Additional Environmental Studies

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Table of Contents

ADDITIONAL STUDIES ON NATURAL ENVIRONMENT FOR REVIEW OF FEASIBILITY STUDY AND PREPARATION OF DETAILED DESIGN AND BIDDING DOCUMENTS
MORAGOLLA HYDROPOWER PROJECT, SRI LANKA

Final Report 1

Water quality in the Mahaweli Ganga - upstream and downstream of the proposed dam at Moragolla

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Contents

Annexure

List of Figures

Executive Summary

Introduction

The Ceylon Electricity Board (CEB), the institution responsible for electricity generation, transmission, distribution and retailing in the country, plans to develop a new hydropower scheme in Moragolla, Kandy with a designed capacity of 30.0 MW. The proposed project envisages construction of a 35 m high dam across the Mahaweli Ganga at Weliganga.

Nippon Koei Co. Ltd., the consultant appointed by CEB to review the feasibility study and prepare designs and bidding documents for the Moragolla Hydropower Project, appointed the National Building Research Organization (NBRO) to conduct additional studies on the natural environment. This work is one of several studies conducted in order to update and upgrade the previous EIA study to comply with the ADB safeguard policy (Safeguard Policy Statement, ADB 2009).

In this regard, the water quality of the Mahaweli Ganga was studied with the intention of: investigating the present water quality upstream and downstream of the proposed dam in order to determine the nature, extent and sources of pollution, to predict the likely impacts of the Moragolla HP Project during the operational stage and to propose mitigation measures for likely negative impacts.

The river water in the study area is used for bathing by the local people and also for some industry and irrigation. The potential pollution sources include one point pollution source: the wastewater outfall of Crysbro Broiler Farm, sand mining sites and diffuse pollution from small tea plantations on either side of the river upstream.

Monitoring river water quality

Water samples were collected at 10 locations from upstream of each of the rivers from the confluence of the Kotmale Oya and the Mahaweli River to downstream of the confluence of Atabage Oya and Mahaweli River, on ten locations on 06.03.2013 during low flow season (dry season) and on 15.05.2013 during the high flow season (wet season). In situ measurements of pH, Temperature, Dissolved Oxygen, and Turbidity were undertaken and BOD_5, Ammonia, Nitrate, Total Phosphorus, Total Suspended Solids, Faecal Coliforms and Total Coliforms were analyzed in the NBRO laboratory. Sampling and analysis were carried out according to National and International Standard Methods. Water quality status and seasonal variations are reported and compatibility with proposed national standards; “Ambient Water Quality – EA1P-DHV-2000” is assessed.

Status of river water quality

In general, increased levels of several determinands were observed in the wet season compared to the dry season. Notably high levels were observed in wet season for Nitrates, Ammonia, Total Coliforms, Total Suspended Solids and Total Phosphorus. Levels of pH, DO, BOD_5, Nitrates, Ammonia and Total Phosphorus of all samples were observed to be within the acceptable limits of the standards in the categories considered namely, Drinking water with simple and conventional treatment, Bathing, Fish and aquatic life, and irrigation and agriculture in both seasons. Bacteriological counts of the water were found to be in a range which exceed the safe limits for the above categories , however with some deviations and hence, water in this part of the Mahaweli River is not suitable for drinking (after simple or conventional treatment) or bathing, because of its high bacterial content. The field observations and analysis of wastewater of Crysbro Broiler farm provide evidence of potentially high pollutant levels, specially: Biochemical Oxygen Demand, Total Suspended Solids, and faecal coliforms and oil and grease.

Water quality impacts due to power plant operation

The water quality of the proposed reservoir after impoundment is likely to be affected due to the accumulation of sediments and nutrients. The proposed reservoir would receive sediments from the upstream area, due to ingression of silt-laden runoff water, especially during the wet season when the average rainfall is relatively high. High amount of nutrient - bound sediments might trigger eutrophication in the proposed reservoir and accumulation of the floating, and the settleable (organic) debris would also impair the water quality. In contrast, reduction of Faecal Coliform counts and Suspended Solids can be anticipated due to their natural decay after longer retention in the reservoir. Reduction of these constituents will have a positive impact on the downstream water quality. The entry of floating debris of plant and anthropogenic origin, was observed to be a possible source of contamination, and this would increase the organic content, nutrients and suspended load in the reservoir with potential impacts on water quality and the power generation turbines.

Water quality downstream of the dam is likely to be affected by impacts such as flow reduction, reduction of sediment load, altered nutrient flux during the operational stage. Since the Crysbro Broiler Farm discharges its wastewater into this part of the Mahaweli River, significant deterioration of the quality can be anticipated due to inadequate dilution, especially in the dry season. The irrigation water supply, Dunhinda Ela, is likely in the downstream to be affected, because water contaminated with the broiler farm wastewater may enter into the irrigation water canal and pose potential health problems. Impacts on the drinking water sources, in the downstream area are insignificant as there are no drinking water intakes between the proposed dam and the tailrace outlet. It may take 30 years or more for the sediment in the reservoir to reach the spillway crest level. The sediment further accumulated needs to be removed without extreme increases in sediment load in the downstream. Release of the intended environmental flow, $1.5 m^3/sec$, will have a significant positive impact on the river water quality up to the tailrace outlet. Nevertheless, the analysis of wastewater of Crysbro Broiler Farm suggests possibility of exceeding tolerance limits for industrial wastewater discharge standards.

Proposed mitigation measures

In the operation phase, floating debris is suggested to be discharged downstream with water over the flap gate mounted on one of the spillway gates. Debris built up at the intake trashrack can be removed by a mechanical rake. The sediment accumulated above the spillway crest level will be removed by mechanical dredging or sediment sluicing through the spillway gates at the high flow season or the combination thereof. Regular monitoring of Crysbro Broiler Farm's effluent to ensure the enforcement of stipulated industrial discharge limits and relocation of the effluent outfall downstream of the proposed tailrace outlet are recommended as alternative mitigation measures to minimize the downstream water quality impacts due to above wastewater discharge during the operational stage.

1. Introduction

The Ceylon Electricity Board (CEB) plans to develop a new 30.0 MW hydropower project at Moragolla in Kandy District. The scheme involves construction of a 35 m high concrete gravity dam (with a 5-gate spillway) across the Mahaweli Ganga at Weliganga, to create a 38.5 ha (1.98 MCM) reservoir with a Full Supply Level (FSL) at 548 msl. The water from the reservoir will be diverted through a 3.1 km underground tunnel, surge shaft and penstock on the left bank of the river, to a powerhouse and outfall located opposite the confluence with the Atabage Oya.

The CEB intend seeking international financial support for the project implementation and potential funders include the Asian Development Bank (ADB). For this purpose, CEB has appointed Nippon Koei Co. Ltd in joint venture with Nippon Koei India Pvt Ltd to review the Feasibility Study and prepare detailed designs and bidding documents for the project. Review of the EIA indicated that further studies were needed in order to update and amend the document to comply with ADB safeguard policy (Safeguard Policy Statement, ADB 2009).

The Nippon Koei Co. Ltd, Moragolla Hydropower Project appointed the National Building Research Organization (NBRO) to conduct the following additional studies on natural environment:

- Water quality of the Mahaweli Ganga
- Aquatic ecology of the Mahaweli Ganga
- Groundwater quality and distribution along the proposed tunnel route
- Updated land-use mapping

This report presents the study conducted for river water quality as described in Terms of Reference (ToR) shown in **Annex 1,** which addresses following aspects:

- Water quality in the river upstream and downstream of the proposed dam site at Moragolla during the low flow season in March 2013 and May 2013; at the start of high flow season
- Sampling, analysis and Quality Control procedures
- Local and seasonal variations in the water quality in the Mahaweli Ganga
- Likely water quality impacts in the reservoir during and after impoundment, with a discussion of likely seasonal variations
- Likely water quality impacts downstream during scheme operation
- Mitigation measures

2. Scope of the study

The ToR required river water quality to be monitored in two seasons namely, dry season- low flow condition and wet season- high flow condition. Accordingly, two sampling events were planned. Monitoring in dry and wet seasons was conducted in March and May, 2013 respectively.

In the sampling program, 10 locations were employed for the collection of water samples at approximately 500 m intervals along the river. These extended from 500 m above the confluence between the Kotmale Oya and Mahaweli Ganga (one station at the confluence and one station

500 m upstream in both rivers) to 500 m downstream of the confluence with the Atabage Oya. The locations were chosen with the intention to capture baseline water quality of the river immediately upstream and downstream of the proposed Moragolla dam and the reservoir. Duplicate samples were supposed to be collected from all 10 locations within a day.

3. Justification for selection of sampling points

The project staff of NBRO (refer **Annex 2**) visited the study area on the 1^{st}, 2^{nd} and 5^{th} March 2013 to decide sampling locations. In these site visits, it was found that access to some sampling locations indicated in the ToR was difficult due to steep terrain conditions. It was also noticed that proposed upstream locations around the confluence inundate during high-flow conditions as floodplain is wide in this river section. The sampling points 1, 2 and 3 specified in the ToR were changed accordingly (refer Fig.1, **Annex 3**: L1, L2 and L3). The water quality at these sampling points can be considered representative of those specified in the ToR, as there were no major inputs from tributaries between the two.

Although, the ToR specified a sampling point at Crysbro Broiler Farm wastewater outfall, this could not be established due to the following site-specific reasons (a) the Crysbro Broiler Farm has installed a pipeline to divert its wastewater directly into the river, down a very steep slope and this line was observed to be severely damaged during the days of sampling (b) during all sampling sessions there was no discharge from this outfall although it was observed in the initial survey (refer **Annex 4**). A new sampling point replacing the one specified in the ToR (point L8) was then established in the river immediately downstream of the Crysbro wastewater outfall to capture the effects of any discharge from it.

Considering the expected influence of wastewater released from Crysbro Broiler Farm on water quality in the river, an additional visit was made on 2^{nd} July 2013 to locate the wastewater outfall of this farm as there were no indications of any discharge to the waterways from the outfall during previous visits. In this visit, the NBRO team observed a small path carrying wastewater from the farm (refer Fig. 2) getting collected downhill (refer Fig. 2.2). Water samples from this downhill location were collected as access to uphill is very unsafe. This location is assigned, L11 (refer Fig.1 and **Annex 3**).

Water Quality Sampling Locations of Proposed Moragolla Hydropower Project Area

Fig. 2.1 Flow path of Crysbro Broiler Farm wastewater effluent

Fig. 2.2 Accumulation point of the wastewater

Fig. 2.3 Accumulated oil and grease scum of the wastewater

Fig. 2.4 Floating feathers and oil in the wastewater accumulation point

Fig. 2 Downhill collection point of Crysbro Broiler Farm wastewater

4. The river uses and potential pollution sources

4.1 The river uses

The river water is used for several purposes in the length covered by this survey. These include bathing (local people), industrial use and irrigation. Two bathing spots were observed in the proposed reservoir area during surveys. The water intake of the Crysbro Broiler Farm (abandoned during field surveys) and an irrigation supply named Dunhida Ela are located about 2 km downstream of the proposed dam site. (Refer Fig. 1, **Annex 3**).

4.2 Potential pollution sources

Wastewater discharges
The only point pollution source in the study area near stations L3 and L10 (Fig.1) is the wastewater discharge from the Crysbro Broiler Farm (refer **Annex 3**).

Sand mining activities
There are two active sand mining sites in the study area. The sand is mined manually by using a locally fabricated basin like device fixed to a long bamboo pole. The river bed is scooped using this device, the collected sand is then loaded into floating barges made of bamboo and taken elsewhere. The sand mining activity causes: (a) increased short-term turbidity at the mining site due to re-suspension of sediment during sand removal operations, (b) alteration to river morphology and river bank erosion in the long run. Sand mining activities were not observed during the initial water quality sampling work.

Tea plantations
Isolated small scale plots of tea plantations were observed alongside and adjacent to the river bank, around sampling locations L1, L2, L3 and L8. These plantations use agrochemicals[1] such as fertilizers and pesticides. The runoff contaminated with agrochemicals may pollute the river.

5. Sample collection, transportation and preservation

To reflect the low and high flow water quality conditions, samples were collected on 06.03.2013 (during dry season) and 15.05.2013 (after recent rainfall). All samples were collected between 7.30 am and about 4.00 pm because river flow conditions could change in a short period of time depending on precipitation in the upper catchment. The samples of wastewater discharge from Crysbro Broiler Farm were collected on 02.07.2013. It was done during the high low season and the point of collection was location L1. **Figure 1 and Annex 3** show the sampling locations and **Annex 5** provides the GPS reference and a description of each site.

Sample collection, preservation, transportation and analysis for physicochemical parameters were carried out according to the Standard Methods[2]. The bacteriology (Faecal Coliforms and Total Coliforms) sampling and analysis were done according to the Specification for Potable Water[3]. Different devices were used in sampling depending on the method requirement. Accordingly, samples for general water quality parameters were collected by flinging a clean

[1] The recommended Nitrogen and Phosphorus fertilizer applications for tea plantations are: Nitrogen, 10kg/ha , P_2O_5 60kg/ha , Source:www.fertilizer.org/ifa/content/download/9002/133893
[2] Standard Methods for the Examination of Water and Wastewater, American Public Health Association, AWWA, WEF, 20th Edition, 1998.
[3] Specification for potable water, bacteriological requirement, Sri Lanka Standards,614:1983, part 2

plastic bucket, tied to a rope, to the flowing water stream. Bottles having a ground-glass stopper and flared mouth were used for the collection of water samples for the determination of Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD) whilst pre sterilized bottles were used for the collection of samples for bacteriological analysis. Duplicate water samples were collected from each location within 10 minutes from the collection of first sample. Accordingly, the sampling covered collection of 22 samples from 11 locations.

The water samples collected for water quality parameters except for DO, BOD and bacteriological analysis were transferred securely into clean plastic screw-top containers, and those collected for Dissolved Oxygen were fixed at site by adding $MnSO_4$ and alkali-iodize – azide reagents. All samples were labelled with location No, date and specific parameter to be analysed. Carefully packed samples in separate cooler boxes with ice were then transported to the NBRO laboratory, Colombo on the same day. A temperature of 4 -10^0 C was maintained during transportation. In the laboratory, the samples were stored at 4^0 C until analysis was performed.

6. Analysis of samples for water quality parameters

The ToR instructs that the water should be analyzed for the total of nine water quality parameters, namely, Total Suspended Solids, Biochemical Oxygen Demand (BOD_5), Nitrate, Phosphate, Total Coliforms, Faecal Coliforms, Temperature, Dissolved Oxygen and Turbidity. Considering the presence of forest river cover[4], the slow stream flow in certain sections, rock pools and the nature of anthropogenic pollution sources, Ammonia[4] content in the water was also measured. Instead of Phosphates, samples were analyzed for Total Phosphorus[5]. The pH, Temperature and Turbidity were measured at site using calibrated meters. The analysis was commenced on the following day of the sampling event of each session and continued 7 days.
Annex 6 presents the methodology followed in sampling and analysis.

7. Existing water quality

7.1 Seasonal variation of water quality

Tables 1 and 2 of **Annex 7** contain the results of the analysis of river water quality in the wet and dry seasons, and the data are shown graphically in Fig 3. This shows that at most stations the concentration of most of the analysed parameters increases quite significantly in the wet season, in comparison with the dry. Thus values of dissolved oxygen are generally higher under high flow conditions because of increased atmospheric exchange caused by high surface turbulence. However values of suspended solids, plant nutrients (nitrate and phosphate) and other contaminants such as ammonia and faecal and total coliform bacteria are also higher in the wet season, most likely because of runoff of soil containing fertilizers and other material of anthropogenic origin. The significantly higher counts of total coliform than faecal coliforms

[4] Water draining from forest catchment generally contains high ammonia levels. Most of the nitrogen found in forest runoff originates from the decay of plants and animals waste products including animal urine. Ammonia Nitrogen is the early form of nitrogen resulting from biological breakdown of biological waste products. Since it is readily oxidized to either nitrite or nitrate under aerobic conditions, high amounts of this pollutant may indicate a fairly fresh or recent pollution event.

[5] Phosphorus occurs in dissolved organic and inorganic forms or attached to sediment particles. Phosphate is an inorganic dissolved form and readily taken by aquatic flora, but other forms can be used when phosphates are unavailable.

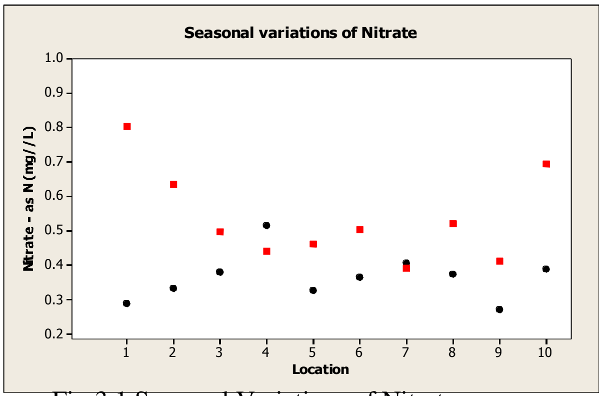


Fig 3.1 Seasonal Variations of Nitrate

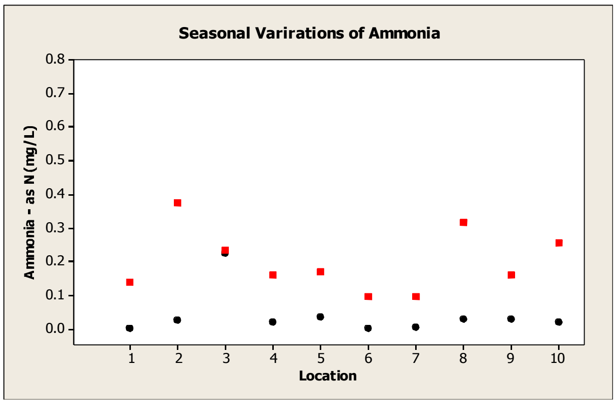


Fig 3.2 Seasonal Variations of Ammonia

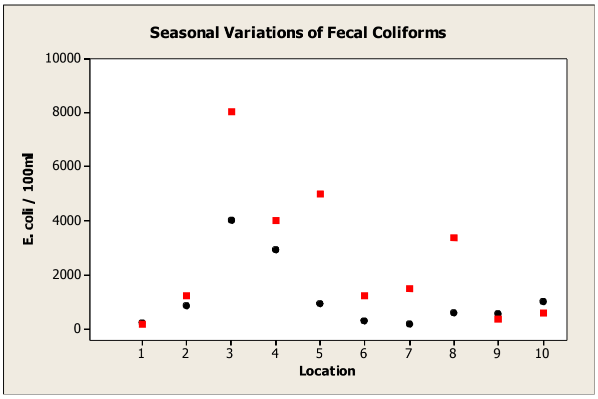


Fig 3.3 Seasonal Variations of Faecal Coliforms

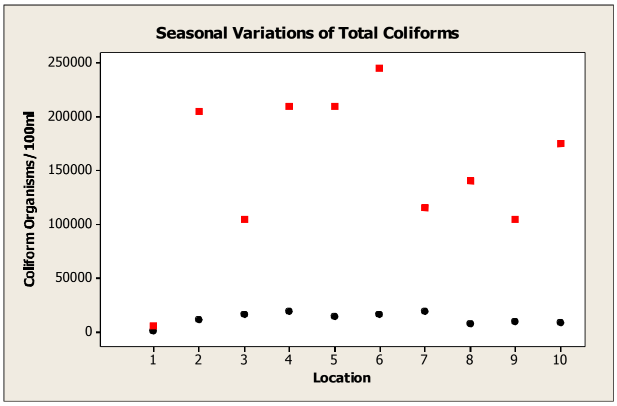


Fig 3.4 Seasonal Variations of Total Coliforms

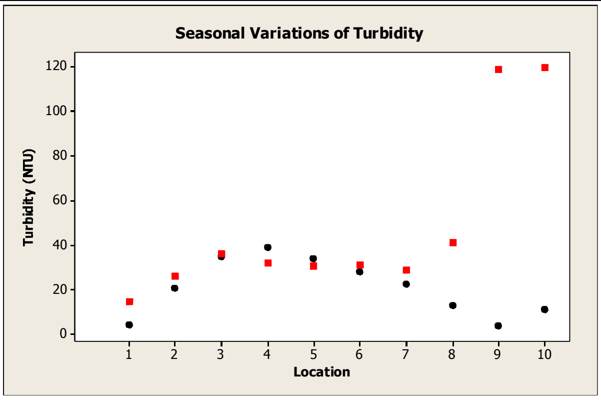


Fig 3.5 Seasonal Variations of Turbidity

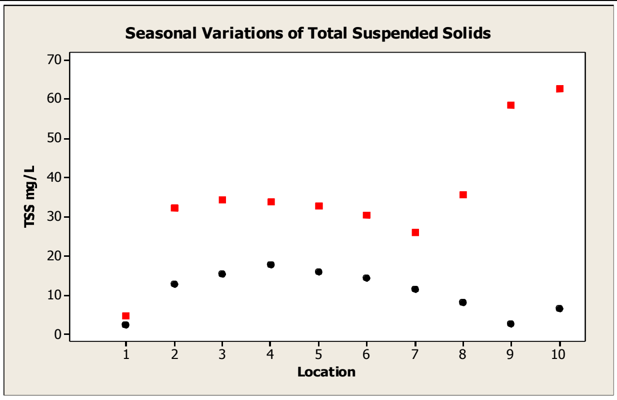


Fig 3.6 Seasonal Variations of Total Suspended Solids

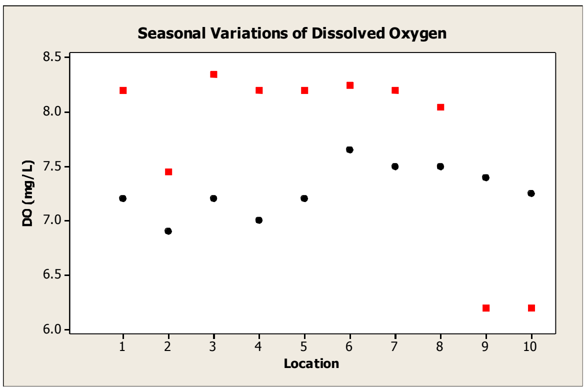


Fig 3.7 Seasonal Variations of Dissolved Oxygen

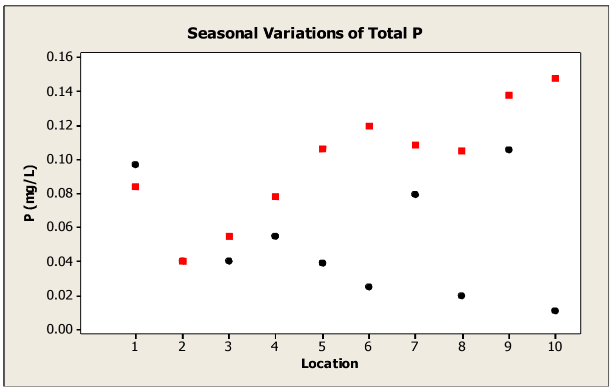


Fig 3.8 Seasonal Variations of Total Phosphorous

Fig. 3 Seasonal variations in surface water quality parameters (* 1-10 depict the sampling locations L1-L10)
Dry season data are shown in black while wet season data are shown in red)
(Values are the average of two duplicate samples)

indicates that most of this material is unrelated to sewage contamination, and is probably mainly from fertilizers washed in with soil and plant debris.

Other notable results are the high values of both turbidity (120 NTU) and suspended solids (60 mg/litre) at Stations L9 and L10 in the wet season, presumably caused by the discharge of water retained in the Kotmala reservoir during the dry season (see location of tailrace outfall in Fig 1). For the same reason, dissolved oxygen is significantly reduced at these stations at this time, because oxygen is depleted by decomposition of organic matter in water under longer-term storage.

7.2 Suitability of water for different uses

The country has no gazetted ambient water quality standards for designated uses at present, but a Proposed Standard; "Ambient Water Quality – EA1P-DHV-2000", is available. This standard was therefore used for comparative purposes to indicate the quality of the water in the river reach. The proposed standard specifies seven user categories:

- Category 1 - Nature conservation
- Category 2 - Drinking water with simple treatment
- Category 3 - Bathing
- Category 4 - Fish and aquatic life
- Category 5 - Drinking water with conventional treatment
- Category 6 - Irrigation and agriculture
- Category 7 - Minimum Quality

These comparisons suggest that the quality of water at all ten locations conform with all six uses (Categories 2-7) with respect to pH, DO, BOD, Nitrate and Total Phosphorus in both seasons. Locations L1 (Kotmale Oya) and L9 (below Atabage Oya) also conform with Category 2 water use (for drinking after simple treatment) in both seasons with respect to faecal coliforms, and locations L6-L9 conform with this use in the low flow season. However in contrast, most values of turbidity and total coliforms exceed the Category 2 limits in both seasons; and levels of suspended solids (for which there is no standard) are also quite high, being above 10 mg/litre at L2-L7 during the low flow season and above 25 mg/litre at all stations except L1 during high flows.

The results also show that at all locations in both seasons the water is not suitable for bathing or use in irrigation, as coliform counts exceed the limits for Category 3 and Category 6 waters. At most locations the water is also not suitable for drinking after simple treatment (Category 2) or conventional treatment (Category 5), as limit values for both faecal and total coliforms are exceeded. L1 (Kothmala Oya) is the only station where the water is suitable for drinking with simple treatment in both seasons.

7.3 Wastewater quality of Crysbro Broiler Farm effluent discharge

The quality of Crysbro Broiler Farm effluent was tested for same parameters as for river water quality, except Total Phosphorus, for which dissolved phosphates were tested instead. The results were then compared with relevant discharge standards, as shown in Annex 8. Of the 7 parameters tested for which tolerance limits are given in the standards, the sample of Crysbro effluent complied with the limits for pH, temperature, ammonia, and dissolved phosphorus, but exceeded the standard with respect to BOD_5, Total Suspended Solids and faecal coliforms. This analysis indicates that the Crysbro Farm discharges inadequately treated wastewater that is high in organic content, faecal bacteria and suspended solids.

7.4 Existing status of water quality in the Mahaweli Ganga

The results presented in Annexes 7 and 8 and Fig 3 and discussed in Sections 7.1-7.3 suggest that water quality in this part of the Mahaweli Ganga is quite mixed, with certain parameters that are indicative of good water quality (neutral pH, high DO and low BOD), but some parameters that are characteristic of poorer quality water (high Turbidity, Total Suspended Solids and Coliform bacteria). There is some evidence of pollution from run-off of fertilizers (containing N and P) and other anthropogenic materials (high Faecal Coliforms), but the results do not suggest that the river is grossly polluted. Concentrations of most of the analysed determinands increase in the wet season: Dissolved Oxygen because of increased aeration from turbulent water; and Nitrates, Phosphorus, Ammonia, Coliforms, TSS and Turbidity because of runoff of soil and contaminants from the land. The results indicate that the Crysbro outfall releases water that is high in organic content, suspended solids and faecal bacteria and exceeds the standards for these parameters. The influence of water from the tailrace discharge of Kotmale Reservoir can be seen in high levels of turbidity and suspended solids in the immediate downstream area, and reduced dissolved oxygen, caused by the release of water retained in the reservoir in the dry season. Comparing the results with the water quality standards recommended for specific uses suggests that water in this part of the Mahaweli Ganga is not suitable for drinking (after simple or conventional treatment), bathing or irrigation, especially because of its high turbidity and bacterial content. The field observations and the analysis of wastewater from the Crysbro Broiler Farm indicate wastewater discharges with inadequate treatment (refer Fig. 2).

8. Anticipated impacts on water quality

8.1 Likely water quality impacts in the reservoir after impoundment

The main operational phase action in the project is impoundment of water in a reservoir by a dam. This will result in retention of a water mass upstream of the dam to about 2 km. The Moragolla reservoir will operate as a “run-off-river” river scheme, where the relatively small reservoir will act as a regulatory pond, not a storage basin. For most of the rainy season (May-November) there will be sufficient water to generate power almost constantly, and the excess water will flow from the reservoir through the spillway gates, so water will remain in the reservoir for a short time only. During the dry season (December –April) the Moragolla scheme will be operated primarily to satisfy peak electricity demand for a few to several hours on most days. Water therefore will be retained in the reservoir for longer periods during the dry season, so water quality could fluctuate, as discussed below.

