimal to marginal such as in the Nukunuku Creek site the fauna was dominated by dipterans (two – winged flies), lepidoptera (moths), hirudinea (leeches) and oligochaetae.
- **Figure 4-7** Mean (± 1 SD) QMCI score At Sites Surveyed (N = 5) In The 2006 Survey.

- **Figure 4-8** Mean (± 1 SD) QMCI Score At Sites Surveyed (n = 5) In The 2005 Survey.
5. Water Quality

5.1 Introduction
This section of the report provides a summary of the surface water quality data collected during the 2006 fieldwork undertaken by SKM and compares the results with the 2005 survey data.

5.2 Results
The results of the 2005 and 2006 surveys are presented in Table 5-1 and Table 5-2. For sites that were repeated in the 2006 survey, the key points to note are as follows:

General Parameters
- Water temperatures ranged from 19.7°C at the upstream site (lower) in the Qaliwana Creek to 26.3°C at the Savatu Creek site.
- Dissolved oxygen concentrations ranged from 7.34 mg/L at the upstream site in Nukunuku Creek to 9.46 mg/L at the upstream site on the Qaliwana River. All concentrations are above the ANZECC (2000) guideline minimum concentration of 6 mg/L.
- Conductivities ranged from 55 µS/cm at the upstream site (lower) in the Qaliwana Creek to 164 µS/cm at the Savatu Creek site. Overall, the high conductivities tended to be in the watercourses with greater flows at the time of sampling.
- pH ranged from 7.2 at the upstream site in Nukunuku Creek to 8.4 at the upstream site on the Ba River. All pH recorded are within the ANZECC (2000) guideline range of 6.5 – 8.5.
- Turbidity ranged from 0.31 NTU at the Savatu Creek site to 2.9 NTU at the upstream site in Qaliwana Creek. All turbidity results are within the ANZECC (2000) guideline of 4.1 NTU.
- Total suspended solids concentrations for both surveys were at (3 mg/L) or below the detection limits of the analysis (<3 mg/L).
- Total alkalinity and total hardness ranged from 26 and 22 mg/L respectively at the downstream site in the Ba River to 83 and 75 mg/L at the Savatu Creek site.

Nutrients
- Total N and TKN in samples collected in both SKM surveys were at (0.1 mg/L) or below the detection limits (<0.1 mg/L) of the analysis with the exception of the downstream site in the Qaliwana River (0.2 mg/L). No samples exceed the ANZECC (2000) guideline concentration of 0.295 mg/L.
- Ammonium – N concentrations at all sites were below the detection limits (<0.01 mg/L) of the analysis and the recommended ANZECC (2000) guideline concentration of 0.9 mg/L.
Nitrate concentrations ranged from 0.002 mg/L at the upstream sites in Nukunuku and Qaliwana Creeks to 0.048 mg/L at the downstream site on the Ba River. No samples exceeded the ANZECC (2000) guideline concentration of 0.7 mg/L.

Nitrite concentrations at all sites in both surveys were below the detection limits (<0.002 mg/L) of the analysis and the recommended ANZECC (2000) guideline concentration of 0.7 mg/L.

Total phosphorus concentrations ranged from 0.011 mg/L at the upstream site (lower) on the Qaliwana Creek and Nukunuku Creek to 0.084 mg/L at the Savatu Creek site. A number of samples exceeded the ANZECC (2000) guideline concentration of 0.026 mg/L.

DRP concentrations ranged from <0.004 mg/L at the upstream site on Nukunuku Creek and the upstream site (lower) on the Qaliwana Creek to 0.082 mg/L at the Savatu Creek site.

**Cations, Anions and Metals**

Calcium concentrations ranged from 3.44 mg/L at the Nadala Creek site to 14.1 mg/L at the Savatu Creek site.

Magnesium concentrations ranged from 3.16 mg/L at the upstream site (upper) on the Qaliwana River to 9.57 mg/L at the Savatu Creek site.

Sodium concentrations ranged from 1.67 mg/L at the Nadala Creek site to 7.34 mg/L at the downstream site on the Ba River.

Potassium concentrations ranged from 0.28 mg/L at the Nadala Creek site to 2.63 mg/L at upstream site on the Ba River.

Chloride concentrations ranged from 1.8 mg/L at the Nadala Creek site to 2.5 mg/L at the downstream site on the Qaliwana River.

Sulphate concentrations ranged from <0.5 mg/L at a number of sites to 1.0 mg/L at the Nadala and Savatu Creek sites.

Total Fe concentrations ranged from 0.03 mg/L at the upstream site in the Qaliwana River and the Savatu Creek site to 0.55 mg/L at the downstream site on Nukunuku Creek.

Total Mn concentrations ranged from 0.0016 mg/L at the Savatu Creek site to 0.0211 mg/L at the downstream site on Nukunuku Creek. There were no exceedences of the ANZECC (2000) guideline value of 1.2 mg/L.

**5.3 Summary**

Samples were collected from six sites in the July 2006 survey compared to eight sites in the February 2005. Samples were analysed for a range of general parameters, nutrients, cations, anions and trace metals. Sites that have been repeatedly sampled are located upstream and downstream of the various proposed hydropower scheme elements in the Qaliwana and Nukunuku Creeks, and Ba River, and in a control stream. Several minor exceedences of ANZECC (2000) guideline values were observed.
Table 5-1  A Comparison Of Water Quality Data For Streams Sampled By SKM In 2006 And 2005 With Accepted Water Quality Guideline Concentrations (All Results Mg/L Unless Stated).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ba River</th>
<th>Nukunuku Creek</th>
<th>Nadala Creek</th>
<th>Qaliwana Creek</th>
<th>Savatu Creek</th>
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<td>pH</td>
<td>8.4, 7.5</td>
<td>8.3, 7.9</td>
<td>7.9, 7.2</td>
<td>7.7, -</td>
<td>7.3, -</td>
<td>8.1, -</td>
</tr>
<tr>
<td>Turbidity (NTU)</td>
<td>0.53, 1.63</td>
<td>0.55, 0.93</td>
<td>0.94, 2.45</td>
<td>2.93, -</td>
<td>0.4, -</td>
<td>0.34, -</td>
</tr>
<tr>
<td>TSS</td>
<td>&lt;3, &lt;3</td>
<td>&lt;3, &lt;3</td>
<td>&lt;3, &lt;3</td>
<td>&lt;3, -</td>
<td>&lt;3, -</td>
<td>&lt;3, &lt;3</td>
</tr>
<tr>
<td>Total alkalinity</td>
<td>28, 64</td>
<td>26, 73</td>
<td>43, 34</td>
<td>26, -</td>
<td>71, -</td>
<td>70, -</td>
</tr>
<tr>
<td>Total hardness</td>
<td>24, 55</td>
<td>22, 62</td>
<td>38, 32</td>
<td>22, -</td>
<td>57, -</td>
<td>55, -</td>
</tr>
<tr>
<td>Total N</td>
<td>&lt;0.1, &lt;0.1</td>
<td>&lt;0.1, &lt;0.1</td>
<td>0.1, &lt;0.1</td>
<td>&lt;0.1, -</td>
<td>&lt;0.1, -</td>
<td>&lt;0.1, -</td>
</tr>
<tr>
<td>TKN</td>
<td>&lt;0.1, &lt;0.1</td>
<td>&lt;0.1, &lt;0.1</td>
<td>0.1, &lt;0.1</td>
<td>&lt;0.1, -</td>
<td>&lt;0.1, -</td>
<td>&lt;0.1, -</td>
</tr>
<tr>
<td>Ammonium - N</td>
<td>&lt;0.01, &lt;0.01</td>
<td>&lt;0.01, &lt;0.01</td>
<td>&lt;0.01, &lt;0.01</td>
<td>&lt;0.01, -</td>
<td>&lt;0.01, -</td>
<td>&lt;0.01, -</td>
</tr>
<tr>
<td>Nitrate</td>
<td>0.030, 0.05</td>
<td>0.031, 0.048</td>
<td>0.01, 0.002</td>
<td>0.004, -</td>
<td>0.003, -</td>
<td>&lt;0.002, -</td>
</tr>
<tr>
<td>Nitrite</td>
<td>&lt;0.002, &lt;0.002</td>
<td>&lt;0.002, &lt;0.002</td>
<td>&lt;0.002, &lt;0.002</td>
<td>&lt;0.002, -</td>
<td>&lt;0.002, -</td>
<td>&lt;0.002, &lt;0.002</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>0.06, 0.064</td>
<td>0.059, 0.067</td>
<td>0.02, 0.02</td>
<td>0.022, -</td>
<td>0.009, -</td>
<td>0.009, -</td>
</tr>
<tr>
<td>DRP</td>
<td>0.058, 0.049</td>
<td>0.057, 0.049</td>
<td>0.016, &lt;0.004</td>
<td>0.016, -</td>
<td>0.005, -</td>
<td>0.010, -</td>
</tr>
</tbody>
</table>

Notes: - = no data available.  1 ANZECC (2000).  2 ANZECC (2000) for level of protection afforded to 95% of species.
Table 5-2 Comparative Summary Of Cations, Anions And Trace Metals For Streams Sampled By SKM In 2005 And 2006 With Guideline Values (All Results Mg/L Unless Stated).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Ba River</th>
<th>Nukunuku Creek</th>
<th>Nadala Creek</th>
<th>Qaliwana River</th>
<th>Savatu Creek</th>
<th>Guideline Values²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upstream</td>
<td>Downstream</td>
<td>Upstream</td>
<td>Downstream</td>
<td>Upstream</td>
<td>Downstream</td>
</tr>
<tr>
<td>Calcium</td>
<td>11.7, 10.9</td>
<td>12.4, 12.9</td>
<td>6.45, 5.25</td>
<td>6.83, -</td>
<td>3.44, -</td>
<td>3.54, -</td>
</tr>
<tr>
<td>Magnesium</td>
<td>6.32, 6.65</td>
<td>6.41, 7.2</td>
<td>5.22, 4.59</td>
<td>5.3, -</td>
<td>3.31, -</td>
<td>3.16, -</td>
</tr>
<tr>
<td>Sodium</td>
<td>6.53, 5.91</td>
<td>7.33, 7.34</td>
<td>2.24, 1.76</td>
<td>2.22, -</td>
<td>1.67, -</td>
<td>2.29, -</td>
</tr>
<tr>
<td>Potassium</td>
<td>2.63, 2.55</td>
<td>2.59, 2.76</td>
<td>1.03, -</td>
<td>1.09, -</td>
<td>0.28, -</td>
<td>0.82, -</td>
</tr>
<tr>
<td>Chloride</td>
<td>2.2, 2.2</td>
<td>2.3, 2.4</td>
<td>2, 1.9</td>
<td>1.9, -</td>
<td>1.8, -</td>
<td>2.3, -</td>
</tr>
<tr>
<td>Sulphate</td>
<td>0.9, 0.6</td>
<td>1, 0.6</td>
<td>&lt;0.5, &lt;0.5</td>
<td>&lt;0.5, -</td>
<td>&lt;0.5, -</td>
<td>&lt;0.5, -</td>
</tr>
<tr>
<td>Total Anions</td>
<td>1.47, 1.36</td>
<td>1.5, 1.55</td>
<td>0.91, 0.73</td>
<td>0.95, -</td>
<td>0.57, -</td>
<td>0.59, -</td>
</tr>
<tr>
<td>Total Cations</td>
<td>1.46, 1.41</td>
<td>1.53, 1.63</td>
<td>0.87, 0.74</td>
<td>0.9, -</td>
<td>0.52, -</td>
<td>0.56, -</td>
</tr>
<tr>
<td>Total Fe</td>
<td>0.03, 0.08</td>
<td>0.05, 0.08</td>
<td>0.14, 0.161</td>
<td>0.12, -</td>
<td>0.55, -</td>
<td>0.15, -</td>
</tr>
<tr>
<td>Total Mn</td>
<td>0.0026, 0.0063</td>
<td>0.0056, 0.0122</td>
<td>0.0142, 0.0175</td>
<td>0.0151, -</td>
<td>0.0211, -</td>
<td>0.0058, -</td>
</tr>
</tbody>
</table>

Notes: - = no data available. ID – Insufficient data to derive a reliable trigger value. ² ANZECC (2000) for level of protection afforded to 99% of species.
6. References


Appendix 1  Site Photos
Appendix 1  Site Photos

- Plate 1: Upstream (lower) Qaliwana Creek site looking upstream
- Plate 2: Upstream (lower) Qaliwana Creek site looking downstream
- Plate 3: Downstream Qaliwana Creek site looking upstream
- Plate 4: Downstream Qaliwana Creek site looking downstream
- Plate 5: Upstream Nukunuku Creek site looking upstream
- Plate 6: Upstream Nukunuku Creek site looking downstream
Plate 7: Upstream Ba River site looking upstream

Plate 8: Upstream Ba River site looking downstream

Plate 9: Downstream Ba River site looking upstream

Plate 10: Downstream Ba River site looking downstream

Plate 11: Savatu Creek site looking upstream

Plate 12: Savatu Creek site looking downstream
## FIELD ASSESSMENT COVER FORM:
WADEABLE HARD-BOTTOMED AND SOFT-BOTTOMED STREAMS

<table>
<thead>
<tr>
<th>STREAM NAME:</th>
<th>ASSESSOR:</th>
</tr>
</thead>
<tbody>
<tr>
<td>SAMPLE NUMBER:</td>
<td>DATE:</td>
</tr>
<tr>
<td>SITE NUMBER:</td>
<td>TIME (NZST):</td>
</tr>
<tr>
<td>GPS COORDINATES:</td>
<td>Downstream end of reach - Easting – Northing –</td>
</tr>
</tbody>
</table>

### CHANNEL AND RIPARIAN FEATURES

<table>
<thead>
<tr>
<th>Canopy Cover:</th>
<th>Riparian Vegetation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>µ Open</td>
<td>µ Pasture</td>
</tr>
<tr>
<td>µ Partly shaded</td>
<td>µ Retired grass</td>
</tr>
<tr>
<td>µ Significantly shaded</td>
<td>µ Crops etc</td>
</tr>
<tr>
<td>µ One side or partial</td>
<td>µ Native-young</td>
</tr>
<tr>
<td>µ Complete both sides</td>
<td>µ Exotic trees</td>
</tr>
</tbody>
</table>

### INSTREAM HYDRAULIC CONDITIONS

Estimated or measured reach average:
- Stream width (active channel) _______ m
- Stream width (water) _______ m
- Stream depth _______ m
- Surface velocity _______ m/sec

### WATER QUALITY

- Temperature: _______ °C
- Conductivity: _____ µS/cm @ 25°C
- Dissolved Oxygen: _______ mg/L
- Turbidity: µ Clear, µ Slightly turbid, µ Highly turbid, µ Stained, µ Other _______

### INORGANIC SUBSTRATE

#### Compaction:
- µ assorted sizes tightly packed &/or overlapping
- µ moderately packed with some overlap
- µ mostly a loose assortment with little overlap
- µ no packing / loose assortment easily moved.

#### Embeddedness:
- µ <5% gravel-boulder particles covered by fine sediment
- µ 5-24% covered by fine sediment
- µ 25-49% covered by fine sediment
- µ 50-75% covered by fine sediment
- µ >75% covered by fine sediment

### ORGANIC MATERIAL (% cover - need not sum to 100%)

- Large wood (>10 cm diameter): _______%
- Detritus (small wood, sticks, leaves etc > 1 mm): _______%
- Fine organic matter < 1 mm: _______%

### INSTREAM PLANTS

#### Algal cover (focus on stable substrates):
- µNone, µSlippery, µObvious, µAbundant, µExcessive

#### Macrophyte cover:
- µ<5%, µ5-25%, µ25-50%, µ50-75%, µ>75%

### HABITAT TYPES SAMPLED (% of effort; each column should sum to 100%)

#### Stones:
- _______%

#### Wood:
- _______%

#### Rocks:
- _______%

#### Riffles:
- _______%

#### Runs:
- _______%

#### Edges:
- _______%

### NO. INVERTEBRATES RETURNED:

- Shrimps: _______
- Crabs: _______
- Mussels: _______
- Others (specify) __________________________
### WADEABLE HARD-BOTTOMED STREAMS

Qualitative Habitat Assessment Field Data Sheet

**STREAM NAME:**  
**SITE NUMBER:**  
**SAMPLE NUMBER:**  
**ASSESSOR:**  
**DATE:**

<table>
<thead>
<tr>
<th>Habitat Parameter</th>
<th>Optimal</th>
<th>Suboptimal</th>
<th>Marginal</th>
<th>Poor</th>
</tr>
</thead>
</table>
| **1. Riparian Vegetative Zone Width** (score each bank; determine left or right side by facing downstream) | • Bankside vegetation buffer is >10m  
• Continuous and dense | • Bankside vegetation buffer is <10m  
• Mostly continuous | • Pathways present and/or stock access to stream  
• Mostly healed over | • Breaks frequent  
• Human activity obvious |
| **1.1 Left bank** | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1 |
| **1.2 Right bank** | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1 |
| **Mean LB&RB** |  |  |  |  |

| **2. Vegetative Protection** (score each bank; determine left or right side by facing downstream) | • Bank surfaces and immediate riparian zones covered by native vegetation  
• Trees, understory shrubs, or non-woody plants present  
• Vegetative disruption minimal | • Bank surfaces covered mainly by native vegetation  
• Disruption evident  
• Banks may be covered by exotic forestry | • Bank surfaces covered by a mixture of grasses/shrubs, blackberry, willow and introduced trees  
• Vegetation disruption obvious  
• Bare soil/closely cropped vegetation common | • Bank surfaces covered by grasses and shrubs  
• Disruption of streambank vegetation very high  
• Grass heavily grazed  
• Significant stock damage to the bank |
| **2.1 Left bank** | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1 |
| **2.2 Right bank** | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1 |
| **Mean LB&RB** |  |  |  |  |

| **3. Bank Stability** (score each bank; determine left or right side by facing downstream) | • Banks stable  
• Erosion/bank failure absent or minimal  
• <5% of bank affected | • Moderately stable  
• Infrequent, small areas of erosion mostly healed over  
• 5-30% of bank eroded | • Moderately unstable  
• 30-60% of bank in reach has areas of erosion  
• High erosion potential during floods | • Unstable  
• Many eroded areas  
• 60-100% of bank has erosional scars |
| **3.1 Left bank** | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1 |
| **3.2 Right bank** | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1 |
| **Mean LB&RB** |  |  |  |  |

| **4. Frequency of Riffles** | • Riffles relatively frequent  
• Distance between riffles divided by width of stream = 5-7  
• Variety of habitat is key | • Occurrence of riffles infrequent  
• Distance between riffles divided by width of stream = 7-15 | • Occasional riffle or run  
• Bottom contours provide some habitat  
• Distance between riffles divided by width of stream = 15-25 | • Generally flat water, shallow riffles  
• Poor habitat  
• Distance between riffles divided by width of stream = >25 |
| **4.1 Left bank** | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1 |
| **4.2 Right bank** | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1 |
| **SCORE** | 20  19  18  17  16 | 15  14  13  12  11 | 10  9  8  7  6 | 5  4  3  2  1 |