Impacts on water quality and sediments movement

The damming and impoundment of water in the reservoir will result in aggregation of sediment on the upstream side of the dam as heavier particles will sink and settle on the reservoir bed. This will reduce the sediment content in the reservoir water and in the water diverted for power generation and discharged through the tailrace. The proposed Moragolla Reservoir is likely to receive a high load of suspended solids from the Mahaweli Ganga upstream from Nawalapitiya catchment during the wet season, where average rainfall in the southwest monsoon is 445 mm, compared with 147 mm[6] in the dry season. The results from the present survey show increased Suspended Solids in water in the wet season in comparison to dry season (refer Fig 3.6), most probably due to ingression of silt-laden runoff water into the river. Furthermore, a reduction in Faecal and Total Coliform bacteria counts in the tailrace discharge can be anticipated due to natural decay after retention of water in the reservoir. The reduction in both sediments and Faecal Coliform bacteria will have positive impact on the downstream water quality. The accumulation of sediment, however, should be taken into account in planning, design and operation of the reservoir.

The accumulated sediments may also contain organic and nutrient-bound particles, especially Phosphorus (the limiting nutrient for algal growth), and there is therefore a likelihood of increased levels of these nutrients in the reservoir as well as in the tailrace discharge.

The above mentioned impacts of eutrophication and low oxygen levels are not expected to be highly significant however, and will depend on several factors such as hydraulic retention, reservoir circulation, inputs of organic matter, nutrients, rainfall, wind conditions, reservoir sediment management, reservoir operation etc. Moragolla being a “run - of - river” reservoir, the water will have low retention in both seasons and will not be subjected to sufficient retention to cause the above mentioned impacts.

Entry of debris into reservoir

During the survey, heavy loads of debris were observed trapped in natural depressions along either side of the river. They consist of dead plant material, plastic bottles, polythene and other anthropogenic matter (refer **Annex 4**) left stranded after the previous high flow season. The floating and settable organic material may decompose and impair the water quality by increased BOD and Suspended Solids, and lower Dissolved Oxygen levels. Furthermore, influx of plastics and other inert debris into the reservoir may hamper power generation operations if left unattended.

8.2 Likely downstream water quality impacts during scheme operation

The river reach downstream of dam is likely to be affected by impacts such as flow reduction, reduction in sediment load, altered nutrient flux due to presence of the physical barrier imposed by the dam and the upstream impoundment. The water quality impacts specific to this project are indicated below.

As explained in Section 8.1 above, throughout most of the wet season, water will be retained in the reservoir area for a relatively short time, so there are unlikely to be major changes in water quality, apart from small improvements that may arise from reductions in the sediment and bacterial content as a result of natural settlement and decay respectively. Throughout the dry season however, water will be retained for longer periods, so there could be changes in water quality, the nature and extent of which will depend on the factors mentioned above. In general the water flowing downstream at this time is expected to be lower in sediment and bacterial content, but also lower in oxygen because of the decay of organic matter in the reservoir and limited atmospheric replenishment at the surface. There will also be reductions in the quantity of water flowing downstream in the dry season, when water will flow through the tailrace and into the river only when power is generated (ie a few to several hours on most days). The only water flowing from the dam at this time will be the $1.5 m^3/s$ environmental flow.

[6] Revised Feasibility Study Report (Draft) Moragolla Hydropower Project Volume 1- Main Report-Nippon Koei Co., Ltd in Joint venture with Nippon Koei India Pvt. Ltd

Water quality impacts due to reduction in river flow between proposed dam and the tailrace
The impoundment will reduce natural stream flow along the river reach of 3 km from the proposed dam to the tailrace outfall. The reduced flow is likely to have an impact on the river water quality as wastewater from the Crysbro Broiler Farm is discharged in to the river reach to be affected by low flow during generation of hydropower. In the dry season, the low stream discharge may be inadequate to dilute the pollutants in the wastewater. The BOD, Suspended Solids, Oil and grease from the wastewater will increase the levels of these pollutants in the river, and may cause a reduction in dissolved oxygen from the decomposition process. Furthermore, Faecal Coliform counts in the river reach up to the tailrace are likely to rise.

Impact on the irrigation water
The likely impacts noted above could be significant on the water in the irrigation canal (Dunhida Ela) because the river water contaminated with waste from Crysbro Broiler Farm may enter the irrigation water supply posing potential health problems for people who come into contact with the water. The impacts however, may not be highly significant during wet season because Moragolla project is a "run-of-river" reservoir and will spill frequently during this time.

Impacts on downstream drinking water sources
The likely impacts on the drinking water sources are insignificant as there are no drinking water intakes between proposed dam and the tailrace outlet. The Crysbro Broiler Farm water intake is located downstream of the dam above their wastewater discharge location. This location is abandoned at present and therefore there is no impact.

Impacts on aquatic fauna
The river water contaminated with pollutants will have an impact on the natural aquatic fauna and flora downstream. The water quality impacts on aquatic fauna are discussed in the ecology report.

9. Proposed mitigation measures

The impact analysis above revealed some impacts that are significant on water quality and water uses. They include impacts due to: entry of debris into reservoir, sediment management activities and downstream water quality impacts and those on downstream water quality due to Crysbro Broiler Farm wastewater. The mitigation measures are proposed in this section to minimise these impacts.

9.1 Mitigation of likely water quality impacts in the reservoir after impoundment

Mitigation of impacts due to entry of debris into reservoir
The Moragolla dam will be equipped with a flap gate on the top of one of the spillway gates. The floating debris in the vicinity of the dam will be discharged with water over the flap gate. Debris built up at the intake trashrack can be removed by a mechanical rake equipped at the intake.

Mitigation of impacts due to sediment management activities
The design of the Moragolla dam does not have a facility for the flushing of retained sediment. It may take 30 years or more for the sediment in the reservoir to reach the spillway crest level which is 8m below the minimum operation level of the reservoir. The sediment further accumulated will then be removed by mechanical dredging or sediment sluicing through the spillway gates at the high flow season or the combination thereof.

9.2 Mitigation of likely downstream water quality impacts

The following mitigation measures are proposed to minimize likely downstream water quality impacts due to project actions in the operation phase.

Release of Environmental flow

A release of 1.5m^3/sec Environmental flow has been considered in the project feasibility to compensate downstream water uses. This environmental flow will provide some dilution for incoming pollutants including those from Crysbro Broiler Farm wastewater. The analysis of wastewater however, suggests that this industry might discharge wastewater containing pollutants exceeding stipulated tolerance limits. The dilution to be provided by the above environmental release and other inputs from tributaries therefore may not be adequate to maintain good water quality in the river reach up to the tailrace. Mitigation options indicated below are proposed to minimize potential impacts of Broiler farm wastewater on water quality in the river.

Alternative 1 - Monitoring to ensure enforcement of stipulated discharge limits for Crysbro Broiler Farm wastewater

Action by the project agencies in coordination with the Central Environmental Authority is suggested to ensure that the Crysbro industry discharges treated wastewater in compliance with stipulated discharge standards at all times. This option is considered reasonable due to the following: a) the wastewater of Crysbro Broiler Farm is the only point pollution source in the area with potentially high impact on downstream water quality; b) the water quality in the river is not heavily impaired at present so it has an assimilation capacity for pollutants; and c) more importantly, the river reach that will be most affected by reduced flow (between the dam and the tailrace) has no highly sensitive water uses such as drinking and bathing, although it does support sensitive aquatic organisms. Establishment of a sound monitoring plan is therefore suggested to ensure that the wastewater discharges comply with the appropriate legal standards. The actions in the event of violation of the stipulated standards will be determined by CEA, which is the legally responsible body.

Alternative 2- Relocation of Crysbro Broiler Farm outfall downstream of the proposed tailrace outlet

The project design has considered this option as a viable alternative and the option suggests conveying wastewater of this industry and locating its outfall downstream of the proposed tailrace outlet. This option, however may be costly and also require proper design and operation to ensure that the volume of wastewater is within the design capacity of the conveyance system.

Annexure

Annex 1

Terms of Reference (ToR)

TOR FOR WATER QUALITY IN THE MAHAWELI GANGA

Objective

Data presented in the EIA[1] report provided some evidence of water quality issues in the Mahaweli Ganga, including possible contamination with faecal bacteria from the outfall of the Crysbro Broiler Farm.

This is downstream of the dam in the 3 km reach that will be subjected to lower flows during scheme operation, so pollution impacts could be exacerbated by reduced dilution and dispersion. This survey will: a) investigate the present quality of water in the river upstream and downstream of the proposed dam site; b) determine the nature, extent and likely sources of any pollution; and c) predict the quality of water impounded in the Moragolla reservoir, and discharged downstream when the scheme is operating.

Scope of work

The Contractor shall collect duplicate water samples from the Mahaweli Ganga at 10 stations located at approximately 500m intervals, from 500m above the confluence between the Kothmale Oya and Mahaweli Ganga (one station at the confluence and one station 500 m upstream in both rivers) and 500m downstream of the confluence with the Atabage Oya. One station shall be located directly in the outflow from the Crysbro Broiler Plant.

Water samples shall be collected at midday, from the centre of the river at each station, during the low flow season in February/March 2013 and at the start of the high flow season at the end of May 2013. Samples shall be transported promptly to a Government-accredited laboratory, under controlled temperature conditions as prescribed by the laboratory. In the laboratory, samples shall be analysed for total suspended solids, BOD5, nitrate, phosphate, total coliforms and faecal coliforms. Temperature, dissolved oxygen and turbidity shall be measured on site, using accurately calibrated meters.

[1] Moragolla Hydropower Project, Feasibility Study. Final Report: Volume Environmental Impact Assessment (Central Engineering Consultancy Bureau, Sri Lanka and AI-Habshi Consultants Office, Kuwait).

Programme and Reporting
The Contractor shall submit a draft Interim Report on 31 March 2013 and a draft Final Report on 7 June 2013. Both reports will be reviewed by the Study Team and the Contractor shall amend the reports to address all comments and shall submit final reports within two weeks of receipt of comments.

The Interim Report shall present and discuss all data collected in the first survey and the Final Report shall present all data from both surveys and shall include the following:

- Map of the sampling stations, site photographs and appropriate tables and illustrations of key data

- Written descriptions of all sampling and analysis methods (full details) and quality control procedures operated by the laboratory

- A detailed discussion of the results, including but not necessarily limited to

  - Water quality in this part of the Mahaweli Ganga and local and seasonal variations;

  - Evidence of any pollution, comparing data with appropriate national and international standards; and likely pollution sources;

  - Likely water quality in the reservoir during and after impoundment, with reasons;

  - Likely water quality downstream during scheme operation (flow characteristics will be shown by a hydrological simulation study to be conducted in January 2013)

  - Suitable mitigation for any negative impacts of scheme operation on water quality

Tables showing all data should be provided in an appendix.

Annex 2

Study team

Study team

Key staff

Name	Designation
Ms S V Dias	Senior Scientist Water Quality Specialist
Mr IAVP Iddamalgoda	Senior Scientist
Ms S A M S Dissanayake	Senior Scientist
Mr HDS Premasiri	Senior Scientist
Mr Vimukthi Sumanasekara	Scientist
Ms H.T.J. Seneviratne	Scientist

Laboratory analysis team

Name	Designation
Ms P D C Pathiraja	Technical Assistant
Ms P H D Silva	Technical Assistant
Ms Thilangika Gunawardena	Project Assistant

Support staff

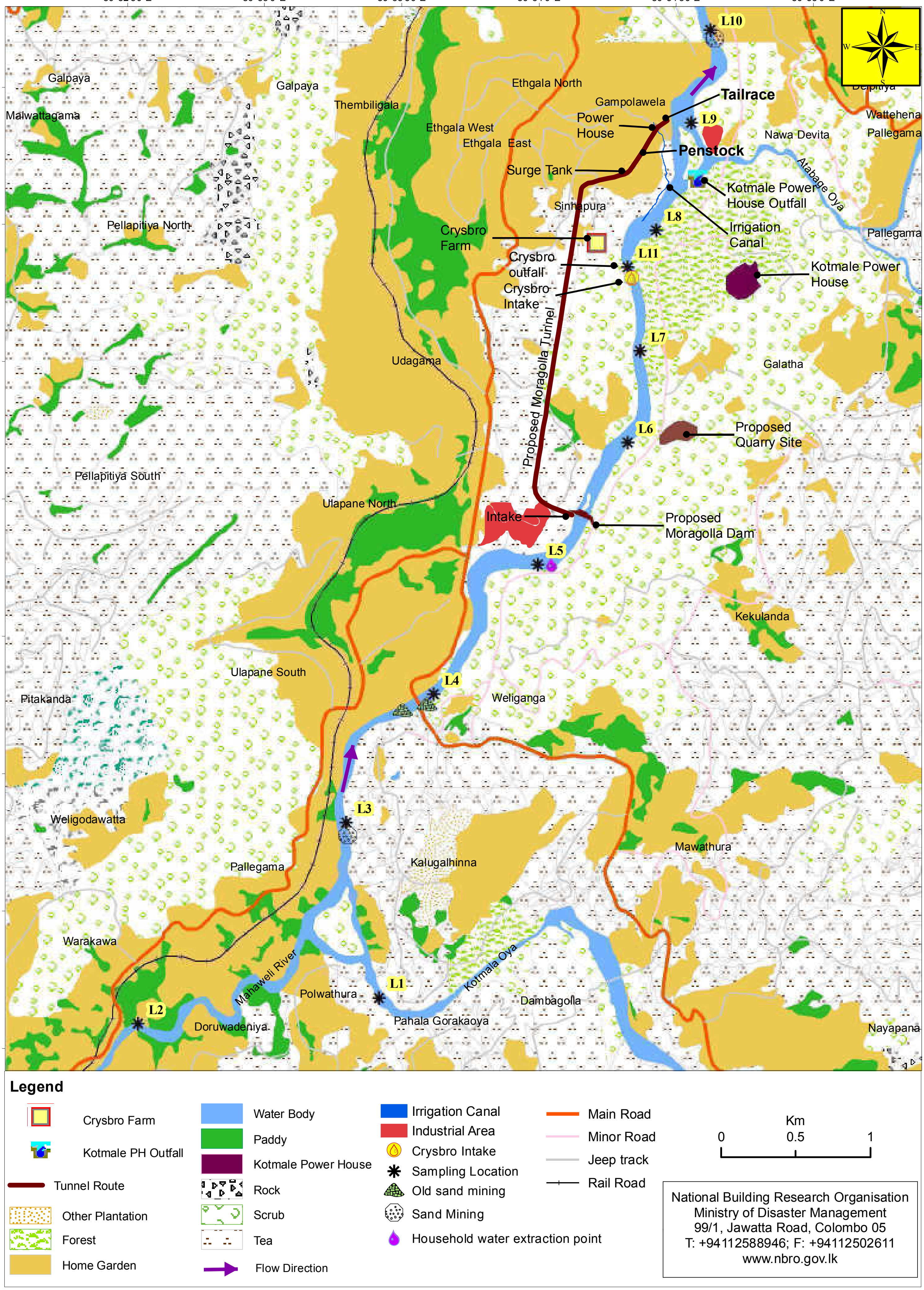
Name	Designation
Mr N Krishnamoorthi	Field Assistant
Mr Chamath Vithanage	Field Assistant
Mr WA Weerasinghe	Field Assistant
Mr A Premaratne	Field Assistant

Annex 3

Map of river water quality sampling locations

Water Quality Sampling Locations of Proposed Moragolla Hydropower Project Area

July, 2013



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Annex 4

Photographs of pollution sources, river uses and river degradation

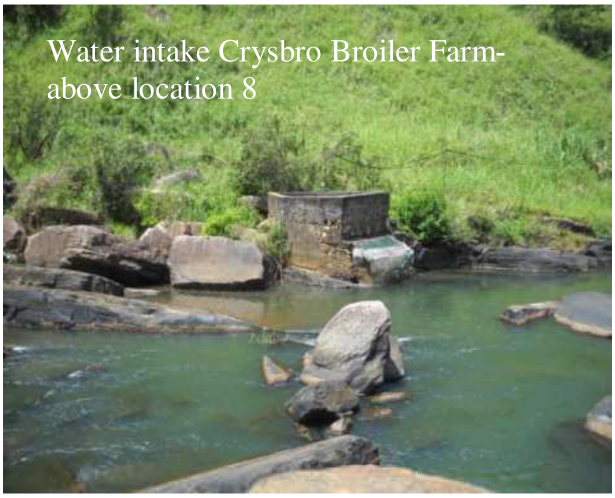
Pollution sources, River uses and river degradation

Crysbro Broiler farm wastewater outflow

Indicated in red arrows is the suspected wastewater outflow of the Crysbro Broiler farm. The milky white discharge is suspected to be the wastewater discharged by the industry. The wastewater appears to be discharged via two paths. In one the wastewater is brought along a closed pipeline along a steep slope driven to the river. The Pipeline is wrecked in the middle of its path draining wastewater along the bare slope. The other path discharges wastewater along an unlined canal dug along the steep slope- Photograph taken on 1st March 2013

Some river uses

Sand mining – Between Locations 6-7



Water intake Crysbro Broiler Farm- above location 8

Water intake irrigation canal- bellow location 7

River degradation

Accumulation of trash in rock pools - observed in locations 5.6.7.8

Annex 5

GPS reference, descriptions and photographs of sampling locations

GPS reference of sampling locations and descriptions

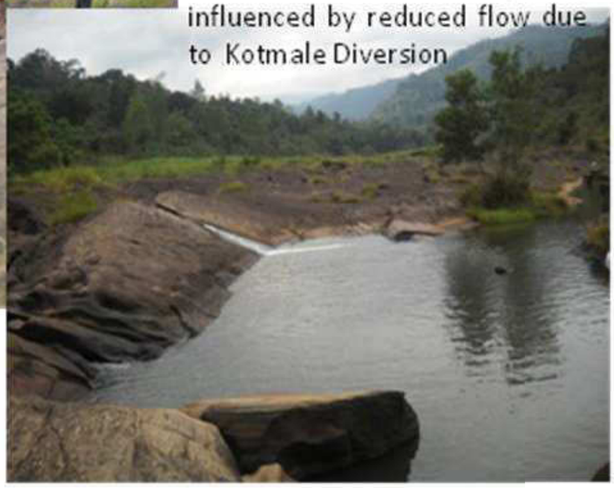
Sample location reference	GPS reference	Description of location
L1- Kothmale Oya	80^0 55’ 65.84” 7^0 07’ 78.92”	The sample location is at Kothmale Oya about 1km upstream from the confluence of the Mahaweli and the Kothmale Oya. The river section is relatively high gradient rocky terrain having exposed bed rock out crops. In this section water flows through a cascade of pools separated with short drops. In pools there is very little surface turbulence and at drops the flow is highly turbulent. In this section isolated water pools filled during high flow conditions were also present. These were cut-off from the main river stream due to reduced flow conditions. The water appeared colourless and clear. Aquatic organisms were observed on the water surface of pools. Both river banks were consisting of exposed bed rock out crops and disturbed riparian vegetation. At right hand side isolated plots of tea cultivations were observed in addition to trees and shrubs.
L2 - Mahaweli Ganga – closes to 13/6 culvert of the Ulapane – Nawalpitiya Road	80^0 54’ 19.18” 7^0 07’ 65.34”	Sample was collected over the “Sangili palama” (Hanging bridge) of Mahaweli Ganga near Pattunupitiya school of the sampling event of low flow season. However, the bridge was broken during sampling event of high flow season due to high rains and sample was taken by flinging a bucket to the mid water stream from the river bank. There were home gardens and isolated small tea plots present on the right hand side. On the Left bank, the riparian vegetation was dominated with a thick strip of Bamboo trees. Sand mining sites are located from 50m upstream from the sampling location. At the time of sampling there was no mining activity. The water is more turbid and muddy in colour and high in velocity during high flow season than low flow season.
L3 - downstream from the confluence of the Mahaweli River and Kothmale Oya	80^0 55’ 46.70” 7^0 08’ 85.13”	On the right hand side of the land of sampling location there was a Pinus plantation. River riparian vegetation is dominated with bamboo trees and tea lands are located along the buffer area. An old sand mining point 10m downstream from the location was observed. The water is more turbid and muddy in colour during high flow season than low flow season. Stream velocity is high owing to moderately high terrain gradient.
L4 - about 150 m downstream from the bridge at 1/1 Ulapane- Pussellawa Road	80^0 55’ 99.02” 7^0 09’ 63.11”	The sampling location is about 150m from the bridge towards downstream. There were rock boulders along the river. A small tributary discharges to river, just upstream to sample location at right hand side. Tea cultivations are observed at the right bank of the river. The Bridge was under construction. The water was more turbid and muddy and flow velocity is high during high flow season than low flow season.
L5-Mahaweli Ganga – at bathing point and sand mining point	80^0 56’62.02” 7^0 10’ 41.82”	The sampling location is about 300m upstream from the proposed dam location. The sample location was accessed by a sand miner’s ferry during low flow season however, in the sampling event of high flow season the ferry was not available due to high rains. The area is used for sand mining. No mining activity was observed during sampling. The water is more turbid and muddy in colour during high flow season than low flow season. The disturbed riparian vegetation consisted of shrubs and herbs; dominated with grasses. Ulapane Industrial zone was visible over the left bank of river. The trash material consist of plastic bottles, rubber, polyethylene bags were seen alone the rock cavities on either sides of the river which were carried away and deposited during high flow.

GPS reference of sampling locations and descriptions – contd...

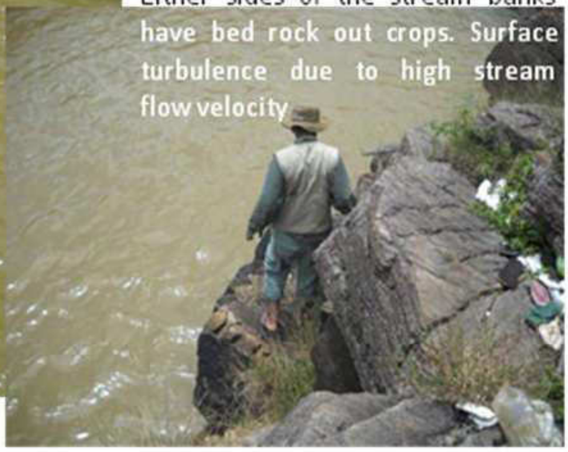
Sample location reference	GPS reference	Description of location
L6 - Mahaweli Ganga 250 m downstream from the proposed Dam	80^0 57' 20.14" $7^0$11' 13.83"	The sampling location is about 250 m downstream from the proposed dam. Water flows through terrain dominated with bed rock out crops which result formation of cascade of wide pools. Water drain into these pools through the exposed bed rock. The water flowing velocity is very low in the pool like river sections. The reservation land area along the both river banks consist forest riparian vegetation. The water was more turbid and muddy and flow velocity is high during high flow season than low flow season.
L7 - Mahaweli Ganga - sand mining site	80^0 57' 26.78" 7^0 11' 71.51"	The sampling location is about 1km from the proposed dam towards downstream. The river bottom substrate is excavated for sand mining but no mining activity at the collection of sample. The reservation land area along both river banks consists of forest riparian vegetation The water was more turbid and muddy and flow velocity is high during high flow season than low flow season.
L8 - Mahaweli Ganga - about 50 m downstream from the Crysbro effluent outlet	80^0 57" 34.89" 7^0 12' 44.09"	The terrain is dominated with large exposed bed rock out crops to form a cascade of short falls and pools. The stream flow is fast and highly turbulent at drops where sample was collected. Outlet of the Crysbro effluent plant was just upstream. Zero effluent flow was observed from wastewater outlet at the time of sampling in both seasons. The water was more turbid and muddy and flow velocity is high during high flow season than low flow season. There were forest vegetation on the right bank side and on the left hand side there were scrubland and pathana. Note: Refer annexure 6
L9 - Mahaweli Ganga- near the confluence of Mahaweli Ganga and Atabage Oya	80^0 57' 66.60" 7^0 13' 09.12"	The sampling location is about 50 m upstream from the confluence of Mahaweli Ganga (right arm stream) and Atabage Oya. The "Maga Neguma" Metal Crusher was located 10m upstream from the sampli point. Kothmale HPP tailrace outfall was located upstream to this location. There was no outflow during the sampling event of low flow season (March 2012). However, the tailrace released high flow of water with high turbulence and muddy colour during the sampling event of high flow season (May 2013). The stream bottom substrate consists of large to moderate size boulders. Left hand side of the riparian vegetation consist of shrubs and herbs, dominated with grasses. Right hand side is consisted of shrubs and stream bank dominated with Bamboo trees.
L10 - Mahaweli Ganga about 500 m from the confluence of Mahaweli Ganga and Kothmale tail race with Atabage Oya	80^0 57' 72.00" $7^0$13' 67.35"	The sampling location is about 500m downstream from the confluence of the Mahaweli Ganga and Atabage Oya. The area is used for sand mining but no mining activity during sampling. There was some aquatic flora in the water. The river width was about 20m at this location. Riparian vegetation consisted of shrubs and herbs, dominated with "mana". The water was highly turbid and muddy in colour and flow velocity is high during high flow season than low flow season.

River morphology and stream flow condition of the water quality sampling locations

Sample location 1- Kothmale Oya. A terrain with exposed bed rock out crops, sharp drops and rock pools. Water is flowing through a cascade of rock pools with short high gradient drops. High turbulence to flow at drops and smooth gentle flow in the rock pools with no surface turbulence. Terrains is greatly influenced by reduced flow due to Kotmale Diversion

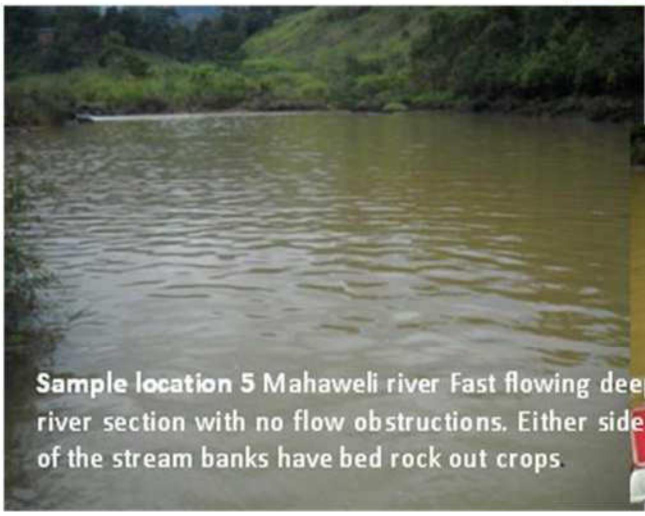


Sample location 2- Mahawei river draining Nawalapitiya area– Long straight low gradient river section without flow obstructions (Upstream). Stream flow is low and gentle with little or no turbulence. Floating aquatic plants. Deposits of sand ,gravel and pebbles along the river bank (down stream). River bottom substrate is excavated for sand.



Sample location 3- Mahaweli river after the confluence. Moderate flow velocity deep river section . Either sides of the stream banks have bed rock out crops. Surface turbulence due to high stream flow velocity

Sample location 4- Mahaweli river Low gradient shallow river section with some surface turbulence to stream flow. Either sides of the river banks and river bottom have bed rock out crops resulting obstruction to flow.



Sample location 5 Mahaweli river Fast flowing deep river section with no flow obstructions. Either sides of the stream banks have bed rock out crops.

Sample location 6 - Mahaweli river moderate gradient river section with obstruction to stream flow due to presence of bed rock out crops and embedded boulders resulting disturbance to smooth flow

Sample location 7 - Mahaweli river- Upstream Chrysbro wastewater outfall. Low gradient deep river section with no surface turbulence to stream flow. either sides of the river banks have bed rock out crops. Location has become deep due to sand mining.

Sample location 8 - Mahaweli river- Down stream Chrysbro wastewater outfall. High gradient rapid fall with bed rock outcrops and boulders. Swiftly flowing highly turbulent water flow section is characteristic with cascade of short falls and pools

Sample location 9 - Tail race out flow after the confluence of Atabage oya Low gradient shallow river section with some degree of surface turbulence to stream flow. either sides of the river banks have bed rock out crops and large boulders resulting obstruction to flow. No flow input from Kothmale power house tail race at the time of sampling.