**SUBTOTAL:** ____________
<table>
<thead>
<tr>
<th>Habitat Parameter</th>
<th>Optimal</th>
<th>Suboptimal</th>
<th>Marginal</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>5. Channel Alteration</strong></td>
<td>Changes to channel/dredging absent or minimal</td>
<td>Some changes to channel/dredging</td>
<td>Channel changes/dredging extensive</td>
<td>Banks shored with gabion or cement</td>
</tr>
<tr>
<td></td>
<td>Stream with normal pattern</td>
<td>Evidence of past channel/dredging</td>
<td>Embankments or shoring structures present on both banks</td>
<td>&gt;80% of the stream reach channelised and disrupted.</td>
</tr>
<tr>
<td></td>
<td>Recent channel/dredging not present</td>
<td>Recent channel/dredging not present</td>
<td>Recent channel/dredging not present</td>
<td>Instream habitat altered or absent</td>
</tr>
<tr>
<td><strong>SCORE</strong></td>
<td>20 19 18 17 16</td>
<td>15 14 13 12 11</td>
<td>10 9 8 7 6</td>
<td>5 4 3 2 1</td>
</tr>
<tr>
<td><strong>6. Sediment Deposition</strong></td>
<td>Little/no islands or point bars present</td>
<td>New increase in bar formation, mostly from gravel, sand or fine sediment</td>
<td>Some deposition of new gravel, sand or fine sediment on old and new bars</td>
<td>Heavy deposits of fine material</td>
</tr>
<tr>
<td>(out of channel and in channel)</td>
<td>&lt;20% of the bottom affected by sediment deposition</td>
<td>20-50% of the bottom affected</td>
<td>50-80% of the bottom affected</td>
<td>Increased bar development</td>
</tr>
<tr>
<td></td>
<td>Slight deposition in pools</td>
<td>Sediment deposits at obstructions, constrictions, and bends</td>
<td>Sediment deposits at obstructions, constrictions, and bends</td>
<td>&gt;60% of the bottom changing frequently</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pools almost absent due to sediment deposition</td>
</tr>
<tr>
<td><strong>SCORE</strong></td>
<td>20 19 18 17 16</td>
<td>15 14 13 12 11</td>
<td>10 9 8 7 6</td>
<td>5 4 3 2 1</td>
</tr>
<tr>
<td><strong>7. Velocity/Depth Regimes</strong></td>
<td>4 velocity/depth regimes present</td>
<td>3 of 4 velocity/depth regimes present</td>
<td>2 of 4 velocity/depth regimes present</td>
<td>Dominated by 1 velocity/depth regime</td>
</tr>
<tr>
<td></td>
<td>Slow/deep, Slow/shallow, Fast/shallow, Fast/deep</td>
<td>If fast/shallow is missing then score lower</td>
<td>If fast/shallow or slow/shallow are missing score lower</td>
<td>Usually slow/deep</td>
</tr>
<tr>
<td><strong>SCORE</strong></td>
<td>20 19 18 17 16</td>
<td>15 14 13 12 11</td>
<td>10 9 8 7 6</td>
<td>5 4 3 2 1</td>
</tr>
<tr>
<td><strong>8. Abundance and Diversity of Habitat</strong></td>
<td>&gt;50% substrate favourable for invertebrate colonisation and wide variety of woody debris, riffles, root mats</td>
<td>30-50% substrate favourable for invertebrate colonisation</td>
<td>10-30% substrate favourable for invertebrate colonisation</td>
<td>&lt;10% substrate favourable for invertebrate colonisation</td>
</tr>
<tr>
<td></td>
<td>Snags/submerged logs/undercut banks/cobbles provides abundant fish cover</td>
<td>Snags/submerged logs/undercut banks/cobbles</td>
<td>Snags/submerged logs/undercut banks/cobbles</td>
<td>Fish cover patchy</td>
</tr>
<tr>
<td></td>
<td>Must not be new or transient</td>
<td>Fish cover common</td>
<td>Fish cover common</td>
<td>60-90% substrate easily moved by foot</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Moderate variety of habitat types. Can consist of some new material</td>
<td>Woody debris rare or may be smothered by sediment</td>
<td>Woody debris rare or may be smothered by sediment</td>
</tr>
<tr>
<td><strong>SCORE</strong></td>
<td>20 19 18 17 16</td>
<td>15 14 13 12 11</td>
<td>10 9 8 7 6</td>
<td>5 4 3 2 1</td>
</tr>
<tr>
<td><strong>10. Periphyton</strong></td>
<td>Periphyton not visible on hand held stones</td>
<td>Periphyton not visible on stones</td>
<td>Periphyton visible</td>
<td>Periphyton obvious and prolific</td>
</tr>
<tr>
<td></td>
<td>Stable substrate</td>
<td>Stable substrate</td>
<td>&lt;20% cover of available substrate</td>
<td>&gt;20% cover of available substrate</td>
</tr>
<tr>
<td></td>
<td>Surfaces rough to touch</td>
<td>Periphyton obvious to touch</td>
<td>Periphyton obvious to touch</td>
<td>Periphyton obvious to touch</td>
</tr>
<tr>
<td><strong>SCORE</strong></td>
<td>20 19 18 17 16</td>
<td>15 14 13 12 11</td>
<td>10 9 8 7 6</td>
<td>5 4 3 2 1</td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td></td>
<td></td>
<td></td>
<td>NB: Use only means of LB and RB values</td>
</tr>
</tbody>
</table>
Appendix 3 Laboratory Results
Client: Sinclair Knight Merz Limited  
Address: P O Box 9806, Newmarket  
AUCKLAND  
Contact: Luke Gowing  

Laboratory No: 424797  
Date Registered: 10/07/2006  
Date Completed: 20/07/2006  
Page Number: 1 of 3  

Client’s Reference: Overseas Samples  
The results for the analyses you requested are as follows:

### Sample Type: Water

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Lab No</th>
<th>pH (pH units)</th>
<th>Electrical Conductivity (mS/m)</th>
<th>Total Alkalinity (g.m-3 as CaCO3)</th>
<th>Bicarbonate (g.m-3 at 25°C)</th>
<th>Turbidity (NTU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ba Upper 06/07/06</td>
<td>424797/1</td>
<td>7.9</td>
<td>13.2</td>
<td>64</td>
<td>78</td>
<td>1.63</td>
</tr>
<tr>
<td>Ba Lower 06/07/06</td>
<td>424797/2</td>
<td>8.0</td>
<td>14.9</td>
<td>73</td>
<td>88</td>
<td>0.93</td>
</tr>
<tr>
<td>Nukunuku 06/07/06</td>
<td>424797/3</td>
<td>7.7</td>
<td>7.0</td>
<td>34</td>
<td>41</td>
<td>2.45</td>
</tr>
<tr>
<td>Qaliwana Upper 05/07/06</td>
<td>424797/4</td>
<td>7.7</td>
<td>6.8</td>
<td>32</td>
<td>38</td>
<td>0.44</td>
</tr>
<tr>
<td>Qaliwana Lower 06/07/06</td>
<td>424797/5</td>
<td>7.7</td>
<td>8.4</td>
<td>40</td>
<td>49</td>
<td>2.90</td>
</tr>
<tr>
<td>Savatu 06/07/06</td>
<td>424797/6</td>
<td>8.0</td>
<td>16.5</td>
<td>83</td>
<td>100</td>
<td>0.64</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Lab No</th>
<th>Total Suspended Solids (g.m-3)</th>
<th>Dissolved Calcium (g.m-3)</th>
<th>Dissolved Magnesium (g.m-3)</th>
<th>Total Hardness (g.m-3 as CaCO3)</th>
<th>Dissolved Sodium (g.m-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ba Upper 06/07/06</td>
<td>424797/1</td>
<td>&lt; 3</td>
<td>10.9</td>
<td>6.65</td>
<td>55</td>
<td>5.91</td>
</tr>
<tr>
<td>Ba Lower 06/07/06</td>
<td>424797/2</td>
<td>&lt; 3</td>
<td>12.9</td>
<td>7.20</td>
<td>62</td>
<td>7.34</td>
</tr>
<tr>
<td>Nukunuku 06/07/06</td>
<td>424797/3</td>
<td>&lt; 3</td>
<td>5.25</td>
<td>4.89</td>
<td>32</td>
<td>1.76</td>
</tr>
<tr>
<td>Qaliwana Upper 05/07/06</td>
<td>424797/4</td>
<td>&lt; 3</td>
<td>4.74</td>
<td>4.31</td>
<td>30</td>
<td>2.29</td>
</tr>
<tr>
<td>Qaliwana Lower 06/07/06</td>
<td>424797/5</td>
<td>&lt; 3</td>
<td>7.16</td>
<td>4.35</td>
<td>36</td>
<td>3.02</td>
</tr>
<tr>
<td>Savatu 06/07/06</td>
<td>424797/6</td>
<td>&lt; 3</td>
<td>14.1</td>
<td>9.57</td>
<td>75</td>
<td>6.18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Lab No</th>
<th>Dissolved Potassium (g.m-3)</th>
<th>Total Ammoniacal-N (g.m-3)</th>
<th>Total Nitrogen (g.m-3)</th>
<th>Total Kjeldahl Nitrogen (TKN) (g.m-3)</th>
<th>Nitrate-N + Nitrite-N (TON) (g.m-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ba Upper 06/07/06</td>
<td>424797/1</td>
<td>2.55</td>
<td>&lt; 0.01</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td>0.051</td>
</tr>
<tr>
<td>Ba Lower 06/07/06</td>
<td>424797/2</td>
<td>2.76</td>
<td>&lt; 0.01</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td>0.048</td>
</tr>
<tr>
<td>Nukunuku 06/07/06</td>
<td>424797/3</td>
<td>0.74</td>
<td>&lt; 0.01</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td>0.002</td>
</tr>
<tr>
<td>Qaliwana Upper 05/07/06</td>
<td>424797/4</td>
<td>0.75</td>
<td>&lt; 0.01</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td>0.002</td>
</tr>
<tr>
<td>Qaliwana Lower 06/07/06</td>
<td>424797/5</td>
<td>1.87</td>
<td>&lt; 0.01</td>
<td>0.2</td>
<td>0.2</td>
<td>0.025</td>
</tr>
<tr>
<td>Savatu 06/07/06</td>
<td>424797/6</td>
<td>2.24</td>
<td>&lt; 0.01</td>
<td>&lt; 0.1</td>
<td>&lt; 0.1</td>
<td>0.061</td>
</tr>
</tbody>
</table>

This Laboratory is accredited by International Accreditation New Zealand (IANZ), which represents New Zealand in the International Laboratory Accreditation Cooperation (ILAC). Through the ILAC Mutual Recognition Arrangement (ILAC-MRA) this accreditation is internationally recognised. The tests reported herein have been performed in accordance with the terms of accreditation, with the exception of tests marked *, which are not accredited.
### Sample Name

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Lab No</th>
<th>Nitrate-N (g.m-3)</th>
<th>Nitrite-N (g.m-3)</th>
<th>Dissolved Reactive Phosphorus (g.m-3)</th>
<th>Total Phosphorus (g.m-3)</th>
<th>Chloride (g.m-3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ba Upper 06/07/06</td>
<td>424797/1</td>
<td>0.050</td>
<td>&lt; 0.002</td>
<td>0.049</td>
<td>0.064</td>
<td>2.2</td>
</tr>
<tr>
<td>Ba Lower 06/07/06</td>
<td>424797/2</td>
<td>0.048</td>
<td>&lt; 0.002</td>
<td>0.049</td>
<td>0.067</td>
<td>2.4</td>
</tr>
<tr>
<td>Nukunuku 06/07/06</td>
<td>424797/3</td>
<td>0.002</td>
<td>&lt; 0.002</td>
<td>&lt; 0.004</td>
<td>0.020</td>
<td>1.9</td>
</tr>
<tr>
<td>Qaliwana Upper 05/07/06</td>
<td>424797/4</td>
<td>0.002</td>
<td>&lt; 0.002</td>
<td>&lt; 0.004</td>
<td>0.011</td>
<td>2.2</td>
</tr>
<tr>
<td>Qaliwana Lower 06/07/06</td>
<td>424797/5</td>
<td>0.024</td>
<td>&lt; 0.002</td>
<td>0.029</td>
<td>0.047</td>
<td>2.5</td>
</tr>
<tr>
<td>Savatu 06/07/06</td>
<td>424797/6</td>
<td>0.080</td>
<td>&lt; 0.002</td>
<td>0.073</td>
<td>0.084</td>
<td>1.9</td>
</tr>
</tbody>
</table>

### Sample Name

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Lab No</th>
<th>Sulphate (g.m-3)</th>
<th>Total Iron (g.m-3)</th>
<th>Total Manganese (g.m-3)</th>
<th>Total Anions (mEq/L)</th>
<th>Total Cations (mEq/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ba Upper 06/07/06</td>
<td>424797/1</td>
<td>0.6</td>
<td>0.08</td>
<td>0.0063</td>
<td>1.36</td>
<td>1.41</td>
</tr>
<tr>
<td>Ba Lower 06/07/06</td>
<td>424797/2</td>
<td>0.6</td>
<td>0.08</td>
<td>0.0122</td>
<td>1.55</td>
<td>1.63</td>
</tr>
<tr>
<td>Nukunuku 06/07/06</td>
<td>424797/3</td>
<td>&lt; 0.5</td>
<td>0.16</td>
<td>0.0175</td>
<td>0.73</td>
<td>0.74</td>
</tr>
<tr>
<td>Qaliwana Upper 05/07/06</td>
<td>424797/4</td>
<td>&lt; 0.5</td>
<td>0.12</td>
<td>0.0042</td>
<td>0.69</td>
<td>0.71</td>
</tr>
<tr>
<td>Qaliwana Lower 06/07/06</td>
<td>424797/5</td>
<td>0.5</td>
<td>0.21</td>
<td>0.0139</td>
<td>0.88</td>
<td>0.89</td>
</tr>
<tr>
<td>Savatu 06/07/06</td>
<td>424797/6</td>
<td>0.7</td>
<td>0.03</td>
<td>0.0044</td>
<td>1.73</td>
<td>1.82</td>
</tr>
</tbody>
</table>

### Sample Containers

The following table shows the sample containers that were associated with this job.

<table>
<thead>
<tr>
<th>Container Description</th>
<th>Container Size (mL)</th>
<th>Number of Containers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unpreserved (1L)</td>
<td>1000</td>
<td>6</td>
</tr>
<tr>
<td>Sulphuric Preserved (250 mL)</td>
<td>250</td>
<td>6</td>
</tr>
<tr>
<td>Nitric Preserved (100 mL)</td>
<td>100</td>
<td>6</td>
</tr>
</tbody>
</table>

Details of sample bottle preparation procedures are available upon request.

### Summary of Methods Used and Detection Limits

The following table(s) gives a brief description of the methods used to conduct the analyses for this job. The detection limits given below are those attainable in a relatively clean matrix. Detection limits may be higher for individual samples should insufficient sample be available, or if the matrix requires that dilutions be performed during analysis.

#### Substance Type: Water

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method Used</th>
<th>Detection Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample filtration for general testing</td>
<td>Sample filtration through 0.45μm membrane filter.</td>
<td>N/A</td>
</tr>
<tr>
<td>Sample filtration for metals analyses</td>
<td>Sample filtration through nitric washed 0.45μm membrane filter. APHA 3030 B 20th ed. 1998</td>
<td>N/A</td>
</tr>
<tr>
<td>Total (nitric) acid digest for low level metals</td>
<td>Nitric acid digestion. APHA 3030 E 20th ed. 1998</td>
<td>N/A</td>
</tr>
<tr>
<td>pH</td>
<td>pH meter APHA 4500-H* B 20th ed. 1998</td>
<td>0.1 pH units</td>
</tr>
<tr>
<td>Electrical Conductivity</td>
<td>Conductivity meter, 25°C APHA 2510 B 20th ed. 1998</td>
<td>0.1 mS/m</td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>Titration to pH 4.5 (M-alkalinity), Radiometer autititrator. APHA 2320 B (Modified for alk &lt;20) 20th ed. 1998</td>
<td>1 g.m-3 as CaCO3</td>
</tr>
<tr>
<td>Bicarbonate</td>
<td>Calculation: from alkalinity and pH, valid where TDS is not &gt;500 mg/L and alkalinity is almost entirely due to hydroxides, carbonates or bicarbonates. APHA 4500-CO₂ D 20th ed. 1998</td>
<td>1 g.m-3 at 25°C</td>
</tr>
<tr>
<td>Parameter</td>
<td>Method Used</td>
<td>Detection Limit</td>
</tr>
<tr>
<td>------------------------</td>
<td>----------------------------------------------------------------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Analysis using a Hach 2100N, Turbidity meter. APHA 2130 B 20th ed. 1998</td>
<td>0.05 NTU</td>
</tr>
<tr>
<td>Total Suspended Solids</td>
<td>Filtration (GF/C, 1.2 μm), retained residue dried at 103 - 105 °C, Gravimetric. APHA 2540 D 20th ed. 1998</td>
<td>3 g.m-3</td>
</tr>
<tr>
<td>Dissolved Calcium</td>
<td>Filtered sample, ICP-MS APHA 3125 B 20th ed. 1998</td>
<td>0.05 g.m-3</td>
</tr>
<tr>
<td>Dissolved Magnesium</td>
<td>Filtered sample, ICP-MS APHA 3125 B 20th ed. 1998</td>
<td>0.02 g.m-3</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>Calculation: from Dissolved Ca and Dissolved Mg APHA 2340 B 20th ed. 1998</td>
<td>1 g.m-3 as CaCO3</td>
</tr>
<tr>
<td>Dissolved Sodium</td>
<td>Filtered sample, ICP-MS APHA 3125 B 20th ed. 1998</td>
<td>0.02 g.m-3</td>
</tr>
<tr>
<td>Dissolved Potassium</td>
<td>Filtered sample, ICP-MS APHA 3125 B 20th ed. 1998</td>
<td>0.05 g.m-3</td>
</tr>
<tr>
<td>Total Ammoniacal-N</td>
<td>Filtered sample. Phenol/hypochlorite colorimetry. Discrete Analyser. (NH4-N = NH4+-N + NH3-N) APHA 4500-NH3 F (modified from manual analysis) 20th ed. 1998</td>
<td>0.01 g.m-3</td>
</tr>
<tr>
<td>Total Nitrogen</td>
<td>Calculation: TKN + Nitrate-N + Nitrite-N</td>
<td>0.1 g.m-3</td>
</tr>
<tr>
<td>Total Kjeldahl digestion</td>
<td>Sulphuric acid digestion with copper sulphate catalyst. APHA 4500- N O D. (modified) 20th ed. 1998</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Kjeldahl Nitrogen (TKN)</td>
<td>Kjeldahl digestion, phenol/hypochlorite colorimetry (Discrete Analysis). APHA 4500-N O B. (modified) 4500-NH3 F (modified) 20th ed. 1998</td>
<td>0.1 g.m-3</td>
</tr>
<tr>
<td>Nitrate-N + Nitrite-N (TON)</td>
<td>Total oxidised nitrogen. Automated cadmium reduction, Flow injection analyser. APHA 4500-NO3 I (Proposed) 20th ed. 1998</td>
<td>0.002 g.m-3</td>
</tr>
<tr>
<td>Nitrate-N</td>
<td>Calculation: (Nitrate-N + Nitrite-N) - Nitrite-N.</td>
<td>0.002 g.m-3</td>
</tr>
<tr>
<td>Nitrite-N</td>
<td>Automated Azo dye colorimetry. Flow injection analyser. APHA 4500-NO3 I (Proposed) 20th ed. 1998</td>
<td>0.002 g.m-3</td>
</tr>
<tr>
<td>Dissolved Reactive Phosphorus</td>
<td>Filtered sample. Molybdenum blue colorimetry. Discrete Analyser. APHA 4500-P E (modified from manual analysis) 20th ed. 1998</td>
<td>0.004 g.m-3</td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>Acid persulphate digestion, ascorbic acid colorimetry, Discrete Analyser. APHA 4500-P E (modified from manual analysis). 20th ed. 1998</td>
<td>0.004 g.m-3</td>
</tr>
<tr>
<td>Chloride</td>
<td>Filtered sample. Ferric thiocyanate colorimetry. Discrete Analyser. APHA 4500-CI E (modified from continuous-flow analysis) 20th ed. 1998</td>
<td>0.5 g.m-3</td>
</tr>
<tr>
<td>Sulphate</td>
<td>Filtered sample. Ion Chromatography. APHA 4110 B 20th ed. 1998</td>
<td>0.5 g.m-3</td>
</tr>
<tr>
<td>Total Iron</td>
<td>Nitric acid digestion. ICP-MS. APHA 3125 B 20th ed. 1998</td>
<td>0.02 g.m-3</td>
</tr>
<tr>
<td>Total Manganese</td>
<td>Nitric acid digestion. ICP-MS. APHA 3125 B 20th ed. 1998</td>
<td>0.0005 g.m-3</td>
</tr>
<tr>
<td>Total Anions</td>
<td>Calculation: sum of anions as mEq/L [Includes Alk, Cl, NOxN &amp; SO4]</td>
<td>0.07 mEq/L</td>
</tr>
<tr>
<td>Total Cations</td>
<td>Calculation: sum of cations as mEq/L [Includes Ca, Mg, Na &amp; K]</td>
<td>0.05 mEq/L</td>
</tr>
</tbody>
</table>

**Analyst's Comments:**

These samples were collected by yourselves and analysed as received at the laboratory.

Samples are held at the laboratory after reporting for a length of time depending on the preservation used and the stability of the analytes being tested. Once the storage period is completed the samples are discarded unless otherwise advised by the submitter.

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---

Terry Cooney MSc (Hons), PhD, MNZIC  
Divisional Manager - Environmental

Peter Robinson MSc (Hons), PhD, FNZIC  
Client Services Manager - Environmental Division

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- R J Hill Laboratories Ltd -
Appendix 4  Habitat Assessment Data
### Table 4a Summary of habitat parameters determined at sites in the 2006 survey using established habitat assessment protocols

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Nukunuku Creek</th>
<th>Qaliwana Creek</th>
<th>Ba River</th>
<th>Savatu Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upstream</td>
<td>Upstream (lower)</td>
<td>Downstream</td>
<td>Upstream</td>
</tr>
<tr>
<td>Habitat abundance / diversity</td>
<td>O</td>
<td>SO</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Velocity / Depth regimes</td>
<td>SO</td>
<td>O</td>
<td>O</td>
<td>SO</td>
</tr>
<tr>
<td>Sediment deposition</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>SO</td>
</tr>
<tr>
<td>Channel alteration</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Frequency of riffles</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Left bank stability</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>SO</td>
</tr>
<tr>
<td>Right bank stability</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>SO</td>
</tr>
<tr>
<td>Left vegetative protection</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>SO</td>
</tr>
<tr>
<td>Right vegetative protection</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>SO</td>
</tr>
<tr>
<td>Left riparian vegetative zone width</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>M</td>
</tr>
<tr>
<td>Right riparian vegetative zone width</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>M</td>
</tr>
<tr>
<td>Periphyton growth</td>
<td>M</td>
<td>P</td>
<td>M</td>
<td>O</td>
</tr>
</tbody>
</table>

Notes:  
- O = Optimal,SO = Sub-optimal, M = Marginal and P = Poor.  
- Refer to Appendix A for definitions.

### Table 4b Summary of habitat parameters determined at sites in the 2005 survey using established habitat assessment protocols

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Nukunuku Creek</th>
<th>Nadala Creek</th>
<th>Qaliwana Creek</th>
<th>Ba River</th>
<th>Savatu Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Upstream</td>
<td>Downstream (upper)</td>
<td>Upstream (lower)</td>
<td>Upstream</td>
<td>Downstream</td>
</tr>
<tr>
<td>Habitat abundance / diversity</td>
<td>O</td>
<td>SO</td>
<td>SO</td>
<td>SO</td>
<td>O</td>
</tr>
<tr>
<td>Velocity / Depth regimes</td>
<td>SO</td>
<td>SO</td>
<td>SO</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Sediment deposition</td>
<td>O</td>
<td>O</td>
<td>SO</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Channel alteration</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Frequency of riffles</td>
<td>O</td>
<td>O</td>
<td>SO</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>Left bank stability</td>
<td>O</td>
<td>O</td>
<td>SO</td>
<td>SO</td>
<td>SO</td>
</tr>
<tr>
<td>Right bank stability</td>
<td>O</td>
<td>O</td>
<td>SO</td>
<td>SO</td>
<td>SO</td>
</tr>
<tr>
<td>Left vegetative protection</td>
<td>O</td>
<td>O</td>
<td>M</td>
<td>M</td>
<td>O</td>
</tr>
<tr>
<td>Right vegetative protection</td>
<td>O</td>
<td>O</td>
<td>M</td>
<td>P</td>
<td>O</td>
</tr>
<tr>
<td>Left riparian vegetative zone width</td>
<td>O</td>
<td>O</td>
<td>M</td>
<td>M</td>
<td>O</td>
</tr>
<tr>
<td>Right riparian vegetative zone width</td>
<td>O</td>
<td>O</td>
<td>M</td>
<td>M</td>
<td>O</td>
</tr>
<tr>
<td>Periphyton growth</td>
<td>M</td>
<td>M</td>
<td>P</td>
<td>M</td>
<td>O</td>
</tr>
</tbody>
</table>

Notes:  
- O = Optimal, SO = Sub-optimal, M = Marginal and P = Poor.  
- Refer to Appendix A for definitions.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Nukunuku Creek</th>
<th>Qaliwana Creek</th>
<th>Ba River</th>
<th>Savatu Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Up-stream</td>
<td>Down-stream</td>
<td>Up-stream</td>
<td>Down-stream</td>
</tr>
<tr>
<td><strong>Compaction</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tightly packed &amp; / or overlapping</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mod. packed with some overlap</td>
<td>√</td>
<td>√</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mostly loose with little overlap</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>No packing/loose assort./easily moved</td>
<td></td>
<td></td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td><strong>Embeddedness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;5% covered by fine sediment</td>
<td>√</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>5-25%</td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>26-49%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51-75%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&gt;76% covered by fine sediment</td>
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Appendix 6  Results of Statistical Analysis
### Total Abundance

#### Anova: Two-Factor With Replication

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### Number of Species

#### Anova: Two-Factor With Replication

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**Anova: Two-Factor With Replication**

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Appendix E  Consultation Meeting Notes
APPENDICES

Appendix A
The Monasavu Experience

Introduction

This chapter is composed based on the feedback received during community consultation. There are men and women in Nadala, Navai and Nadrau villages who had worked on the Monasavu Project. They freely shared their experiences during discussion recounting both the positive and negative impacts of Monasavu. They also suggested measures that could be taken to avoid or mitigate the negative social impacts of the proposed FEA project.

Working Conditions at Monasavu

All workers irrespective of where they came from had to stay in camps. Both men and women lived and worked at the camp Work was carried out in three shifts of eight hours each. An employee worked for two weeks at a stretch. After two weeks of work the employee will get weekends off. He or she would leave the camp on Friday evening and return to camp on Sunday evening to start work on Monday.

Boarding arrangements were made at the camp. Food was of good quality and liquor was freely available at the camp site. There was a lot of drinking, dancing and partying during the weekends. The security arrangement at the camp was lax; outsiders could easily move in and out of camp without being questioned. This brought a lot of undesirable elements to the camp site, especially during drinking, dancing and partying.

The workers were paid weekly. In some cases, the family rarely saw the first week wage since workers returned home after second week. First week’s wage was used up on merry making. The family got the benefit of the wage paid during the second week.

At the decommissioning of Monasavu Camps, all sleeping and bedding gears were burnt without any consideration to the workers or those who had used the gears. They should have been given away to the workers or people who were using them while camping.

The housing structures were sold (auctioned) without any consideration to the landowners. They could have been converted to some useful social amenity.

When the Monasavu camp was decommissioned the entire place was left in a mess—somewhat resembling the status of Lami Dump but on a smaller scale. The entire campsite was strewn and speckled with rubbish, used spare parts, spent oil and grease, broken machinery, discarded bedding gear, timber pieces, etc. The villagers would like to see that the camp site is properly decommissioned, rehabilitated, and left spick-and-span.

Social Problems Encountered
It is partly because of living and working conditions described above, Monasavu faced a number of social problems. These problems, among others, include family estrangement, divorce, unwanted and teen-age pregnancies, abortions, drunkenness, drinking brawls, accidents, long absences from home (some workers did not return home even after the fortnight break), and in some cases the family did not get the benefit of the first week’s wages.

Sex industry saw it’s hey day during Monasavu operation. Since security was not tight sex workers could easily pass in and out of camp. According to a ex-Monasavu Navai villager:

“There were three dangerous ingredients at Monasavu: drinks, money, and youth. Street girls came from Lautoka, Suva, and other places. There was no restriction on camp entry and sex industry flourished during weekends.” Navai villager.

“A number of ‘kaivalagi’ children (children born out of wedlock) could be seen growing up in the villages after the work was over”. Nadrau villager

Traffic Hazard at Monasavu: A number of serious accidents took place at Monasavu. This was attributed to drinks, overworking, over-speeding, road conditions, and lack of awareness. (A road accident that happened at the start of the drilling operation of this project became the talking point for the villagers)

“Because of drinks and money, young people tended to misbehave. They flouted cultural and traditional norms and had no respect for village elders. They neglected their family welfare and stayed away from homes for long periods of time”. Nadala resident.

Positive Aspects of Monasavu

Monasavu had better working conditions than Vaturu in terms of food, residence, transportation, uniforms, safety gears, OHS compliance, etc.

The Monasavu Employment brought cash to the villages. The cash flow improved for many the standard of living, though not for all. The improvement in the standard of living was reflected in improved housing, household goods and appliances, tools and implements, education, sanitation and hygiene, etc.

There was also opportunity to learn and improve ones skills. The community was enriched by skill transfer and by training on the job. It helped many people to remain on the farm and improve their farm conditions.

Lessons Learned: Mitigative measures

1. There should be no camp for local residents i.e. those who reside in the project area should daily travel to and from work.
2. Women to work only from 8.00 am to 4.00 pm. There should be no women in the camp area after four (like what was done during Vaturu dam construction.).
3. The camp sites should be well fenced for security reasons; strict security arrangement should be put in place. Individual workers should always wear ID cards; no outsiders should be allowed at the camp (Vatukoula’s case was cited as an example of tight security arrangement).
4. Use of liquor should be regulated. Provisions of Liquor Act should be enforced. Drinking should be allowed only at the camp; no drinking in the villages at any time and under no circumstances.
5. Encourage rural banking- make the recently launched ANZ Rural Banking Facility available on payment days close to the disbursement site. If the employees agree, certain percentage of wages/salary could be directly banked by the employer.
6. Camp sites should be located away from the villages.
7. All OHS precautions to be enforced at the work place.
8. Workers especially from outside should be educated and made aware of village protocol, the easy going pastoral life of the residents in the project area, and the groups that are vulnerable to accidents and mishaps.
9. Before the project starts there should be community awareness program to make people aware of the positive and negative impacts and consequences of the proposed project.

Appendix B

Community Consultation- Koro

Place: Koro Village
Venue: Community Bure
Date: 18 Jan. 2005
Start Time: 9.30 am
End Time: 11.30 am

Present:
Malakai G Village Elder
Aparusi Taukei Village Elder
Iliavi Masori Teacher
Savenaca Boladroka Turaga ni Koro lewa
Master Isikeli Field Assistant
Apology Turaga ni Koro of Koro- away in Lautoka
Others:
Men- 12 Women- 6 Youth- 5

Issues, Concerns and Requests
1. What would be the effect of water discharge from Ba Power Station into the river? Would it lead to flooding- especially during rainy season? Since the villagers ford the river daily to go to their plantation on the other side (tiliva).
2. What would be the effect of the water discharge on the fish population? Three sections of the river in front of the village is a protected area. It serves as a nursery ground and fishing is done only on special occasions like the arrival of an important visitor to the village.

3. The river is an important source of drinking water. During dry months the mountain spring dries up and villagers depend on the river for their water needs. Uses of river water include drinking and cooking, bathing and washing, fishing, and watering animals. The river in fact is an integral part of Koro villagers. What effect the project activities would have on these river amenities?

4. One family is entirely dependent on river water all the time- during rainy and dry months as well.

5. Traffic Hazard- children go to school at Nagatagata. Can a footpath be provided along with safety measures?

6. The village has no FEA power connection. Please give us electricity this time.

7. Koro village is right on the banks of Ba river. FEA can come and assess things for themselves.

8. Request- Could FEA help the villagers to build a swinging bride across the river? During rainy days it is difficult to cross the river. Since the villagers have their plantations on the other side of the river they need to cross the river almost daily.

### Appendix C

**Community Consultation- Drala**

**Place:** Drala village  
**Venue:** Community Hall  
**Date:** 18th Jan. 2005  
**Start Time:** 12.00 noon  
**End Time:** 3.00 pm

Present:
- Paula Nabau  
  Turaga ni Koro- Drala  
- Luba K  
  Turaga ni Mataqali  
- Jone Nabau  
  Member  
- Sevenaca Boladroka  
  Turaga ni Koro- Lewa  
- Master Isikeli  
  Field Assistant- Local dialect expert

Others:
- Men- 15  
- Women- 8  
- Youth- 4

**Issues, Concerns and Requests**

1. Like Koro village, Drala villagers also depend on Ba River for fishing, drinking, bathing, washing, and watering animals.

2. How will FEA make good the loss of fishes resulting from the discharge of water into Ba River?

3. The villagers use the river two or three times a week for fishing that provides them protein in their diet.

4. The village is situated about a mile and 8 chains from the point of water discharge in Ba River.
5. Will there be compensation for crop damages? Will FEA compensate for other forms of damages (tree crops such as citrus, coconut, pine trees, indigenous timber trees, etc. in and around Votualevu - the site for Ba Power Station?
6. Traffic hazard - both children to school and adults use the road frequently and uncontrolled traffic can be a serious problem. Can FEA look at the road infrastructure in its entirety?
7. Request: The village has no FEA power connection. Could FEA please consider supplying power to the village?

Appendix D
Community Consultation- Nagatagata

Place: Nagatagata Village
Venue: Vale ni Vanua
Date: 19th Jan. 2005
Start Time: 9.00 am
End Time: 11.30 pm

Present:
Semi Leiene- Turaga ni Taukei
Josefa Buli- Village Elder
Savenaca Boladraka- Turaga ni Koro Lewa
Master Isikeli Field assistant, local dialect expert
Indra Deo Social Consultant
Apology Turaga ni Koro Nagatagata- away on some other duty.

Others:
Men- 12 Women- 7 Youth- 5

Issues, Concern and Requests
1. The land owning mataqalis are not confined to one place or village; they are spread over in different places. For example Mataqali Nageregere members are living in Nadala and Nagatagata villages, Ekubu in Lewa and Nagatagata. The Task Force on Land should consult all the members of concerned mataqalis.
2. While recruiting for jobs, priority should be given to skilled and unskilled workers available with the landowners. Possibly a Village Recruitment Committee should be formed.
3. Traffic Hazard- Nagatagata with Savatu Primary School and a Nursing Station is an important hub for a number of transactions for the villagers living around.
4. Compensation for damages to plantation and other assets resulting from project activities?
5. What if project activities damage the water mains supplying water to the village? (earthworks, heavy trucks and machinery)
6. Will there be any compensation to the landowners before the work commences?
7. WE have no faith in GPS in determining land boundaries; we want the old method of surveying using compass, chains, etc.
8. Gender Employment Equity: women should be considered for employment in appropriate areas (kitchen, dining hall, sanitation, security, laundry, office works, communications, etc.) otherwise most to the jobs will go to men only.

**Appendix E**

**Community Consultation- Buyabuya**

Place: Buyabuya village  
Venue: Community Bure  
Date: 19th Jan. 2005  
Start Time: 12.00 noon  
End Time: 3.30 pm

Present:  
Isikeli Tabaniwa- Turaga ni Koro- Buyabuya  
Jone Nabau- Turaga ni Mataqali- Votualevu  
Apalosi Goneva- Village Elder  
Savenaca Boladraka- Turaga ni Koro Lewa  
Master Isikeli- Field Assistant, Local Dialect Expert  
Others:  
Men- 20 Women- 5 Youth- 7

**Issues, Concern and Requests**

1. The road to Ba Power Station will use the existing Buyabuya road. The villagers request the condition of the road be improved before the construction phase starts.
2. The mataqali Votualevu residing in close proximity of the main village owns the land where Ba Power Station would be located. They have already given a list of claims to FEA.
3. Drinks are to be confined to the workers camp only; no drinks in the villages. There is need for the workers to adhere to Village Protocol. The villagers agreed to develop a draft Village Protocol.
4. Will there be compensation for the loss of fishing amenity, damage to plantations, and useful trees like bamboo, coconut, etc. on the proposed Ba Power Station site?
5. Priority be given to local people while recruiting workers for the project.
6. Will FEA compensate if the source of water for the village is damaged?
7. Traffic Hazard is an important consideration for the residents of Buyabuya.
8. Request: FEA power connection and a water tank for water system to the village.
Appendix F
Community Consultation- Marou

Place: Marou village
Venue: Vale ni Vanua
Date: 20th Jan. 2005
Start Time: 9.00 am
End Time: 12.00 noon

Present:
Sailosi Biau- Turaga ni Koro- Marou
Ovini Durutamata- Turaga ni mataqali
Semibukete- Village elder
Savenaca Boladroka- Turaga ni Koro- Lewa
Malakai Kali- Field Assistant, Local Dialect Expert
Others:
Men- 17 Women- 12 Youth- 5

Issues, Concerns and Requests
1. Would the tunneling operation affect the water sources i.e. spring or vure used as drinking water?
2. Historical, cultural, religious, and sacred sites should be protected from any damage by project activities.
3. There should be compensation for helicopters flying over our land i.e. the space (maliwa lala) over our vanua.
4. The road to Marou needs improvement. Could FEA improve the road condition since they are also lewe ni Navinoji (members of mataqali Navinoji).
5. Would the project activities affect the fishing ground (qoliqoli)? If it does how would FEA compensate?
6. Veitaratara (communication) - there is need to improve communication amongst the key landowning mataqalis. There are members of Navinoji mataqali also residing in Marou and there needs should also be considered.
7. Concern about Traffic Hazard- Marou children walk to schools at Lewa as well as to Nagatagata.
8. The villagers should be given the opportunity to supply food crops to the camp sites.
9. Decommissioning of campsites- after the construction phase is over the camp sites should be properly rehabilitated and left spick and span. (rubbish, garbage, oils and grease, spare parts, sheds, junk items, etc should be properly disposed.)
10. Requests: FEA power supply, three street lights, village footpath, a van to transport children to school, and a tank for collecting water. (in all told 14 issues)
Appendix G

Community Consultation- Lewa

Place: Lewa village
Venue: Community Hall
Date: 17 Jan. 2005
Start Time: 8.30 pm
End Time: 11.00 pm

Present:
Sakaraiya Navukula- Turaga ni Yavusa member
Apisaikuruicivi - Turaga ni Taukei
Neulele Daukuro- Member
Savenaca Boladroka- Turaganikoro- Lewa
Master Isikeli- Field Assistant
Others: Men- 14 Women- 8 Youth- 5

Issues, Concerns and Requests
1. Concern about water drying up downstream as a result of dam construction. Loss of aquatic resources including fishes.
2. The level of water upstream will rise as result of dam construction. Will this lead to flooding and affect the villages situated in close proximity to the rivers?
3. If the dam structures fail (natural disasters being one of the causes) will the people leaving downstream be affected? What does the project proponent proposes to do?
4. The process of drilling goes quite deep. What if the Company (FEA) finds loads of gold or diamond underneath? How can the landowners know what is happening? [Behind this concern is the “legend of Navinoji.”]
5. During construction if care is not taken landslides can happen. What does FEA proposes to do about this disaster waiting to happen?
6. Would the siting of power stations affect the grazing of cattle in the designated areas? (Lewa and Marou)
7. Would the project activities affect the Cultural, Historical, Sacred, and Archeological artifacts? (koro makawa, bulubulu, wavu, etc.)
8. Risk posed by the sudden increase in size, speed, and number of vehicles on the road. FEA should look at the issue in details including sealing road segments that run through villages, footpath for school children, road humps, proper signage, etc
9. The project will create job opportunity for the villages in the project area. Cash income will drive other forms of much needed development in the area.
10. In the process of recruiting workers, priority should be given to the members of the land owning mataqalis.
11. The two proposed tunnels traverse through a large distance. Would compensation be paid for damages incurred to plantations, gardens, water resources (vore) etc.
12. What sort of agreement or obligation will guide the creation of catchment area? Would landowners be about to extract wild foods, firewood, timber? Compensation for the use of land foregone?
13. WE don’t want alcohol to enter our village. Selling of alcohol be confined to the
   camp sites only. All rules regarding the sale and use of liquid should be enforced
   at the camp sites.
14. The outside workers should observe the traditional village protocol?