Sample location 10 – Mahaweli River after confluence of the two river sections -Low gradient shallow river section little surface turbulence to stream flow. either sides of the river banks and river bottom have bed rock out crops and embedded boulders.

Photographs of sampling event – high flow season

Sample location 1 – Kotmale Oya

Sample location 2 - Mahawei River draining Nawalapitiya area

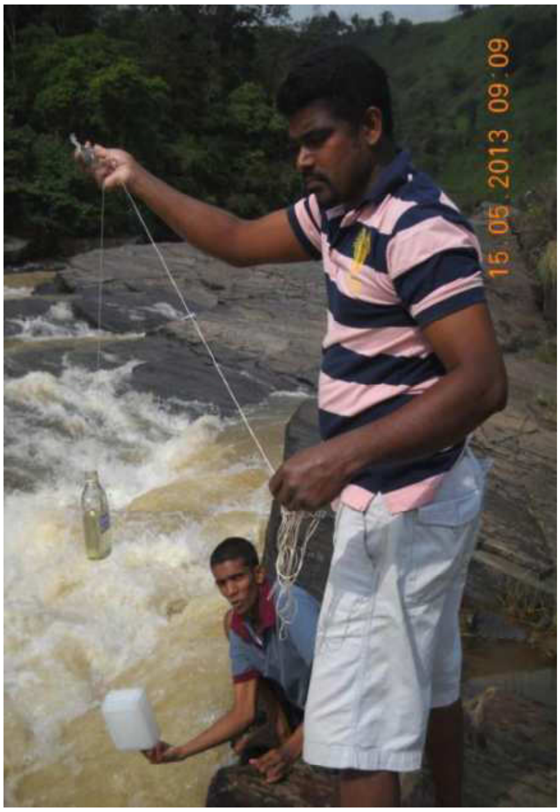
Sample location 3 - Mahaweli River after the confluence

Sample location 4 - downstream from the bridge Mahaweli River

Sample location 5 - Mahaweli River

Sample location 6 - Mahaweli River

Sample location 7 - Mahaweli River; upstream Crysbro wastewater outfall



Sample location 8 - Mahaweli River; downstream Crysbro wastewater outfall

Sample location 9 - Tail race out flow after the confluence of Atabage oya; The tailrace of the Kothmale power plant released high flow of water with high turbulence and muddy

Sample location 10 – Mahaweli River after confluence of the two river sections

It was observed that water was highly turbid and muddy color and flow velocity was high during the high flow season than the low flow season in all sample locations.

Annex 6

Analytical Methods and Quality Control procedures

1. Analytical Methods

Parameter	Method Reference	Description of the Method
pH	APHA 4500 H-B Electrometric method	pH and Temperature were measured using ***pH meter, brand ; pH 5+ pH/^{0}C of EUTECH Instrument Singapore origin.*** The meter was first calibrated using NIST pH 4.01 and pH 6.86 buffer solutions (NIST; National Institute of Standard Technology). The pH and Temperature of water samples were taken after calibration by immersing electrode and the probe
Temperature	APHA 2550 B Electrometric method	
Turbidity	APHA - 2130 B Nephelopmetric method	Turbidity was measured using Turbidity meter: ***TN-100/T-100 Portable Turbidity meter EUTECH instruments Singapore origin***. The meter follows the ISO 7027 standard. Turbidity meter was first calibrated using series of Environmental Protection Agency (EPA) approved standards (CAL 1:800, CAL 2:100, CAL 3: 20, CAL 4: 0.02). The 800 NTU vial was inserted into the sample well, aligning the mark on the vial with mark on the meter. Vial was pressed down until it snaps fully into the instrument and then covered using the light shield cap. Meter was switched "ON" and calibration function Calibration was repeated for CAL 2, CAL 3 & CAL 4 calibration standards. The vial was then rinsed and then filled with the sample water. The capped vial was then placed inside the sample well and aligned the vial's index mark with the meter's index mark. The meter was set "ON" and the reading appeared in the displa taken as the measurement.
Dissolved Oxygen	APHA-4500-O-C Azide modification	Water samples were collected in a 300 ml bottles having a ground-glass stopper and a flared mouth without entrapping air bubbles. Dissolved oxygen in the sample was fixed by adding 2 mL of $MnSO_4$ and 2 mL of alkali-iodize –azide reagents to the bottle at the site. Then the bottle was stoppered carefully to avoid air bubbles and mixed well by inverting the bottle a few times. These bottles were transported to the laboratory at 4 to 10 ^{0}C.. In the determination of DO, 2.0mL of conc. H_2SO_4 was added to the bottle and mixed well until dissolution of precipitate is completed. A 200 mL portion from this sample was titrated with 0.025M Na_2SO_4 solution to a pale yellow color. Then few drops of starch solution were added and titration was continued to first appearance of blue color. **Calculation** For titration of 200mL sample, 1mL 0.025N Na_2SO_4 = 1mg DO/L

Parameter	Method Reference	Description of the Method
Biochemical Oxygen Demand	APHAA 5210-B 5-Day BOD test	Water samples were collected in a 300 ml bottles having a ground-glass stopper and a flared mouth without entrapping air bubbles. To prevent entry of air in to bottles during incubation water was added to the flared mouth of the bottle and then capped with plastic cap. For each measurement two bottles were prepared in the above manner and transported to the laboratory at 4-10^{0}C. Of the two sets, the dissolved oxygen in one set was determined on the following day. This gives the Initial oxygen levels. The bottles in the other set were incubated at 20^{0}C for 5 days. After 5 days the DO was determined similar to first set. This gives remaining oxygen after five days Determination of BOD BOD mg/l = Initial dissolved oxygen level in the sample - Final dissolved oxygen level in the sample (Initial dissolved oxygen is the value measured as dissolved oxygen)
Nitrate	APHA 4500-NO2-B Photometry	10 mL of sample was taken to the sample vial and color was developed by crushing Nitrate test tablet supplied by the manufacturer. The developed color was then measured using Lovibond, Maxi Direct SN 10-1083 photometer made in Germany. The Method used is APHA 4500-NO2-B. The reading appeared on the meter was taken as the measured value
Ammonia	APHA-4500-NH_3 F	10 mL of sample was taken to a sample vial and color was developed using ammonia No.1 and No.2 tablets supplied by the manufacturer. The developed color was then measured using Lovibond Maxi Direct SN 10-1083 photometer made in Germany. The Method used is APHA-4500-NH_3 F. The reading appeared on the meter was taken as the measured value.
Total phosphorus	APHA 4500- P-D Stannous Chloride method	In the laboratory 100 mL of sample was digested with 1mL of H_2SO_4 acid and 0.4 g solid $(NH4)_2S_2O_8$ until a final volume of 10 mL was reached. The digested sample was then cooled, diluted to 30 mL with distilled water, and neutralized with NaOH. The sample was made up to 100 mL in a volumetric flask with distilled water. Then the color was developed by adding 4.0 mL Ammonium Molybdate reagent I ($NH_4Mo_7O_{24}.4H_2O$) and 0.5 mL stannous chloride reagent I ($SnCl_2.2H_2O$). After 10 minutes, colour was measured at 690 nm using UV visible spectrophotometer and compared with a calibration curve prepared using series of standard phosphate solution of KH_2PO_4 and the distilled water blank. In the analysis of dissolved Phosphated the digesion part was omitted. **Calculation** $\text{mg P/l} = \frac{\text{mg P (in approximately final volume)}}{\text{ml sample}} \times 1000$ The result phosphorus was expressed as P mg/L.

Parameter	Method Reference	Description of the Method
Total Suspended Solids	APHA 2540 D	Glass-fibre filter papers were used in the determination of suspended solids. First, the filter papers were washed with distilled water and dried in an oven at 103^{o}C to 105^{o}C for 1hour. Then the initial measurements were taken to 0.001g accuracy until constant weight is reached. The sample was then stirred with a magnetic stirrer at a speed to shear larger particles, if practical, to obtain a more uniform particle size. While stirring, a measured volume (100ml) was pipetted onto the pre weighed filter paper seated on glass-fibre filter. Vacuum suction was applied to filter the sample. The trapped suspended solids in the filter paper were dried in an oven at 103^{o}C to 105^{o}C for 1hour and cooled in desiccators to balance temperature and then weighed to 0.001g accuracy. This cycle of drying cooling, desiccating and weighing was repeated until a constant weight was obtained. The suspended solids content in the sample was then determined using following calculation. **Calculation** $\text{Mg Total Suspended Solids/L} = \dfrac{(A-B) \times 1000}{\text{Sample volume, mL}}$ Where: A = weight of filter + dried residue, mg B = weight of filter, mg
Faecal Coliforms and Total Coliforms	SLS 614: 1983 Part 2 Membrane filtration method	250 ml capacity sterilized glass bottles with attached twin thread were used for the collection of samples for analysis of Faecal and Total Coliforms. In the sampling, first the bottle was lowered to the water by unwinding the cord slowly. The bottle was immersed in the water completely, and once the bottle was judged to be sufficiently filled, the thread was rewound and bottle was brought up. Some water was discarded if the bottle was completely filled. In the laboratory, for the analysis of Faecal Coliforms, 100 ml of sample was filtered through a 0.45 µm grid marked membrane filter paper and the filter was placed in MFC agar and incubated at 44.5 ^{0}C for 24 hours. For the Total Coliforms, 100 mL of sample was filtered and filter was placed on M-Endo agar LES (Sigma origin) media and incubated at 36 ^{0}C for 24 hours. Colonies which showed a characteristic appearance of blue colour on the filter paper counted as Faecal Coliforms. No confirmation was done to Faecal Coliforms since MFC agar was used as the medium and it is specific for Faecal Coliforms (especially *E.coli*) as per SLS (1983). In detecting Total Coliform counts, colonies with metallic yellow sheen in M- Endo agar LES medium were sub cultured to phenol red lactose broth and all tubes showing acid and gas production were recorded as confirmed Total Coliforms after incubation of 36 ^{0}C for 48 hours. Confirmed Coliforms were expressed as Total Coliform counts per 100 ml. Confirmed Faecal Coliforms were expressed as Faecal Coliform counts per 100 ml.

2. Quality Control procedures

- The NBRO is registered in the Central Environmental Authority (CEA)- Laboratory as Consultant/ Specialist for Technical Guidance (Reg. No. 07/LM/Cons/10/2008).
  Copy of certificate - 2013 and a Letter indicating participation in Proficiency testing programs with CEA are given below. .

- Quality Control for the analysis of all the parameters was carried as per the procedures given in the Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF- 20^{th} edition (APHA).

- All chemicals used in the analysis were of Analytical Grade (AR).

- The pH meter was calibrated before commencing the sample measurements using pH 4.01 and pH 6.86 buffer solutions (traceable to National Institute of Standards and Technology - NIST).

- Turbidity meter was calibrated using a series of Environmental Protection Agency (EPA) approved) calibration standards of 800 NTU, 200 NTU, 20 NTU and 2 NTU before commencing sample measurements.

- Dissolved Oxygen and BOD analysis - Glucose Glutamic acid (GGA) standard check solution was checked for reliability of the sample analysis. The GGA control is a standardized solution to determine the quality of the seed, where its recommended BOD_5 concentration is 198 mg/l ± 30.5 mg/l. The dilution water blank was used to confirm the quality of the dilution water that was used to dilute the samples. This is necessary because impurities in the dilution water may cause significant alterations in the results.

- In the Nitrates analysis, standard KNO_3 (strength was 1.00 mL= 100 µg NO_3^-) was prepared as per APHA and 0.1 mg/L solution as a known sample and deionized water was checked for an each set of sample analysis.

- In the Ammonia testing standard solution of NH_4Cl was used as the standard (1.00 mL =1.22 mg NH_3). For each set of sample analysis 0.01 mg NH_3/L solution as a known sample and deionized water as a blank were checked.

- For the Total Phosphates analysis, standard phosphate solution of KH_2PO_4 was used to prepare the calibration curve (The strength was 1.00 mL=50.0 g PO_4^{3-}P). In each set of analysis, 6 samples at a time; 3 water samples, 1 known standard sample, 1 spiked sample and a blank sample (deionized water) were digested and analyzed.

- In the Faecal Coliforms and Total Coliforms quality control procedures were carried out according to APHA.

This includes:

- Checking incubator temperatures:
    - Faecal Coliforms - 44.5^0 C Total Coliform - 37^0C
    - Performance of Autoclaves Sterilization using sterilization tapes - temperature 121^0C, pressure 15 lbs)

- Blank sample testing - Dilution water (KH_2PO_4 buffer) blanks were analyzed during the sample analysis. Three dilution blanks were filtered during the sample analysis for each set of analysis (beginning/ middle and at the end) and tested for Faecal and Total Coliforms.

- The Balance (electronic top loading balance AUW 120 D, Shimazdu, Japan) used for the preparation of reagents was calibrated from an accredited institution. (Calibration date - 15 08.2012 - Copy given below.


Central Environmental Authority

Consultant / Specialist for Technical Guidance

This is to certify that

National Building Research Organization ....of

99/1, Jawatta Road. Colombo- 05 ....

Registered as a Consulting Agency for Technical Guidance on Pollution Control Activities for the year 2013

Reg. No: .
07/LM/ Cons/10/2008

Validity Period:
From: 01.01.2013 to: 31.12.2013

....
Deputy Director General
Environmental Pollution Control

....
Director General
Central Environmental Authority

Certificate - NBRO registration in Central Environmental Laboratory as Consultant/ Specialist for Technical Guidance (Reg. No. 07/LM/Cons/10/2008)

ඔබේ යොමුව / உமது தொடர்பு / Your Ref.

අපේ යොමුව / எனது தொடர்பு / Our Ref. 19.08.2013

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மத்திய சுற்றாடல் அதிகாரசபை
Central Environmental Authority

"පරිසර පියස", 104, ඩෙන්සිල් කොබ්බෑකඩුව මාවත, බත්තරමුල්ල, ශ්‍රී ලංකාව.
"பரிசர பியச", 104, டென்சில் கொப்பேகடுவ மாவத்தை, பத்தரமுல்லை, ஸ்ரீ லங்கா.
"Parisara Piyasa", 104, Denzil Kobbekaduwa Mawatha, Battaramulla, Sri Lanka.
Web : www.cea.lk

To whome it may concern

This is to certify that the Environment Laboratory of the National Building Research Organization is a registered laboratory under CEA for environmental monitoring and analysis since the year 2008 up to date.

They have participated in proficiency testing programmes and will be taking part in the CEA PT programme, which is scheduled to be held in mid September 2013.

This letter is issued on request of Ms. S.V. Dias, Director (Environment Division), NBRO.

Yours faithfully,

Deputy Director General (EPC)
Envtl pollution Control Division
Central Environmental Authority

Letter indicating participation in Proficiency testing programs with CEA

... **Continuation Sheet**

CALIBRATION CERTIFICATE
Issued by an Accredited
Calibration Laboratory

SWEDAC ACKREDITERING
1791
ISO/IEC 17025

Calibration Certificate

Certificate No. SS – 1208426

CUSTOMER National Building Research Organization No 99/1 Jawatta Road Colombo 05	**DESCRIPTION** Electronic Top Loading Balance (Dual range) Capacity (Max.) : 120 g / 42 g Resolution : 0 to 42 g: 0.01 mg 42 g to 120 g : 0.1 mg	**SERIAL No.** D 449911128 **IDENTIFICATION NO.** Not given

MANUFACTURER & MODEL NO. SHIMADZU, AUW 120 D	**RECEIVED CONDITION** Not applicable
REQUEST RECEIVED ON : 2012 June 19	**REFERENCE :** C 1205218/03

CALIBRATION DATE 2012 August 15	**LOCATION OF CALIBRATION** Laboratory National Building Research Organization	**TEST CONDITIONS** Temperature : $24 \pm 2^{0}C$ Relative humidity : $55 \pm 10\%$

REFERENCE STANDARD
Set of weights of accuracy class E2 (Eqp. No. MA/004), traceable to Primary standard maintained at Korea Research Institute of Standards and Science, KRISS & Physikalisch Technische Bundesanstalt (PTB). (Our Ref: IML-344)

METHOD OF CALIBRATION
The balance was calibrated generally in accordance with the test method manual Ref. No MM/MA/01 – Calibration of Electronic Balance.

The balance scale was externally adjusted 50 g with weight of accuracy class E2 before the calibration.

Calibration certificate – Balance; AUW 120 D, Shimazdu, Japan

Annex 7

The river water quality (low flow season and high flow season)

Table 1 Water quality of river water **Date of sampling- 06th March 2013**

Category No.*	Location	Sample code	pH	Temperature ^{0}C	Turbidity NTU	Dissolved Oxygen mg/L	BOD_5 mg/L	Ammonia (as N) mg/L	Nitrate (as N) mg/L	Total Phosphorus (as P) mg/L	Total Suspended Solids (mg/L)	Faecal Coliforms (E.coli /100ml)	Total Coliforms (Coliform Organisms /100ml)
	L 1	D1-1	7.1	27.2	3.9	7.2	<1	0.00	0.328	0.120	2.4	100	400
		D1-2	7.0	27.2	4.1	7.2	<1	0.00	0.247	0.074	2.3	300	1600
	L 2	D2-1	7.1	25.4	20.4	6.9	<1	0.03	0.362	0.035	12.4	800	11200
		D2-3	7.1	25.1	20.9	6.9	<1	0.02	0.301	0.045	13.1	900	12200
	L 3	D3-1	7.4	26.3	34.6	7.2	<1	0.26	0.325	0.044	14.6	3100	14200
		D3-2	7.3	26.4	34.5	7.2	<1	0.19	0.433	0.036	15.8	4900	18000
	L 4	D4-1	7.4	26.5	38.6	7.0	<1	0.00	0.365	0.097	17.4	3100	18600
		D4-2	7.2	26.3	39.0	7.0	<1	0.04	0.662	0.012	18.1	2700	19000
	L 5	D5-1	7.3	26.0	34.0	7.1	<1	0.04	0.268	0.032	14.7	800	12000
		D5-2	7.3	26.0	33.9	7.3	<1	0.03	0.384	0.046	17.1	1000	16200
	L 6	D6-1	7.2	26.0	27.8	7.7	<1	0.00	0.355	0.029	14.3	124	11600
		D6-2	7.3	25.9	27.9	7.6	<1	0.00	0.373	0.021	14.5	400	21000
	L 7	D7-1	7.4	25.8	22.8	7.4	<1	0.00	0.407	0.079	12	100	18600
		D7-2	6.6	25.8	21.4	7.6	<1	0.01	0.407	0.080	11.1	200	19400
	L 8	D8-1	6.2	25.4	12.9	7.5	<1	0.00	0.369	0.020	7.8	600	5200
		D8-2	6.6	25.3	12.8	7.5	<1	0.06	0.377	0.019	8.1	530	9000
	L 9	D9-1	6.7	25.1	3.7	7.4	<1	0.00	0.421	0.088	2.6	500	8800
		D9-2	7.3	25.1	3.7	7.4	<1	0.06	0.120	0.124	2.8	580	9200
	L 10	D10-1	7.3	25.8	11.2	7.3	<1	0.00	0.397	0.012	6.9	1000	8000
		D10-2	7.3	25.9	10.8	7.2	<1	0.04	0.380	0.010	6.2	980	9600
2	Drinking water – Simple Treatment		6.0-8.5	-	5 (max)	6 (min)	3 (max)	-	5 (max)	0.23 (0.7 as PO_4) max	-	600 (max)	5000
3	Bathing		6.0-9.0	-	-	5 (min)	4 (max)	-	5 (max)	0.23 (0.7 as PO_4) max	-	50	1000
4	Fish & aquatic life		6.0-8.5	-	-	3 (min)	4 (max)	0.94 (max) (pH < 7.5)	5(max)	0.23 (0.7 as PO_4) max	-	-	20000
5	Drinking water – Conventional Treatment		6.0-9.0	-	-	4 (min)	5 (max)	-	5 (max)	0.23 (0.7 as PO_4) max	-	-	5000
6	Irrigation & Agriculture		6.0-8.5		-	3 (min)	5 (max)	-	5 (max)	0.23 (0.7 as PO_4) max	-	-	1000

*Ambient Water Quality – EA1P-DHV-2000

"<" denotes minimum detection level of the methodology employed.

	Non compliance with Category 2

Table 2 Water quality of river water **Date of sampling- 15th May 2013**

Category No.	Location	Sample code	pH	Temperature ^{0}C	Turbidity NTU	Dissolved Oxygen mg/L	BOD_5 mg/L	Ammonia (as N) mg/L	Nitrate (as N) mg/L	Total Phosphorus (as P) mg/L	Total Suspended Solids (mg/L)	Faecal Coliforms (E.coli /100ml)	Total Coliforms (Coliform Organisms /100ml)
	L 1	D1-1	6.6	21.8	13.5	8.3	<1	0.17	0.698	0.105	5.5	196	6000
		D1-2	6.6	21.9	15.4	8.1	1.3	0.11	0.908	0.063	4.1	120	5100
	L 2	D2-1	7.1	23.8	25.9	7.5	<1	0.37	0.632	0.040	31.1	1300	210000
		D2-3	7.1	23.6	25.7	7.4	<1	0.38	0.641	0.000	33.2	1100	200000
	L 3	D3-1	6.8	22.0	36.2	8.4	1.3	0.23	0.471	0.057	34.7	8000	110000
		D3-2	6.9	22.1	36.1	8.3	1.1	0.24	0.521	0.052	33.8	8100	100000
	L 4	D4-1	6.6	21.2	31.7	8.3	<1	0.17	0.433	0.085	34.7	3200	220000
		D4-2	6.4	20.9	32.1	8.1	<1	0.15	0.450	0.071	33.1	4800	200000
	L 5	D5-1	6.6	21.7	31.1	8.4	1.2	0.10	0.453	0.127	30.6	6000	140000
		D5-2	6.4	21.4	30.0	8.0	1.4	0.24	0.473	0.086	34.8	4000	80000
	L 6	D6-1	6.9	22.2	32.4	8.3	<1	0.09	0.493	0.128	29.5	1100	210000
		D6-2	6.5	21.5	29.9	8.2	<1	0.10	0.512	0.112	31.1	1300	280000
	L 7	D7-1	7.2	21.9	27.1	8.3	1	0.11	0.370	0.098	26.2	2000	140000
		D7-2	6.6	22.6	30.1	8.1	1	0.08	0.412	0.119	25.7	1000	90000
	L 8	D8-1	7.6	22.1	42.3	8.1	<1	0.33	0.532	0.110	36.9	3700	160000
		D8-2	7.1	21.0	40.1	8.0	<1	0.30	0.510	0.101	34.2	3000	120000
	L 9	D9-1	7.2	21.3	118	6.1	<1	0.19	0.185	0.160	55.4	300	110000
		D9-2	6.7	21.6	119	6.2	<1	0.13	0.636	0.116	61.6	400	100000
	L 10	D10-1	7.0	20.8	120	6.0	<1	0.31	0.730	0.161	63.3	600	170000
		D10-2	6.9	20.8	119	6.4	1	0.20	0.656	0.135	61.8	550	180000
2	Drinking water – Simple Treatment		6.0-8.5	-	5 (max)	6 (min)	3 (max)	-	5 (max)	0.23 (0.7 as PO_4) max	-	600 (max)	5000
3	Bathing		6.0-9.0	-	-	5 (min)	4 (max)	-	5 (max)	0.23 (0.7 as PO_4) max	-	50	1000
4	Fish & aquatic life		6.0-8.5	-	-	3 (min)	4 (max)	0.94 (max) (pH < 7.5)	5(max)	0.23 (0.7 as PO_4) max	-	-	20000
5	Drinking water – Conventional Treatment		6.0-9.0	-	-	4 (min)	5 (max)	-	5 (max)	0.23 (0.7 as PO_4) max	-	-	5000
6	Irrigation & Agriculture		6.0-8.5		-	3 (min)	5 (max)	-	5 (max)	0.23 (0.7 as PO_4) max	-	-	1000

*Ambient Water Quality – EA1P-DHV-2000

"<" denotes minimum detection level of the methodology employed.

Non compliance with Category 2

Annex 8

Analysis data of Crysbro Broiler Farm outlet

Quality of Crysbro Broiler Farm outfall

Location	Sample code	pH	Temperature ^0C	Turbidity NTU	Dissolved Oxygen mg/L	BOD_5 mg/L	Ammonia (as N) mg/L	Nitrate (as N) mg/L	Dissolved Phosporus (as P) mg/L	Total Suspended Solids (mg/L)	Faecal Coliforms (E.coli /100ml)	Total Coliforms (Coliform Organisms /100ml)
L 11	D11-1	6.7	27.2	160	1	800	8.5	0.502	3.60	70	268	24000
	D11-2	6.8	26.4	155	<1	780	8.3	0.410	3.50	80	280	22000
* Tolerance Limit Value		6.0 -8.5	<40	NM	NM	30	50	NM	5	50	40	NM

*Tolerance Limits for the Discharge of Industrial Waste in to Inland Surface Waters–National Environmental Act Gazette No.1534/18, 01.02.2008

NM – Not Mentioned

Non compliance with the standard

ADDITIONAL STUDIES ON NATURAL ENVIRONMENT FOR REVIEW OF FEASIBILITY STUDY AND PREPARATION OF DETAILED DESIGN AND BIDDING DOCUMENTS MORAGOLLA HYDROPOWER PROJECT, SRI LANKA

Final Report 2

Aquatic ecology in the Mahaweli Ganga

Prepared by
The National Building Research Organization

Prepared for
NIPPON KOEI Co Ltd - Moragolla Hydropower Project

July 2013

National Building Research Organization
Ministry of Disaster Management
99/1, Jawatte Road, Colombo 05, Sri Lanka

Contents

Annexure

List of Tables

List of Figures

Executive Summary

Introduction

The Ceylon Electricity Board (CEB), the institution responsible for electricity generation, transmission, distribution and retailing in Sri Lanka, plans to develop a new hydropower scheme in Moragolla, in Kandy District with a designed capacity of 30.0 MW. The proposed project envisages construction of a 35 m high dam across the Mahaweli Ganga at Weliganga. Nippon Koei Co. Ltd, Ltd., the consultant appointed by CEB to review the feasibility study and prepare designs and bidding documents for the Moragolla Hydropower Project, appointed the National Building Research Organization (NBRO) to conduct additional studies on the natural environment. This work is one of several studies conducted in order to update and upgrade the previous EIA study to comply with the ADB safeguard policy (Safeguard Policy Statement, ADB 2009).

In this study, surveys were conducted to provide a) an overview of the aquatic ecology downstream of the proposed dam, and b) a detailed account of the ecology at the project site. The objective was to determine the present status and importance of aquatic ecology, identify the likely impacts of constructing and operating the project, and propose suitable mitigation for any negative impacts.

Information and data collection

An overview of the aquatic ecology in Mahaweli River from the Moragolla project area to Polgolla weir 30 km downstream was prepared by referring to satellite images, published literature, conducting interviews and discussions with local people and experts, and this was followed by field visits and surveys in March and May 2013.

The detailed aquatic ecological assessment conducted in the Mahaweli River covered the area from upstream of the Kotmale Oya confluence to 500 m downstream of the Atabage Oya confluence. The survey involved investigation of 17 sites in the study area in March and May 2013 representing both low flow (dry) and high flow (wet) seasons. *In situ* studies on riparian vegetation, features of the river valley and river banks, presence of different habitats, river bed and substrate forms were done via the line-transect method and by referring to accepted international criteria for river habitat assessment. The macro/micro aquatic fauna and flora were studied qualitatively and quantitatively following standard ecological techniques. The fish were captured with cast nets, trammel nets and gill nets.

Overview of the aquatic ecology in Mahaweli River

The Mahaweli River at Moragolla is a diverse aquatic ecosystem, which flows through different valleys consisting of disturbed environments with only scattered natural habitats left. The river morphology is diverse and channel condition varies from rock pools, rapids, riffles to runners. River bed substrate is largely rocky in this area, but it is sandy to muddy further downstream in the Kalugamuwa-Getambe and Katugastota-Polgolla reaches. The Katugastota to Polgolla reach of the river has changed to a slow moving reservoir due to construction of a wire at Polgolla.