Appendix H
Community Consultation- Naiyaca

Place: Naiyaca village
Venue: Community Hall
Date: 20th Jan. 2005
Start Time: 2.30 pm
End Time: 5.30 pm

Present:
Penaiya Sadege- Turaga ni Koro- Naiyaca
Apete Matanivanua- Village elder
Vatemo Vodivodi- Village elder
Savenaca Boladroka- Turaga ni Koro- Lewa
Malakai K.- Field Assistant, Local Dialect Expert
Others:
Men- 12 Women- 5 Youth- 3

Issues, Concerns and Requests
1. Vakacava na qereqere? Will the resource owners of gravel and other resources be
   compensated by the company?
2. The village water supply pipe runs across the road since the village is spread on
   both sides of the road. The company should take necessary steps to see that water
   pipes are not damaged.
3. Traffic Hazard especially in Naiyaca since the road runs through the village and
   children walk to school at Lewa. Can a clear footpath be provided?
4. The company workers should maintain Village Protocol at all times.
5. The overall condition of the road in the project area will need improvement from
   safety and health point of views. Sections of road passing through villages would
   require sealing.
6. Employment opportunity could start with the land owners and spread from inside
   out ie. The order of priority should be landowners, other villages in the project
   area, other parts of Fiji, and finally overseas.
7. If the village water supply (spring/vure) falls within the catchment area or is
   affected in some way by project activities would alternative sites and/or
   compensation be provided? What rules govern an area designated as catchment to
   the proposed project?
8. Requests: If three ‘street’ lights could be provided by FEA because stray animals
   roam about in the village at night.
Appendix I
Community Consultation- Nadala

Place: Nadala village  
Venue: Community Hall  
Date: Mon 24 January 2005  
Start Time: 8.00 pm  
End Time: 11.00 pm  

Present:  
Peniasi Ketewai- Turaga ni Koro Nadala  
Luke Dauciri- Turaga ni Mataqali  
Penisoni Rawasoi- Local Dialect Expert  
Orisi Qio- Ex Monsavu and Vaturu  
Luke Dauciri- Ex-Monasavu and Vaturu  
Litiana- Ex Mosnasavu  
Others:  
Men- 15  Women-12  Youth-7

Issues, Concern and Requests
1. The Nadala River Flats is prone to flooding during periods of heavy rains which may or may not coincide with hurricane or tropical cyclone. The Government than carries out the disaster relief and assistance work. Who will do the relief and rehabilitation work after the dam is in place?  
2. Would the frequency of flooding increase once the dam is built? In other words would the dam structure aggravate the flooding episode? There are about 12 families living in the Nadala River Flats. Who would compensate the damages caused by flooding?  
3. Grazing Area will be affected: At anytime there are 70 to 80 heads of cattle grazing in the Nadala River Flats. If the grazing is inundated will there be any compensation for the lost gazing amenity.  
4. What can the project proponents do regarding noise disturbance arising out of increased number of vehicles and helicopters flying over head. The children in primary and Junior Secondary School are likely to be disturbed.  
5. Traffic Hazard: The road passes through Nadala village and traffic hazard is one of the main issues. Need to inform and educate teachers, school children, and project workers.  
6. Relocation of homes due to changes in road: What procedure is followed and what is the compensation schedule? Who will negotiate and manage this issue? (contact PWD for more information on this that can be passed on to the villagers.)  
7. The possible jobs that women could do during the construction phase of the proposed project include baby sitting, cooking, waitress, janitors, security officers, clerical workers, semi skilled jobs, laundry, and skilled jobs depending upon qualification and experience.  
8. Monasavu work conditions: All workers whether local or overseas or irrespective of where they came from stayed in camp near the work site. Work was carried out
in three shifts of eight hours each. After two weeks of work an employee would leave the camp on Friday evening and return to camp on Sunday evening to start work on Monday. The workers were paid weekly. Both men and women worked at the camp. Liquor was available freely at the camp site. There was a lot of drinking, dancing and partying at the camp site. The security arrangement at the camp site was so lax that outsiders (non-workers) could easily move in and out of camp without being questioned. This brought a lot of undesirable elements to the camp site.

9. Social Ills of Monasavu: It is because of the above conditions Monasavu faced a number of social problems. Family estrangement, divorce, teen pregnancies, unwanted pregnancies, abortions, drunkenness, drinking brawls, accidents, long absences from home people did not return after the fortnight break, family sometime did not see the first week payment – it was spent on drinks and marry making. Prostitution was quite rampant. Security was not tight so people could easily pass in and out of camp.

10. Preventive Measures: No camp for local residents i.e. those who reside in the project area – daily travel. Women to work only from 8.00 am to 4.00 pm. There should be no women in the camp area after four. (like what was done in Vaturu dam construction.). Camp site well fenced for security reasons, Strict security arrangement; people with ID cards, no outsiders allowed (Vatukoula’s case was cited as an example to tight security arrangement), Liquor served only within the camp site and nowhere else with specified time. Drinking only at the camp sites. (check details with liquor tribunal). Encourage rural banking- make the facility available on payment days close the disbursement site. Or if employees agree certain percentage of wages/salary can be directly banked by the employer.

11. Traffic Hazard at Monasavu: A number of serious accidents took place at Monasavu. This was attributed to drinks, overworking, overspeeding, and road conditions, and lack of awareness. (A road accident that happened at the start of the drilling operation of the proposed project became the starting point for this discussion for the villagers)

12. The loss of fishing amenity can be made good by breeding different types of fishes in the dam waters. Instead of Monasavu model where only Malaya (Tilapia) fish is available, the Vaturu model should be adopted where three kinds of fish are available, namely, Tilapia, Grass Carp, and Best (like Oqo fish). The people would be happy with this arrangement.

13. Local Employment Arrangement: There is need to put a system in place where people can seek information and make formal application for jobs available. This should be within the project area for the benefit of the residents in the project area. (Could be part of the project office in the area. This brings up the question: which is the best mode of mass communication for the residents of the area?)
Appendix J
Community Consultation- Navai

Place: Navai village
Venue: Community Hall
Date: 25th Jan. 2005
Start Time: 5.30 pm
End Time: 8.00 pm

Present:
Sailosi Tamani Valu- Ex Monasavu
Sukana Saga- Village Elder
Jimilai Waqa
Nemia Marovia
Esira S
Ranadi Kelera
Seniana Ranadi
Janiti Dalawa
Vilikesa
Penisoni Rawasoi- Local Dilect Expert
Others:
Men: 5 Women: 7 Youth: 4

Issues, Concerns and Requests
1. The Monasavu Employment brought cash to the villages. The cash inflow improved for many, though not for all, the standard of living. The improvement was reflected in improved housing, access roads, education to children, household goods, etc. BUT with cash economy came lot of social problems.
2. Social problems included traffic hazard, drunkenness, fights, family breakdown, teen and unwanted pregnancies, divorce, etc.
3. Because of drinks and money, young people were out of control. They broke cultural and traditional rules and had no respect for village elders. They neglected their family welfare and stayed away from homes for long periods of time.
4. “There were three dangerous ingredients at Monasavu: drinks, money, and youth. Street girls came from Lautoka, Suva, and other places. There was no restriction and merry making went on the camps.” Navai villager.
5. The Social consultant related his experience of what happened on a payday night in Dawara village during Mount Kasi mining operation.
6. At Monasavu, the family rarely saw the first week wage since workers returned home after second week. First week’s wage was blown on drinking, dancing, and partying. The wife only knew of the wage paid during the second week.
7. People would are apprehensive about AIDS issue. They would like more information and education before the project starts.
8. People would like to know the extent of inundation as a result of dam construction because of the reasons given below.
9. At present during heavy rains there is flooding and the village gets affected in several ways. These include: the Navai village bridge/crossing is under water restricting the flow of traffic, school children are stranded, plantations and houses near river get affected, flood waters cut across the river (river meandering), etc.

10. Will construction of dam aggravate the above situation? Can FEA, Government, PWD do some things to improve the situation?

11. Can PWD improve the design of the Navai bridge/crossing? The present construction is low and culverts used are small in size leading to frequent flooding for longer periods of time.

12. The villagers are concerned about their water pipe which runs along the road and utility wires running overhead. Would they be damaged by tall and heavy traffic vehicles frequently running through the village?

13. Ladies carrying heavy loads on their backs (firewood and garden produce) and children walking to and from school are especially at risk of fast and frequently moving HTV and other vehicles used on the project.

14. One accident has already occurred with the drilling vehicle plying between the EGM rest house and the drilling site.

15. People would like to know the difference between a dam and a weir

16. Catchment Area: People would like to know what entails an area being declared catchment for the project.

Appendix K
Community Consultation- Nadrau

Place: Nadrau Village
Venue: Community Bure
Date: Wed. 26 Jan 2005
Start Time: 10.00 am
End Time: 1.00 pm
Present:
Villiame Vakamalua- Turaga ni Koro – Nadrau
Anare Robu
Epeli Nabati
Ratu Savenaca Viliame
Simione
Seniloli
Abarez Seveci
Buli, Sireli, Eroni, Epeli, Seru, Natadra
Penisoni Rawasoi- Local Dialect Expert

Issues, Concerns, Requests

1. The villagers would like to know the fate of the Sigatoka/Qaliwana River after the dam is build. What level and kind (purity) of water will be maintained downstream? (downstream effect? )

2. At present, according to the villagers, the river is used for fishing, watering animals, and some times for drinking purposes. When smaller tributaries feeding the main stream dry up during drought, the main Sigatoka River becomes the source of drinking water. What happens if that dries up too!
3. The project has advantages too- it will bring cash income to the villagers and the consequent improvement in living standards, no sudden blackouts, fishing in the dam reservoir, etc.
4. Naga villagers, now living inland, used to live on the banks of Sigatoka River. But they still go and live at koro makawa for a few days working on their plantations. They use the river water for drinking especially during those days they are away from the village.
5. What would be the quality of the river after the dam is build? Would decomposing vegetation, animal life, microflora and fauna, and impounding effect of water impact the quality of water downstream?
6. The loss of fishing amenity in the rivers if compensated with better fishing facility at the dam would be acceptable to the villagers.
7. Monasavu Issues: Monasavu had better working conditions than Vaturu in terms of food, residence, transportation, uniforms, safety gears, OHS compliance, etc.
8. Camp sites should be located away from the villagers.
9. A number of kaivalagi children could be seen growing up in the villages after the work was over.
10. At the decommissioning of Monasavu Camp, all sleeping and bedding gears were burnt. They should be given away to the workers or people who were using them while camping.
11. The housing structures were sold (auctioned) without any consideration to the landowners or community use to which the structures could be converted. (Like building a rural marketing centre).

Appendix L
Consultation with Civil Servants

Place: Nadarivatu Government Station  
Venue: Assistant District Officer’s Office  
Date: 25th Jan. 2005  
Start Time: 9.00 am  
End Time: 11.00 am

Present:
Peni Koro- Assistant District Officer, Nadarivatu
Esira Serumasi- Agriculture Assistant
Peni Nagata- Forestry Office
Satagi- Fiji Hardwood Office

Apology: Sister Tokasa Health Centre.

Issues discussed:

1. Stressing the importance of the project and need for coordination the ADO said that it was a FEA- Government project. Further he briefed as follows:
2. The Government intends to upgrade the Buyabuya Road. Money has been allocated in 2005 budget
3. The Nanoko – Navatusila Road has been completed and opened to traffic.
4. The Government now has special allocation for Dalo- Yagona or Farm Access Road as opposed to Cane Access Road.
5. The Nasogo Road near Nagelewai village has been graveled.
6. Because of geographical peculiarity the DO’s office at Nadarivatu serves three tikinas belonging to three different provinces; Tikina Savatu (Ba province), Tikina Nabobuco (Naitasiri) and Tikina Navatusila (Nadroga/Navosa).
7. Ministry of Fijian Affairs and Regional Development has been merged to form the Ministry of Fijian Affairs, Culture, Heritage, and Provincial Development. The Minister is the Prime Minister. There are two other Ministers: Minister for Provincial Development is Hon. Ted Young, and Minister for Fijian Affairs, Culture and Heritage is Hon. Ratu Suliana Matanitobua (Tui Namosi). CEO is Ratu Meli Bainimarama.
8. The position of Divisional Planning Officer has been abolished in all the Divisions. The Provincial Administrator with Commissioner and District Officer coordinated development projects within a Province.
9. There is a proposal to link Marou and Buyabuya by road? (there is deep valley separating the two villages.)
10. Would the two proposed tunnels affect the mountain springs which are important sources of drinking water to the villagers. At present Lewa village and School get their water supply from Savuwawa vure (between Lewa and Naiyaca). The present source is inadequate. They are proposing a new source Butoni near Lewa vou village close to Lewa Power Station. Similarly Buyabuya, Nagatagata (village and school), and Marou have their sources near Ba tunnel. ADO wanted to know the effect of tunneling before considering funding proposal. The social consultant consulted the geologist at the dam drilling site but she said it was the domain of a hydrogeologist.
11. Traffic hazard especially the stretch passing through the Government station.
12. The Nadarivatu Road especially the stretch from Waikubukubu to Government Station needs upgrading so the public transport and services can be delivered to the residents in the project area. In this regard FEA, Government, PWD, and LTA should put their axe together.

**Appendix M**
Discussion with Sister Toakasa
Nadarivatu Health Centre

Venue: Nadarivatu Health Centre
Date: 28th Jan. 2005
Time: 12.00 to 1.00 pm

Issues discussed
1. There are no reported cases of HIV positive in the proposed project area. And they would like to remain so. This would entail dissemination of information, community education and visits by PHC staff to villages, schools, and community based groups.
2. The present level of drug supply, staffing, and other facilities correspond to the present size of population. The requirement would change drastically once the project enters the construction phase.
3. In view of the proposed project health planning should take into consideration increased demand for drugs, medical equipment and accessories, staff, transport, and preparedness to deal with medical emergencies and evacuations.

4. At present there is only one nurse at the health centre. She has her priorities in terms of clinics and community visits and it would be difficult to deploy her in times of medical emergencies.

5. Traffic Hazard especially at the health centre. The building is so close to the road that it shakes when vehicles pass by. What would happen if the size and frequency of vehicles increase?

Appendix N
Discussion with Samisoni Naqica – 84 years old

Nadala Floodplains
Date: 28th January, 2005
Venue: Samisoni’s Bure

There are 11 families living on the Nadala Flood Plains; on the left and right banks of Nadala river (from Nadala village facing toward the dam).

From Dam end Right bank
Semi Lewelowa- lives in Ba but comes to the farm occasionally.
Joveci
Josaia Kitou
Penisoni Saukileya
Vunisa qitou
Meli Qarakoso

From Dam End Left Bank
Asava Manulevu
Samisoni Naqica Sr
Timoci Ratu
Samisoni Naqica Jr – PC at Tavua Station

Apenisa Vunitali

Last flood episode in April 2004 when it rained for one whole day and half a night. Six families living close to the river were affected. (Hurricane Bibi and Kina the flooding was extensive in the floodplains).

The Flood damage included damages to crops (kakana dina and I coi), and small livestock like chickens. There was no damage to the houses.
Most cattle graze in the floodplains.

The river meanders in the plains, enters the narrow valley leading to a fall about 15 metres and then she slides down towards the proposed dam site.
Catchment Area issue is important since much of the area is inhabited. As population increases so do the need to exploit natural resources, boundary line, do’s and don’ts, and of course compensation, can they remove the timber which is ready for harvesting pine and indigenous trees, etc

Sacred sites Sau Tabu are important for mataqalis identity and survival. Recommend for a relook if the design changes and new areas are involved.

- People are happy with the consultation process. Not done during monasavu
- They on their own were able to think of the costs and benefits/ negatives and positives
- They were able to suggest mitigating measures in some cases
- When cantankerous issues are rationalized impartially they were able to discern the point.

Bibliography


Minutes of Presentation to Government Departments for Environmental Impact Assessment (EIA) report for Nadarivatu hydro & Butoni Wind Farm Project

Date: 1st June, 2005

Venue: FEA Board Room

Time: 10.15am

Present:
1. Pene Burns (Environmental Scientist, Sinclair Knight Merz)
2. Shivangini Bishwa (Environmental Engineer, Fiji Electricity Authority)
3. Victor Prasad (Unit Leader, Renewable Energy Development, Fiji Electricity Authority)
4. Priya Nair (EIA Officer, Department of Environment)
5. Shinichi Isoda (JICA EIA Expert, Department of Environment)
6. Intiyaz Khan (Senior Energy Analyst, Department of Energy)
7. Susana Pulini (Scientific Officer, Department of Energy)
8. Jeremaiya Taganesia (Senior Mapping Geologist, Mineral Resources Department)

The purpose of this meeting was to present to the relevant Government Departments the contents of the Nadarivatu Hydro Project EIA and the Butoni Wind Farm Project EIA report so as to clarify any issues that the Departments may have regarding the EIA reports.

1. Introduction
Representatives from the Government Departments present gave an introduction of their roles and involvement with regards to the project.
FEA – developer
SKM – EIA consultants
DOEnvt – EIA approval
DOE – Energy related issues
MRD – Geological issues

2. Presentation on Nadarivatu Hydro Project by Pene Burns
Questions were answered as they came up during the presentation.

- Department of Environment
What types of background studies were conducted to determine feasibility of this project?
- Detailed prefeasibility and feasibility work carried out over the years to determine scheme.

How will threatened species be managed if they are come across during construction?
- This would be part of the EMP and DOEnvt is expected to advise on this. The Department of Forestry is carrying out surveys to determine if there are threatened species on site.

What type of consultation has, is and will be carried out with locals?
- FEA lands people, agriculture and forestry people have been in consultation with locals.
- Formation of a task force with all major stakeholders with principle objective to consult LOU’s and keep them advised on the developments of the scheme

What about villagers’ concerns about lower outflow of water which may cause inconvenience and also about prediction that flows will not exceed current maximum levels.
- Monitoring of downstream effects suggested.
- Warning system recommended about river levels rising

Social impact assessment was the major issue raised by DOEnvt – a recommendation was made that FEA needs to handle each issue raised by the villages regarding the construction workers camp to avoid conflicts in future. FEA needs to make management of these issues clear in the EIA, and any claims to be logged and a system of communication set up. Advised that a “one stop shop” concept has been discussed.

Attention was brought to Appendix F Section 1.4 which says that “The philosophy of this approach is that the Contractor has the necessary skills and experience in this type of work and is entirely familiar with the operation, maintenance and management of all of the activities that have the potential to adversely impact the environment.”
- DOEnvt pointed out that as the developer FEA should take the responsibility for the environmental management plan and the contractor takes responsibilities for the details.

• Department of Energy
  Would people living next to the scheme be getting electricity?
  - Villagers are requesting electricity

3. Site Visit
   A site visit is being proposed for Department of Energy and Mineral Resources Department for the second week of June.
   ➢ Victor agreed to facilitate. MRD to confirm availability.

4. Presentation on Butoni Wind Project by Pene Burns
  • Department of Environment
  Concern about solid waste and wastewater disposal
- Port-a-loos will be used during construction and there will be a septic tank in the substation during operation of the wind farm

- **MRD**
  What action will FEA take if there are complaints about noise once all 37 WTG are installed?
  - villagers have been consulted about noise and noise monitoring will be carried out and any complaints will be recorded

The presentation concluded at 3pm.
Meeting minutes

**Purpose of Meeting**  
**Presentation of EIA for Nadarivatu Revised Scheme**

**Project**  
Nadarivatu Hydropower Scheme

**Project No**  
AE02809 / LT00884

**Prepared By**  
Pene Burns

**Phone No**  
+64 21 728 767

**Place of Meeting**  
Holiday Inn, Suva

**Date/Time**  
6 September 2006  
11am – 12pm

**Attendees**

- Kamalesh Lalchan.  Ministry of Agriculture.  Senior Agricultural Officer
- Isineli Vuetilsau.  Native Land Trust Board.  Corporate Accounts Officer.
- Naisia Khan.  Director Town and Country Planning.
- Jerry Taganesia.  Mineral Resources Department.
- Shivangini Bishwa, FEA
- Pene Burns, SKM
- Peter Sullivan.  World Bank representative.
- Ron Steenbergen, Victor Prasad  
  FEA (present for introductions)

**Distribution**

- Murray Chopping, PHL
- Ron Steenbergen, FEA
- Victor Prasad, FEA
- Fatiaki Gibson, FEA
- Shivangini Bishwa, FEA
- Rouven Lau, SKM
- Kenn Wood, PHL

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**Item** | **Person**
--- | ---
1)  
**Introductions.** |  
Ron Steenbergen

Ron welcomed people to the meeting, thanked people for their interest and attendance and discussed the importance of the Nadarivatu project going ahead (amongst other FEA hydro projects).

Introductions around the room.  Naisia Khan, Shivan Gounder, Jope Davetanivalu and Priya Nair were party to the original stakeholder group meetings for the original scheme.  Other attendees were not familiar with the scheme.
2) **Presentation of the Revised Nadarivatu Scheme and EIA**  
   Pene provided a power point presentation of the proposal.  
   Some time was taken to discuss the hydrological effects of the scheme, using flow duration curves, and discussion centred around the downstream water availability and sediment movement effects in both the Sigatoka and Ba Rivers.

3) **Nature of the Application**  
   It was discussed that the process for the revised scheme is for a change to the existing Environmental Approval. There would be no public submission period, but that this stakeholder group could contribute to the decision of the Ministry of the Environment.  
   Discussed that the scheme was similar in effects to the original scheme, that was discussed previously with this group.  
   Mentioned lodgement on 20th of September.

4) **Why is FEA doing a JV with a private firm (PHL)?**  
   Questions and concerns were raised about the set up of the JV, where the funds were going to go and would it be profitable and what would be the effect on power consumers. PB and SB made it clear that we could not answer those questions and that it was not relevant in the context of a discussion regarding the EIA.

5) **Reduction in water in the Sigatoka River is a concern for growers in the Sigatoka Valley who use water and rely on the water tables.**  
   Discussed that growers require water in the Sigatoka Valley for vegetable and fruit growing. Concerned that there would be less water in the river for them.  
   Discussed the changes are very similar to the original scheme, and that at median flow it is approximately 7% change at the Sigatoka River mouth. Riparian groundwater levels will have a minor impact. Overall SKM’s assessment is that downstream impacts in the valley will be minor, although upstream in the headwaters it will be noticeable.  
   There are were records available regarding who is using water, how much water and where this water is from, therefore it is difficult to assess actual impacts.  
   Discussed monitoring requirements, such as cross sectional surveys of the river to more accurately predict changes in river depth / flow.
6) **Reduction in water in Sigatoka River may affect sedimentation in the lower stretches, and affect navigation.**

Navigation in the river is already being affected by sedimentation. Will this scheme make it worse?

SKM discussed that sediment movement was looked at in the EIA studies based on changes in river flows and flushing events, and that the impacts appear minor, although no data on sediment has been gathered. Will make sure this is assessed in the final document. Contribution / impacts from the scheme may be minor or unmeasureable against all of the other impacts on sedimentation / sediment movement in the catchment.

Kamalesh Lalchan.

6) **Increases in flow in the Ba River may affect flooding and sedimentation.**

Concerns were raised about the effect of more flow in the Ba River. Discussed the predicted changes in flow in the Ba River, and mentioned that they will be similar to the existing scheme. Approximately 9% increase in median flow.

Ministry of Agriculture is responsible for, and pays for, dredging of Ba and Sigatoka River mouths – will SEL pay for any increased dredging requirements?

Discussed that SKM does not have any data on current sediment movements in the Ba. Discussed it would be difficult to isolate the hydropower scheme's influence compared to other instream and land uses. Discussed monitoring that could assist to measure the impacts from the scheme, including sediment movements and surveys of river beds to more accurately determine changes to downstream flow / depth.

A request was made to provide all attendees with a copy of the final Supplementary Report.

Kamalesh Lalchan.
Shivan Gounder.
Jerry Taganesia.
Mineral Resources Department.

All
Appendix F  Environmental Management Plan
Nadarivatu Hydropower Scheme

ENVIRONMENTAL MANAGEMENT PLAN

- Final Draft
- October 2007
Nadarivatu Hydropower Scheme

ENVIRONMENTAL MANAGEMENT PLAN

- Final Draft
- October 2007

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Appendix E TOR Environmental Monitoring Plan
Appendix F Construction and Workers’ Camp Management Plan (Contractor - to be inserted)
Appendix G Environmental Supervision of Construction (Supervising Engineer - to be inserted)
Appendix H Socio-economic Management Plan (FEA - to be inserted)
Appendix I Construction Environmental Monitoring Plan (Supervising Engineer – to be inserted)
Appendix J Operations Environmental Monitoring Plan (FEA – to be inserted)
Appendix K Ecological Flows and Management of Water Releases (FEA – to be inserted)
Appendix L Chance Finding Procedures
Appendix M Training Schedule and Records (to be developed)
Appendix N EMP Evaluation and Review Audit Schedule (to be developed)
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**Last saved:** 22 October 2007 04:27 PM  
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**Author:** SKM  
**Project manager:** Pene Burns, Rouven Lau  
**Name of organisation:** Fiji Electricity Authority  
**Name of project:** Nadarivatu Hydropower Scheme Consolidated EIA  
**Name of document:** Environment Management Plan  
**Document version:** Final Draft  
**Project number:** AE03336.001 / LT01069
1. Introduction

1.1 Purpose
This Environmental Management Plan (EMP) identifies the methods that will be used to control and
minimise the environmental impacts of all construction and operational activities associated with the
Nadarivatu Hydropower Scheme. The plan addresses all relevant requirements identified in the
following documents:

- Approval from Department of Environment (DOE) dated July 2005 and November 2005
- Nadarivatu Hydropower Scheme Consolidated EIA October 2007

FEA and its contractors and consultants, though implementation of this EMP, will construct the various
components of the scheme, and generate electricity once the scheme is operational, with due regard for
protecting the natural and social environment. In particular, FEA will:

- Comply with the relevant environmental legislation (Environment Management Act 2005).
- Fulfil all conditions of the Approval letter(s) (see Appendix A) issued to the project
- Fulfil all commitments made in the documents outlined above.
- Promote environmental awareness and understanding among employees and contractors through:
  - regular training;
  - assignment of roles and responsibilities under this EMP; and
  - linking performance of environmental responsibilities to overall performance.
- Foster a shared sense of responsibility for environmental performance among all project
  participants.
- Monitor environmental performance and implement continuous improvement actions as
  necessary.
- Continue to interact with the range of stakeholders involved in the project.

1.2 Environmental Approvals
The DOE has issued the following environmental approvals for the Nadarivatu Hydropower Scheme:

- July 2005
- November 2006

All work shall be in accordance with the conditions of the approvals.

The approvals are attached in Appendix A.

1.3 Format and Function of the EMP
This EMP is designed as an overriding document in a hierarchy of control plans, and sets out the
framework of environmental management to be applied to the project. This EMP includes the
Environmental Principles, Communication, Reporting, Monitoring and Review Procedures to
which all staff and contractors are required to comply with, including any sub plans.
Under this plan sits the following ‘sub-plans’:

- Construction and Workers' Camp Management Plan
- Environmental Supervision during Construction
- Socio-economic Management Plan
- Environmental Monitoring Plan
- Ecological Flows and Management of Water Releases
Figure 1 EMP Framework

Key:
- red lines – reporting
- dashed lines – content required under more than one plan
The schematic in Figure 1 illustrates the hierarchy of documents, the responsibilities and the reporting lines.

Any reference to ‘the EMP’ in this document means all procedures in this document and all of the compliant sub plans.

1.3.1 Construction and Workers Camp Management Plan
This Plan will address all issues regarding the management of construction activities and the workforce during project construction. These issues are required to be addressed by contractors, by producing detailed earthworks management plans and site operation plans outlining the measures that are proposed to minimize, mitigate and manage the effects, for the duration of the construction works.

The Plan will include:

- The control of the adverse impacts associated with erosion and sediment discharges from earthworks activities.
- The operational controls on various aspects of the project including traffic management, noise and vibration management and operation of the workers camps.
- The management of social impacts stemming from the installation of workers camps in the area of Nadarivatu.

1.3.2 Environmental Supervision during Construction
Supervision of compliance with the EMP by contractors will be the responsibility of the Supervision Engineer. The Environmental Unit in FEA will have oversight of the performance of the Supervision Engineer, review supervision reports on environment and make recommendations as needed during the construction process. The Environmental Unit will provide the necessary information and reports to DoE. Regardless of the above scheme, DoE will carry out its own monitoring and inspection of the project.

The Supervising Engineer is also responsible for the Environmental Education and Awareness Programme and the Construction Environmental Monitoring Plan.

1.3.3 Socioeconomic Management Plan
The project has the potential to significantly increase jobs, employment and incomes of men and women in the local area which would help to mitigate the above negative impacts. FEA will be responsible for a plan that addresses how the potential social impacts can be managed to minimise adverse impacts and promote beneficial impacts, including all necessary activities, institutional arrangements and budget to ensure the maximization of these benefits for the local communities.

The Plan will include the following programmes:

- Environmental Education and Awareness Programme (responsibility delegated to the Supervising Engineer)
- Infrastructure programme for local communities
- Health Programme (included in Construction Management and responsibility of the Contractor)
- Traffic Safety and Regulations (included in Construction Management and responsibility of the Contractor)
Grievance mechanism

1.3.4 Environmental Monitoring Plan
A detailed water quality, ecology and hydrological monitoring programme to assess the impacts from construction and operation. Monitoring locations are based on baseline monitoring sites. This plan will also further the establishment of the existing baseline conditions and assess the impacts of the scheme. Environmental monitoring during construction will be implemented by the Supervision Engineer. During operation, FEA will carry out the monitoring plan.

1.3.5 Ecological Flows and Management of Water Releases
The proposed Nadarivatu scheme construction and operation shall consider the following provisions for control of catchments hydrology and sediment management at the weir, and any requirements for compliance of proposed minimum flows and discharges to natural water. This plan should also include downstream warning systems for river users. All of these provisions will be included in the Operational Manual of the hydropower scheme.

1.4 Summary of Plan Responsibilities, Budget, Scheduling, Approval
Figure 1 and
Table 1 Plan schedule, Budgets and Approvals.

provide the framework and a summary of the 5 key programmes within the Environmental Management Plan, the institutional responsibility funding sources, schedule or timing for the preparation and implementation of the plan, the approval process prior to implementation, and the responsibilities for monitoring and reporting.
## Table 1 Plan schedule, Budgets and Approvals.

<table>
<thead>
<tr>
<th>Programme</th>
<th>Institutional Responsibility</th>
<th>Budget/Sources of Financing</th>
<th>Timing/Schedule</th>
<th>Approval Process</th>
<th>Monitoring</th>
<th>Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Construction and Workers Camp Management Plan</strong></td>
<td>Contractor</td>
<td>Included in construction costs.</td>
<td>Prepared for construction tender. Approved prior to works commencing. Updated throughout the construction period.</td>
<td>Approval by FEA. Approval by DOE at least 1 month prior to implementation. Approval may be granted with conditions.</td>
<td>Contractor - daily actions. Supervising Engineer - compliance with EMP.</td>
<td>Contractor - Supervising Engineer. Supervising Engineer - FEA. FEA – DOE.</td>
</tr>
<tr>
<td><strong>Environmental Supervision during Construction</strong></td>
<td>Supervision Engineer will enforce EMP, report to Environment Unit in FEA Monitoring Committee</td>
<td>Included in Supervision Engineer’s contract FEA/Government agencies will agree on financing arrangements</td>
<td>Prepared for engineering tender. Approved prior to works commencing. Updated throughout the construction period.</td>
<td>Approval by FEA. Approval by DOE at least 1 month prior to implementation. Approval may be granted with conditions.</td>
<td>Supervising Engineer - daily actions. Environmental Unit FEA – compliance with EMP.</td>
<td>Supervising Engineer - FEA. FEA – DOE.</td>
</tr>
<tr>
<td><strong>Social Management Plan</strong></td>
<td>FEA – overall plan Consulting Engineer FEA Contractor Contractor</td>
<td>Approx. $350,000. Included in contract budget FEA Budget Included in contract</td>
<td>Communication and environmental education and awareness programmes should be initiated prior to construction. Rural electrification coordinated prior to start of operations. Health and traffic management initiated prior to construction initiation of</td>
<td>Approval by FEA. Approval by DOE at least 1 month prior to implementation. Approval may be granted with conditions.</td>
<td>Supervising Engineer and Contractor – daily actions. Environmental Unit FEA – compliance with EMP.</td>
<td>Supervising Engineer - FEA. FEA – DOE.</td>
</tr>
<tr>
<td>Grievance Mechanism</td>
<td>FEA</td>
<td>FEA Budget</td>
<td>Construction. Grievance office in place at start of construction.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---------------------</td>
<td>-----</td>
<td>------------</td>
<td>------------------------------------------------</td>
<td>----------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Monitoring Plan</td>
<td>Construction: Supervising Engineer; oversight from FEA Environmental Unit. Operation: FEA Environmental Unit.</td>
<td>Included in Supervision Engineer contract.</td>
<td>Prior to construction starting and during construction.</td>
<td>Approval by FEA. Approval by DOE at least 1 month prior to implementation. Approval may be granted with conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Plan finalised prior to operation, and implemented during operation.</td>
<td>Supervising Engineer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FEA. FEA – DOE.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ecological Flows and Management of Water Releases</td>
<td>FEA</td>
<td>Included in recurrent costs for operation of scheme</td>
<td>Water releases and other environmental restrictions will be included in operation manual for the scheme.</td>
<td>Approval by FEA. Approval by DOE at least 1 month prior to implementation. Approval may be granted with conditions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FEA Environmental Unit.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>FEA – DOE.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1.5 Approvals
All plans (and any subsequent changes to the plan) shall be approved by FEA Environmental Unit prior to implementation. In accordance with the Environmental Approval, at least one month prior to the commencement any works or operations, FEA (or its delegated representative) shall submit to the DOE and to the Tavua Rural Local Authority, for approval, the EMP and / or subplans. Relevant works shall not commence until the document has been approved and conditions of the approval addressed in the Plan.

Any subsequent changes to any part of the EMP or sub-plans shall go through the same approval process.

1.6 Document Version
The plans are dynamic documents, which may be subject to change or modification as a result of project development or changes on the sites. The review procedures are documented in Section 9.

The EMP is a controlled document.

This is Version 1: First version for implementation. Subsequent versions shall be documented in this section, with a brief summary of changes.
2. Project Overview

The Nadarivatu Hydro Power Project is located in the Nadrau Plateau, in the highlands of Viti Levu, the main island in Fiji. The 42MW scheme, in an average year, would generate approximately 15% of the Viti Levu electricity requirements and displace 22,000 tonnes of diesel. At a growth rate of 6-7% a year, the electricity demand in Fiji is currently being serviced by a growing number of diesel power plants.

The Nadarivatu scheme involves taking water from the Sigatoka River, which flows to the south coast of Viti Levu, to the Ba River, which flows to the north coast. A 31 metre (m) weir in the head waters of the Sigatoka River diverts water through a tunnel and penstock to the Ba Power Station on the bank of the Ba River. The closest settlements are the Lewa and Buyabuya villages.
Figure 2 Schematic of the Nadarivatu Hydropower Scheme

1. KO ROI WEIR
   - 1.5 M HIGH AND 15.0 M WIDE
     APPROXIMATELY 3 M ABOVE THE
     CURRENT WATER SURFACE

2. TUNNEL INLET PORTAL
   & GATE TOWER

3. TUNNEL & PENSTOCK

4. POWER HOUSE
   - 84 MW (4 X 21 MW)
     TURBINE GENERATORS
     CONTROL ROOM, SWITCHGEAR,
     SWITCH ROOM, STAFF
     QUARTERS AND STORAGE
     ROOMS AND TRANSFORMER HOUSE

5. TRANSMISSION LINE
   - 7 MW OF 110 kV LINE FROM
     POWER STATION

6. NADARIVATU SWITCHYARD
   - CONNECTION TO 132 kV B "SAILA"
     110 kV LINE
### Table 2 Summary of scheme components

<table>
<thead>
<tr>
<th>Component</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum Output</td>
<td>42MW (41.8MW)</td>
</tr>
<tr>
<td>Mean Annual Output</td>
<td>101GWh</td>
</tr>
<tr>
<td>Korolevu Weir</td>
<td>40m high (from its foundations) and 80m wide (at the top). Approximate 31 m above the current stream bed. Located immediately downstream of the confluence of the Nukunuku Creek and Qaliwana Creek, on the Sigatoka River. Concrete construction. Three spillways at the top of the weir, each with a gate that can hold and control weir water at high flows and open up to pass flood flows over the spillway during extreme flood events. Capable of passing a 1 in 1,000 year flood without the water level in the reservoir rising. Two 4.2m x 4.2m sluice gates through the base of the weir for regular flushing of trapped sediments and other debris.</td>
</tr>
<tr>
<td>Korolevu Weir Storage</td>
<td>1,009,000m³ of ‘live’ storage (water that is available for power generation, above the intake structure). 9ha maximum holding pond area, extending up the Qaliwana and Nukunuku creeks. Maximum of 18.7 hours storage.</td>
</tr>
<tr>
<td>Operating Range</td>
<td>22m</td>
</tr>
<tr>
<td>Tunnel intake</td>
<td>A submerged intake is located approximately 25m upstream of the weir on the true right bank.</td>
</tr>
<tr>
<td>Tunnel and penstock</td>
<td>2km tunnel from weir to penstock near Buyabuya. 3 m diameter and D shaped (flat bottomed). Drill and blast construction method. Concrete floor and lined with concrete or steel. Expected excavated loose volume is 20,000 to 25,000 m³. 1.4km steel penstock from tunnel to power station at the Ba River. 2.25m outer diameter.</td>
</tr>
<tr>
<td>Ba Power Station</td>
<td>42 MW power station west of Buyabuya village, on the true left hand side of the Ba River. 2 x 22MW vertical Pelton wheel turbine generators. The power house will include a ‘substructure’ which will house the turbines. The ‘superstructure’ above the turbines will include the gantry crane (used for maintenance), control room, workshop, switch room and staff facilities (including living quarters). The power house will be built of reinforced steel and have galvanised steel cladding. Transformers will be located adjacent to the power house.</td>
</tr>
<tr>
<td>Maximum discharge from power station</td>
<td>15m³/s</td>
</tr>
<tr>
<td>Approximate mean annual diesel replacement</td>
<td>22,000T, based on mean output of 101GWh</td>
</tr>
</tbody>
</table>

The land use in and around the project area at present is generally low intensity grazing, agriculture and occasional hunting and fishing. A number of small villages and settlements are located along the ridges...
of the Nadrau Plateau, high above the steeply incised river valleys. Buyabuya village is located adjacent to the Ba River and the proposed power station site. The populations are predominantly living according to traditional Fijian values and culture with a mix of subsistence and cash economies.