Biological diversity from Moragolla to Polgolla weir is generally high and this provides habitat to a recorded total of 49 fish species (14 endemics), 3 indigenous aquatic reptile species, 12 aquatic bird species and a semi-aquatic indigenous mammal. None of these are confined only to this river stretch.

There are 17 aquatic flowering plant species, of which 7 have been identified as rare and endemic, that are confined to Peradeniya-Getambe reach. Seven endemic dragonfly and damselfly species and one endemic crab also inhabit the overall study area.

At present, the river from Moragolla to Polgolla is subject to several uses including bathing, abstraction of drinking water, fishing, farming, sand mining and aesthetic uses but the environment is stressed due to colonization of noxious alien species, waste dumping, discharge of wastewater carrying pollutants, and soil erosion.

Existing aquatic ecology at Moragolla study area

The river bed in the immediate project area is entirely rocky with large boulders with rock pools, rapids, glides and cascades. The river valley varies in form from shallow to broad, with moderately to highly disturbed river banks. The river at the dam site and immediate downstream area has natural barriers that impair the passage of fish under average flow conditions. The river substrate consists of a mixture of cobble, gravel and pebble in different percentages. There is a good forest canopy (> 75% shading) at the proposed dam site and the adjacent downstream area. Other areas generally have disturbed riparian vegetation with some exotic alien plant species.

The zooplankton and phytoplankton distribution at the sites studied showed a seasonal variation in dry and wet months. Bio indicators of poor water quality such as invertebrates of many species were also recorded, suggesting the presence of water pollution. Here are 20 species of damselflies and dragonflies in the study area of which 7 are endemic to Sri Lanka. The fish species diversity is high, with 40 of the total of 91 fish species in Sri Lanka found here (including 14 endemics and six migratory species). In the river and associate habitats the survey recorded 3 aquatic reptiles, 7 aquatic bird species and a single species of aquatic mammal, none of which are endemic or confined only to the study area. Only four aquatic flowering plant species were recorded and these are also not endemic or threatened. The studies suggest that the aquatic fauna in the Moragolla area is under stress due to the impairment of water quality.

Potential impacts of the project

Soil and river bank erosion leading to siltation and depletion of water quality are the most likely impacts on aquatic fauna in the area during dam construction. In particular, rare fish species inhabiting rock pools in this area could be affected due to removal or alteration of their habitat size, depth and water quality. Drying of river-bed areas due to the diversion of the river, accumulation of garbage and vegetation removal during construction phase may also alter habitats of intact aquatic, semi-aquatic fauna and terrestrial animals. Further, effects on the behaviour and physiology of animals in the river due to blasting and vibration are significant impacts of concern.

When operating, the dam and the reservoir will cause changes in water level, altering the upstream river morphology and inundating the present river banks and adjacent areas. This will change aquatic habitat conditions. Obstruction of migratory movements and habitat fragmentation of aquatic organisms, especially fish, might lead to long-term decline in their populations in this river. Changes in downstream water quality are not expected to result in highly significant ecological impacts but, reduction of water level in the dry season may affect the downstream aquatic life and will hinder connectivity of deep rock pools while blocking in between fish passages. Thus, reconfiguration of the river is expected to cause changes in distribution patterns and population densities of fish and other organisms, but is unlikely to result in the loss of any species. Sediment build-up behind the dam may cause a decline in downstream habitat conditions, by reducing the amount of soft-sediment habitats and the oxygen content of water retained in the reservoir and flowing downstream. The likely risk of erosion, bank failures and undercuts leading to land degradation, land slippages and increased reservoir sedimentation from the steeply sloping new reservoir banks with little natural vegetation may also occur also expected during the operation stage.

Proposed mitigation measures

During construction work, adherence to basic soil conservation practices are proposed to minimize soil erosion and reduce the entry of sediment laden runoff into the river. Formulating and implementing a proper waste management plan covering all construction sites including accommodation camps, is recommended to minimize the entry of litter, organic matter and debris from vegetation clearance, fuel, oil or other toxic materials from accidental spills. Dynamite blasting should be avoided in areas in or close to the river and restricted only to necessary areas.

The proposed mandatory environmental flow of $1.5m^3/s$, should be released and channelized to supply enough water to deep rock pool areas continuously. The stream Thismada Ela, an additional source of perennial flow to the immediate downstream area of the dam, should not be blocked to maintain quality of the ecosystem. Translocation of the already stressed threatened endemic fish *Labeo fisheri* and other sensitive aquatic species that will be trapped in isolated pools below the dam to a suitable relief point is strongly recommended over much more costly fish ladder option. Regular monitoring of Crysbro Broiler Farm's effluent to ensure the enforcement of stipulated industrial discharge limits or relocation of the effluent outfall downstream of the proposed tailrace outlet are recommended to minimize the impacts on downstream aquatic ecology and water quality during the operational stage.

The dam and the reservoir across the river will act as an excellent sediment and debris trap that prevents downstream transportation of both. This, together with the proposed management efforts to maintain the effluent discharge of Crysbro Broiler Farm within stipulated pollutant discharge limits or its relocation downstream of proposed tailrace outfall will significantly benefit already stressed downstream water quality and aquatic ecology.

1. Introduction

The Ceylon Electricity Board (CEB) plans to develop a new 30.0 MW hydropower project at Moragolla in the Kandy District. The scheme involves construction of a 35 m high concrete gravity dam (with 5-gate spillway) across the Mahaweli Ganga at Weliganga, to create a 38.5 ha (1.98 MCM) reservoir with a Full Supply Level (FSL) at 548 masl. Water will be diverted through a 3.1 km underground tunnel, surge shaft and penstock on the left bank of the river, to a powerhouse and outfall located opposite the confluence with the Atabage Oya.

In this regard, CEB intend seeking international financial support for project implementation and potential funders include the Asian Development Bank (ADB). CEB has appointed Nippon Koei Co. Ltd in joint venture with Nippon Koei India Pvt Ltd to review the Feasibility Study and prepare detailed designs and bidding documents for the project. Review of the EIA indicated that further studies were needed in order to update and amend the document to comply with ADB safeguard policy (Safeguard Policy Statement, ADB 2009).

The Nippon Koei Co Ltd, Moragolla Hydropower Project appointed the National Building Research Organization (NBRO) to conduct additional studies on the natural environment and the studies covered the following:

1. Water quality in the Mahaweli Ganga
2. Aquatic ecology in the Mahaweli Ganga
3. Groundwater distribution and quality along the tunnel route
4. Updated land-use mapping

This report presents the results of the aquatic ecology survey in the Mahaweli Ganga and includes: present status of the aquatic ecology in the river upstream and downstream of the proposed dam site at Moragolla, the likely impacts on aquatic organisms during construction and operation phases and the proposed mitigation measures.

2. The scope of the study

According to the TOR (refer **Annex 1**) the aquatic study is required to be conducted as follows.

Overview of Mahaweli Ganga
An overview of the aquatic ecology of the Mahaweli Ganga in the 30 km stretch downstream of the project site was required to be prepared by consulting published information and other data from government agencies, consultancy reports and other sources, referring to aerial photographs and satellite imagery, visual observations on site and interviews with local people, and discussions with experts from Peradeniya University.

Aquatic ecology of the project site
For the detailed ecological study, aerial photographs and satellite images were to be referred to obtain a rough picture of the type and distribution of aquatic habitats of the river in the study area and refined further by site investigations including analyses of the type and distribution of river bed substrates and vegetation, supplemented by information obtained from local people, including sand miners.. Quantitative analyses were also required to describe the species present (flora and fauna) in each habitat type and the average numbers of individuals of the major species in the different habitats. This should cover the aquatic habitats (sampled by fish nets, traps, plankton nets etc) and river bed habitats (sampled by sediment grabs, quadrat sampling if

feasible and other suitable methods). Quantitative surveys were required to be conducted twice; during the low flow season in March 2013 and at the start of the high flow season at the end May 2013 to give an indication of seasonal variations.

3. Overview of aquatic ecology of the Mahaweli Ganga between the project site and Polgolla diversion weir

3.1 Methodologies adopted

Preparation of an overview of aquatic ecology of the Mahaweli River between Moragolla project site and Polgolla diversion weir, 30 km downstream, was done by referring to satellite image. (refer **Annex 2**) and the web site www. googleearth.com. The purpose of this was to get a rough picture of different types and distribution of aquatic habitats therein. All possible information and data pertaining to the aquatic ecology in this part of the river were gathered from the published and unpublished literatures, consultancy reports and etc. that are available at government and non-government agencies. For this study, a total of 31 sites (refer to the map in **Annex 3**) were selected based on the habitat type (presence of runner, riffle, pool, etc.), easy access and previous records of ecological significance (presence of rare, exotic or threatened taxa). Accordingly, two field visits were made in April 2013 and May 2013 to make visual observations at the selected sites. The field observations were supported by interviews with local people and discussions with experts in the field of aquatic ecology.

3.2 Overview of Aquatic Ecology

Mahaweli River, the largest river system in Sri Lanka, has a total of 24 sub-rivers that flow through different bio-climatic zones of the island (Arumugam, 1969). The Kotmale Oya, the main upstream tributary of the Mahaweli River is formed by the convergence of three main streams, namely Dambagastalawa Oya in the Ambewela hills, Agra Oya in Horton Plains, and the Nanu Oya in Piduruthalagala. Kotmale Oya has a large catchment area (1891 km^2) and it carries a substantial amount of water (mean annual runoff, 2,430 thousand acre feet)[1]. As such it has been dammed at two upstream locations to produce hydropower as well as to act as flood mitigation reservoirs, particularly in the Gamploa-Peradeniya reaches of the Mahaweli Ganga (Manchanayake and Madduma Bandara, 1999). Due to these diversion weirs, the Kotmala Oya is now having a pseudo lacustrine system (artificial reservoirs) in its upper reaches. At present it is considered as an altered and a disturbed river cascade system (Silva, 2013). The Kotmale Oya converges with Dik Oya, a tributary that flows through Hatton Dik Oya area near Ulapane to form the Mahaweli proper.

The Mahaweli River at Moragolla (the proposed project area) is a diverse flowing water habitat which flows through different valleys. The river has remarkable morphological diversity. Most of the natural vegetation in the river valley was removed many years ago to provide land for tea plantations and other types of farming, hence very little natural habitat is left at present. Consequently, this has resulted in negative effects on the river water quality mainly due to soil erosion. Traditional home gardens, tea plantations, and plantation sector colonies are prevalent in the valley and these represent highly disturbed environments.

The diverse aquatic habitats in this part of the river comprise steep, shady, cool, fast flowing perennial rock pools, rapids, riffles and runners. these are significant and they provide breeding,

[1] (http://www.mahawelicomplex.lk)

feeding and foraging grounds for the aquatic life therein, especially for cool water loving species such as Green Mountain Labeo (*Labeo fisheri*), Ceylon Stone-sucker (*Garra ceylonensis*), and Black Mahseer (*Tor khudree*) (Kortmulder *et al.* 1990; Shirantha, 2012). The presence of a series of rock pools ensures a constant flow of water in all seasons, providing habitat for species that inhabit deeper waters. Two small islands are also present in this part of the study area near the proposed powerhouse. These islands not only add aesthetic beauty to the area, but also provide shelter, nesting sites for waders, raptors and other wildlife in the surroundings.

Downstream of the project site, the river in the Gampola-Kalugamuwa reach (sites 17 to 21 of the map in **Annex 3**) is relatively wider and deeper in comparison to the project site. There are several small sand islands along this river reach and their length varies from 10 to 16 m. These islands support diverse habitats for the inhabitants in different water levels. Diverse river morphological features have resulted due to the presence of sand bars[2], passages, backwaters etc. and these are responsible for river flow modification. The habitats in this area are predominately occupied by native and non-native schooling fish species such as Cyprinds (Carp and Minnows) and Cichlids. At certain places the river width is about 25 m and has rocky substrate (site 21 in the map in **Annex 3**). This area also has rock pools and a number of small islets. These small islands provide habitats for terrestrial, semi-aquatic and aquatic animals which inhabit different water regimes. The water's edge on either side of the river bank contains shrub forest cover. Some places are predominantly occupied by invasive alien species: *Mimosa pigra* (Giant Mimosa), *Panicum maximum* (Guinea Grass) and *Wedelia trilobata* (Singapore Daisy) (Marambe, 2001a; Shirantha and Ranawaka, 2009). Several locations in this area are used for sand mining (refer Fig.11 in **Annex 4)**. This brings some negative impacts on the river morphology as in-stream mining lowers the stream bottom leading to bank erosion. Almost the entire river bank and valley areas are disturbed along this river stretch, which is densely populated and used for farming, along with various other activities. A Few locations in the river are still being used as bathing/washing sites by local communities; and there is some fishing for local consumption, but there is no commercial fishing activity.

The next downstream part of the Mahaweli River is the Kalugamuwa-Peradeniya reach (sites 21 to 25 of the map in **Annex 3**), which is mainly composed of runners with slow flowing water. The bed substrate in this area is sand to mud. The left bank of the Mahaweli River in this reach is open due to construction of Peredeniya-Katugastota Road. The open river bank is noticeable in the river stretch that runs around the Peradeniya Royal Botanic Garden. Closer to Hal-Oluwa-Warathenna (sites 26 to 27 of the map in **Annex 3**), the river channel narrows and the bed is entirely rocky, with few inhabitants because of the inhospitable bottom substrate and fast-flowing water. After this area the river is more ecologically important, with diverse habitats as the river becomes shallower and spreads over a large area, containing over 30 small islets (sites 28 and 29 of the map in **Annex 3**). This morphology has created suitable habitats for various types of endemic and non-endemic flora i.e. *Farmeria metzgerioides* and *Polypleurum elongatum* of the family Podostemaceae; *Cryptocoryne parva*, *C. walkeri*, *C. beckettii*, and *C. undulata* and *Lagenandra praetermissa* of the family Araceae (Yakandawala, 2012). These plants inhabit the submerged rocks at the water's edge (Environment Management Lanka (Pvt.) Ltd, 2006, Rehel S. 2011, Yakandawala 2012). The area is also a home for a total of 15 indigenous fish species including the endemic critically endangered *Labeo fisheri* (Green Mountain Labeo), the endemic vulnerable *Garra ceylonensis* (Ceylon Stone-sucker), and indigenous the near threatened *Tor khudree* (Black Mahseer) (Environment Management Lanka (Pvt) Ltd, 2006, Shirantha 2012). This part of the river is economically important as a tourist attraction and elephant bathing site. In addition to these, this particular Mahaweli River stretch

[2] Sand bar: a ridge of sand formed in a river or along a shore by the action of waves or currents, passage: a deep and relatively narrow body of water, backwater: a part of a river in which there is little or no current.

receives runoff water from urban and agricultural lands, which carry urban pollutants and agrochemicals into the river (Environment Management Lanka (Pvt) Ltd, 2006). This part of the river has been proposed for the Getambe mini hydropower project, which will be implemented in the near future.

The river in Katugastota reach (sites 30 and 31 of the map in **Annex 3**) shows some reservoir features due to river modification. About 1 km downward, the river is totally modified and has become a reservoir, with a very low flow rate due to Polgolla weir, constructed in 1976. This area is largely colonized by some exotic fish species such as *Oreochromis* spp. (Tilapia), *Cyprinus carpio* (Common Carp), *Cirrhinus mrigala* (Mrigal), *Labeo rohita* (Rohu) and *Catla catla* (Catla) introduced for aquaculture development of the country in the late 1950s (Pethiyagoda, 1991). There are some native fish species such as *Systomus spilurus* (Sri Lanka Olive Barb), *Ompok bimaculatus* (Butter Catfish), *Wallago attu* (Shark Catfish) and *Clarias brachysoma* (Walking Catfish), which are important as food fish. This artificial reservoir plays a vital role as an economically important water segment in the Central Province providing grounds for sand mining, eco-tourism, hydropower generation as well as for a capture-based inland fishery (De Silva and Wansapura, 1991).

One of the remarkable features of aquatic life in the Mahaweli River from the Moragolla project site to the Polgolla weir is its invertebrate diversity. Various taxa of macro invertebrates such as Ephemeropterans (mayflies), Odonates (dragonflies and damselflies), Crustaceans (crabs and shrimps), Coleopterans (beetles) and Dipterans (true flies) have been recorded from this part of the river (Environment Management Lanka (Pvt.) Ltd, 2006; Shirantha *et al*. 2010). However, little can be said about the invertebrate species present in this area, or their density and importance, as there have been no previous studies.

Of the vertebrate faunal groups, the river from Moragolla to Polgolla harbours a total of 49 freshwater fish species belonging to 18 families (Pethiyagoda, 1991; Shirantha and Amarasinghe, 2005) (see table 3 in **Annex 9).** Of these, the presence of the critically endangered *Labeo fisheri* (Green Mountain Labeo) is significant as it is only found in the middle catchment of the Mahaweli River (Pethiyagoda 1991; Senanayake, and Moyle 1982; Shirantha 2012). Other inhabitants of this area include the aquatic reptilian Water Monitor (*Varanus salvator*) and some aquatic bird species namely, the Indian Cormorant (*Phalacrocorax fuscicollis*), Little Cormorant (*P. niger*), Common Kingfisher (*Alcedo atthis*), White Breasted Water-hen (*Amaurornis phoenicurus*), Little Egret (*Egretta garzetta*), Cattle Egret (*Bubulcus ibis*), Pond Heron (*Ardeola grayii*), Intermediate Egret (*Mesophoyx intermedia*) and White-throated Kingfisher (*Halcyon smyrnensis*) (Environment Management Lanka (Pvt) Ltd, 2006). The Eurasian Otter (*Lutra lutra*) also shows a wide distribution in this area (De Silva, 1997), but there is no published record on any endemic faunal taxon that is confined only to this river stretch.

As mentioned above, the aquatic plant species diversity is high in the Mahaweli River from Moragolla to Polgolla weir. There are some rare endemic species belonging to the families *Podostemaceae* (*Farmeria metzgeniodes* and *Polypleurum elongatum*) and *Araceae* (C*ryptocoryne becketti, C. parva*, *C. undulata*, *C. walkeri* and *C. willisii)* that are restricted to this area (Wijesundara and Shantha Siri, 2004; Yakandawala, 2012). However, at present their existence is threatened due to development activities and rapid colonization of noxious aquatic species such as Water Hyacinth, Giant Mimosa and Giant Salvinia (Yakandawala, 2012).

The aquatic ecological integrity of this part of the river is degraded as a result of the many human activities in the area. The water pollution threat in the upper reach, particularly upstream of Gampola, mainly arises through soil erosion, use of agrochemicals and fertilizer and direct deposition of solid and liquid waste into the river (Amarathunga *et al*. 2010). This situation is severe between Gampola and Kandy due to increased inputs of urban waste; dilution by water is high however in this part of the river due to the presence of numerous perennial streams and high precipitation (annual average rainfall of 1450 mm source: http://www.gampolacity.com).

At present the low gradient Katugastota-Pollgolla River reach (sites 28 to 31 of the map in **Annex 3**) is heavily invaded by some alien species. Among them, the Orinoco Sailfin Catfish (*Pterygoplichthys multiradiatus*) has been identified as the biggest threat (Shirantha & Amarasinghe, 2005; Shirantha, 2009). Further, a rapid loosing of the natural balance in the ecosystem from heavy growth of some aquatic invasive plant species such as Water Hyacinth (*Eichhornia crassipes*) and Giant Salvinia (*Salvinia molesta*) has been reported as invade in the water's edge area and choke the river channels (Yakandawala, 2012).

During the monsoon the Moragolla project site to the Polgolla weir experiences a large influx of water and as a result the Katugastota area experiences flooding. There is therefore a clear need to utilize this renewable resource for the economic benefit of the country, and in a way that will reduce flooding and associated risk to human life, property and socio-economic development. Hydropower development is therefore, justified in this already heavily-exploited region however, combined with a proper river management plan, that will control and minimise the threats from pollution, promote land-use and use the water in this river reaches either for hydropower generation or other development projects which especially concerning its pollution trend and terrain stability.

4. Aquatic ecology of the project site

4.1 The study area considered for detailed ecological assessment

The assessment was initiated by referring to aerial photographs and satellite images of the study area in order to obtain a consensus of the different types and distribution of aquatic habitats. A total of 17 sites, covering approximately a 7 km river stretch was studied, from 500 m above the confluence with the Kotmale Oya to 500 m below the confluence with the Atabage Oya (refer to satellite image in **Annex 2** and the map in **Annex 3**).The site selection was based on the quality, the types of habitats present and accessibility. A detailed assessment of each site was done during three field visits, conducted from April 2013 to May 2013. Additional information on the sites, their inhabitants and importance was gathered by interviewing local villagers, and by referring to published data.

4.2 Methodologies adopted

An assessment of aquatic life in different habitats was done by employing the line transect method. At each of the 17 sites, a rope, clearly marked at 50 m intervals was strung along the river bank and across the river. At each 50 m point detailed observations were made on the main visual features of the substrate, and the presence of visible animals and plants. A special emphasis was given to study attached and submerged flora and riparian vegetation. Presence of any special (fish breeding and aggregation sites) and fragmented habitat (a place separated from a sand bar or isolated rock pools) was also noticed and studied. A non-mechanised boat was used to reach into deep, fast flowing distant areas. The other specific studies were conducted at each survey point as described below.

Plankton sampling and analysis

Plankton samples were collected from each sampling site using 50 µm mesh plankton net. Two samples were collected by lowering the net vertically into the water until the bottle at the end of the net is filled with water. Then pull until the net is extended and begin to tow. After about 5 minutes, the net was taken out and let it hang for a 1 to 2 minutes. Then all the plankton washed into the bottle by running freshwater from the outside of the net. One sample was collected in a plastic bottle and 3 to 5 drops of Lugol's solution[3] were added to preserve the samples for phytoplankton analysis in the laboratory. Another sample was preserved in 5% formalin for zooplankton analysis. In the laboratory, the plankton sample collected from each site was shaken well and 1 ml was transferred into a Sedgwick rafter cell (a counting cell) using a small dropper, Then the sample was covered with the glass cover without air bubbles. Later the plankton were examined under the mid power (10×10) of a light microscope and were identified using Needham and Needham (1962), Mendis and Fernando (1962) and Abewickrama (1979). The relative volume of each plankton in one transect along the Sedgwick rafter cell at 100x was measured following the method described in Vollenweider *et al.* (1974). Here, a cell of *Spirogyra* was selected as an arbitrary unit as it was the common phytoplankton in the samples collected.

Benthos sampling and analysis

On each sampling occasion, five benthic samples using a Peterson grab of 1250 cm^3 capacity (see Fig. 1 in **Annex 11**) were randomly collected at all sites, except the sites with rocky substrate. The sample was placed in a polythene bag and preserved immediately in 10 % formalin with Rose Bengal[4] and transported to laboratory for further analysis. In rocky sites, a 30 cm × 30 cm quadrat was placed. The animals found within the quadrat were collected into a container, identified *in situ* to the lowest possible taxonomic level using Mendis and Fernando (1962) and Needham and Needham (1962). Their number also recorded. The animals that needed further taxonomic confirmation were preserved in 5 % formalin and transported to the laboratory. This quadrat sampling procedure, however, could not be followed in higher water levels in May 2013.

In the laboratory, benthic samples collected from each of the sites were subjected to the wet sieving (sieving with water) method as described by Southwood (1966). The mesh sizes of sieves ranged from 2.00 mm to 250 µm. The collected benthic fauna were then placed in a white enamel tray and observed under a 1 × 10 magnifying lens. The benthos were identified to the lowest possible taxonomic level using Mendis and Fernando (1962) and Needham and Needham (1962) and their abundance was calculated as follows: Population density = number of individuals/sample volume.

Other aquatic macro fauna sampling and analysis

Various non-quantitative sampling methods, including visual observations and digital photographing were used to assess aquatic life in the river bed area, river banks, and peripheral areas. The aquatic macro fauna such as crabs, snails, damselfly and dragonfly larvae were captured with a hand net and a scoop net. The free-living nymphs and larvae of aquatic insects which live attached to river substrate (e.g. caddis flies) in the river were dislodged with a fine paint brush and subsequently collected into a white enamel tray. Some animals were picked up with fine-tipped forceps. They were then identified to the possible lowest taxa using Needham and Needham (1962) and Mendis and Fernando (1962). The animals that needed to have further

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[3] Lugol's solution is a solution of 5% iodine dissolved in 10% potassium iodide. It acts as a preservative and stains the plant tissues.

[4] Rose Bengal is a vital stain that colours animal tissue pink and therefore it aids to recognize the animals in sediment samples

taxonomic confirmation were transferred into plastic bottles, preserved in 10% formalin and transported to the laboratory. In the laboratory, their taxonomic confirmation was done under the low power of a light microscope.

Fish sampling
At each sampling site, fish were caught using the cast nets of 1 cm (1.5 m height), 2.5 cm (2.5 m height) and 3.5 cm (3.5 m height) stretched mesh hauling 5 times at each site. The small hand nets, made up of the mosquito netting were used as drag nets or scoop nets grab (see Fig. 2 in **Annex 11**) to catch fish at the water's edges. A 15 m long trammel net with three layers of 3.0, 4.5, 6.0 cm netting and a 20 m long gill net of 3.5 cm stretched mesh were laid and kept 1 to 2 hours in large rock pools. The entangled fish were identified up to species level *in situ* using Pethiyagoda (1991). The Catch Per Unit Effort (CPUF) was calculated as follows:

CPUF = number of individuals caught/number of hauling

Assessing the occurrence of large animals
Survey work was supplemented by direct visual observations where possible, and by obtaining indirect evidence of the presence of certain animals, via bird calls, pugmarks (mammals), scat (carnivorous mammals), dung (herbivores), egg masses (amphibians), and discarded fur, seeds, flowers or fruit. In addition, local people were also interviewed regarding the presence of certain species and habitats, and sand miners were employed to collect additional samples of flora and fauna in locations with difficult access. The conservation status of each taxon was determined referring to The National Red List 2012 of Sri Lanka (MOE, 2012).

River habitat assessment
At present different river habitat assessment criteria have been developed by several countries to assess river habitat quality. Among them, River Habitat Audit Procedure (Anderson, 1993a) AUSRIVAS (Parsons *et al*., 2001) and Index of Stream Conditions (Ladson and White, 1999) are largely utilised in different countries (Ravena *et al*., 1998).These methods enable straightforward classification of rivers and streams based on their principal physical and biological features. They have been utilized successfully in many countries to assess river habitats (http://www.environment.gov.au). In Sri Lanka, the AUSRIVAS assessment criteria have been successfully utilized to assess site-specific river quality in the uppermost catchments of the Mahaweli River (Shirantha *et al*., 2010). The river habitat assessment criteria derived from River Habitat Audit Procedure (Anderson, 1993a), AUSRIVAS, Index of stream conditions (Ladson and White, 1999) and Stream Ecology and function (David Allen, 1998) were therefore used to assess the river habitat at each study site. Those criteria are given in **Annex 5.**

The river habitat assessment was done with the study conducted at each of the 17 survey locations and noted on pre-prepared recording sheets. Observations were made on each of the 22 assessment criteria by referring to the associated list of specified features. Decisions were made based on previous experience of using this assessment methodology in rivers similar to the Mahaweli Ganga. The decisions on percentage cover and other features were made by visual observations.

4.3 Aquatic ecology of the project site

4.3.1 River habitat variation

The results of the river habitat assessment at the study sites are given in **Annex 6**. According to the adapted assessment criteria, the river valley in this area varies widely, from "shallow" to "broad" and "gorge". The riparian vegetation cover along the river banks at the proposed dam site is relatively undisturbed, whereas in other areas, the disturbance to the river bank is "moderately undisturbed" to "highly disturbed". There is good shading of the river channel (> 75%) at the proposed dam site and the adjacent downstream area due to the presence of a forest reservation along the river on the right bank. The channel shading is however, in the range of 5-25% at most of the other sites where riparian vegetation is considerably disturbed with by certain invasive exotic alien plant species *viz.*, *Wedelia trilobata* (Singapore Daisy), *Mimosa pigra* (Giant mimosa) and *Panicum maximum* (Guinea Grass).