The rivers are not used by many people, as access into the steep valleys is very difficult. The rivers are not navigable and do not provide the primary source of protein. Domestic water supplies are taken from springs rather than the rivers, and there is no irrigated agriculture until the coastal plains.

The existing land cover consists predominantly of native forest in the steeper valleys in the Sigatoka catchment with open grasslands on the flanks and ridges of the hills. At the Ba Power Station site it is predominantly modified forest and grassland.
3. Roles and Responsibilities

This section describes the organisational structure and responsibilities of individuals involved in implementing the EMP, listed in Table 3.

Table 3 Roles and Responsibilities for EMP Preparation and Implementation

<table>
<thead>
<tr>
<th>Position</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FEA</strong></td>
<td>Implementation, monitoring and compliance of the EMP including the performance of contractors, subcontractors, staff and the Supervising Engineer.</td>
</tr>
<tr>
<td></td>
<td>Reviewing the performance of the EMP and making any changes that may be appropriate for improving the environmental management of site activities.</td>
</tr>
<tr>
<td></td>
<td>Reporting to DOE.</td>
</tr>
<tr>
<td></td>
<td>Compliance of the project activities with the EIA and conditions of the EIA approval letter.</td>
</tr>
<tr>
<td><strong>Supervising Engineer</strong></td>
<td>Preparation and implementation of the ‘Environmental Supervision During Construction’ Plan.</td>
</tr>
<tr>
<td></td>
<td>Preparation and implementation of the Communication and Environmental Education and Awareness Programme.</td>
</tr>
<tr>
<td></td>
<td>Preparation and implementation of the Construction Environmental Monitoring Plan.</td>
</tr>
<tr>
<td></td>
<td>Supervision of the Construction and Workers Camp Management Plan implemented by the Contractor.</td>
</tr>
<tr>
<td></td>
<td>Working in accordance with the EMP.</td>
</tr>
<tr>
<td></td>
<td>Communicate and report incidents, monitoring and other information to FEA as required.</td>
</tr>
<tr>
<td></td>
<td>Making any recommendations to FEA that may be appropriate for improving the environmental management of site activities.</td>
</tr>
<tr>
<td><strong>The Contractor(s)</strong></td>
<td>Preparation and implementation of the Construction and Workers Camp Management Plan, consistent with this document.</td>
</tr>
<tr>
<td></td>
<td>Maintain and keep all administrative and environmental records in accordance with the EMP and the reporting of these records to the Supervising Engineer.</td>
</tr>
<tr>
<td><strong>All Staff / Subcontractors</strong></td>
<td>Working in accordance with the EMP and sub-plans.</td>
</tr>
<tr>
<td></td>
<td>Making any recommendations to the Contractor, Supervising Engineer and / or FEA that may be appropriate for improving the environmental management of site activities.</td>
</tr>
</tbody>
</table>

Table 4 Stakeholders

<table>
<thead>
<tr>
<th>Agency</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Department of Environment</strong></td>
<td>Approval of the EMP, including sub-plans, approval of significant changes to the EMP and subplans.</td>
</tr>
<tr>
<td></td>
<td>Enforcement and monitoring of the Environmental Approvals</td>
</tr>
<tr>
<td></td>
<td>Coordination of the Monitoring Committee</td>
</tr>
<tr>
<td><strong>Monitoring Committee</strong></td>
<td>FEA</td>
</tr>
<tr>
<td>(Government Stakeholder Group)</td>
<td>DOE</td>
</tr>
<tr>
<td></td>
<td>Tavua Local Authority</td>
</tr>
<tr>
<td></td>
<td>Department of Town and Country Planning</td>
</tr>
<tr>
<td></td>
<td>Ministry of Agriculture</td>
</tr>
</tbody>
</table>
Ministry of Fisheries
Ministry of Energy
Mineral Resources Department
Periodic review of project progress, particularly with regard to environmental management and compliance with the Environmental Approvals.
Communications between Monitoring Committee and government departments.

**Task Force**
Team of FEA, government department CEO’s, Native Land Trust Board representatives.
Land lease issues, community grievances, progress reports.
4. Key Environmental Risks

The EIA identified the following key environmental effects that could result from the construction of the weir, tunnel and power house:

1) Runoff of suspended solids and other pollutants into the Ba River and Sigatoka River resulting from earthworks, working in the river bed, concrete batching and tunnel dewatering.

2) Noise and vibration effects from construction, excavation / blasting on local populations.

3) Traffic impacts, dust and general nuisances on local populations resulting from general construction activities.

4) Spills and pollution arising from the transport and storage of fuels and chemicals and vehicle / plant refuelling.

5) Impacts on village life from an influx of resident workers.

During operation, the key environmental risks are:

6) Daily variations in river flow for downstream users in the Ba River (up to 15m$^3$/s increase in discharge during generation).

7) Changes in flow conditions in the Ba River affecting sediment movement and instream ecology.

8) Changes in median and low flow river conditions on the Sigatoka River, affecting instream ecology and sediment movement.
### 5. Minimum Environmental and Social Standards

Table 5 through to Table 16 sets out the minimum environmental and social standards that must be achieved. The methods and procedures detailed in all sub-plans provided by FEA, Contractors and the Supervising Engineer, must be sufficient to meet these minimum standards.

Note that these requirements are valid for all works.

#### Table 5 Soil / Overburden Removal and Placement, Alluvial Mining

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Measure</th>
</tr>
</thead>
</table>
| Generation of suspended solids from bare ground and runoff into watercourses | Development activities should not give rise to stormwater containing elevated suspended solids. | • No direct discharge of sediment laden water without treatment.  
• Earthworks and land clearance should be minimised and phased.  
• Stormwater should be diverted around exposed areas.  
• Any discharges to the Ba or Sigatoka River should occur during high flow and / or discharged as close to the outfall as possible to maximise mixing.  
• Stockpiling should occur at least 10m from a water course.  
• Revegetation of exposed areas as soon as practicable.  
• Timing of works around the drier seasons where possible.  
• Provision of stormwater cut off drains wherever possible. |
| | Provide treatment to achieve 75% reduction in suspended solids. | |
| Introduction of invasive species | Fill material should not contain invasive species. | • The use of imported fill shall be minimised.  
• Machinery should be cleaned prior to working on site to reduce the opportunity of the spread of weed seeds. |
| Disturbance of natural habitats for spoil / alluvial material. | Soils should be reused where possible in the development – to reduce the need for spoil sites and the need to import fill. | • Stockpile and reuse soils before excavating new soils / alluvium. |
| Efficiency of control measures over time | Control measures should continue to work appropriately throughout the construction period. | • Earthworks control measures should be inspected and maintained in efficient operating condition over the construction period. |
### Table 6 Excavation and Blasting

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise disturbance of local populations</td>
<td>Noise must not unreasonably intrude on traditional village life.</td>
<td>▪ Keep a current list of all noise producing machinery.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ This machinery operation to occur only during designated hours (to be confirmed by contractor in agreement with villages).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Blasting to occur at the same time each day, and/or a warning siren should sound prior to blasting.</td>
</tr>
<tr>
<td>Vibration disturbance of local populations</td>
<td>Vibration must not unreasonably intrude on traditional village life.</td>
<td>▪ Keep a current list of all vibration producing machinery.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ This machinery operation to occur only during designated hours (to be confirmed by contractor in agreement with villages).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Blasting to occur at the same time each day, and/or a warning siren should sound prior to blasting.</td>
</tr>
</tbody>
</table>

### Table 7 Material stockpiling

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Runoff of suspended sediments from stockpiles</td>
<td>Stockpiling activities should not give rise to stormwater containing elevated suspended solids. Provide treatment to achieve 75% reduction in suspended solids.</td>
<td>▪ No direct discharge of sediment laden water without treatment.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Stockpiles should be compacted as much as practical and not be exposed for extended periods.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Stockpiles should be reused as soon as practicable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Stormwater should be diverted around stockpiles.</td>
</tr>
<tr>
<td>Dust generation from stockpiles</td>
<td>Dust must not cause a hazard or nuisance to village life.</td>
<td>▪ Stockpiles should be compacted as much as practical not be exposed for extended periods.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Stockpiles should be reused as soon as practicable.</td>
</tr>
</tbody>
</table>
### Table 8 Tunnel dewatering and tunnel portal construction

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contaminants in water discharged from tunnel during construction</td>
<td>No direct discharges of tunnel water to any water course.</td>
<td>• Settlement ponds and / or sediment infiltration gallery.</td>
</tr>
<tr>
<td></td>
<td>Provide treatment prior to discharge to achieve 75% reduction in suspended solids.</td>
<td>• Monitoring immediately upstream and 50m downstream of the discharge with a clarity tube to estimate any effects on clarity; for nutrients to detect explosives residue and for pH.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Any discharges to the Sigatoka or Ba River should occur during high flow and / or discharged as close to the outfall as possible to maximise mixing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Spill kits and emergency procedures should be used for spills of chemicals, fuels and oils and staff trained.</td>
</tr>
</tbody>
</table>

### Table 9 Concrete Manufacture

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contaminants in water discharged from concrete manufacturing, including a rise in pH.</td>
<td>No direct discharges of concrete batching water to any water course.</td>
<td>• Settlement ponds and / or sediment infiltration gallery.</td>
</tr>
<tr>
<td></td>
<td>Provide treatment prior to discharge to achieve 75% reduction in suspended solids.</td>
<td>• Monitoring immediately upstream and 50m downstream of the discharge with a clarity tube to estimate any effects on clarity; for pH to detect alkali discharges.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Any stormwater discharges to the Sigatoka or Ba River should occur during high flow and / or discharged as close to the outfall as possible to maximise mixing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Water to be reused where possible in the process.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Procedures for handling of unhydrated cement material and wet cement to avoid spills.</td>
</tr>
<tr>
<td>Community nuisances.</td>
<td>Noise and dust must not unreasonably intrude on traditional village life.</td>
<td>• Concrete batching plants and other noisy / dusty equipment to be located as far as practical from villages.</td>
</tr>
</tbody>
</table>
### Table 10 Fuel storage and use

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Measure</th>
</tr>
</thead>
</table>
| Pollution risk associated with the storage and use of fuels for all plant, generators and vehicles | No oil, lubricants, fuels or containers should be drained or dumped to ground or waterways. | • Keep a current list of all fuels stored on site.  
• Keep the Safety Data Sheet of all hazardous materials used on site.  
• Develop appropriate storage, transport and use practices to recognised standards.  
• Diesel to be stored in truck tankers or in overhead tanks to a maximum of 5000 litres.  
• Diesel to be stored on flat ground, and 100m from a waterway.  
• Bunding to capture 100% of fuel must be placed around fuel storage areas.  
• All refuelling of vehicles and plant to be done on flat ground.  
• All significant vehicle and plant maintenance shall be undertaken offsite where possible.  
• Spill kits and emergency procedures should be used and staff trained.  
• There shall be no deliberate discharge of oil, diesel, petrol or other hazardous materials to the surrounding soils and waterways. |
|                                                                      | Accidental spills shall be minimised, and procedures put in place to clean up the environmental damage. |                                                                                           |

### Table 11 Archaeological and cultural site disturbance

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finding and disturbance of previously unknown sites.</td>
<td>No sites shall be disturbed once identified.</td>
<td>• Follow the ‘chance find’ procedure.</td>
</tr>
</tbody>
</table>

### Table 12 Works in and near rivers

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Method</th>
</tr>
</thead>
</table>
| Sediment discharges arising from working in and near the river.     | Work in the wetted area of the riverbed should be minimised, and only in relation to the construction of the power house, weir and intake structure or to insert culverts for stream crossings. | • Stabilise works at the end of each working day and prior to storm events.  
• Do the work during low flow periods.  
• Works shall be minimised.  
• Diversion of the river around the work area where possible.  
• Culverts shall be placed in access tracks where they cross streams more than 3 metres wide and 0.5m deep. |
| For blasting in or near the river, refer to the blasting issues, above. |                                                                                   |                                                                                           |
### Table 13 General construction issues

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Noise of machinery associated with construction activities</td>
<td>Noise must not unreasonably intrude on traditional village life.</td>
<td>▪ Keep a current list of all noise producing machinery and noisy activities.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ This machinery operation to occur only during designated hours (to be confirmed by contractor in agreement with villagers).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Use of complaints register and procedures to address issues as they arise.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Work to be carried out in daylight, in typical working hours.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Concrete batching plants and other noisy equipment to be located as far as practical from villages.</td>
</tr>
<tr>
<td>Dust generation from construction activities</td>
<td>Dust must not cause a hazard or nuisance to village life.</td>
<td>▪ Dusty operations to occur only during designated hours (to be confirmed by contractor in agreement with villagers).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Use of complaints register and procedures to address issues as they arise.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Concrete batching plants and other dusty equipment to be located as far as practical from villages.</td>
</tr>
<tr>
<td>Vibration disturbance from construction activities</td>
<td>Vibration must not unreasonably intrude on traditional village life.</td>
<td>▪ Keep a current list of all vibration producing machinery and activities causing vibration.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ This machinery operation to occur only during designated hours (to be confirmed by contractor in agreement with villages).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Use of complaints register and procedures to address issues as they arise.</td>
</tr>
<tr>
<td>Increased utilisation of roads by traffic associated with construction activities</td>
<td>There should be no significant increased risk to local populations from traffic associated with the development.</td>
<td>▪ Roading upgrades, including signage, speed humps, regrading.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Training of locals regarding the hazards of traffic.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Training of vehicle drivers regarding the driving risks through villages and along remote roads.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>▪ Use of complaints register and procedures to address issues as they arise.</td>
</tr>
</tbody>
</table>
### Table 14 Village impacts

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Method</th>
</tr>
</thead>
</table>
| Pollution risk activities occurring on site| Develop appropriate storage, transport and use practices for storage and handling of mixed classes of dangerous goods in packages and intermediate bulk containers. There shall be no solid or liquid waste disposal directly or indirectly to any water course (whether flowing or not). | - Keep a current list of all potentially contaminating materials used on site.  
- Develop and implement appropriate storage, transport and use practices to recognised standards.  
- Solid waste disposal shall be taken off site. |
| Monitoring                                 | Monitoring shall be undertaken to ensure villager’s concerns are recorded and addressed.          | - A complaints record shall be kept of all issues raised by villagers in response to construction activities. The record shall include responses by the contractor. |

- Set up a communication network for discussing issues between FEA, supervising engineer, contractors and the villagers.
- FEA Lands Department to manage a grievance mechanism in the Socio-economic Management Plan, and have staff on site at all times to manage grievances.
- The Health Programme included in the Contractor’s Construction and Workers’ Camp Management Plan will be made available to the communities of Lewa and Buyabuya.
- Worker Behaviour Guidelines in the Construction and Workers’ Camp Management Plan.
- Developing village protocol in the Construction and Workers’ Camp Management Plan and train outside workers.
- Education and orientation of outside workers to Fijian culture and social norms before the start of work.
- Observe days of rest, such as Sunday.
- Camps to be secure and discourage visitors and workers leaving the camp.
- Camps to be self sufficient in resources and services. (refer to the workers camp table below)
Issue | Key Principle / Mitigation Standard | Minimum Mitigation Method
--- | --- | ---
villages. | implemented as per the Land Lease agreement. | programme to be developed in the Socio-economic Management Plan and implemented so that electricity is provided to households in Marou Village (34); Vatokatoka Settlement (13); Koro Village (52); Buyabuya Village (31); Voyualevu Settlement (3); Drala Village (27); for a total of 160 households.

Health and safety risks from such activities as increased traffic, blasting, heavy machinery operating | Health and safety risks to villagers are minimised. | ▪ Refer to the sections above discussing impacts from traffic hazards and blasting hazards.

Villagers shall be adequately informed of all potential hazards to health and safety.

Villagers have the expectation that issues will be addressed and resolved by negotiation.

Nuisance issues such as noise, dust and vibration | Nuisances shall be minimised. | ▪ Refer to the sections above discussing nuisance effects.

Villagers have the expectation that issues will be addressed and resolved by negotiation.

Traffic causing safety risks to road users | Construction traffic will be managed to minimise the impact on existing road users. | ▪ Signage to be used to identify current risks to road users.
▪ FEA and Contractors to discuss major traffic issues with Mataqali and village representatives prior to the event to discuss course of action.
▪ Heavy traffic to avoid the hours when school children walk to and from school.
▪ Traffic safety programmes included in the Construction and Workers’ Camp Management Plan.
▪ Education to villagers.

Sediment affecting river water uses. | Sediment discharges to the river shall be minimised. | ▪ Refer to the sections above discussing erosion and sediment control.

Table 15 Worker’s Camp

Issue | Key Principle / Mitigation Standard | Minimum Mitigation Method
--- | --- | ---
Water supply affecting ecology or village water supply. | Camp to provide its own water supply that does not affect village water supply. | ▪ Any water supply sources in the Ba catchment should be located so that it does not adversely affect the Buyabuya village supply.
▪ The take of water from streams
### Issue Key Principle / Mitigation Standard Minimum Mitigation Method

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastewater discharges affecting water quality</td>
<td>Waste water to be treated prior to discharge.</td>
<td>Sewerage disposal methods should be designed to the standards outlined in the Australia / New Zealand Standard for the Management of On Site Sewage Systems AS/NZ1547: 2000.</td>
</tr>
<tr>
<td>Solid waste polluting the environment and causing health hazards</td>
<td>No waste to be burnt or buried on site.</td>
<td>All solid wastes shall be removed from site and disposed of at a municipal landfill.</td>
</tr>
<tr>
<td>Camps using local services and resources, at the expense of villagers.</td>
<td>Refer to the village impacts table above.</td>
<td>Refer to the village impacts table above.</td>
</tr>
<tr>
<td>Workers intruding on village life and disrespecting traditional cultural values.</td>
<td>Refer to the village impacts table above.</td>
<td>Refer to the village impacts table above.</td>
</tr>
<tr>
<td>Camp followers increasing camp population and causing disturbances.</td>
<td>Refer to the village impacts table above.</td>
<td>Refer to the village impacts table above.</td>
</tr>
<tr>
<td>Unregulated development of workers' camps</td>
<td>Refer to the village impacts table above.</td>
<td>Refer to the village impacts table above.</td>
</tr>
</tbody>
</table>

### Table 16 Ecological Flows and Water Releases

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Principle / Mitigation Standard</th>
<th>Minimum Mitigation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow changes in the Ba River leading to daily pulses of flow and sediment movement / erosion.</td>
<td>The discharge of water to the Ba River for scheme operation shall be up to 15,000 L/s.</td>
<td>Appropriate early warning system in place at Ba Power house to warn of impending hydropower discharges to the Ba River.</td>
</tr>
<tr>
<td></td>
<td>Flow from the Ba Power Station to the Ba River shall be ramped up and down at a rate no greater than 1,000 L/s flow per minute.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sediment concentrations from the Ba power station should remain below 17mg/L for Ba River flows at / or below the natural mean (estimated at 2,822 L/s).</td>
<td></td>
</tr>
<tr>
<td>Flow changes in the Sigatoka River, leading to low flow conditions for large periods of time. Sediment and erosion issues.</td>
<td>Post weir construction and during initial filling of the weir, suitable provision via sluice gates shall enable a minimum of 200 L/s flow continuation to the Sigatoka River below the weir, at catchment input flows of 200 L/s and above.</td>
<td>The sluice gates shall be in operation over the full range of weir storage, and shall provide 200 L/s to the river as a continuous residual flow when applicable.</td>
</tr>
<tr>
<td></td>
<td>The take of water from the weir for scheme operation shall be up to 15,000 L/s.</td>
<td>Monitoring of catchment input flow to the weir, and residual flow released, shall be provided by continuous measurement / recording. Residual flows</td>
</tr>
<tr>
<td>Issue</td>
<td>Key Principle / Mitigation Standard</td>
<td>Minimum Mitigation Method</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td></td>
<td>released shall be reduced in conjunction with monitored input flow to the weir.</td>
<td>• Provision is to be made for suitable release of flood flows down the river.</td>
</tr>
</tbody>
</table>
6. Environmental Monitoring

Monitoring of the Sigatoka and Ba catchments, and discharges of contaminants to any water ways, is required during construction and operation of the scheme.

Appended is a TOR for the Environmental Monitoring Plan that details the monitoring requirements as approved by DOE (Appendix E). This shall be expanded in detail prior to construction starting.

6.1 Construction

During construction, the monitoring is to enable the monitoring of the adequacy of the EMP, assessment of any impacts and to implement relevant mitigation measures. Parameters to include:

- Water quality
- Macroinvertebrate samples
- Habitat Assessment

In addition, the following discharges and treatment devices shall be routinely monitored

- Tunnel discharges
- Concrete manufacturing discharges
- Sediment treatment ponds

The Supervising Engineer is responsible for preparing and implementing the Construction Environmental Monitoring Plan. The Supervising Engineer may contract the monitoring and analysis of results to a third party.

The Contractor may monitor as required to check the performance of treatment systems and other control devices.

6.2 Operation

During operation, monitoring of the Sigatoka and Ba River flow and water quality is the responsibility of FEA. Monitoring is required to measure environmental impacts from the scheme and provide information to implement mitigation measures. An Operations Environmental Monitoring Plan shall cover all of the required monitoring procedures.
7. Communications and Reporting

7.1 General Communications Matrix

Table 17 sets out the lines of communication for local villagers, potential employees, workers, government stakeholders and other individuals in relation to complaints or enquiries during the construction of the scheme.

Detailed communication strategies, including awareness programmes, shall be developed in the Socio-Economic Management Plan.

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Main Interest</th>
<th>Means of Contact and Relevant Management Plan</th>
<th>Key Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land owners and villagers</td>
<td>Disturbance from construction activities, environmental and social issues</td>
<td>Complaints/inquiries to village representatives ‘One-Stop-Service’ on the site for villagers to raise issues, as per the grievance mechanism.</td>
<td>FEA</td>
</tr>
<tr>
<td>Project updates, land lease concerns, compensation issues.</td>
<td>Task Force meetings</td>
<td>FEA</td>
<td></td>
</tr>
<tr>
<td>Information on hazards, including road use and traffic, blasting, vibration, etc.</td>
<td>Task Force meetings. Special consultative procedures with each village.</td>
<td>FEA Contractor Supervising Engineer</td>
<td></td>
</tr>
<tr>
<td>Potential employees</td>
<td>Employment opportunities</td>
<td>Advertise key positions in local papers Advertise at project site office Maintain register of potential employees Recruitment of locals at project site office, and through word of mouth</td>
<td>Contractor</td>
</tr>
<tr>
<td>General public</td>
<td>General interest, range of concerns</td>
<td>Media updates –press releases to local and regional papers as required Complaints / inquiries routes</td>
<td>FEA</td>
</tr>
<tr>
<td>Government stakeholders</td>
<td>Environmental and social issues</td>
<td>Monitoring Committee</td>
<td>FEA</td>
</tr>
<tr>
<td>Workers</td>
<td>Village issues, code of conduct for behaviour, environmental issues</td>
<td>Tool box meetings Memo’s and bulletins</td>
<td>Supervising Engineer Contractor</td>
</tr>
</tbody>
</table>

The following measures are proposed to be implemented to assist with communication between the local villagers, contractors and FEA.

7.2 EMP Reporting

Reports shall be produced for the following:

- Monitoring
- Incidents
- Progress
- Audits of Compliance against the EMP.
Reporting lines and responsibilities are shown in red in Figure 1.

## 7.3 Schedule of External Reporting

External reporting by FEA is required as shown in Table 18.

<table>
<thead>
<tr>
<th>Type of Report and Purpose of Reporting</th>
<th>Frequency of Submission</th>
<th>Submit To:</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMP and any sub-plans prepared under the EMP.</td>
<td>As required, prior to implementation.</td>
<td>DOE.</td>
</tr>
<tr>
<td>For approval prior to implementation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMP updates (including any changes in management and monitoring procedures).</td>
<td>As required, prior to implementation.</td>
<td>DOE</td>
</tr>
<tr>
<td>For approval, prior to implementation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Key changes in project activities that may affect the Environmental Approvals.</td>
<td>As required, prior to implementation.</td>
<td>DOE</td>
</tr>
<tr>
<td>Incident report</td>
<td>Within 24 hours of incident (in accordance with incident procedures, which outline severity of incident that requires reporting).</td>
<td>DOE</td>
</tr>
<tr>
<td>Non-compliance report</td>
<td>Within 1 week of a significant event. Otherwise annually for minor breaches that were remedied.</td>
<td>DOE</td>
</tr>
<tr>
<td>Archaeological chance find report</td>
<td>Within 24 hours of finding an archaeological site, human remains or artefact.</td>
<td>Fiji Museum, Mataqali, DOE</td>
</tr>
<tr>
<td>Environmental monitoring reports</td>
<td>Annually.</td>
<td>DOE</td>
</tr>
<tr>
<td>Other monitoring data</td>
<td>As required</td>
<td>DOE</td>
</tr>
</tbody>
</table>
8. Capacity Development and Training

8.1 Management and Operations of the EMP
All those responsible for the management and operation of any aspect of the EMP shall be adequately trained for their role. Evidence of training should be maintained on site, for inspection / auditing purposes.

The EMP document shall include a training schedule, and procedure for keeping records. Records of training attendance and training programmes shall be kept and be available for inspection by DOE.

FEA shall ensure that the Environmental Unit has capacity to develop, implement, monitor, evaluate and report on an EMP for construction and operation of a hydropower scheme. External training, and / or the use of third party contractors or consultants may be required to develop the in-house capacity.

8.2 Management and Operations of the Sub Plans
Training is required for all staff undertaking work in accordance with the EMP. A training schedule shall be developed for each sub plan to the EMP and procedure for keeping records. Records of training attendance and training programmes shall be kept and be available for inspection by DOE.

Where suitable training does not exist in the market place in Fiji, the Contractor, Supervising Engineer or FEA shall be responsible for finding or providing such training.

8.3 Instream Environmental Monitoring and Interpretation of Results
Instream monitoring and data interpretation shall be carried out by suitably qualified personnel. Where the supervising engineer does not have these skills, it may subcontract the work.

Within Fiji there are several agencies with the ability to carry out monitoring work and interpret the results:

- Private consulting firms / individuals
- University of South Pacific
- Fiji Institute of Technology

8.4 Hazardous Substances Management and Emergency Procedures
All staff involved in the handling and use of chemicals, fuel and explosives must be trained in handling, spill and emergency procedures. The Contractor must organise training from New Zealand or Australia where the suitable training does not exist in Fiji.

Evidence of training should be kept for inspection / auditing purposes.

8.5 Sediment Control, and Control of Discharges
Training shall be provided by a third party, or provide evidence of previous training, for the construction, maintenance and monitoring of environmental protection and discharge treatment devices. This training is available from private consulting firms or individuals in Fiji, New Zealand and Australia.

Evidence of training should be kept for inspection / auditing purposes.
9. Plan Monitoring and Review

The FEA Environmental Unit shall periodically monitor and audit the effectiveness and implementation of the plan whether a review of the document is required.

The audit programme and procedures should cover the scope, frequency and methods as well as the responsibilities and requirements for conducting audits and reporting results.

The frequency of audits will reflect the level of significance of environmental impacts and the results of previous audits.

9.1 EMP Review

The EMP will be reviewed periodically to evaluate environmental controls and procedures to make sure they are still applicable to the activities being carried out. Reviews will be undertaken by the Environmental Unit, as follows:

- The full EMP shall be reviewed at least annually.
- Relevant parts of the EMP shall be reviewed following a reportable incident.
- Relevant parts of the EMP shall be reviewed following the receipt of an updated sub-plan.
- At the request of stakeholders, including DOE, the Monitoring Committee, Contractor, Supervising Engineer or the host communities.

The review shall include analysis of the data collection and analysis of data, monitoring reports, incident reports, complaints, feedback from stakeholders, DOE reports, consultation meeting minutes and training records to evaluate the effectiveness of the procedures. Site visits, interviews and other auditing methods may also be used.

Updates to the plan shall follow the procedure in Section 9.2.

9.2 Control and Update of the EMP

This document will be issued as a controlled document all relevant staff and organisations. The procedure to be followed to control the issue of the documents, provide a review of its effectiveness and provide updates will be as follows:

- Issued copies by the Environmental Unit of FEA shall be numbered.
- The Environmental Unit shall initiate a review of any relevant sections following modification to the Environmental Approval, issue of a new approval, receipt of written requirements by the DOE authority or a change to internal procedures based on corrective actions or improvements in methodologies.
- The Environmental Unit shall ensure the document is reviewed in accordance with Section 9.1 and that all sections are up to date.
- Any parts of the EMP that require DoE approval shall be lodged with DOE and may not be implemented until an approval has been provided.
- All controlled copies shall be updated following a change, coordinated by the Environmental Unit.

All updated sub-plans shall be forwarded to the Environmental Unit in order to update the relevant appendices in this plan.
Updates shall be communicated to all interested and affected stakeholders.
Updates shall be recorded in Section 1.6.

9.3 Department of Environment Review
All reports, registers and monitoring results must be made available to the DOE and the Monitoring Committee on request. The DOE must have the ability to audit the results and carry out duplicate monitoring or auditing at any time to ensure compliance with the EMP and any approvals issued.

Where the DOE does not have the capacity to audit, FEA shall ensure that an independent audit is carried out at the request of the DOE and to their satisfaction.
Appendix A  Environmental Approvals
Appendix B    TOR Construction and Workers’ Camp Management Plan

Construction and Workers Camp Management Plan (CWCMP)

MANAGEMENT OF CONSTRUCTION ACTIVITIES AND WORKERS CAMPS

IN THE NADARIVATU HYDROPOWER PROJECT IN FIJI

Terms of Reference for Contractors

INTRODUCTION

The Contractor will assess and propose mitigation measures to address a series of environmental and social impacts stemming from all construction activities and the presence of a large workforce (180 workers) in the Buyabuya and Lewa area. As part of the tender for construction, the Contractor shall propose a “Plan for the Management of Construction Activities and Worker camps for the Nadarivatu Hydropower Project” or CWCMP. This plan will form part of the Nadarivatu Hydropower Project Environmental Management Plan (EMP), and shall be consistent with the EMP and ultimately the Environmental Approvals issued by Department of the Environment.

IMPACTS FROM CONSTRUCTION AND CAMP ACTIVITIES

Particular issues that the Contractor will address:

Footprints from Construction Sites

In addition to the land occupied by the weir and power house, the construction of the project will require land for rig sites, camps, workshops, quarries, spoil tips, etc. Although the total the impact on the land might not be significant and even though some of the land might be deserted and reclaimed after the construction is finished, there might be permanent damage and eyesores in the landscape.

Earthworks

In a mountainous region such as Nadarivatu the project must include measures to reduce or halt erosion and landslide problems. This might include erosion control structures, protective re-vegetation and reforestation, slope stabilization, etc. Larger changes in the landscape from quarries, tunnel spoil tips, etc. should be landscaped and replanted, both to reduce erosion problems and to reduce the visual impact of the construction.

Pollution

All larger construction activities have the potential of causing pollution and other hazards for the environment. Pollution of soil and water can occur from hazardous substances such as diesel and oil, sediment discharges from exposed work sites, waste water, solid waste and discharges from concrete manufacture and tunnelling. These activities require controls and monitoring to ensure that the pollution events are minimised.
Impacts on Communities

**Nuisances:** The construction activities will always cause some degree of negative impacts and risks (dust, noise, air and water pollution, traffic hazards, etc.), which might affect local communities and natural qualities. These impacts can be minimised by applying the principle of “best professional practice”. It will be necessary, however, to define these principles in detail in the CWCMP and the Contractor shall specify how it plans to adhere to those principles.

**Workforce influx / social impacts:** Hydropower projects typically initiate a construction “boom”. This will to some extent give opportunities for paid work for local people but there will always be an influx of outside workforce and followers (families, traders, etc.). This influx might impose a serious threat to the local communities’ social and cultural fabric, which might be under additional stress from uncertainty related to loss of land and changes in natural resource use. Pioneer settlements like this are also associated with increased risk for spread of HIV/AIDS and other Sexually Transmitted Diseases (STD).

The increased population in the project area will constitute a pressure on the available natural resources like fuel wood, drinking water, wildlife, etc. but on the other hand, create a market for local products and services which might trigger local development. The management of these social and economic issues will need the participation of local governments.

Negative effects can also occur when workforces leave an area, removing potential income sources and the need for services.

**CONSTRUCTION AND WORK CAMP MANAGEMENT PLAN**

The Contractor will prepare comprehensive and detailed environmental specifications for the management of environmental and social impacts stemming from all construction activities associated with construction and workers camps in the Nadarivatu project. These specifications will complement specific environmental and social mitigation measures that are included in the overarching Nadarivatu Hydropower Project Environmental Management Plan for the project as a whole. These specified requirements will be included in legally binding documents and contracts.

Three separate but interlinked plans are envisioned:

**Construction Management Plan:** This plan will control the adverse impacts associated with erosion and sediment discharges from all earthworks activities.

**Camp Management Plan:** This plan will outline the operational controls on various aspects of the project including traffic management, noise and vibration management and operation of the workers camps.

**Social Management Plan:** This plan will address on site and off-site site social issues especially regarding health and social issues arising from the influx of workers and camp followers.

These plans should also be closely coordinated with all other environmental management plans and programmes that have been designed for the project under the EMP.
Environmental Management of Construction Activities

The environmental issues and key principles associated with construction of the scheme are listed in tabular form below and serve as guide for producing detailed environmental management practices for earthworks and other site operations. The Contractor is expected to detail the measures that are proposed to minimise, mitigate and manage the effects, for the duration of the construction works. The plans are dynamic documents, which may be subject to change or modification as a result of project development, incidents, community feedback or changes on the sites.

The key principle or mitigation standard is a minimum standard that must be met by the Contractor in order to comply with the EMP and the Environmental Approvals.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Issue</th>
<th>Key Principle/Mitigation standard</th>
</tr>
</thead>
</table>
| Vegetation clearance for all sites and work fronts | Loss and disturbance of existing ecology | Disturbance of forest habitat shall be minimised
Undertake clearing activities manually.
Keep organic soils for rehabilitation of sites. |
| Site rehabilitation            | Loss and disturbance of existing ecology
Sediment run off
Introduction of native species | All sites should be rehabilitated with native species. |
| Soil/overburden removal and placement | Generation of suspended solids from bare grounds and run-off into watercourses | Development activities should not give rise to storm water containing elevated suspended solids
Provide run-off containment and management.
Provide treatment of run-off prior to discharge to watercourses.
Sediment traps and barriers around all sites. |
| Excavation and blasting         | Noise disturbance of local populations
Vibration disturbance of local populations | Noise should not unreasonably intrude on village life.
Keep a current list of all noise producing machinery.
Designated hours of operation for certain machinery and blasting. |
| Material Stockpiling            | Run-off with suspended sediments from stockpiles
Dust generation from stockpiles | Stockpiling activities should not give rise to storm water containing elevated suspended solids
Run-off control, management around stockpiles.
Dust should not cause hazard or nuisance to village life. |
| Tunnel dewatering               | Contaminants in water discharged from tunnel during construction | No direct discharges of tunnel water to any watercourse.
Provide treatment. |
| Fuel storage and use            | Pollution risk associated with the storage and use of fuels for all | Keep current list of all fuels stored on site. |
## Activity Issue Key Principle/Mitigation standard

<table>
<thead>
<tr>
<th>Activity</th>
<th>Issue</th>
<th>Key Principle/Mitigation standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant, generators, and vehicles</td>
<td>Development of appropriate storage, transport and use practices to recognized standards.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Containment bunds around all fuel storage areas.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No oil, lubricants, fuels or containers to be drained or disposed to water ways.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No vehicle washing in or near water ways.</td>
<td></td>
</tr>
<tr>
<td>Archaeological and cultural site</td>
<td>Findings during excavation</td>
<td>Chance finding procedures to be developed and implemented.</td>
</tr>
<tr>
<td>disturbance</td>
<td>Land instability resulting from project activities.</td>
<td>Land should not be rendered unstable as a result of project activities.</td>
</tr>
<tr>
<td>Erosion control</td>
<td>Erosion providing sediment to water courses.</td>
<td>All sites should have erosion and run-off management plans.</td>
</tr>
<tr>
<td>Borrow pits</td>
<td>Sediment run off</td>
<td>All borrow pits will be restored, stabilised and landscaped.</td>
</tr>
<tr>
<td>Construction traffic</td>
<td>Increased utilisation of roads by traffic associated with construction activities.</td>
<td>There should be no significantly increased risk to local populations from traffic associated with the dam construction.</td>
</tr>
</tbody>
</table>

### Workers Camp Management Plan

The Contractor will prepare specifications for Camp Management Plans to address issues such as those presented in the following table.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Key Issue/Mitigation standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water pollution and solid waste</td>
<td>Sewage and grey water treatment to be provided to national standards.</td>
</tr>
<tr>
<td></td>
<td>Solid waste disposal off site to an appropriate facility.</td>
</tr>
<tr>
<td></td>
<td>No burning of solid waste.</td>
</tr>
<tr>
<td>Illegal activities by workers</td>
<td>Code of conduct</td>
</tr>
<tr>
<td></td>
<td>Mandatory environmental education and social/cultural sensitivity awareness courses for all workers</td>
</tr>
<tr>
<td>Accidents/health risks</td>
<td>Health and safety programme in camp.</td>
</tr>
<tr>
<td></td>
<td>Camp to provide its own health professionals.</td>
</tr>
<tr>
<td>Pressure on natural resources from food demand</td>
<td>Food supply policy</td>
</tr>
<tr>
<td></td>
<td>Camp to have its own water supply.</td>
</tr>
</tbody>
</table>

The Contractors will analyse the proposed sites for camp location and will make recommendations as to what additional mitigation measures are needed. In particular, the Contractors will address the need for self contained/controlled camps in this project. The requirements for self containment should be specified in the proposal from the Contractor.
Social Management Plan

It is clear that the existing social environment within the primary impact area has virtually no social carrying capacity to absorb and service the estimated workforce and camp followers. Without social management interventions, the risk of significant social impacts arising from the project is considered high. The social impact of a workforce of this size will be significant especially in small communities near the camp such as Lewa and especially Buyabuya. A high percentage of the workforce will be men and a high percentage of the camp followers will be women. Although the impact will be short term (construction period) it will also be intense. There are also a number of specific impacts arising from the interaction between the social and physical environment which requires immediate mitigation such as the risk of exposure to dust, the increased risk of traffic accidents and the increased risk.

The Contractors will assess social issues associated with the large work force in Nadarivatu through:

- Understanding existing conditions and trends related to demography and employment.
- Identifying potential impacts of camps and related construction activities, including the workforce requirements and potential impacts on services and communities in the project area, and developing procedures to minimise the impacts.
- Identification of mitigation measures.
- Direct workforce local labour recruitment policy.
- Social management of potential risks associated with spontaneous camp followers.
- Management and monitoring of health issues in the entire area of influence of the project.
- Community outreach and communication programme including conflict resolution mechanisms to deal with issues and concerns that may arise during the construction period.