The river habitat analysis showed the presence of natural physical barriers for fish passage in the average water flow condition at the proposed dam site and in the immediate downstream area (between sites 11 to 15). The river in this part is almost entirely rocky with large boulders, and consists of pools, rapids, glides and cascades. However, in other areas, the conditions are generally "good" to "moderate" and favorable for fish passage. In addition to the above river morphological features, mid channel sand bars with vegetation cover are also found at many places. A prominent side-pointed sand bar is present 500 m downstream of the Atabage Oya confluence. The river substrate composition analysis shows that the bed substrate composition varies quite widely amongst the sites except at the proposed dam site, where it is 95% bed rock and in this part, the river flows through a gorge. At all other sites, the river bed substrate is basically a mixture of cobble, gravel and pebble in varying proportions.

4.3.2 Diversity and abundance of plankton

Tables 1 and **2** in **Annex 8** lists taxonomic groups of phytoplankton and zooplankton recorded at each study site. A total of 27 phytoplankton genera belonging to three families were recorded from these sites in the study area, of which diatoms (Family Chlorophyceae) and green algae (Family Bacillariophyceae) were common and their diversity was relatively high. However, this analysis was not sophisticated enough to reveal variations in phytoplankton species composition between the studied sites.

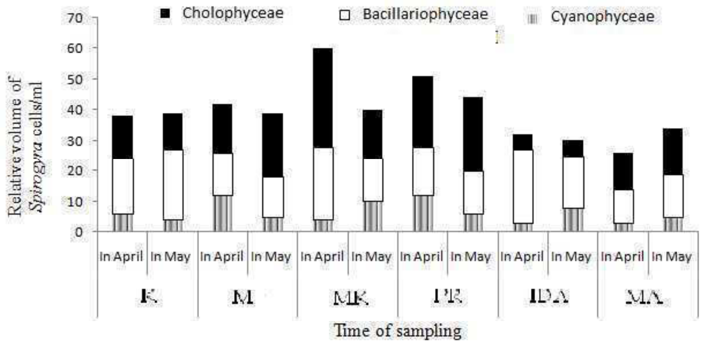


Fig. 1 Variation in relative volume (*Spirogyra* cells/ml) of different taxonomic groups of phytoplankton

Key: K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence,

Fig. 1 shows the variation in relative volume (*Spirogyra* cells/ml) of different taxonomic groups of phytoplankton recorded at each study site: in April at the end of the dry season and in May at the beginning of the monsoon. The phytoplankton species composition is comparable to streams in Kelani and Kalu river basins in the country (Shirantha, 2004). In general there is a decline in the relative volume of phytoplankton during the month of heavy rain (in May 2013) compared to the dry month (in April 2013). This variation is common for flowing waters in the island which show seasonal variation in flow and water quality (Silva, 1996).

The zooplankton at each study site consists mainly of larval stages of aquatic insects, crustaceans, rotifers and protozoa. Most of the species in their larval form could not be identified to generic or species level, as the identification of larval stages of many aquatic insects and crustaceans in Sri Lanka is still at a neonate stage. **Fig. 2** shows the observed variation in the diversity and composition of zooplankton in the dry and wet months. The zooplankton show seasonal variation in their relative volumes in dry and wet months similar to the phytoplankton and this is common to other rivers in the country (Silva, 1996).

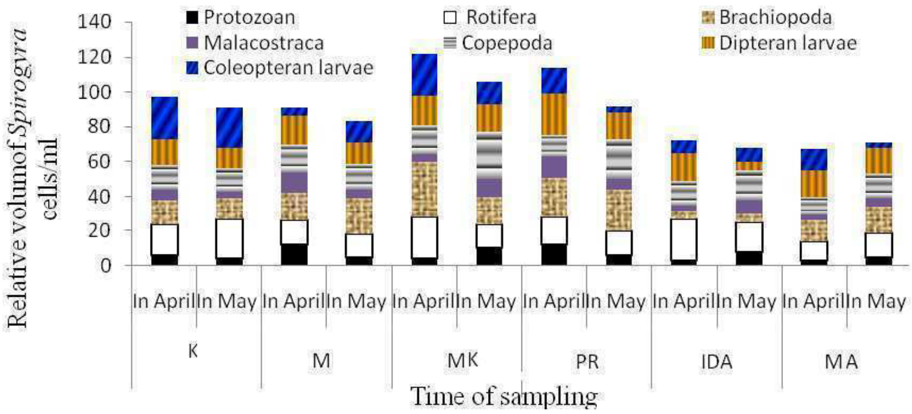


Fig. 2 Variation in the relative volume of different zooplankton taxa (*Spirogyra* cells/ml) at each study site (in April: low water level and in May: high water level)

Key: K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence,

4.3.3 Diversity and abundance of the aquatic invertebrates

Tables 1 and 2 in **Annex 9 (**see also photographs in Annex 10 - Figs 1-12) show the estimated population densities (individuals/cm^3) of all invertebrates recorded throughout the study area. This shows the presence of a variety of worms, molluscs, crustaceans and insects, with a similar taxonomic composition to those found elsewhere in upland areas of the Mahaweli River (Shirantha *et al.* 2009, 2010). Cladocerans and Copepods were the most numerous groups, and *Caridina* sp. is the most widespread species, being found at most stations, possibly because of its omnivorous habit. Most other species are quite low in abundance, which is likely to be a product of several factors, including the capture methods, the difficulty of sampling a fast-flowing river in May, and the limited coverage of particulate sediments in the study area.

Some of the species present have been suggested as being indicative of poor water quality, including the free-living turbellarian flatworms (Dudgeon, 1999) and the gastropod molluscs *Paludomus chilinoides*, *P. loricatus* and *Melanoides tuberculata* (Shirantha *et al.*, 2009); so water quality could have a limiting effect on invertebrate density, especially during the first survey period, at the end of the dry season. In contrast, Table 2 of **Annex 9** shows that there was quite a good diversity of dragonflies and damselflies, comprising 20 species, of which 7 are endemic to Sri Lanka, and two are Near Threatened according to MOE 2012 i.e. *Indothemis carnati*ca and *Paragomphus henryi*.

4.3.4 Diversity and abundance of aquatic plants

The list of aquatic plants and their occurrence in each study site are given in **Table 1** in **Annex 7.** The study reveals that the aquatic plant diversity is very low at the project site compared to the Mahaweli River at the Getambe area where there are some rare, endemic and non-endemic aquatic plant species such as *Cryptocoryne parva*, *C. walkeri*, *C. beckettii*, *C. undulata* and *Lagenandra praetermissa* (Yakandawala, 2012). None of these species were found in the project area, possibly because of the rapid flow of the river and the presence of rocky substrate, which does not support the growth of such submerged plants. The only similar species recorded was *Lagenandra ovata* (Malayan Sword), which is present in a small patch at the proposed reservoir area. Some other very rare plant species i.e. *Farmeria metzgerioides* and *Polypleurum elongatum* of the family Podostemaceae, were recorded in the submerged rocky substrate at Getambe but were absent from the project site. In contrast, certain common exotic and indigenous submerged aquatic plant species such as *Hydrilla verticillata* (Hydrilla), *Vallisneria spiralis* (Mini Twister) and *Blyxa aubertii* (Roundfruit Blyxa) were found at the water's edge at all the sites studied. There was also a dense growth of *Potamogeton pectinatus* (Sago Pondweed) in the Kotmale Oya and at the Atabage Oya confluence.

4.3.5 Diversity and abundance of fish fauna

Table 3 in **Annex 9** gives the list of fish species recorded in the project area. This shows that the fish diversity in the study area is relatively high. The survey recorded a total of 40 fish species out of 91 species in Sri Lanka (MOE, 2012). These species belong to 17 families, representing 14 endemics, 21 indigenous and 5 exotics. Of these, eight species are nationally threatened according to the current Red Data List of Sri Lanka (MOE, 2012). They include, *Channa ara* (Giant Snakehead), *Labeo fisheri* (Green Mountain Labeo), *Channa orientalis* (Smooth-breasted Snakehead), *Garra ceylonensis* (Ceylon Stone-sucker), *Pethia melanomaculata* (Fire fin barb), *Pethia reval* (Red fin barb), *Pethia nigrofasciata* (Black ruby barb) and *Wallago attu* (Shark catfish). Further, there are six migratory fish; *Anguilla bicolor* (Level fined eel) and *A. nebulosa* (Long finned eel), *Labeo fisheri* (Green Mountain labeo), *Tor khudree* (Black Mahseer)*, Garra ceylonensis* (Ceylon Stone Sucker) and *Wallago attu* (Shark catfish), which swim upstream to spawn in the breeding season (Silva & Davies, 1986). Figure 3 shows the abundance of some endemic fish in the project area calculated as Catch Per Unit Effort (CPUE). The figure 3 shows that *Dawkinsia singhala* was the most abundant endemic fish species (5.75 CPUE) in the project area whereas the others were all relatively low in density (<1.5 CPUE). The CPUF of *Belontia signata* and *Clarias brachysoma* was very low <0.01 and therefore, not included in the figure 3.

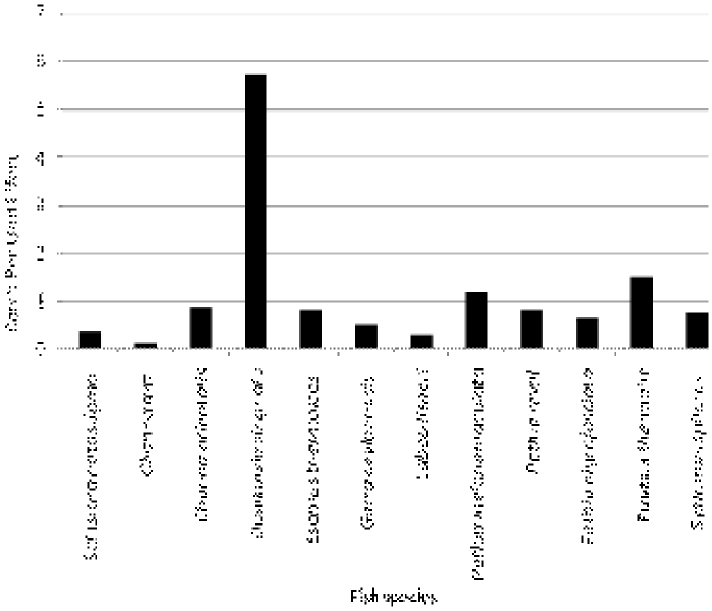


Fig. 3 Variation in abundance (CPUE: Catch Per Unit Effort) of the endemic fish species recorded in the study area

4.3.6. Diversity and abundance of other vertebrates

The aquatic/semi aquatic birds, reptiles and mammals that were recorded at the Moragolla project area are given in Table 4, 5 and 6 in **Annex 9** respectively. Three species of aquatic reptiles, seven species of aquatic birds, one aquatic mammal species and two species of terrestrial mammals that hunt their prey mainly in rivers and associated habitats. Of these species, the Eurasian otter (*Lutra lutra*) and the fishing cat (*Prionailurus viverrinus*) are of particular interest as they both feed mainly on fish, crustaceans and frogs, and are classified as Near Threatened and Endangered respectively according to the IUCN Red List of Threatened Species 2012[5]. It should be noted however that none of the species listed in Tables 4, 5 and 6 are confined only to the Moragolla project area.

5. Potential impacts

5.1 Impacts on aquatic ecology during construction

5.1.1 Soil erosion and siltation in the river

Intensified soil erosion is expected in areas where land clearing, excavation, drilling and laying of foundations take place for the proposed dam, underground tunnel, surge shaft, penstock and powerhouse, as well as the areas for other activities such as development of access roads and other facilities for the project. All these involve operation of heavy machinery and other equipment that will disturb the surface soil cover on land alongside the riverine areas, and many of the construction activities also require removal of surface soil. The dam construction will lead to soil cover removal on either side of the river bank, whereas the powerhouse, underground tunnel, surge shaft and penstock construction will lead to removal of soil on the left bank only.

[5] www.environmentmin.gov.lk/b

During construction the drilling of the bed rock and the uprooting of large woody trees and others vegetation will be inevitable. These and other activities during the construction phase of the project will cause disturbance to soil cover in the riparian area that will lead to soil erosion during rainfall and entry of silt-laden water into the river. This could be severe in the rainy season as the bank of the entire river stretch concerned is already disturbed, having little natural vegetation cover. Excessive soil erosion is therefore already a very common environmental degradation issue in this area, and the anticipated additional disturbances caused by the construction process may also cause earth slippages if surfaces from which vegetation has been cleared are exposed to heavy rain. This may be more severe in the steep areas of silt or muddy substrate, and may be more of a risk on the left bank, where there are abandoned tea plantations, an industrial area and home gardens that are susceptible to heavy surface runoff. Removal of riparian vegetation along the river bank will also reduce the stability of the banks, and increase insolation and raise the temperature of the water, especially during the low flow season.

Bedrock and boulders may have to be removed for the dam foundations and other structures, and this may exacerbate soil erosion in these areas. The anticipated soil erosion will deliver sediments into the river channel, which may cause detrimental effects on in-stream habitats and inhabitants.

Soil erosion usually causes high siltation in the river, producing highly turbid water from the increased amount of suspended loads. In these circumstances, gills of fish and invertebrates could become clogged, impairing respiration, and if the condition becomes severe, the more sensitive life forms, including larvae of fish and other aquatic animals could die (Kerr, 1995). Motile animals may move to avoid highly turbid waters so distribution patterns could change, and if light penetration is impeded, photosynthesis by macroscopic plants and phytoplankton would be reduced, leading to reduced overall productivity of the ecosystem. Increasing the sediment input in the river could therefore have a variety of impacts in the project area and downstream, depending on the extent and duration of any siltation issue. It should be borne in mind however that little soil disturbance is anticipated on the right bank, where there is less construction activity and a relatively good riverine forest cover, and that these anticipated impacts will occur mainly in the construction phase.

5.1.2 River bank erosion

Construction work in the river channel will be required in order to build the dam and the tailrace outfall, and the river will be diverted temporarily in the area of the dam to enable safe access for the riverbed construction. There will be changes therefore in flow patterns in the river, which could cause erosion of the river banks, and this could be exacerbated by any damage caused by heavy machinery operating alongside river banks in these and other locations. There is a direct and indirect interconnection between the substrate and the biota in river banks as the substrate provides a surface to cling to or burrow in, shelter from the current, materials for construction of cases and tubes, and refuge from predators. Thus if banks were allowed to erode significantly, any inhabiting plants, together with fauna such as crabs, molluscs, some aquatic insects (mayflies, caddis flies, etc), and annelid worms would be dislodged. The natural morphology of the river in the project area however provides quite stable bedrock (see **Annex 4**) and banks that are naturally protected by rock boulders, so it may not be necessary to have specific mitigation measures for these impacts. Particularly in the tailrace construction area the river consists of mainly riffles where the water flow rate is rather high, and any changes in flow patterns will be dissipated by the presence of the small islands and good woody plant cover and rock boulders, described in **Section 4** above. This will minimize erosion of the river bank as they act as a barrier to break up the energy of the flow.

5.1.3 Water quality depletion in the river

There are several ways in which the water quality in the river could be reduced during construction. The principal risks include: direct contamination by cement and other construction waste, or by spillage of fuel and other materials into the water; indirect contamination due to spillage of these materials onto soil, which washes into the river; and increased inputs of silt (as described above), which then settle out in quiet waters, causing siltation and sedimentation. Any impacts resulting from these factors would be greatest at and immediately downstream of the construction sites, after which any pollutants will gradually be diluted by water from inflowing rivers downstream.

5.1.4 Impacts on aquatic fauna and flora in the river

Impacts on fish

The immediate project area (from site 6 to 16) is home to a total of 32 native species fish, out of which 11 are endemic (refer **Table 3** in **Annex 9**). Of the endemics, the presence of *Labeo fisheri,* locally known as "Kalu Gadeya", a critically endangered species (MOE, (2012), is of particular interest as it is only found in the middle catchments of the Mahaweli river system (Pethiyagoda, 1991; Shirantha, 2012). During the present survey it was recorded at Ethgala "Hath-wala" (7°07´.453N and 80°34´.476E); site 15 (**Fig.7** in **Annex 4**) and site 16 where the river provides a series of large, cool, dark rock pools (>10 m depth) of ever-present water, approximately 1.5 km downstream of the proposed dam site. *L. fisheri* is a species that shows reproductive migration, moving upstream to spawning sites to breed (Senanayake and Moyle, 1982; Silva and Davies, 1986, Silva, 1993; Shirantha 2012). If it is present in this area there is then a risk that this very rare species could be affected by dam construction, if rock pools in this area dry out or become severely reduced in size, depth and water quality, or removed by rock blasting and excavation of the dam foundations. It will be important therefore, that adequate care is taken to adopt the mitigation measures described below (see **Section 6**) and not to exceed the approved limits for rock blasting.

Notwithstanding the above, it is not considered that the presence of the endemic and endangered Green Mountain Labeo in the project area is a major conservation issue or a severe environmental problem. The proposed mitigating measures given elsewhere in this report will almost certainly minimize the anticipated impacts, so CEB along with their consultants and contractors should ensure that these actions are implemented carefully and in full. It should also be stressed that this species is currently recorded at more than 10 other locations within the Mahaweli river system (Shirantha, 2012). Recent studies and surveys have shown that the fish fauna of this part of Sri Lanka is quite secure in some fast flowing waters in reserved and legally protected areas of the sub-catchments of Loggal Oya, Beli-ul Oya, Badulu Oya, Wasgamuwa Oya, Nicola Oya, Heen Ganga, Theligamuwa Oya and Kalu Ganga (Shirantha, 2012).

Project construction could also adversely affect breeding and feeding grounds of some other endemic fish species, such as *Garra ceylonensis, Belontia signata, Channa orientalis* and *Schistura notostigma* as they lay eggs or build their nests at the water's edge. However this is unlikely to be of major significance, as they are common endemic fish species and there are enough nesting sites in both upstream and downstream areas for them. Furthermore they will probably adapt to the river morphological changes and seek alternative places to survive and breed within a very short period of time.

The presence of some other threatened endemic fish species in the project area, such as *Pethia nigrofasciata* and *Pethia reval* is a result of translocation practices that took place in the late

1980s as a conservation strategy (Wickremanayake, 1990). At present these fish species are well established in the Gamploa, Nawalapitiya and Ginigathena area (Wickremanayake, 1990, Pethiyogoda 1991, Shirantha, 2004). The construction process is therefore unlikely to cause severe population declines in these species within the Mahaweli river catchments.

The largest Cyprinid in Sri Lanka, *Tor khudree* (Black Mahseer) was found in this part of the river particularly around the river convergence with the Atabage Oya. This species is unlikely to be significantly affected although the river channel will be temporarily diverted during the construction period, as the water from the Atabage Oya will facilitate them to move into a more secure area in the downstream.

There could be some effect on the fish fauna from the changes in water quality as stated above (pollution from spillage of oil, cement and other materials; and increased turbidity and sedimentation) and the species most at risk are the small Cyprinid fishes such as *Rasbora dandia, Devario malabaricus* and *Dawkinsia singhala*. If there are substantial and prolonged changes in water quality, the more delicate younger stages of these and other species may die, and adults could also succumb, or alter their distribution to avoid the worst affected areas.

Impacts on other aquatic vertebrates

The other vertebrate fauna recorded in the immediate project area includes three mammals that are of conservation importance according to the National Red List of Sri Lanka 2012 (MOE, 2012): the Eurasian otter *Lutra lutra* is categorised as vulnerable; the rusty spotted cat *Prionailurus rubiginosus* is endangered; and the fishing cat *Prionailurus viverrinus* is endangered. Most of the other aquatic vertebrates recorded are relatively common in aquatic habitats throughout the country. It should also be noted that none of the endemic or endangered mammalian, reptilian or aquatic bird species are confined only to this part of the Mahaweli river system.

During the construction period the feeding grounds of some of the rare and important species (including *L. lutra, P. rubiginosus, P. viverrinus, Varanus salvator* (Water monitor) and *Haliaeetus leucogaster* (White-bellied sea eagle)) could be altered and disturbed by ground clearance, construction work and other activities. This is unlikely to be a major impact however, as these are all highly mobile animals that can move into alternative areas to find their prey, in both aquatic and terrestrial environments.

Impacts on aquatic/semi aquatic flora

As shown by the description in **Section 3** and **4** above, very few endemic or rare aquatic flora have been found in this reach of the river. The project area is generally characterised by fast flowing water and with a predominance of rocky substrates. As such this part of the river is not a conducive habitat for extensive growth of rooting, submerged or floating aquatic plants. A few plants of *Lagenandra ovata* (Malayan Sword) were recorded at the water's edge, but they are already disturbed due to prevailing river bank erosion. It is not expected therefore that the project will have significant impacts on macroscopic aquatic plants.

Impacts on aquatic invertebrates

Various insects and other macroscopic invertebrates, including aquatic bivalves and gastropods were recorded from the project area during the surveys (see Table 1 in **Annex 9**), and most were relatively common and none are threatened or endangered, or confined only to the Moragolla project area. As mentioned above, there have been no detailed studies on the presence, distribution, conservation and taxonomic status of most of the aquatic invertebrates in Sri Lanka, so it is very difficult to make definitive statements on the potential impacts of the project on these organisms or their likely significance. It can be said however that invertebrates will be susceptible to some of the construction activities as they tend to be aggregated in water-edge areas. They could therefore be removed by excavation in these areas for construction of the dam and tailrace outfall, crushed by any vehicles or machinery that is operated in or outside such areas, or washed away if there is any bank erosion. They might also be affected by any pollutants that are spilled in the water (especially toxins like vehicle oil), and increase of sediment content could clog their respiratory surfaces, impeding oxygen uptake and causing metabolic stress. Most probably less mobile animals such as aquatic worms, shellfish and bivalves will be most affected by any such impacts as others can move into less disturbed areas as they are very sensitive to even slight changes in their environments. Some of the dragonfly and damselfly species are endemic to the island but none of them are restricted only to this part of the river. All taxa shown in **Annex 9** Tables 1 and 2 are very common in all riverine habitats in the wet zone of Sri Lanka. Impacts on invertebrates are therefore unlikely to be of major significance.

5.1.5 Impacts on associated terrestrial fauna and flora in riparian area

According to the project design very little of the riparian area will be cleared of vegetation for the construction work. Some woody trees and shrubs will be removed, but the total cleared area will be less than 2 ha. This vegetation supports some terrestrial fauna, especially underground dwellers such as mongoose and shrews, and small numbers may be killed during this process, or they may move to other areas, including the riparian shrub cover along the right river bank where there is a forest reservation agro gardens. None of the animals found in the areas of riparian vegetation are rare or endangered, and most will move into other similar areas nearby once vegetation removal begins; so these will not be major impacts and no special mitigation is required. Keeping vegetation removal to the minimum is however necessary as it helps conserve these species *in situ*. During the construction period the migratory paths of some carnivorous animals such as wild cats and otters may be blocked or disturbed temporarily, but this will also not be a major impact as these are highly mobile animals that will avoid the construction site anyway, and will utilise undisturbed areas in the vicinity or elsewhere.

Some plant cover at the water's edge may also be damaged or destroyed during site clearance, and due to movement of machinery and other heavy equipment. Most of these species are alien invasive e.g. *Wedelia trilobata* (Singapore Daisy) and *Panicum maximum* (Guinea grass), so they are of no special floral value. They play an important role however, in controlling soil erosion and providing shelter for the animals that live at the water's edge (adult dragonflies and damselflies, crabs, etc.). This is therefore another reason for keeping the damage and loss of bank-side and in-river vegetation to the minimum possible.

5.1.6 Impact due to recruitment of labour force for construction activities

The project contractors will employ some people from outside the project area in their workforce and this may require provision of an accommodation camp, closer to the dam site. This could be a source of water pollution that could affect aquatic ecology, for example if raw sewage from the camp was discharged into the river, causing reductions in oxygen under low flow conditions as the waste decomposes. Solid waste could also be a problem if it is discarded into the river, as it could damage habitats and cause the death or injury of aquatic mammals, fish or invertebrates from contact with or ingestion of the waste. This will need to be avoided by proper waste management procedures at the accommodation camp, as described below.

There is also the risk that workers may capture fish for consumption, especially as the project area supports some large food fish species that are of high consumer preference including the

Black Mahseer, Green Mountain labeo, Common carp, Shark catfish and some other large Cyprinds such as Olive barb and Long-snouted barb. During periods of low flow in the construction period these fish will tend to congregate in the large rock pools that are common around the dam site and downstream near the tailrace outfall. These pools will be accessible because of the low water levels and workers may attempt to kill the fish by the use of dynamite or poisons. This is quite a common occurrence in river diversion projects and it causes detrimental effects on the fish populations as these agents indiscriminately kill all stages, including young individuals, and also other aquatic animals in the vicinity. It will be very important that prompt actions are taken to avoid this.

5.1.7 Removal of riparian vegetation and loss of shade

For the road construction, machinery movement and excavation of on-land foundations for the dam and powerhouse some trees, grass cover and non-woody plants will have to be cut and removed. This may lead to more debris and leaf/woody material entering the river, which could cause sudden changes in river water quality from eutrophication if this material accumulates in low flow areas and decomposes. It could also promote microbial activity and create new micro habitats, and could clog water channels, etc. These impacts could affect aquatic life by impeding migration or limiting feeding and breeding areas, or if reductions in water quality impede respiration and cause metabolic stress. Proper measures should therefore be taken to minimize these impacts.

Vegetation removal, especially trees, will cause loss of shade, and where this occurs close to the river, the increased action of the sun on the water could lead to temporary increases in water temperature, especially during the low flow season. Tree and shrub removal will also lead to increased soil erosion during rainfall, and will also reduce the nesting, foraging and feeding grounds for the aquatic and semi-aquatic fauna as well as for the terrestrial animals. These will be relatively small-scale impacts as removal of vegetation will not affect large areas, and the project site anyway does not contain very much natural habitat. Nevertheless, as explained above, vegetation removal should be minimised as much as possible, as the impacts could be more serious if combined with other impacts, e.g. reduction in water quality and loss or disturbance of aquatic habitats.

5.1.8 Construction in the river bed

The project will involve significant construction in the river bed, to build the dam and the tailrace outfall. The river will be diverted to allow most of this work to be done, so some river-bed areas in the vicinity will dry out and their inhabiting plants and animals will die. This will affect relatively small areas in which none of the aquatic plants or invertebrates are known to be rare, so no special mitigation measures will be needed to protect these organisms. Some of the rare and locally important food fish however might become trapped in rock pools, so to avoid those impacts, a small scale capture and relocation programme should be conducted.

If any construction is conducted directly in the river in these and other areas, the associated disturbance of the river bed could increase the sediment load in the river, and contribute to increases in turbidity and downstream siltation from other sources, and associated impacts on fish and other fauna and flora as described above. Measures will therefore be required to minimise any such disturbance, and in particular to avoid the spillage of potentially toxic materials into the river, e.g. oil and cement.

5.1.9 Other construction hazards

In relation to the various other construction activities, the key concern regarding impacts on the aquatic ecology is the effect of blasting and vibration. There may be some blasting in the river itself to break up and remove bedrock at the dam site, and there is likely to be other detonations on either side of the river bank, and along the underground tunnel. Depending on the frequency of blasting, its location and the severity and penetration of the related shockwaves, there could be effects on the behaviour and physiology of animals in the river. Fish and other motile animals may move away from areas where there are vibration impacts, but these will not be permanent changes and any displaced individuals may return once the disturbance is over. There could however be more permanent impacts on organisms inhabiting pools in the riverbed during the dry season, as severe vibration from blasting nearby could cause stress and even death. The programme of capture and relocation mentioned above should therefore also encompass rock-pools in the vicinity of any proposed blasting.

5.1.10 Waste disposal and accumulation in the river and riparian area

The river is already subject to an unsightly and unnecessary accumulation of garbage of anthropogenic origin as described above and shown in Fig. 6 in Annex 4, and this can affect aquatic habitats and inhabitants as described in Section 5.1.6 above. This pollution load and its ecological impacts could be increased significantly through used snack wrappers, bottles, etc. discarded by construction workers, and there could also be inputs of organic waste, from defecation/urination, discarded food and cut vegetation. These will add some more organic and inorganic pollutants to the river of the project area. Since this is an existing threat, the impacts would be amplified by the construction work. This can be minimized if proper mitigating actions are taken, including a proper waste disposal program that is implemented with the local government.