Responsibility and Capacity for Development and Implementation of Plans

The Contractor has to demonstrate in its proposal that it will have the necessary skills and experience in this type of work and is entirely familiar with the operation, maintenance and management of all of the activities that have the potential to adversely impact the environment and surrounding communities. Furthermore, the Contractor has direct control over the plant, equipment, staff and resources employed on this project and therefore are best placed to plan, programme, implement and monitor mitigation practices. The Contractor will present a “Plan for the Management of Construction Activities and Worker camps for the Nadarivatu Hydroelectric Project” that includes adequate staff for its implementation and control and that has included the necessary budget for their implementation.

The Contractor is also be required to prepare suitable procedures for monitoring the performance of mitigation measures, including establishing schedules for records of the performance of mitigation measures and monitoring the receiving environment. As required by the plans, they will also have to establish contingency plans for any risks that are specifically identified in the plan. A Contingency Plan section will detail procedures and detail appropriate materials and equipment that are to be maintained on site to deal with a particular type of environmental incident (e.g. oil or fuel spill).
Plan Approval, Review and Reporting Processes

The Plans will be approved by FEA and must subsequently be approved by the Department of Environment in the Ministry of Tourism, Labour, and Environment, prior to initiation of construction. After approval of the plans, the Contractor shall be responsible for the implementation and maintenance of all measures set out in the plan. They will also be responsible for reviewing the performance of the measures and making any recommendations that may be appropriate for improving the environmental management of site activities.

The Supervising Engineer will be responsible for monitoring the Contractor’s performance against the CWCMP.

The Contractor will be responsible for regular environmental inspections of the various activities on the construction site. The inspections are likely to be activity based and frequency of inspections may vary from once a day to weekly intervals, as appropriate and as set out in the plans. The Contractor will maintain and keep all administrative and environmental records. Agreements should be made regarding reporting of these records to the Supervising Engineer and FEA.

Outline of Plan for the Management of Construction Activities and Worker Camps

The following is a suggested outline for the plan, as a minimum:

1) Purpose and objectives
2) Roles and responsibilities
   - Key staff, roles, responsibilities
   - Reporting structures
   - Approval processes
3) Key environmental risks and issues
   - List of environmental issues requiring specific attention on this project
4) Key social risks and issues
   - List of social / community issues requiring specific attention on this project
5) Training
   - Training of EMP
   - Task-specific training (camp operations, fuel storage and handling, erosion control etc)
6) Construction Management Plan
   As a minimum, detailed procedures for
   - Fuel and hazardous substances storage, handling and disposal
   - Erosion and sediment control, including slope stability
   - Works in the river bed
   - Discharges of sediment to water courses
   - Tunnel dewatering, treatment and discharge
   - Blasting and vibration during tunnelling
- Noise Management
- Dust Management
- Concrete manufacturing treatment and discharge
- Vegetation clearance
- Chance finding of archaeological sites
- Stockpiling
- Traffic management

7) Camp Management Plan
   As a minimum, detailed procedures for
   - Water supply
   - Wastewater treatment and disposal, including specification for the treatment plant and monitoring of performance
   - Solid waste containment and removal
   - Health facilities
   - Food supply
   - Transport of staff
   - Rehabilitation of sites
   - Fuel storage

8) Social Management Plan
   As a minimum, detailed procedures for
   - Receiving and addressing complaints, including a complaints register
   - Educating the workforce on traditional village life
   - Addressing camp followers
   - Monitoring of health issues
   - Recruitment of locals
   - Security and visitors to the camp
   - Camp interaction with the villagers
   - Code of Conduct – workforce behaviour

9) Communicating risks to villagers and river users.
   - Operation of a contact centre or one-stop-shop for communication.

10) Contingency and Incident procedures
    - Spills
    - Erosion and Sediment Discharges
    - Discharges
    - Breach of Camp Code of Conduct

11) Monitoring
    - Monitoring of the environmental protection measures
12) Reporting
   • Routine reporting to Supervising Engineer
   • Incident reporting

13) Evaluation and Review
   • Procedures for reviewing, updating and approving changes to the Plan
Appendix C	TOR Environmental Supervision During Construction

Environmental Supervision During Construction

SUPERVISION OF ENVIRONMENTAL AND SOCIAL ISSUES DURING THE CONSTRUCTION OF THE NADARIVATU HYDROPOWER PROJECT IN FIJI

Terms of Reference for Supervision Engineer

Environmental Supervision

In addition to the technical supervision tasks, the Supervision Engineer will be responsible for (i) enforcing and ensuring the implementation of all environmental and social mitigation measures included in the Construction and Workers Camp Management Plan presented by the Contractor as approved by FEA and the DoE; (ii) designing and implementing the Social Communication Programme and Environmental Education and Awareness Programme included in the Socioeconomic Management Plan of the project and (iii) implement the Environmental Monitoring Plan.

The plans listed above form part of the Nadarivatu Hydropower Project Environmental Management Plan, for which FEA is responsible.

Capacity for Environmental Supervision

In the proposal, the Supervision Engineer will:

- Demonstrate familiarity with the tasks involved environmental supervision of construction projects.
- Propose adequate staff, facilities, equipment and resources to carry out environmental supervision tasks.
- Propose an outline of the Communication Programme and Environmental Education and Awareness Programme and the schedule for final design and the implementation of the programmes.

Before Construction

Prior to construction the Supervision Engineer will:

- Prepare a Communication Programme and an Environmental Education and Awareness Programme for the approval of FEA. These programmes should address the following issues:
  - Feedback to the communities regarding the issues and concerns raised by the communities.
  - Environmental Education and Awareness Programme about project impacts.
  - Worker Behaviour Guidelines: Developing a village life protocol that could serve as a guideline for outside workers.
Education and orientation of outside workers to Fijian culture and social norms before the start of work.

Awareness and education of hazards and nuisances (such as noise and dust) during construction.

Timing, location and mitigation of noisy or dusty construction methods to be sensitive to village life.

Mechanisms to agree on work schedules with villagers. For instance, work to be carried out in daylight, in typical working hours. Concrete batching plants and other noisy equipment to be located as far as practical from villages.

Capacity building for local agencies and staff regarding community issues, labour issues etc.

Promoting the preservation of traditional values and customs.

- Initiate the implementation of the Communication Programme and the Environmental Education and Awareness Programmes as approved by FEA.
- Hold discussions with FEA and government officials such as DoE and villagers to develop procedures for inter-agency coordination and reporting.
- Review the Contractor’s Construction and Workers Camp Management Plan and recommend improvements and modifications as needed.
- Assess the capacity of the Contractor to implement the Construction and Workers Camp Management Plan and recommend strengthening as needed.
- Inspect camps and other facilities as to their compliance with agreed Construction and Workers Camp Management Plan and recommend improvements as needed.
- Make all arrangements for initiating the Environmental Monitoring Plan.

**During Construction**

During the construction phase, the Supervision Engineer will:

- Inspect all construction sites and facilities of the Contractor to ensure compliance with agreed plans.
- Report non-compliance by Contractor to FEA and work with all parties to identify remedial measures for implementation by the Contractor.
- Ensure remediation measures in the event of environmental and social impacts stemming from non-compliance.
- Report all environmental and social incidents to FEA and work with all parties to identify remedial measures.
- Prepare monthly reports to FEA on the results of the environmental supervision, the problems encountered and solutions agreed with the contractor. FEA will in turn report this information to the DoE.
- Continue the implementation of the Communication Programme and Environmental Education and Awareness Programme as approved by FEA.
– Update the Communication Programme and Environmental Education and Awareness Programme as required. During construction, the programmes shall be updated regarding educating downstream villages of the operational regime and the consequential changes in the Ba River.

– Implement the Environmental Monitoring Plan.
Appendix D  Guidelines for Socio-Economic Management Plan

The Socio-economic Management Plan should address all of the potential issues, key principles and minimum mitigation measures in the EMP. The Plan shall also identify all necessary activities, institutional arrangements and budget to ensure the maximization of these benefits for the local communities. The Plan will include the following programmes:

- Communication Programme
- Environmental Education and Awareness Programme
- Infrastructure programme for local communities
- Health Programme (included in Construction Management)
- Traffic Safety and Regulations (included in Construction Management)
- Grievance mechanism

<table>
<thead>
<tr>
<th>Programme</th>
<th>Main Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication and Environmental Education and Awareness Programme (FEA)</td>
<td>Feedback to the community regarding the issues and concerns raised; Environmental Education and Awareness Programme Worker Behaviour Guidelines Developing village protocol that could serve as a guideline for outside workers. Education and orientation of outside workers to Fijian culture and social norms before the start of work. Awareness and education of hazards and nuisances (such as noise and dust) during construction. Awareness and education of villagers regarding the operational regime and the consequential changes in the Ba River. Timing and location of noisy or dusty construction methods to be sensitive to village life. Work to be carried out in daylight, in typical working hours. Concrete batching plants and other noisy equipment to be located as far as practical from villages. Capacity Building for Local Agencies and Staff Promoting the Preservation of Tradition Values and Customs</td>
</tr>
<tr>
<td>Infrastructure programme for local communities (FEA)</td>
<td>The project will support basic infrastructure in surrounding communities mainly through the construction and upgrading of local roads and the implementation of a rural electrification programme. The rural electrification programme includes the provision of electricity to households in Marou Village (34); Vatokatoka Settlement (13); Koro Village (52); Buyabuya Village (31); Voyualevu Settlement (3); Draila Village (27); for a total of 160 households.</td>
</tr>
<tr>
<td>Health Programme (included in Construction and Workers Camp Management Plan, Contractor)</td>
<td>The Health Programme will be made extensive to the communities of Lewa and Buyabuya</td>
</tr>
<tr>
<td>Traffic Safety and Regulations (included in Construction and Workers Camp Management Plan, Contractor)</td>
<td>The traffic management regulations will be disseminated in all communities of the project area. It will also be included as part of the environmental awareness and education programmes.</td>
</tr>
<tr>
<td>Grievance Mechanism:</td>
<td>FEA will set up an office on site to facilitate the resolution of issues and concerns in the community. This office will be staffed by personnel from the Lands Department.</td>
</tr>
</tbody>
</table>
Responsibilities: The implementation of the Plan is FEA’s responsibility, but will require the participation of local and provincial agencies, as well as the participation, support and financing of the Contractor and Supervising Engineer.
Appendix E  TOR Environmental Monitoring Plan

E.1  Introduction
The Environmental Monitoring Plan is a sub-plan of the Environmental Management Plan and should detail the ongoing monitoring required to assess the impacts of the Nadarivatu Hydropower Scheme during construction and operation.

This TOR was part of the EIA approved by DOE in September 2006.

E.2  Outline of the Environmental Monitoring Plan
The Construction or Operational Environmental Monitoring Plan shall include the following:

Water quality monitoring
- Monitoring sites, including locations, description
- Monitoring routine (frequency, parameters, sites)
- Monitoring methodology (methods, equipment, standards, health, safety, quality, environmental controls)
- Sample analysis (laboratory, tests, field tests etc)
- Training
- Responsibilities
- Data management
- Data interpretation
- Results
- Reporting

Flow monitoring
- Station locations
- Equipment (hardware, software, installation, maintenance)
- Training
- Responsibilities
- Data capture
- Data storage
- Data analysis
- Reporting

E.3  Water quality and instream ecosystem monitoring
The following water quality and ecology monitoring has been proposed to assess the impacts on water quality and ecology from construction and operation. Monitoring locations are to be those located in Figure 3 and described in Table x.
- **Figure 3 Sample Site Locations**

- **Location of Instream Habitat and Water Quality Sampling Sites**

<table>
<thead>
<tr>
<th>Catchment</th>
<th>Site No.</th>
<th>Purpose and Description of Monitoring Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savatu Creek</td>
<td>8</td>
<td>CONTROL: Savatu Creek access from Drala</td>
</tr>
<tr>
<td>Ba River</td>
<td>1</td>
<td>UPSTREAM: Marou Village (above proposed power station)</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>IMPACT: Drala Village (below proposed power station)</td>
</tr>
<tr>
<td>Nukunuku Creek</td>
<td>3</td>
<td>UPSTREAM: Above hydrological station (approximately 1km above proposed Korolevu Weir and intake)</td>
</tr>
<tr>
<td>Catchment</td>
<td>Site No.</td>
<td>Purpose and Description of Monitoring Site</td>
</tr>
<tr>
<td>-------------------</td>
<td>----------</td>
<td>----------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Qaliwana Creek</td>
<td>7</td>
<td>UPSTREAM: 50m above hydrological recording station (approximately 1km above proposed Korolevu Weir and intake)</td>
</tr>
<tr>
<td>Sigatoka River</td>
<td>9</td>
<td>IMPACT: Below confluence with Nukunuku and Qaliwana Creeks (approximately 200m below proposed Korolevu Weir and intake)</td>
</tr>
</tbody>
</table>

### Table 19 Proposed Water Quality and Aquatic Ecosystem Monitoring Programme

<table>
<thead>
<tr>
<th>Phase in project</th>
<th>Frequency</th>
<th>Timing / River flow conditions</th>
<th>Sampling parameters</th>
<th>Sampling sites</th>
</tr>
</thead>
</table>
| 1 Prior to        | At least 1 further round, to ensure at least 3 in total at different times of year and different river flows. | Preferably a low flow and high flow event. | **Baseline establishment:**  Water quality:  
  * ph  
  * temperature  
  * dissolved oxygen  
  * conductivity  
  * clarity  
  * total alkalinity  
  * total suspended solids  
  * nutrients  
  * iron  
  * manganese  
  Visual substrate assessment  
  Macroinvertebrates  
  Suspendible inorganic sediment loads. | All sites in Figure 3 excluding sites 4, 5 & 6, plus:  
  Sigatoka River @ Nadraumakawa Hydrological station  
  Ba River @ Koro (exact locations to be confirmed) |
| construction      |           |                                |                                                                                     |                                                                                 |
| 2 During construction | One month prior, then monthly until completion of works. | Not during flood or high flow conditions. | **Visual substrate assessment**  
  Clarity. | Korolevu Weir site  
  Ba power station site |
| 3 During construction | 6 monthly until completion of works. | na                                | **Water quality as per 1 above.**  
  Suspendible inorganic sediment loads. | All sites in Figure 3 excluding sites 4, 5 & 6, plus:  
  Sigatoka River @ Nadraumakawa Hydrological station  
  Ba River @ Koro |
| 4 During operation | 6 monthly for 2 years. | Not during or following flood event. | **Water quality as per 1 above.**  
  Water quality (DO, Temp, pH profile). | All sites in Figure 3 excluding sites 4, 5 & 6, plus:  
  Sigatoka River @ Nadraumakawa Hydrological station  
  Ba River @ Koro  
  Two sites located in water body behind weir |
E.4 Hydrological Data Gathering and Monitoring

Monitoring prior to, during and after power scheme construction should provide for compliance and operational requirements.

Proposed automated river flow monitoring at the following project sites:

- Qaliwana River at Bulu – currently operating
- Ba River at below Ba power house - new

Proposed automated river flow monitoring stations downstream in each river:

- Sigatoka at Korovouiti (10 – 12 km downstream)
- Ba at Nivala (8 - 10 km downstream)

Survey cross-sections on the Ba River are to be confirmed / completed at: Ba, Koro, Becamoui, Cuave, Nivala and Toge.

Survey cross sections on the Sigatoka River are to be confirmed / completed at least six locations downstream.
Appendix F  Construction and Workers’ Camp Management Plan
(Contractor - to be inserted)
Appendix G  Environmental Supervision of Construction (Supervising Engineer - to be inserted)
Appendix H  Socio-economic Management Plan (FEA - to be inserted)
Appendix I  Construction Environmental Monitoring Plan
(Supervising Engineer – to be inserted)
Appendix J  Operations Environmental Monitoring Plan (FEA – to be inserted)
Appendix K  Ecological Flows and Management of Water Releases (FEA – to be inserted)
Appendix L  Chance Finding Procedures

1. Definition of Physical Cultural Resources (PCR)
The Archaeological Impact Assessment conducted during the course of the Nadarivatu Hydroelectric Scheme involved site identification, surface surveying, site mapping and the recording of Oral Tradition. Eight sites were identified and surveyed during this field survey. The sites identified are significant to the

- Figure 4 Physical and Cultural Resources Location
people of the Yavusa Cawanisa of Lewa Village and the Yavusa Nubu of Nadala Village and its surrounding villages respectively. The location of these sites is presented in Figure 4.

Although these procedures cover archaeological finds such as the ones described above, the procedures apply to all types of physical cultural resources defined as “movable or immovable objects, sites, structures or groups of structures having archaeological, palaeontological, historical, architectural, religious, aesthetic, or other cultural significance”.

2. Ownership
All findings belong to the Government of Fiji. The Fiji Museum will determine the final destination of any artifact that is salvaged during the construction process.

3. Recognition
The Contractor will train all workers, especially those working on earth movements and excavations, on recognition of artifacts most likely to be found in the area. The Fiji Museum can be requested to provide this training.

4. Procedure upon Discovery
a) Suspension of Work
If a PCR comes to light during the execution of the works, the contractor shall stop the works around the site where the discovery was made. This issue should be informed by a qualified archaeologist.

After stopping work, the contractor must immediately report the discovery to the Supervision Engineer.

The contractor is not entitled to claim compensation for work suspension during this period.

The Supervision Engineer is entitled to suspend work and to request from the contractor some excavations at the contractor’s expense if he thinks that a discovery was made and not reported.

b) Demarcation of the Discovery Site
With the approval of the Supervision Engineer, the Contractor is then required to temporarily demarcate, and limit access to, the site.

c) Removal of artefacts
Under Fijian law, no artifacts can be removed without permit from Fiji Museum.

d) Non-Suspension of Work
The Supervision Engineer must consult with the Fiji Museum to decide whether the PCR can be removed and for the work to continue, for example in cases where the find is a small object.

e) Chance Find Report
The Contractor should then, at the request of the Supervision Engineer, and within a period of two working days, make a Chance Find Report, recording:

- Date and time of discovery;
- Location of the discovery;
- Description of the PCR;
- Estimated weight and dimensions of the PCR;
- Temporary protection implemented.

The *Chance Find Report* should be submitted to the Supervision Engineer, who will then submit it to FEA and notify the Fiji Museum of the finding.

**f) Arrival and Actions of Fiji Museum**

Prior arrangements with the Fiji Museum, the Fiji Museum will be requested to send a representative that will arrive at the discovery site within 24 hours to 48 hours, and determine the action to be taken. Such actions may include, but not be limited to:

- Removal of PCR;
- Execution of further excavation within a specified distance of the discovery point;
- Extension or reduction of the area demarcated by the contractor.

These actions should be taken within 7 days.

The contractor will not be entitled to claim compensation for work suspension during this period.

If the Fiji Museum fails to arrive within the stipulated period, the Supervision Engineer will have the authority to extend the period by two days.

If the Fiji Museum fails to arrive after the extension period, the Supervision Engineer will have the authority to instruct the Contractor to undertake mitigating measures and resume work. Such additional works can be charged to the contract. However, the contractor may not be entitled to claim compensation for work suspension during this period.

**g) Further Suspension of Work**

During this 7-day period, the Fiji Museum will be entitled to request the temporary suspension of the work at or in the vicinity of the discovery site for an additional period of up to, for example, 30 days. The contractor will not be entitled to claim compensation for work suspension during this period. However, the contractor will be entitled to establish an agreement with the Fiji Museum for additional services or resources during this further period under a separate contract with the Fiji Museum.
Appendix M  Training Schedule and Records (to be developed)
Appendix N  EMP Evaluation and Review Audit Schedule (to be developed)