5.2 Impacts of dam, reservoir and hydropower scheme operation on aquatic ecology

5.2.1 Impacts of dam creation

Changes in river morphology

The dam will both streamline and distribute the river flows, as in the rainy season water will flow over the crest through the discharge gates, and through the headrace tunnel 3.1 km downstream. The deflection of water through the tunnel and over the sloping crest of the dam will reduce the flow turbulence, and as the river section here is rocky and deep, with large pools and riffles, there should be few impacts on downstream river morphology, as the rocky terrain is not easily susceptible to such changes.

The dam will also divide the river into two and instead of the steep and fast flowing rhithron upstream and the sluggish and flat potamon downstream, there will be a new and larger inundated area upstream and reduced flow downstream in the dry season (January, February and March). This will lead to sudden changes in river morphology upstream, due to the changes in water levels. The relatively narrow river channel will be converted into a wider and deeper man-made lake, and the water surface will be higher and exposed to new and potentially unstable bank areas, with muddy to sandy substrate. It is expected therefore that bank erosion may occur in the proposed reservoir area from the increased surface turbulence in the rainy season. This will require mitigation measures to avoid excessive silt and turbidity in the water, and resulting reduced storage capacity.

Changes in water flow and quality

The presence of the dam and the usage of water for power generation will alter both the downstream water flow in the river and its physical, chemical and biological characteristics. The aquatic environment will therefore change, both upstream and downstream of the dam.

The Moragolla reservoir will operate as a "run-of-river" scheme, where the relatively small reservoir acts as a regulating pond, not a storage basin. During the wet season (May - November) there will be sufficient water to generate power almost constantly, and the excess water will flow from the reservoir through the spillway gates. This will maintain an almost normal rate of downstream flow in the river. Water will be retained by the dam for only a short time (<1 day) so major changes in water quality during this period are unlikely, apart from possibly small reductions in sediment content as the reduced flow speeds in the reservoir will allow some suspended particles to settle onto the bed.

During the dry season (December - April) the Moragolla scheme will be operated primarily to satisfy peak electricity demand, so power will be generated between 6-9 pm each day. For the rest of the time power will be generated when there is sufficient water in the reservoir, which is expected to be for a few hours on most days. Water will therefore be retained in the reservoir for longer periods during the dry season, so water quality could fluctuate. The main changes in quality of the impounded water are expected to be: a) increased temperature from the action of the sun on the surface of the reservoir b) decreased oxygen, especially in the lower water levels, from microbial breakdown of dead and decaying plants and animals and organic debris entering from on land and c) decreased sediment content as particles settle on the reservoir bed. Water flowing downstream at this time will therefore be warmer and slightly lower in oxygen content than normal, and somewhat less turbid. These differences will gradually be reduced by inflows from other rivers downstream, including the "Thismada Ela" a perennial stream that enters the Mahaweli River immediately below the dam. Downstream flow will also be augmented by a continuous release of $1.5m^3/s$ from the dam, which is the "environmental flow", intended to maintain the downstream aquatic ecosystem.

Increase in upstream water levels

The proposed dam is 35 m high and it will create a 38.5 ha, 1.98 MCM reservoir with a full supply level at 548 msl. This will inundate the present upstream river bank and parts of the adjacent on-land riparian areas. This in turn will change habitat conditions in these areas and a different set of dynamics will begin impacting the species that traditionally grow, nest, feed, or spawn in these areas until a new equilibrium emerges. Since the dam site valley is a gorge (see Annex 6) the presence of the dam is unlikely to cause floods in its immediate vicinity, but there will be a significant increase in water level upstream in the area that covers the study sites 5, 6, 7, 8, 9 and 10 (refer Annex 3) as the river valleys here vary at different sites from a broad and asymmetrical floodplain to a shallow valley. The proposed dam will therefore inundate a significant area and it will affect a longer section of the upstream profile. The potential ecological impacts of these changes both upstream and downstream are discussed below.

Impacts on aquatic fauna and flora

The dam will block the movement patterns of migratory aquatic organisms, especially fish. This part of the Mahaweli River supports at least six migratory fish species, all of which were recorded during this survey, namely, *Anguilla bicolor* (Level finned eel) and *A. nebulosa* (Long finned eel), *Labeo fisheri* (Green Mountain labeo), *Tor khudree* (Black mahseer), *Garra ceylonensis* (Ceylon Stone-sucker) and *Wallago attu* (Shark catfish). All these species move upstream cooler waters or downstream (i.e. Eels) to spawn particularly with the onset of the monsoon rain (Senanayake and Moyle 1982; Silva and Davies 1986; Silva 1993; Shirantha

2012). The dam will therefore block their movement as well as the subsequent downstream passage of juvenile fish to the waters where they will spend their adult lives. During the breeding season, adults of some of these species will migrate upstream as far as the dam, and on reaching the barrier may try to pass through it, or remain in the vicinity. This may cause stress and injury, and the individuals may become disoriented, and may die because of contact with the walls of the dam, or deflection screens. They will also congregate in a relatively small area below the dam or around the tailrace outfall, where their exposure to predators will be increased. In such circumstances the breeding success of these and other species is likely to be greatly reduced, which might then lead to long-term decline of the populations in this river. This is of particular concern in the case of the rarer species, in particular the endemic critically endangered *Labeo fisheri.*

The survey results presented in Annex 9 show that at least eight endemic fish species i.e. *Garra ceylonensis*, *Labeo fisheri*, *Pethia nigrofasciata*, *Pethia reval*, *Channa orientalis*, *Dawkinsia singhala*, *Belontia signata* and *Schistura notostigma* are found around the dam site and the habitats of these species will become fragmented due to the construction of the dam. There is therefore a possibility of dilution of the gene pool, which could reduce the biological fitness and survival ability of these populations over the longer term. This impact can be minimized if species translocation will be implemented during the construction period as proposed in Section 6.

The changes in the quality of water flowing downstream (described above), are not expected to result in significant ecological impacts, because they will only occur during the relatively short dry season, and will not extend far downstream because of dilution by other river inputs. The reductions in downstream water flow will be more significant however, especially in the dry season, as this could reduce the connectivity and passage of fish between the deep rock pools in this area during this time. This may lead to their population decline due to alteration of their reproductive cycle, which is largely dependent on river hydrology and food availability. This negative impact can be minimised with some additional mitigation measures given in the Section 6.

The reduction in water level will also affect aquatic flora in the river, as plants in areas that dry out will die from desiccation in the dry season. This will inevitably reduce the coverage and richness of habitats in the downstream area, but these will not be severe impacts, because as explained above the reductions in flow will mainly affect the area between the dam and the tailrace outfall, where there is a predominance of rocky substrates. There are also no known rare or endangered plant species in the area.

Adequacy of the proposed environmental flow

During the dry season (December - April) there is expected to be sufficient water in the reservoir to allow power generation during the peak demand period, and for a few additional hours each day. There is unlikely to be an excess of water discharged through the spillway gates, so for much of this time the only water released from the dam will be the environmental flow of 1.5 m^3/sec. This will be discharged continuously, and it will be augmented by inflows from other rivers and streams, in particular the "Thismada-Ela" immediately downstream of the dam. However these streams will also be under low flow conditions at this time, and as the e-flow is around 42% of the average annual minimum natural flow, it is inevitable that areas of the river bed between the dam and the tailrace will dry out. As a result, plants in these areas will die, along with any animals that are unable to move into areas of flowing or standing water. Fish and other animals that do survive will be subjected to reduced water quality in the remaining pools.

The environmental flow will therefore not be sufficient to maintain the aquatic ecology unaltered in the area between the dam and the tailrace. However the evidence from this study does not justify increasing the environmental flow in order to protect the ecology of this area. This is because:

(a) The area affected by significant reductions in flow will be mainly limited to the 3 km length between the dam and the tailrace, in which this study has found no rare, endangered or otherwise ecologically significant habitats, aquatic plants or invertebrate animals.

(b) Impacts on the rare and endangered fish and aquatic and terrestrial mammals that inhabit this area will be reduced by a series of mitigation measures outlined in Section 6 below, which are expected to ensure the conservation of these species, and may even lead to the growth of their overall populations.

(c) The energy generated will be reduced with the increase of the environmental flow, which will result in an increase of fossil fuelled energy generation.

5.2.2 Impacts resulting from the reservoir

Impacts on fish and other aquatic fauna

The future changes in river morphology and habitats particularly marked in the area of the reservoir where the retained water will inundate extensive areas of land flanking the main channel. This will increase living space for the aquatic flora and fauna, and the release of plant nutrients from newly-submersed soil may produce a surge of primary productivity from growth of phytoplankton and macroscopic plants, followed by an expansion in biomass of certain animal communities. The individual species that prefer lacustrine water bodies, would be expected to adapt quickly to these conditions e.g. fish species like *Oreochromis mossambicus* and *Cyprinus carpio* and aquatic plant species like *Potamogeton pectinatus.* Their adaptations are not only morphological but also behavioural. This could lead to the development of a good fishery, particularly culture-based, in the near future. Some species however may move upstream to avoid conditions that are unfavourable for their breeding or feeding. These species may move upstream, out of the inundated area. The reconfiguration of this running water body into a pseudo lacustrine one is therefore expected to cause changes in the populations of fish and other animals and plants, as different species will react differently to the new conditions. Those that prefer deeper and slow-moving water are expected to thrive in the reservoir, and those that prefer faster moving water, and are intolerant of lower levels of oxygen may move into the upstream area. These readjustments will alter the distribution patterns and population densities, but are not expected to cause any species to die out, so no special mitigation measures are proposed.

Impacts due to sediment accumulation

River water typically contains suspended particles of organic and inorganic materials, eroded from the land or riverbed upstream. These particles tend to settle out where current speeds are low, forming areas of fine sediment on the riverbed. In reservoirs these particles accumulate on the bed behind the dam because the dam itself is a physical barrier. The upstream area at the Moragolla site is surrounded by steeply sloping land containing plantations and home gardens, so there will be man-made as well as natural erosion of lands adjacent to the reservoir, especially during the rainy season. This will probably lead to sediment build-up behind the dam. Once sediments collect, the aquatic ecosystem may be affected in three main ways: downstream habitat conditions may decline because these sediments no longer provide important organic and inorganic nutrients; the amount of soft-sediment habitat may also decline as there is less sediment flowing down the river to replace substrates that are eroded away during the high-flow season; and finally, the nutrient loading may deplete the supply of oxygen in the reservoir due to the increase of sediment-dwelling animals, and from microbial breakdown of dead organisms and waste products that accumulate on the reservoir bed. River gravel is transported downstream under high-flow conditions, so this may also be trapped behind the dam in the same way as finer sediments, so areas of gravel habitat downstream may also decline.

Periodic release of sediments entrapped by reservoirs can have significant impacts on aquatic organisms, as those living in the sediment will be washed downstream and probably killed, and those living downstream will be exposed to highly turbid water, which may clog their gills and hamper respiration and smother and kill animals and plants living on the river bed. The level of impact however, depends greatly on the type of sediment and intended management practice. The Moragolla dam does not include valves or any other mechanism to permit the regular flushing of silt. It may take 30 years or more for the sediment in the reservoir to reach the spillway crest level which is 8 m below the minimum operation level of the reservoir. The sediment further accumulated will then be removed by mechanical dredging at the low flow season or sediment sluicing through the spillway gate at the high flow season. It will be important to manage this process carefully to reduce adverse impacts from sudden increases in the downstream sediment load.

The heavy upland soil degradation including erosion at present transport substantial sediment load in the river this if get accumulated behind the dam, the reservoir may fill its storage earlier than expected. It would be prudent therefore to take additional action to prevent the entry of sediments into the reservoir and the river upstream, through improved land management. This could include: planting a reserve area around the reservoir with species that are known to bind and conserve the surface soil; improving land drainage in this area; incorporating silt traps or other filters to capture sediment before water drains into the reservoir; plus possibly implementing some form of wider study and improvement of land management in the overall Mahaweli Ganga catchment.

Impacts on debris movement

During the survey it was observed that in some areas potholes at the margins of the river, which are habitat for certain fish and other macro fauna, are filled with materials of anthropogenic origin, including plastic bottles, polythene and other non-degradable and degradable organic waste. These materials enter the river from its upland catchments during high flow conditions, and can be a threat to sensitive species, from ingestion of or contact with inert or toxic material, and from damage to their habitats. Construction of the dam and reservoir will greatly reduce downstream movement of these materials, and in this respect, the hydropower project should be beneficial for downstream ecology, provided that these materials are managed in an environmentally sound manner by CEB.

Bank erosion

As explained above, almost the entire natural river bank in the immediate project area comprises primarily rocky material, so river bank erosion is not expected to be a significant additional source for the entry of silt into the reservoir. However, as noted above, once the reservoir is impounded, the upstream water level will rise well above the natural water channel and the edges of the new water body will be in contact with land that is presently cultivated (home gardens or tea plantations) or abandoned (unworked plantations). There is little natural vegetation in this area, so there is a risk of erosion from the new reservoir bank areas. This is compounded by the fact that many of these areas are steeply sloping, and the likely operation of the power plant, whereby water levels in the reservoir will fluctuate regularly, during drawdown and subsequent refilling. This could cause bank failures, erosion, and undercuts leading to land degradation, land slippages and increased reservoir sedimentation. This impact may not be as severe as in certain other reservoirs because at Moragolla it is proposed to have an optimum drawdown of only 6 m. These impacts will therefore be mitigated by land management at the reservoir margins, and other proposed mitigating measures that will be discussed in **Section 6.**

Reduced dilution of pollutants

The River water quality study has shown evidence of water pollution from the Crysbro Broiler Farm (poultry industry), which discharges wastewater from the left bank approximately 2 km below the proposed dam site. The water quality analysis and the field observations suggest discharge of inadequately treated wastewater (see Report 1: Water quality in the Mahaweli Ganga - upstream and downstream of the proposed dam at Moragolla). The reduced flow during operation of the Moragolla scheme may reduce the dilution and dispersion of this effluent, which contains high levels of Biochemical Oxygen Demand, Suspended Solids and animal oils and fats. These pollutants will decompose in the water, reducing levels of Dissolved Oxygen, which may hinder the respiration of sensitive fish and other aquatic organisms. Mitigation measures to minimize these impacts will therefore be needed.

6. Proposed mitigation measures

6.1 Mitigation measures to minimise impacts during construction

This section summarises the potential impacts on aquatic ecology during project construction; and mitigation measures are proposed below for those impacts considered likely to be significant.

Table 6.1 Summary of possible impacts during construction

Project action	Possible negative impacts	Remarks
Soil erosion after vegetation clearance and use of machinery	Increased silt in the river, which may clog the gills of fish and invertebrates causing changes in distribution or even death and reducing plant photosynthesis	Significant Mitigation measures should be taken
River bank erosion	Inhabiting plants and associated fauna may become dislodged and washed away	Unlikely to be significant Temporary Mitigation measures are not proposed as explained in **5.1.2**
Water pollution from spills of oil, cement and other toxins (into the water or onto land)	Toxins may kill plants and animals or affect respiration, metabolism, breeding, etc.	Significant Temporary Some mitigation measures should be taken
River diversion causes an increase in the riverbed area that dries out in the dry season	Reductions in populations of *L. fisheri* and other fish species	Significant Permanent Some mitigation measures should be taken
Damage and disturbance of the riverine area by construction activity	Altered and disturbed feeding grounds and habitats of some important terrestrial species; damage and dislodgement of aquatic and semi-aquatic flora and invertebrates	Less significant Temporary Mitigation measures are not proposed as explained in **5.1.4**
Sewage, solid waste and other pollution may enter the river from the worker accommodation camp and construction sites	Reductions in oxygen and metabolic stress to any inhabitants if organic or inorganic waste accumulates in quiet waters in the dry season Inert waste could also damage habitats	Significant Temporary Some mitigation measures should be taken

	and injure or kill animals and plants if it enters the river	
Increased fishing pressure on rare or popular food fish species	Fish species when isolated in pools in the dry season become more susceptible to predation and capture by fishing. These and other species could also be damaged significantly by the use of dynamite or poison	Significant Temporary Some mitigation measures should be taken
Increased inputs of organic matter and debris into the river during vegetation clearance	May injure animals from direct contact or cause stress from oxygen reductions caused by decomposition	Significant Temporary Some mitigation measures should be taken
Disturbance of the river bed due to construction	Adding to the sediment load in the river	Significant Temporary Some mitigation measures should be taken
Bed rock blasting	Changes in the distribution of fish and other motile animals and may even cause the death of inhabitants of rock pools	Significant Temporary Some mitigation measures should be taken

6.1.1 Minimize soil erosion after vegetation clearance and use of machinery, and damage to river banks

The most basic and simplest mitigation measure that can minimize the potential negative impacts of soil erosion is to conduct as much construction work as possible in the relatively dry period between January and March. The ground soil erosion should be further minimized by paving or grass turfing of the cut slopes, and terracing any cut hill slopes.

It is expected that the Project Approving Agency (Mahaweli Authority of Sri Lanka) will require CEB to prepare a soil conservation action plan for the project area as one of the conditions attached in granting the necessary construction permits; so this should be adhered very carefully by all contractors involved in the construction work.

The damage caused due to excavation of soil for the footings and to lay the foundations of the dam and other structures is unavoidable. Any other damage to river banks and slopes should be rehabilitated concurrently, by replacing boulders and reinstating any damaged vegetation and areas of soft sediment on the river bed, which are relatively scarce habitats in the project area. To reduce the amount of silt-laden runoff entering the river, excavated soil from the dam foundations should be transported for disposal as soon as possible and any soil that is stockpiled at the site should be compacted and protected using rip-rap or rubble pitching to prevent the soil being blown or washed into the river.

The slope cuts and filled embankments should also be protected by adopting appropriate methods of covering, such as gabion protection, coir matting, rubble mounds, vegetation planting and turfing with grass. The best and most effective method should be decided by the site staff depending on the specific site conditions. In any areas of severe erosion an appropriate soil textile should be laid on the surface to prevent further depletion.

An area becomes prone to erosion when vegetation is removed prior to topsoil stripping during initial site clearance. Every care should therefore be taken not to excavate or uproot trees or other vegetation beyond the specified footprint of the works.

Some topsoil will be stockpiled on site for use to rehabilitate the same area or any other area that has been disturbed. Soil stockpiles should be located in cleared areas away from drainage paths, and protected from rainfall to avoid runoff as noted above.

All possible care should be taken not to directly discharge heavy flows from pumps and runoff diversions to natural gullies and drainage paths that are susceptible to erosion. The outlets of all pipes that discharge water from dewatering sites, flow diversions, etc. at each construction location should be placed away from erodible areas and provided with appropriate provisions to avoid erosion by dissipating energy and flow velocities. This can be done by instillation of 'cut off drains' i.e. drainage ditches dug specifically to drain water and control water runoff speed.

The runoff from areas outside construction sites should be diverted away from the site by constructing perimeter drains, diversion banks and other measures prior to starting work at the site.

Use of heavy machinery on steep slopes should be strictly restricted to only that which is absolutely necessary and should be closely monitored. The machinery operation should be done by skilled operators, and before commencement of the work they should be trained in the risks of excessive soil erosion and avoidance measures.

Apart from the above measures the negative impact of soil erosion that will affect river quality should be further minimized via properly erected silt traps in appropriate places to arrest the sediment flux that carries into the river.

6.1.2 Minimize water pollution from spills of oil, cement and other toxins into the water or onto land

Wherever possible, all construction plant, material stockpiles, vehicle parks, labour camps etc., should not be located alongside the river banks to prevent soil erosion and other pollution of the river. Before beginning work, all site workers and staff should be made aware of measures of water conservation and waste minimization in order to stop the entry of mud-laden sediments and other pollutants into the river.

The storage of fuel, oil or other toxic materials on site should be prohibited, ensuring they are stored offsite at premises with appropriate pollution control procedures, including oil separators on drains; and vehicle refuelling and maintenance on site should be prohibited except in an emergency situation.

6.1.3 Conservation of fish fauna

The anticipated impacts on the rare endemic fish species including *Labeo fisheri* in the project area can be minimized by translocation. *L. fisheri* and other species that become trapped in isolated pools below the dam when the river is diverted may be captured and translocated to a suitable relief point. Several such relief points with favourable conditions are present in the Mahaweli river catchment, in both upstream and downstream areas, with undisturbed rock pools, which could be ideal for these species to live no harm (e.g. main tributaries of Mahaweli River: Loggal Oya, Heen ganga, Kalu ganga, Nicola Oya, Hasalaka Oya, Wasgomu Oya, Dunuwila Oya and Badulu Oya). If this is done it should be commenced with a pilot project since there is no such action that has been taken previously for a large habitat-specific fish species in Sri Lanka.

6.1.4 Minimize impacts from river diversion

The Ceylon Electricity Board should take all necessary actions to ensure that the mandatory environmental flow is provided continuously, for 24 hours a day. As mentioned in **Section 5** discharge of the "Thismada-Ela" will supplement this environmental flow to sustain a reduced aquatic ecology in the 3 km between the dam and the tailrace outfall, so this stream must be kept flowing and free of obstruction or pollution throughout the construction period.

6.1.5 Prevent discharge of sewage and other pollution into the river from construction sites and the accommodation camp

The contractor should provide adequate toilets for workers at the accommodation camp and at all construction sites and should ensure that all waste is treated to Sri Lankan legal standards and that no effluent is discharged to the river.

6.1.6 Minimize the increased fishing pressure on rare or popular food fish species, isolated in pools

Illegal fishing in the project area should be avoided by incorporating preventative action in site security procedures. The main contractor should be tasked with informing their appointed security contractors that no fishing is to be allowed in the designated project area by any persons (including the workforce), and requiring the security contractors to take appropriate preventative action, via security patrols, etc.

6.1.7 Minimize increased inputs of organic matter and debris into the river during vegetation clearance, causing injury and stress to animals from oxygen reductions

All cut vegetation and other debris produced during site clearance should be taken to a licenced site for disposal immediately after the removal or cutting. This licenced site should be located away from the river to ensure no seepage of decomposition products.

6.1.8 Minimize harmful effect of bedrock blasting on river inhabitants

The construction constructor should take action to keep the amount of dynamite blasting to the minimum necessary, and avoiding blasting in areas that are in or close to the river channel as far as possible. The contractors should strictly adhere to the standards on vibration for blasting activities established by Central Environmental Authority.

6.1.9 Minimize water pollution from defecation/urination or solid waste discarded by workers

The main contractors should set up and implement a waste management plan covering all construction sites and accommodation camps. The plan should prohibit littering, ensure provision of adequate litter bins and waste receptacles, and ensure that solid waste is taken for disposal at a licenced site twice a week.

6.2 Mitigation measures to minimize impacts during project operation

Table 6.2 summarises potential impacts of the Moragolla project during operation of the dam, powerhouse and reservoir and Section 6.2.1 below describes the proposed mitigation to address all significant impacts.

Table 6.2 Summary of potential impacts during operation

Project activity	Potential negative impacts	Remarks
Presence of the dam	Change in river type and morphology upstream of the dam, where the fast-flowing river is converted into a slow-moving man-made reservoir, and animal populations change their distribution patterns accordingly.	Unavoidable; but not of major significance Permanent No mitigation proposed as explained in Section 5.2.2 (a).
	Blocked movement of migratory fish (*L. fisheri, T. khudree, G. ceylonensis, W. attu* and *Anguilla* spp.) resulting in a) increased predation when adults congregate downstream of the dam; and b) reduced spawning success, leading to long-term population decline.	Significant Permanent Some mitigation measures should be taken
	Fragmentation of populations of eight endemic fish species found at the dam site, leading to reduced genetic vigour.	Significant Permanent Mitigation measures should be taken
Operation of the reservoir	Reduced quality of water flowing downstream in the dry season (warmer, lower turbidity and lower dissolved oxygen).	No significant ecological impacts Seasonal No mitigation necessary
	Gradual build-up of sediment behind the dam; and periodic removal by dredging.	Significant Mitigation measures should be taken
	Reservoir banks erosion from wave action at the water's edge in the regular drawdown area.	Less significant Mitigation measures should be taken
	Erosion of land in the proposed reservoir area in the rainy season leading to excessive silt and turbidity in the water, and reduced storage capacity in the reservoir	Significant Mitigation measures should be taken
Usage of water for power generation	Reduced river flow in the wet season in the 3 km length between the dam and tailrace outfall	Significant Seasonal Increase in environmental flow not justified as explained in Section 5.2.1
	Reduced dilution of pollutants in the broiler farm wastewater discharge	Significant Seasonal Some mitigation measures should be taken

6.2.1 Mitigation measures

Soil conservation and erosion control

Soil erosion is a pervading problem throughout this catchment and elsewhere in Sri Lanka, which reduces the quality of agricultural land and river water, and affects aquatic ecology in a number of ways as explained above. As noted in Section 5.2.2 it could also affect the Moragolla scheme by reducing the quality of water in the reservoir, and filling the dead storage capacity more quickly than the currently estimated 30 year period. Various actions described in Section 6.1 will be taken to reduce soil erosion during the construction period to ensure that the project does not exacerbate this problem during site clearance, excavation and other activities. It will be important that good practice is also extended into the period when the completed scheme is operating, in order to provide more lasting improvements in water quality and aquatic ecology in the project area and downstream.

CEB should therefore ensure that the Soil Conservation Action Plan (see Section 6.1.1) also includes measures to be adopted in the operational phase, and that these are implemented in the areas around the reservoir and at the project sites downstream that are owned by CEB. This could include:

a) Structural measures: terracing; flood interception and diversion works; gully head protection; bank protection structures; silt traps; etc.
b) Vegetative measures: reforestation of the reservoir buffer and other areas; planting soil-retaining shrubs and grasses; etc.

Under Sri Lankan law the on-land area at the edge of the reservoir is demarcated as a buffer zone, in which construction, farming and other usage of the land for purposes not related to the reservoir or power generation is prohibited. Soil conservation is improved if this area is designated as a green belt, and planted with species that are known to promote soil conservation in steep valleys. This should therefore be done in the buffer zone for the Moragolla reservoir. In addition to this the entire area should be declared as a protected area under the control of Ceylon Electricity Board.

Mitigation of impacts due to sediment management activities

The Moragolla dam does not have a facility for the flushing of retained sediment. It may take more than 30 years for the sediment in the reservoir to reach the spillway crest level which is 8m below the minimum operation level of the power generation. It is anticipated that at the end of this time the sediment may be removed by mechanical dredging in the dry season or sediment sluicing through the spillway gates in the rainy period. The removal of sediment by hydraulic dredging and downstream pumping would cause sudden very large increases in the suspended sediment content of the river water, which could have very deleterious impacts on ecology by smothering and killing bottom-dwelling species and impairing the respiration of fish and other organisms, which could also lead to death. Properly-managed on-land disposal of the silt, or using it in agriculture if feasible, would be better options in terms of protecting aquatic ecology, so these should be investigated during the planning of any silt-removal operation. If these are not feasible, then the downstream release of silt should be done gradually over a long period, to avoid sudden large-scale increases of suspended sediment; and this should be done in the rainy season to ensure maximum dilution and dispersal of the material.

Minimize impacts on aquatic ecology

A mandatory environmental flow $1.5m^3/s$ should be released from the dam at all times with the aim of maintaining the sustainability of the aquatic ecosystem downstream. This E-flow should be channelized to supply enough water to deep rock pool areas. At the same time care should be taken not to dam or block the water flow that comes through Thismada Ela, as this will provide an additional perennial flow to the area immediately below the dam and therefore assist in maintaining the ecosystem. However, it was noted during the field surveys that this water is currently pumped for some local usages, so it would be beneficial if CEB could investigate whether it would be possible to provide water from the reservoir for these purposes, to allow the full flow of this stream to flow into the river.

In reservoir projects, the anticipated impacts due to prevention of spawning migrations is often minimized by including in the dam an appropriate fish ladder or similar structure. In the case of the Moragolla project it must be borne in mind however, that good populations of all the migratory fish species are well established elsewhere within the same river catchments, and this reduces the significance of these impacts. For example the Knuckles forest range in the Mahaweli River catchments that come under Forest Department of Sri Lanka harbours viable populations of *Garra ceylonensis*, *Labeo fisheri*, *Systomus spilurus*, *Dawkinsia singhala*, *Belontia signata* and *Schistura notostigma* (Pethiyagoda 1991; Shirantha 2012*).*This area gives enough protection for the above endemic fish species. As such, construction of a fish ladder at this dam site is not considered to be compulsory.

The sensitive aquatic species in the proposed project area are already stressed due to excess sediment and debris in the water, water pollution from upper catchment anthropogenic activities, waste disposal and fishing pressure, and hence translocation of these important species to one of the secure sites mentioned in **Section 5.1.4** or another suitable location.

A limited capture, relocation and release programme was suggested in Section 5.1.8 as a means of ensuring survival of fish trapped in rock pools when the river is diverted to enable construction of the dam. As a less costly alternative to provision of a fish pass, consideration could be given to extending the capture and release programme over the long-term to incorporate fish that are migrating upstream to breed. Adults could be captured at the toe of the dam and released above the reservoir, from where they would be able to continue their migration, at least to the next upstream barrier, which is the Kotmale dam, about 6 km upstream from the Moragolla reservoir tail.

Minimize reduced dilution of pollutants discharged from the broiler farm

The issue of pollution from the Crysbro poultry factory is discussed in detail in the final report of the water quality study. Two mitigation measures are proposed: monitoring to ensure enforcement of stipulated discharge limits for Crysbro Broiler Farm wastewater; and relocation of Crysbro Broiler Farm outfall downstream of the proposed tailrace outlet to ensure effective dilution of the effluent once river flow is interrupted by the Moragolla scheme. At present, potential impacts on downstream water quality and ecology could be high due this wastewater discharge. Implementation of the above mitigation measures therefore will have a very significant positive impact on both river water quality and aquatic ecology.

Annexure

Annex 1

Terms of Reference (ToR)

TOR FOR AQUATIC ECOLOGY IN THE MAHAWELI GANGA

Objective

The EIA study described the ecology of the river, but descriptions consisted largely of lists of species and there was little discussion of the different types of habitats present in the river, their local distribution, the importance of the habitats and species, and how they may be affected by construction and operation of the dam, reservoir and power generation facility. Aquatic ecology is one of the environmental issues that can be most affected by hydropower schemes, so these issues need to be investigated in more detail.

Scope of work

The Contractor shall use a combination of methods to prepare. a) an overview of the aquatic ecology of the Mahaweli Ganga between the project site and Polgolla Diversion Weir, 30 km downstream; and b) a detailed account of the aquatic ecology of the Mahaweli Ganga in the immediate project area, from 500m above the confluence with the Kothmale oya (in both rivers) to 500m below the confluence with the Atabage Oya. The Contractor shall draw conclusions regarding the importance of the aquatic ecology in both areas (with reasons) and the likely impacts of constructing and operating the project.

a) Overview of Mahaweli Ganga

The Contractor shall obtain an overview of the aquatic ecology of the Mahaweli Ganga in the 30 km stretch downstream of the project site, by consulting published information and other data from government agencies, consultancy reports and other sources. This should be supplemented by reference to aerial photographs and satellite imagery (see b below), visual observations on site, interviews with local people, and discussions with experts from Peradeniya University.

b) Aquatic ecology of the project site

For the detailed ecological study, the Contractor shall first consult aerial photographs and satellite imagery to obtain a rough picture of the type and distribution of aquatic habitats in the river in the project area. This will be refined by site investigations, including analyses of the type and distribution of river bed substrates and vegetation, supplemented by information obtained from local people, including sand miners.

Quantative analyses will then be conducted to describe the species present (flora and fauna) in each habitat type and average numbers of individuals of the major species in the different habitats. This will cover the aquatic habitats (sampled by fish nets, traps, plankton nets, etc) and river bed habitats (sampled by sediment grabs, quadrat sampling if feasible and other suitable methods). Quantitative surveys will be conducted twice; during low flows in February 2013 and at the start of the high flow season at the end of May 2013, to give an indication of seasonal variations.

Programme and Reporting

The Contractor shall submit a draft Interim Report on 31st March 2013 and a draft Final Report on 7 June 2013. Both reports will be reviewed by the Study Team and the

Contractor shall amend the reports to address all comments and shall submit final reports within two weeks of receipt of comments.

The Interim Report shall present and discuss all data collected up to that time and the Final Report shall present all data and shall include the following:

A map of the survey area showing sampling stations; site photographs, aerial photographs and satellite imagery; and appropriate tables and illustrations of key data, including a map showing the distribution of habitats and species in area b;

Written descriptions of all sampling, analysis and species identification methods;

A detailed discussion of the results, including but not necessarily limited to:

i) The aquatic ecology of the Mahaweli Ganga (area a) and its importance (with reasons);
ii) Potential impacts of operation of the completed hydropower scheme on aquatic ecology in area a (flow characteristics will be shown by a hydrological simulation study to be conducted in January 2013).
iii) The aquatic ecology of the immediate project area (area b) including the distribution and importance (with reasons) of the main habitats and species and seasonal variations.
iv) The manner in which the habitats and species are likely to be affected by construction and operation of the dam, reservoir and hydropower scheme (operational conditions shown by the January 2013 hydrological simulation);
v) Suitable mitigation for any negative impacts of construction and operation of the project on aquatic ecology in areas a and b;

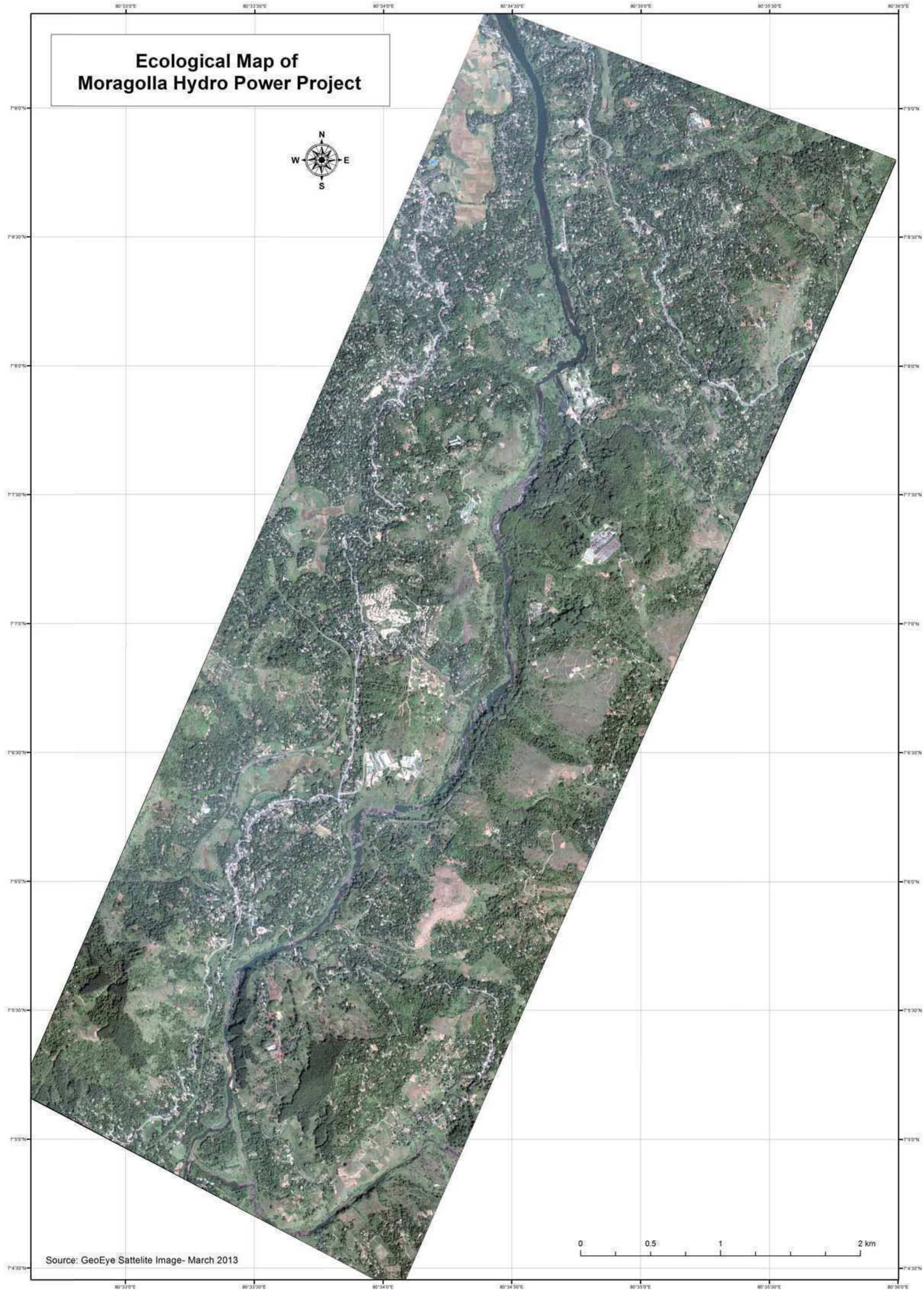
Discussions shall refer to published literature where relevant and the importance of species, habitats and overall ecology shall be assessed on the basis of conservation status, abundance elsewhere in Sri Lanka, the local economy and other relevant criteria.

Discussions should describe existing conditions, then potential impacts of construction and proposed mitigation, and then potential impacts of scheme operation and proposed mitigation;

Tables showing all data should be provided in an appendix.

Annex 2

Satellite image of the proposed Morogolla Hydropower project


Ecological Map of
Moragolla Hydro Power Project
N
W
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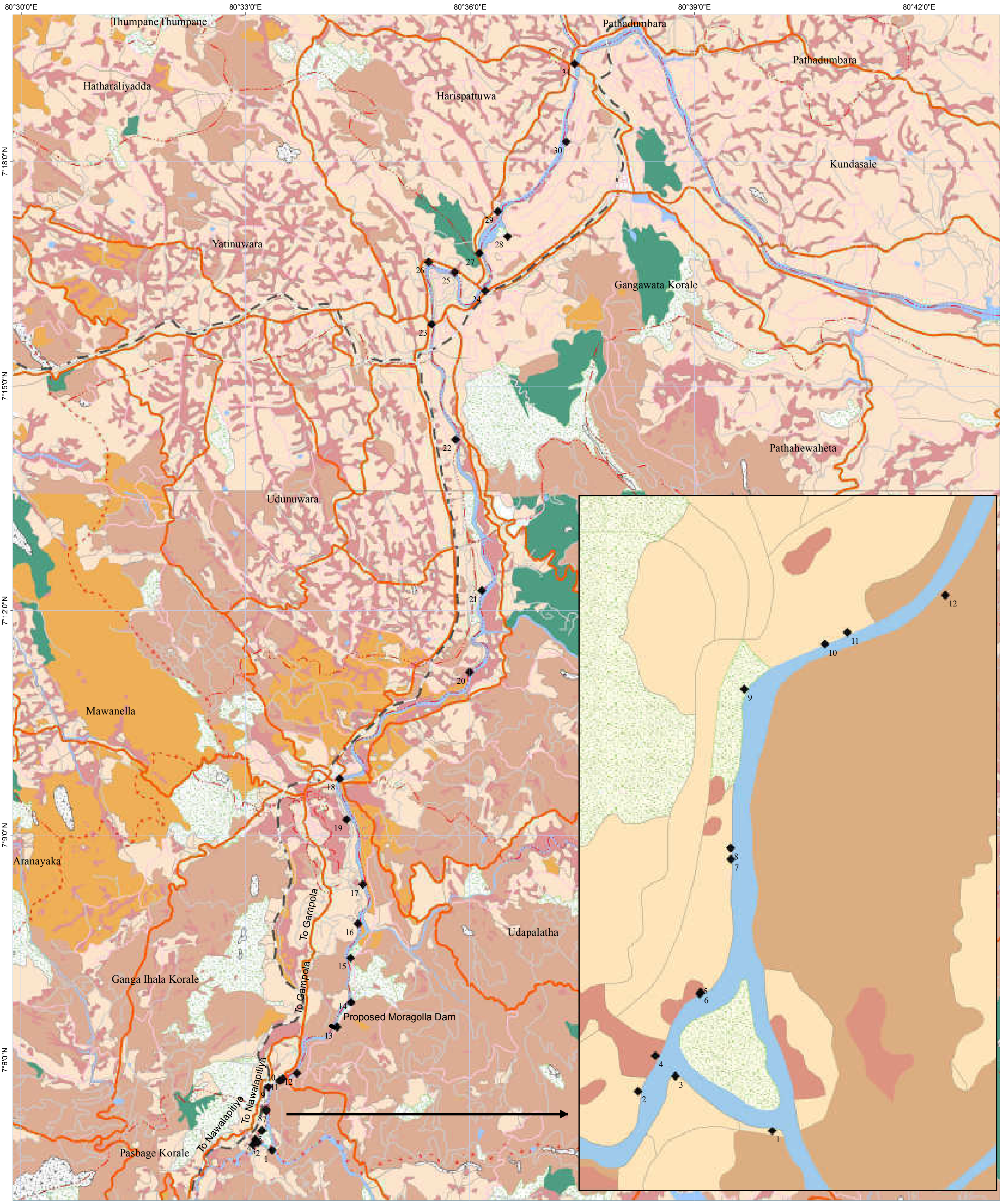
0
0.5
1
2 km
Source: GeoEye Sattelite Image- March 2013

Annex 3

Map - Aquatic ecological survey sites of Moragolla Hydro Power Project

Aquatic Ecological Survey Sites of Moragolla Hydropower Project

March, 2013



Legend

◆ Aquatic Ecology Sampling Site	Minor Road	Coconut	Rubber
Province Boundary	Jeep track	Forest	Rock
District Boundary	Rail Road	Homesteads	Water Body
D.S. Div. Boundary		Marshy Lands	Scrub
Main Road		Paddy	Tea

Name of the Sample Sites

1. Polwathura
2. Pallegama
3. Piliwela
4. Confluence
5. Mahaweli Tea Plantation
6. Balli Bridge
7. Forest Site 1
8. Forest Site 2
9. Forest Site 3
10. Bridge
11. Industrial Estate
12. Weliganga
13. Dam Site
14. Downstream, Dam Site
15. Ethgala
16. Camp Site
17. Sand mining Site
18. Gampola Town
19. Maligapura
20. Geli Oya
21. Kalugamuwa
22. Ganethenne
23. Peradeniya Bridge
24. Suspending Bridge
25. Gannoruwa
26. Botanical Garden
27. Warathenna 1
28. Warathenna 2
29. Hal-Oluwa Suspending Bridge
30. Gohagoda

Km 0 1 2 4

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Annex 4

Photographs of habitats

Fig.1: Disturbed rocky terrain, 500m upstream the Kothmale Oya (Site 1)

Fig. 2: Existing shallow rock pools, good breeding grounds for aquatic fauna (Site1)

Fig.3: Eroded river bank in Pellegama area (Site 2)

Fig. 4: The confluence of Kothmale Oya (Site 4)

Fig. 5: Intrusion of water during the rainy season on to the river banks - Bailey bridge

Fig. 6: Accumulation of garbage washed down from upstream (Site 7)

Fig.7:Typical habitat of *Labeo fisheri* (Site 8)

Fig. 8: Rock pool with small riffle (Site 9)

Fig. 9: Small islets in the river (Site 14)

Fig.10: River narrowing and forest area

Fig. 11: Sand mining site (Site 17)

Fig. 12: Flowing water between Kalugamuwa and Peradeniya (Site 21)

Fig.13: Rocky river – Gatembe/ Warathenna (Site 28)

Fig.14:Rocky river – Gohagoda (Site 30)

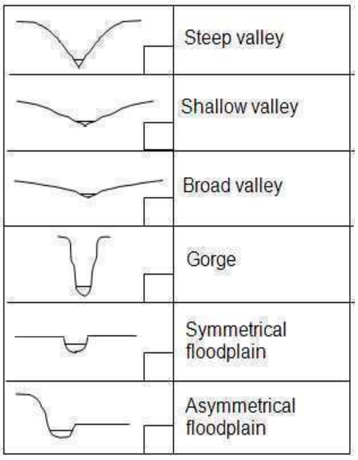
Annex 5

River habitat assessment criteria

River Habitat Assessment Criteria

River Habitat Assessment Criteria adapted from River Habitat Audit Procedure (Anderson 1993a), AUSRIVAS (Australian River Assessment standards) Parsons *et al.* (2001), the Index of stream conditions (Ladson & White, 1999) and (David Allan, 1998).

1. Valley shape



2. Floodplain features

NO
Sampling site has no distinct floodplain

Oxbows / billabongs
Body of water occupying a former river meander, isolated by a shift in the stream channel

Remnant channels
Formed during a previous hydrological regime. May be in-filled with sediment

Flood channels
A channel that distributes water onto the floodplain and off the floodplain during floods

Scroll systems
Short, crescentic strips or patches formed along the inner bank of a stream meander

Splays
Small alluvial fan formed where an overloaded stream breaks through a levee and deposits material on the floodplain

Floodplain scours
Scour holes formed by the concentrated clearing and digging action of flowing water

No floodplain features present
Floodplain present at the sampling site but does not contain any of the above features

3. Riparian zone composition

Assess for entire sampling site

	% Cover
Trees (>10m in height)	______
Trees (<10m in height)	______
Shrubs	______
Grasses / ferns / sedges	______

4. Shading of channel

<5%
5 -25%
25-50%
50-75%
>75%

5. Extent of trailing bank vegetation

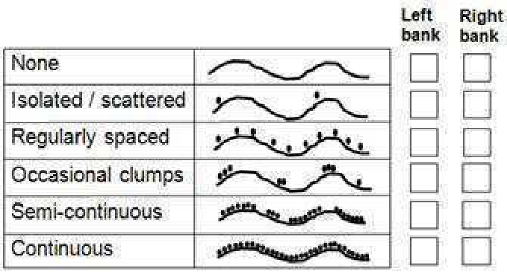
Nil
Slight
moderate
Extensive

6. Native and exotic riparian vegetation

Native %
Exotic %

7. Longitudinal extent of riparian vegetation

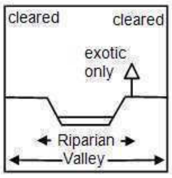
Choose one category for each bank. Do not include ground layer except where site is in native grassland.



8. Overall vegetation disturbance rating

Sites with valley vegetation cleared on BOTH sides, but with riparian vegetation in good condition should be scored in the high disturbance category. Words within the drawings summaries the detailed text about the state of the riparian and valley vegetation for each category.

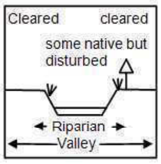
Extreme disturbance



Riparian vegetation – absent or severely reduced. Vegetation is extremely disturbed (ie. dominated by exotic species with native species rare or completely absent)

Valley vegetation – agriculture and/or cleared land BOTH sides. Plants present are virtually all exotic species (willows, pines etc.)

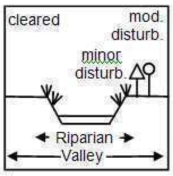
Very high disturbance



Riparian vegetation – some native vegetation present, but it is severely modified BOTH sides by grazing or the intrusion of exotic species. Native species severely reduced in number and cover.

Valley vegetation – agriculture and/or cleared land BOTH sides. Plants present are virtually all exotic species (willows, pines etc.)

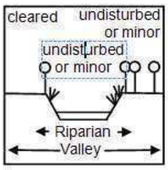
High disturbance



Riparian vegetation – moderately disturbed by stock or through the intrusion of exotic species, although some native species remain

Valley vegetation – agriculture and/or cleared land ONE side, native vegetation on the other side clearly disturbed or with a high percentage of introduced species present

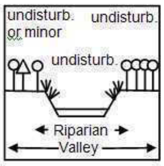
Moderate disturbance



Riparian vegetation – native vegetation on BO sides with canopy intact or with native species widespread and common in the riparian zone. T intrusion of exotic species is minor and of mode impact

Valley vegetation – agriculture and/or cleared l on ONE side, native vegetation on the other in reasonably undisturbed state

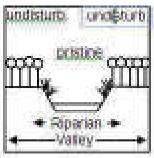
Low disturbance



Riparian vegetation – native vegetation present on BOTH sides of the river and in relatively good condition with few exotic species present. Any disturbance present is relatively minor.

Valley vegetation – native vegetation present on BOTH sides of the river, with a virtually intact canopy and few exotic species

Very low disturbance

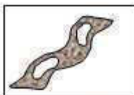
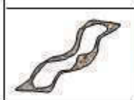
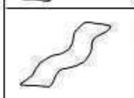


Riparian vegetation – native vegetation present on BOTH sides of the river and in an undisturbed state. Exotic species are absent or rare. Representative of natural vegetation in excellent condition

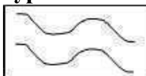
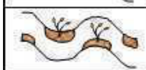
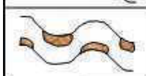
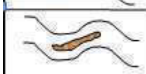
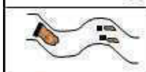
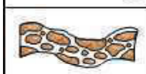
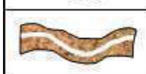
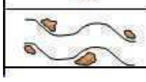
Valley vegetation – native vegetation present on BOTH sides of the river with an intact canopy. Exotic species are absent or rare. Representative of natural vegetation in excellent condition

9. Physical barriers to local fish passage

each flow condition

		Base flow	Low flow	High flow
	No passage	☐	☐	☐
	Very restricted passage	☐	☐	☐
	Moderately restricted passage	☐	☐	☐
	Partly restricted passage	☐	☐	☐
	Good passage	☐	☐	☐
	Unrestricted passage	☐	☐	☐

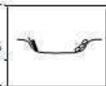
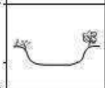
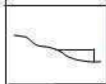
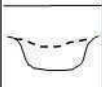
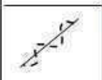
10. Type of bars

	Bars absent
	Side/point bars VEGETATED
	Side/point bars UNVEGETATED
	Mid-channel bars VEGETATED
	Mid-channel bars UNVEGETATED
	Bars around obstructions
	Braided channel
	Unfiled channel
	High flow deposits

11. Dominant particle size on bars

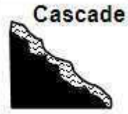
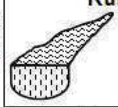
Boulder >256 mm	Cobble 64-256 mm	Pebble 32-64 mm	Gravel 4-16 mm	Sand 0.126-1 mm	Silt/clay < 0.063 mm

12. Channel modifications

	No modifications		Reinforced
	Disengaged		Re-vegetated
	Dams and diversions		In-filled
	Re-sectioned		Berms or embankments
	Straightened	Signs of work still visible	Recently channelized
	Realigned	Works old and re-vegetated	Channelized in the past

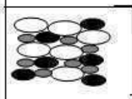
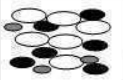
13. Extent of bed-form features

Total % composition for all features must equal 100%

Height >1m Gradient >60°	**Waterfall** 	Gradient 1-3° Small currents Surface unbroken and smooth	**Glide** 
Step Height <1m Gradient 5-60° Strong currents	**Cascade** 	Gradient 1-3° Small but distinct & uniform current Surface unbroken	**Run** 
Gradient 3-5° Strong currents Rocks break surface	**Rapid** 	Area where stream widens or deepens and current declines	**Pool** 
Gradient 1-3° Moderate currents Surface unbroken but unsmooth	**Riffle** 	A reasonable sized (>20% of channel width) cut-off section away from the channel	**Backwater** 

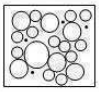
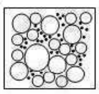
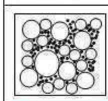
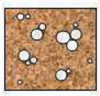
14. Bed compaction

Choose one category only

	Tightly packed, armoured Array of sediment sizes, overlapping, tightly packed and very hard to dislodge
	Packed, un-armoured Array of sediment sizes, overlapping, tightly packed but can be dislodged with moderate effort
	Moderate compaction Array of sediment sizes, little overlapping, some packing but can be dislodged with moderate effort
	Low compaction (1) Limited range of sediment sizes, little overlapping, some packing and structure but can be dislodged very easily
	Low compaction (2) Loose array of fine sediments, no overlapping, no packing and structure and can be dislodged very easily

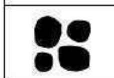
15. Sediment matrix

Choose one category only

	Bedrock
	Open framework 0-5% fine sediment, high availability of interstitial spaces
	Matrix filled contact framework 5-32% fine sediment, moderate availability of interstitial spaces
	Framework dilated 32-60% fine sediment, low availability of interstitial spaces
	Matrix dominated >60% fine sediment, interstitial spaces virtually absent

16. Sediment angularity

Choose one category only
Assess cobble, pebble and gravel fractions only

	Very angular
	Angular
	Sub-angular
	Rounded
	Well rounded
	Cobble, pebble and gravel fractions not present

17. River substrate composition

Bedrock	________
Boulder (>256mm)	________
Cobble (64-256mm)	________
Pebble (16-64mm)	________
Gravel (2-16mm)	________
Sand (0.06-2mm)	________
Fines (silt and clay <0.06mm)	________

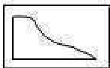
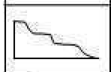
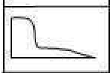
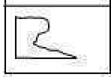
Total 100%

18. Bed stability rating

Severe erosion	Moderate erosion	Bed stable	Moderate deposition	Severe deposition
Streambed scoured of fine sediments. Signs of channel deepening. Bare, severely eroded banks. Erosion heads. Steep streambed caused by erosion.	Little fine sediment present. Signs of channel deepening. Eroded banks. Streambed deep and narrow. Steep streambed comprised of unconsolidated (loosely arranged and unpacked) material	A range of sediment sizes present in the streambed. Channel is in a 'relatively natural' state (not deepened or infilled). Bed and bar sediments are roughly the same size. Banks stable. Streambed comprised of consolidated (tightly arranged and packed) material.	Moderate build-up of fine sediments at obstructions and bars. Streambed flat and uniform. Channel wide and shallow.	Extensive build up of fine sediments to form a flat bed. Channel blocked, but wide and shallow. Bars large and covering most of the bed or banks. Streambed comprised of unconsolidated (loosely arranged and unpacked) material.

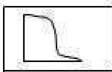
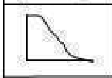
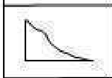
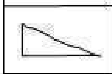
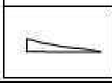
19. Bank shape

Choose one category for each bank

		Left bank	Right bank
	Concave	☐	☐
	Convex	☐	☐
	Stepped	☐	☐
	Wide lower bench	☐	☐
	Undercut	☐	☐

20. Bank slope

Choose one category for each bank

		Left bank	Right bank
	Vertical 80 - 90°	☐	☐
	Steep 60 - 80°	☐	☐
	Moderate 30 - 60°	☐	☐
	Low 10 - 30°	☐	☐
	Flat <10°	☐	☐

21. Bank material Assess % composition for each

	Left bank	Right bank
Bedrock	____	____
Boulder (>256mm)	____	____
Cobble (64-256mm)	____	____
Pebble (16-64mm)	____	____
Gravel (2-16mm)	____	____
Sand (0.06-2mm)	____	____
Fines (silt and clay, <0.06mm)	____	____

Total 100% each

22. Macrophyte cover in bank

Overall % cover of native macrophyte

Overall % cover of exotic macrophyte

Annex 6

River habitat assessment Results of each study site - Mahaweli River

River habitat assessment of each study site- Mahaweli River

River habitat assessment of the each study site at Mahaweli River (K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4-Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence and MP; site 17–Mahawli Proper 500 m downstream after Atabage Oya confluence)

Criteria	Location						
	K **Site 1 & 3**	**M** **Site 2**	**MK** **Site 4**	**PR** **Site 5, 6, 7, 8, 9, 10**	**IDA** **Site 11, 12, 13, 14, 15,**	**MA** **Site 16**	**MP** **Site 17**
1. Valley shape	Shallow	broad	broad	Varies as a broad, asymmetrical floodplain and shallow	gorge	shallow	Shallow
2. Floodplain features	Remnant channels	Remnant channels	Remnant channels	Splays	Floodplain scours	Floodplain scours	Flood channels
3. Riparian zone composition	Trees > 10m 25% Tress < 10m 40% Shrubs 10% Grass/ferns/sedges 25%	Trees > 10m 20% Tress < 10m 25% Shrubs 15% Grass/ferns/sedges 40%	Trees > 10m 25% Tress < 10m 35% Shrubs 30% Grass/ferns/sedges 10%	Trees > 10m 45% Tress < 10m 30% Shrubs 10% Grass/ferns/sedges 15%	Trees > 10m 45% Tress < 10m 20% Shrubs 30% Grass/ferns/sedges 5%	Trees > 10m 30% Tress < 10m 40% Shrubs 20% Grass/ferns/sedges 10%	Trees > 10m 25% Tress < 10m 40% Shrubs 20% Grass/ferns/sedges 15%
4. Shading of channel	5 -25%	5 -25%	5 -25%	50-75%	>75%	5 -25%	5 -25%
5. Extent of trailing bank vegetation	Slight	Slight	Slight	moderate	moderate	Slight	Slight
6. Native and exotic riparian vegetation	Native 55% Exotic 45%	Native 60% Exotic 40%	Native 65% Exotic 35%	Native 95% Exotic 5%	Native 60% Exotic 40%	Native 75% Exotic 25%	Native 65% Exotic 35%
7. Longitudinal extent of riparian vegetation	Occasional clumps L Isolated/scattered R	Semi continuous L Isolated/scattered R	Semi continuous L Occasional clumps R	Semi continuous L Semi-continuous R	Occasional clumps L Semi-continuous R	Semi continuous L Semi continuous R	Occasional clumps L Isolated/scattered R
8. Overall vegetation disturbance rating	High disturbance	High disturbance	High disturbance	Moderate disturbance	Low disturbance	Moderate disturbance	High disturbance
9. Physical barriers to local fish passage	B Moderately restricted L Partly restricted H Good	B Moderately restricted L Partly restricted H Good	B Partly restricted L Good H Good	B Very restricted L Moderately restricted H Moderately restricted	B Very restricted L Very restricted H Moderately restricted	B Good L Partly restricted H Good	B Good L Partly restricted H Unrestricted
10.Type of bars	Mid channel bar vegetated	Mid channel bar vegetated	Side/pointed bar vegetated	Mid channel bar vegetated	Side/pointed bar vegetated	Mid channel bar un-vegetated	Side/pointed bar vegetated

11. Dominant particle size on bars	Boulder and Silt/clay	Cobble and Silt/clay	Cobble and Gravel	Boulder, Pebble Cobble	Boulder	Boulder and Cobble	Boulder and Cobble
12. Channel modifications	Re-sectioned	Re-sectioned	Re-sectioned	Re-sectioned	Re-sectioned	Dam and diversion (Dunhida irrigation canal)	Dam and diversion (Polgolla)
13. Extent of bed-form features	Pool 85 % Backwaters 15%	Glide 90% Backwaters 10%	Riffle 65% Run 25% Backwaters 10%	Rapid 30% Glide 40% Run 20% Pool 10%	Waterfall 5% Cascade 20% Rapid 20% Riffle 15% Pool 40%	Riffle 30 % Glide 30% Run 30% Pool 10%	Glide 60% Run 40%
14. Bed compaction	Tightly packed armoured	Low compaction 2	Moderate compaction	Tightly packed armoured	Tightly packed armoured	Moderate compaction	Moderate compaction
15. Sediment matrix	Framework dilated	Framework dilated	Framework dilated	Framework dilated	Bed rock	Open framework	Open framework
16. Sediment angularity	Well rounded	Well rounded	Well rounded	Well rounded	Well rounded	Well rounded	Well rounded
17. River substrate composition	Bed rock 60% Boulder 20% Cobble 5% Pebble 3% Gravel 4% Sand 3% Fines 5%	Bed rock 5% Boulder 15% Cobble 30% Pebble 20% Gravel 10% Sand 5% Fines 15%	Bed rock 10% Boulder 8% Cobble 50% Pebble 12% Gravel 5% Sand 10% Fines 5%	Bed rock 35% Boulder 18% Cobble 10% Pebble 20% Gravel 5% Sand 12%	Bed rock 95% Boulder 5%	Bed rock 15% Boulder 25% Cobble 35% Sand 15% Fines 05%	Bed rock 5% Boulder 10% Cobble 25% Pebble 5% Gravel 10% Sand 45%
18. Bed stability rating	Moderate erosion	Moderate erosion	Moderate erosion	Moderate erosion	Bed stable	Moderate erosion	Moderate erosion
19. Bank shape	Concave	Concave	Concave	Stepped	Wide low bench	Concave	Concave
20. Bank slope	Flat	Flat	Low	Moderate	Steep	Flat	Low
21. Bank material Assess % composition for each	Bed rock 10% Boulder 5% Cobble 5% Pebble 5% Gravel 5% Sand 20% Fines 50%	Bed rock 10% Boulder 40% Cobble 10% Pebble 5% Gravel 5% Sand 10% Fines 20%	Bed rock 15% Boulder 5% Cobble 15% Pebble 5% Gravel 25% Sand 25% Fines 10%	Bed rock 20% Boulder 20% Cobble 15% Pebble 10% Gravel 10% Sand 15% Fines 10%	Bed rock 80% Boulder 10% Sand 5% Fine 5%	Bed rock 20% Boulder 10% Gravel 50% Sand 15% Fines 5%	Bed rock 5% Pebble 35% Gravel 10% Sand 30% Fines 20%
22. Macrophyte cover in bank	Native 60% Exotic 40%	Native 40% Exotic 60%	Native 30% Exotic 70%	Native 20% Exotic 80%	Native 10% Exotic 90%	Native 15% Exotic 85%	Native 5% Exotic 95%

Annex 7

Aquatic plants in the study sites in Mahaweli River

Table 1: list of the aquatic plants in the study sites in Mahaweli River

(Status; IN: Indigenous, E: Endemic and EX: Exotic, NCS - National Conservation Status: GCS – Global Conservation Status, LC – Least Concern, NT- Near Threatened, VU – Vulnerable, EN – Endangered, CR – Critically Endangered, DD – Data Deficient, LR/cd – Low Risk/conservation dependent, K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence and MPD–Mahaweli River at 30 km stretch downstream to Polgolla weir)

Species				Red list 2012		Location						
Scientific name	**Common English name**	**Local name**	**Status**	**NCS**	**GCS**	**K**	**M**	**MK**	**PR**	**IDA**	**MA**	**MPD**
Family Aponogetonaceae												
Aponogeton crispus	Wavy-edged Aponogeton	Kekatiya	IN	VU	LC							+
Family Alismataceae												
Limnophyton obtusifolium	Blunt Arrowhead		IN	LC	LC				+			+
Family Araceae												
Cryptocoryne becketti	Water trumpet	Athi-Udiyan	E	VU								+
Cryptocoryne parva	Micro Crypt	Athi-Udiyan	E	EN								+
Cryptocoryne undulata	Crypt	Athi-Udiyan	E	CR								+
Cryptocoryne walkeri	Crypt walker	Athi-Udiyan	E	CR								+
Cryptocoryne willisii	Crypt	Athi-Udiyan	E	CR								+
Lagenandra ovata	Malayan Sword	Kethala	IN	LC	LC	+	+	+	+			+
Family Hydrocharitaceae												
Hydrilla verticillata	Hydrilla	Diya Sarupa	IN	LC	LC	+	+	+	+		+	+
Vallisneria spiralis	Mini Twister		EX			+	+	+			+	+
Blyxa aubertii	Roundfruit Blyxa	Diya Hawariya	IN	LC		+	+	+			+	+
Family Typhaceae												
Typha angustifolia	Great Reedmace		EX						+			
Family Potamogetonaceae												
Potamogeton pectinatus	Sago Pondweed		IN	LC		+					+	+
Family Podostemaceae												
Farmeria metzgeriodes			E	VU								+
Polypleurum elongatum			E	VU								+
Zeylanidium subulatum			IN	EN								+
Zeylanidium olivaceum			IN	EN								+
Family Lemnaceae												**+**
Lemna minor.	Duck weed		EX			+	+	+			+	+
FamilyPontederiaceae												
Eichhornia crassipes	Water hyacinth	Japan Jabara	EX									+

Annex 8

Taxonomic groups of plankton in the study sites in Mahaweli River

Table 1 list of the phytoplankton taxa in the study sites in Mahaweli River

(K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence)

Taxa	Location					
	K	M	MK	PR	IDA	MA
Cyanophyceae						
Lyngbya		+				
Rivularia	+					
Scytonema			+	+	+	
Bacillariophyceae						
Achnanthes	+					
Asterionella	+	+				+
Coscinodiscus	+			+	+	
Cymbella		+			+	+
Navicula	+	+	+	+	+	+
Diatoma		+	+	+	+	+
Pinnularia	+	+	+	+	+	+
Stauroneis	+		+	+	+	+
Surirella	+	+		+		
Chlorophyceae						
Bulbochaete			+			
Chaetophora				+	+	
Chaetophora			+			
Closmarium	+	+				+
Costerium	+	+	+	+	+	+
Desmidium	+	+	+	+	+	+
Euastrum	+					
Micrasterias	+					+
Microspora	+		+	+		
Netrium		+		+		+
Oedogonium		+				
Pediastrum	+	+	+	+	+	+
Sorastrum	+	+	+	+		+
Spirogyra	+	+	+	+	+	+
Zygnema	+	+	+	+	+	

Table 2 list of the zooplankton taxa in the study sites in Mahaweli River

(K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence)

Taxa	Location					
	K	M	MK	PR	IDA	MA
Phylum Protozoa						
Acanthocytis	+		+	+	+	+
Actinosphaerium			+	+	+	+
Paramecium	+	+				
Phylum Rotifera						
Conochilus						
Kellioittia	+		+	+	+	
Lecane			+	+	+	
Rotaria	+	+	+	+	+	
Phylum Arthropoda						
Class Crustacea						
Brachiopoda	+	+	+	+	+	+
Malacostraca	+	+	+	+	+	+
Copepoda	+	+	+	+	+	+
Class Insecta						
Dipteran larvae	+	+	+	+	+	+
Coleopteran larvae	+	+	+	+	+	+

Annex 9

Taxonomic groups of fauna in the study sites in Mahaweli River

Different taxonomic groups of fauna in the study sites in Mahaweli River

Table 1: list of different taxonomic groups of invertebrate fauna and their estimated abundance (number of individuals/cm^3) in the study sites in Mahaweli River

(K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, MBCK; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence)

Taxonomic group	Common English name	Location/site K	M	MK	PR	IDA	MA
Phylum Platyhelminthes	Flatworms						
Turbellaria		0.20				0.11	0.05
Phylum Nematoda	Roundworms						
Anguina tritici		0.10	-	-	-	-	0.01
Phylum Annelida	Earthworms and leeches						
Class Oligochaeta	Aquatic earthworms						
Family Aeolosomatidae							
Aeolosoma ternarium		0.75	0.17	-	0.05	-	-
Family Naididae							
Dero sp.		0.37	-		-	-	0.06
Class Hirudinea							
Placobdella emydae		0.03	-	0.24	-	0.13	0.34
Phylum Mollusca							
Class Gastropoda	Snails and Mussels						
Family Thiaridae							
Paludomus chilinoides		0.31	0.10	0.38	0.21	0.03	0.04
P. loricatus							0.08
Melanoides tuberculata		0.08	0.72	0.09	1.02	-	0.03
Family Paludestrinidae							
Bithynia sp.		-	-	0.91	-	-	-
Family Pilidae							
Pila globosa		0.04	-	0.03	-	-	-
Family Lymnaeidae							
Lymnaea sp.		0.05	-	-	-	0.01	-
Family Panorbiddae							
Indoplanorbis sp.		0.01	0.81	-	-	-	-
Family Unionidae							
Lamellidens sp.		0.06	-	-	-	-	-
Class Crustacea							
Sub class Cladocera							
Diaphanosoma sp.		-	17	-	-	-	51

Leptodora kindtii		27	-	-	11	-	--
Sub-class Copepoda							
Diaptomus sp.		12	14	19	-	-	-
Cyclops sp.		13	-	-	15	13	-
Order Decapoda							
Caridina sp.		0.51	0.90	0.94	0.34	1.86	1.43
Macrobrachium rosenbergii		0.27	0.31	-	-	-	-
Perbrinckia sp.		0.45	0.31	0.41	-	0.57	-
Class Insecta							
Family Nepidae	Water Scorpions						
Laccotrephes grossus		0.02	0.13	-	0.20	-	-
Family Ranatridae	Water stick Insects						
Ranatra filiformis							
Family Belostomatidae	Giant Water Bug						
Lethocerus sp.		0.02	-	-	-	-	-
Family Naucoridae	Creeping Water bug						
Naucoris scutellaris		-	.020	-	-	0.59	-
Family Helotrephidae	Backswimmers						
Tiphortephes indicus		-	-	0.23	0.71	-	-
Family Notonectidae							
Anisops barbata		0.03	-	-	-	-	1.02
Family Corixidae	Water Boatmen						
Micronecta sp.		-	-	0.07	-	0.04	-
Family Gerridae	Water Striders						
Gerris adelaids		0.40	1.38	-	0.87	-	-
Order Coleoptera	Beetles						
Family Dytiscidae	Diving beetles						
Copelatus sp.		0.02	-	-	-	0.17	-
Hydraticus facificus		0.21	-	0.03	0.21	-	-
Cybister confusus		0.67	0.23	0.05	0.35	-	-
Family Gyrinidae	Whirligig Beetles						
Gyrinus convexiusculus		-	-	-	1.2	-	0.17
Dipteran larvae	True mosquitoes	0.82	0.21	0.08	-	-	-

Table 2 list of the dragonflies and damselflies fauna in the study sites in Mahaweli River

(Status; IN: Indigenous, E: Endemic and EX: Exotic, NCS - National Conservation Status: GCS – Global Conservation Status, LC – Least Concern, NT- Near Threatened, VU – Vulnerable, EN – Endangered, CR – Critically Endangered, DD – Data Deficient, LR/cd – Low Risk/conservation depend, K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence and MPD–Mahaweli River at 30 km stretch downstream to Polgolla weir)

Species			Redlist 2012		Location						
Scientific name	**Common English name**	**Status**	**NCS**	**GCS**	**K**	**M**	**MK**	**PR**	**IDA**	**MA**	**MPD**
Family Calopterygidae											
Neurobasis chinensis	Oriental Green wing	IN	VU	LC	+	+	+	+	+	+	+
Vestalis apicalis	Black-tipped Flashwing	E	VU	LC	+	+	+	+	+	+	+
Family Chlorocyphidae											
Libellago adami	Sri Lanka Adam's Gem	E	VU		+	+	+	+		+	+
Libellago finalis	Sri Lanka Ultima Gem	E	VU				+	+	+	+	
Libellago greeni	Sri Lanka Green's Gem	E	EN				+	+			
Family Euphaeidae											
Euphaea splendens	Sri Lanka Shining Gossamer wing	E	NT		+	+	+	+	+	+	+
Family Lestidae											
Indolestes gracilis	Mountain Reedling	E	VU	LC	+	+	+	+	+	+	+
Family Coenagrionidae											
Agriocnemis pygmaea	Wandering Wisp	IN	LC	LC	+	+	+	+		+	+
Ischnura aurora	Dawn Blue tail	IN	NT	LC	+	+	+	+		+	+
Ischnura senegalensis	Common Blue tail	IN	LG		+	+	+	+	+	+	+
Family Libellulidae											
Crocothemis servilia	Oriental Scarlet	IN	LC	LC	+	+	+				+
Indothemis carnatica	Light Tipped Demon	IN	NT	LC			+				+
Neurothemis tullia	Pied Paraso	IN	LC	LC	+	+	+	+	+	+	+
Orthetrum pruinosum	Pink Skimmer	IN	NT	LC	+	+	+	+			+
Orthetrum Sabina	Green Skimmer	IN	LC	LC	+	+	+	+			+
Orthetrum triangulare	Triangle Skimmer	IN	EN	LC	+	+	+				
Sympetrum fonscolombii	Red-Veined Darter	IN	EN	LC			+	+			
Trithemis aurora	Crimson Dropwing	IN	LC	LC		+	+	+		+	+
Trithemis festiva	Indigo Dropwing	IN	LC	LC	+	+	+				+
Family Gomphidae											
Paragomphus henryi	Sri Lanka Brook Hooktail	E	EN	NT				+		+	

Table 3 list of the fish species in the study sites in Mahaweli River

(Status; IN: Indigenous, E: Endemic and EX: Exotic, NCS **-** National Conservation Status: GCS – Global Conservation Status, LC – Least Concern, NT**-** Near Threatened, VU – Vulnerable, EN – Endangered, CR – Critically Endangered, DD – Data Deficient, LR/cd – Low Risk/conservation depend, K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence, MPD–Mahaweli River at 30 km stretch downstream to Polgolla weir)

	Species			Redlist 2012		Location						
Scientific name	**Common English name**	**Local Name**	**Status**	**NCS**	**GCS**	**K**	**M**	**MK**	**PR**	**IDA**	**MA**	**MPD**
Family Anabantidae												
Anabas testudineus	Climbing perch	Kawaiya	IN	LC	DD	+	+	+			+	+
Family Anguillidae												
Anguilla bicolor	Level finned eel	Kalu Anda	IN	LC	LC	+	+	+	+		+	+
Anguilla nebulosa	Long finned eel	Polmal Anda	IN	LC	LC	+	+	+	+		+	+
Family Aplocheilidae												
Aplocheilus parvus	Dwarf panchax	Udda	IN	LC		+	+	+				+
Family Bagridae												
Mystus seengi	Yellow catfish	Path Ankutta	IN	LC		+	+	+			+	+
Mystus vittatus	Striped dwarf catfish	Iri Ankutta	IN	LC		+	+	+			+	+
Family Balitoridae												
Schistura notostigma	Banded mountain loach	Kandu Ehirawa	E	NT		+	+	+	+	+	+	+
Family Belontiidae												
Belontia signata	Comb-tail	Thal Kossa	E	NT	LR/cd	+	+	+	+		+	+
Family Channidae												
Channa ara	Giant snakehead	Gan Ara	E	EN			+	+	+			+
Channa gachua	Brown snakehead	Paradel Kanaya	IN	LC		+	+	+				+
Channa orientalis	Smooth-breasted snakehead	Kola Kanaya	E	VU		+	+	+	+		+	+
Channa punctata	Spotted snakehead	Mada Kanaya	IN	LC		+	+	+			+	+
Channa striata	Murrel	Loola	IN	LC		+	+	+			+	+
Family Cichlidae												
Etroplus maculatus	Orange chromide	Kaha Koraliya	IN	LC								+
Etroplus suratensis	Pearl spot	Mal Koraliya	IN	LC								+
Oreochromis mossambicus	Mozambique tilapia	Japan Koraliya	EX			+	+	+				+
Oreochromis niloticus	Nile tilapia	Nile-Tilapia	EX			+	+	+				+
Family Clariidae												
Clarias brachysoma	Walking catfish	Magura	E	NT		+	+	+				+
Clarias batrachus	Marble catfish	-	EX									+
Family Cobitidae												
Lepidocephalichthys thermalis	Common spiny loach	Ehirawa	IN	LC		+	+	+	+	+	+	+
Family Cyprinidae												
Amblypharyngodon melettinus	Silver carplet	Wevu Salaya	IN	LC								+
Catla catla	Catla	Catla	EX									+
Cirrhinus mrigala	Mrigal	Mirigala	EX									+
Cyprinus carpio	Common carp	Rata pethiya	EX			+	+		+	+		+

Dawkinsia singhala	Sri Lanka filamented barb	Dan Kola Pethiya	E	LC		+	+	+	+	+	+	+
Devario malabaricus	Giant danio	Dan Kola Salaya	IN	LC		+	+	+	+	+	+	+
Esomus thermoicos	Flying barb	Reul Dandiya	E	LC		+	+	+				+
Garra ceylonensis	Ceylon stone-sucker	Gal pandiya	E	VU		+	+	+	+	+	+	+
Labeo fisheri	Mountain/Green labeo	Gadeya	E	CR	EN					+	+	+
										(site 15)	(site 16)	
Labeo rohita	Rohu	Rohu	EX									+
Pethia melanomaculata	Fire fin barb	Thith Pathiya	E	VU			+	+				+
Pethia reval	Red fin barb	Rathu viral pethia	E	VU					+	+		
Pethia nigrofasciata	Black ruby barb	Bulat hapaya	E	VU					+			
Puntius bimaculatus	Redside barb	Ipilli Kadaya	IN	LC		+	+	+	+			+
Puntius dorsalis	Long snouted barb	Katu Kuriya	IN	LC		+	+	+	+	+	+	+
Puntius thermalis	Swamp barb	Kota Pethiya	E	LC		+	+	+	+			+
Puntius vittatus	Silver barb	Podi Pethiya	IN	LC								+
Rasbora dandia	Striped rasbora	Iri Dandiya	IN	LC		+	+	+	+	+	+	+
Systomus spilurus	Sri Lanka olive barb	Mas Pethiya	E	DD		+	+	+	+		+	+
Tor khudree	Mahseer	Leylla	IN	NT			+	+	+	+	+	+
Family Gobiidae												
Awaous melanocephalus	Scribbled goby	Bali Weligouwa	IN	LC		+	+				+	+
Glossogobius giuris	Bar eyed goby	Maha Weligouwa	IN	LC		+	+	+	+		+	+
Family Heteropneustidae												
Heteropneustes fossilis	Stinging catfish	Hunga	IN	LC		+	+	+				+
Family Loricaridae												
Pterygoplichthys multiradiatus	Sail fin catfish	Tanki Sudda	EX									+
Family Mastacembelidae												
Mastacembelus armatus	Marbled spiny eel	Gan Theliya	IN	LC		+	+	+	+	+	+	+
Family Osphronemidae												
Osphronemus goramy	Giant gourami	Teppiliya	EX				+				+	+
Family Poeciliidae												
Poecilia reticulata	Guppy	Guppi	EX			+	+	+	+		+	+
Family Siluridae												
Ompok bimaculatus	Butter catfish	Wala Poththa	IN	LC		+	+	+	+	+	+	+
Wallago attu	Shark catfish	Walaya	IN	EN	NT	+			+			+

Table 4 list of the aquatic/semi-aquatic reptiles in the study sites in Mahaweli River

(Status; IN: Indigenous, E: Endemic and EX: Exotic, NCS - National Conservation Status: GCS – Global Conservation Status, LC – Least Concern, NT- Near Threatened, VU – Vulnerable, EN – Endangered, CR – Critically Endangered, DD – Data Deficient, LR/cd – Low Risk/conservation depend, K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence and MPD–Mahaweli River at 30 km stretch downstream to Polgolla weir)

	Species			Redlist 2012		Location						
Scientific name	Common English name	Local name	Status	NCS	GCS	K	M	MK	PR	IDA	MA	MPD
Family Trionychidae												
Lissemys ceylonensis	Flap-shell turtle	Kiri Ibba	E	EN	LC		+	+				+
Family Vaqranidae												
Varanus salvator	Water monitor	Kabaragoya	IN	LC	LC	+	+	+	+		+	+
Family Natricidae												
Xenochrophis asperiimus	Checkered Keelback	Diya Polonga	E	LC	LC	+	+	+	+	+	+	+
						+	+	+	+	+	+	+

Table 5 list of the aquatic and associate avifauna in the study sites in Mahaweli River

(Status; IN: Indigenous, E: Endemic and EX: Exotic, NCS - National Conservation Status: GCS – Global Conservation Status, LC – Least Concern, NT- Near Threatened, VU – Vulnerable, EN – Endangered, CR – Critically Endangered, DD – Data Deficient, LR/cd – Low Risk/conservation depend, K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, M; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence and MPD–Mahaweli River at 30 km stretch downstream to Polgolla weir)

	Species			Redlist 2012		Location						
Scientific name	Common English name	Local name	Status	NCS	GCS	K	M	MK	PR	IDA	MA	MPD
Family Alcedinidae												
Alcedo atthis	Common Kingfisher	Mal Pilihuduwa	IN	LC	LC						+	+
Ceryle rudis	Pied Kingfisher	Gomara Pilihiduwa	IN	LC	LC						+	
Halcyon smyrnensis	White Throated kingfisher	Gela sudu Pilihuduwa	IN	LC	LC	+	+	+	+	+	+	+
Halcyon capensis	Stork-Billed kingfisher	Mana Hota Pilihuduwa	IN	LC	LC							+
Family Phalacrocoracidae												
Phalacrocorax niger	Little Cormorant	Punci Diyakawa	IN	LC	LC	+	+	+	+	+	+	+
Family Ardeidae												
Bubulcus ibis	Cattle Egret	Gawa-Koka	IN	LC	LC	+	+	+			+	+
Ardeola grayii	Indian Pond Heron	Kana Koka	IN	LC	LC						+	+
FamilyAccipitridae												
Spilornis cheela	Crested Serpent-eagle	Silu Sarappakussa	IN	LC	LC	+	+	+	+	+	+	+
Pernis ptilorhyncus	OrientelHoney-buzzard	Silu-Bambarakussa	IN	NT	LC	+	+	+	+	+	+	
Ictinaetus malayaensis	Black Eagle	Kalukussa	IN	NT	LC	+	+	+	+	+	+	
Haliastur indus	Brahminy Kite	Banumu Piyakussa	IN	LC	LC	+	+	+	+	+	+	
Haliaeetus leucogaster	White-bellied Sea Eagle	Kusa-Eli Mudukussa	IN	LC	LC					+	+	+

Table 6 list of the aquatic and associate Mammalian fauna in the study sites in Mahaweli River

(Status; IN: Indigenous, E: Endemic and EX: Exotic, NCS - National Conservation Status: GCS – Global Conservation Status, LC – Least Concern, NT- Near Threatened, VU – Vulnerable, EN – Endangered, CR – Critically Endangered, DD – Data Deficient, LR/cd – Low Risk/conservation depend, K; site1, 3-Kotmala Oya Before Confluence with Mahaweli River, MK; site 2– Mahaweli river Before Confluence with Kotmale Oya, MK; site 4- Mahaweli River-Kotmale Oya Confluence of, PR; site 5, 6, 7, 8,9, 10- Proposed Reservoir Area, IDA; site 11, 12, 13, 14,15–Immediate Dam Area, MA; site 16, Mahaweli River-Atabage Oya confluence nce and MPD–Mahaweli River at 30 km stretch downstream to Polgolla weir)

	Species			Redlist 2012		Location						
Scientific name	**Common English name**	**Local name**	**Status**	**NCS**	**GCS**	**K**	**M**	**MK**	**PR**	**IDA**	**MA**	**MPD**
Family Felidae												
Prionailurus rubiginosus	Rusty Spotted Cat	Kala Diviya	IN	EN	VU	+	+	+	+	+	+	+
Prionailurus viverrinus	Fishing Cat	Handun Diviya	IN	EN	VU	+	+	+	+	+	+	+
Family Mustelidae												
Lutra lutra	Eurasian Otter	Diya balla	IN	VU	NT	+	+	+	+	+	+	+

Annex 10

Photographs of some fauna and flora at the project site

Annexure 10

Photographic images of aquatic fauna and flora

Invertebrate fauna

Fig.1: *Neurothemis tullia*

Fig.2: *Orthetrum pruinosum*

Fig.3: *Vestalis apicalis*

Fig.4: *Orthetrum triangulare*

Fig.5: *Trithemis aurora*

Fig.7: *Laccotrephes* sp.

Fig.8: *Gerris adelaids*

Fig.9:*Anisops barbarata*

Fig.10: *Naucoris scutellaris*

Fig.11: *Paludomus chilinoides*

Fig.12: *Perbrinckia* sp.

Vertebrate fauna

Fig.13: *Euphlyctis cyanophyctis*

Fig.14: *Dawkinsia singhala*

Fig.15: *Garra ceylonensis*

Fig.16: *Belontia signata*

Fig.17: *Tor khudree*

Fig.18: *Labeo fisheri*

Indirect Signs of Mammals

Fig.19: Scat of an otter

Flora

Fig.20: *Vallisneria spiralis*

Fig.21*: Potamogeton pectinatus*

Fig.22: Potamogeton pectinatus

Annex 11

Photographs of a Peterson grab and a hand net

Photographs of a Peterson grab and a hand net

Fig. 1 Peterson grab

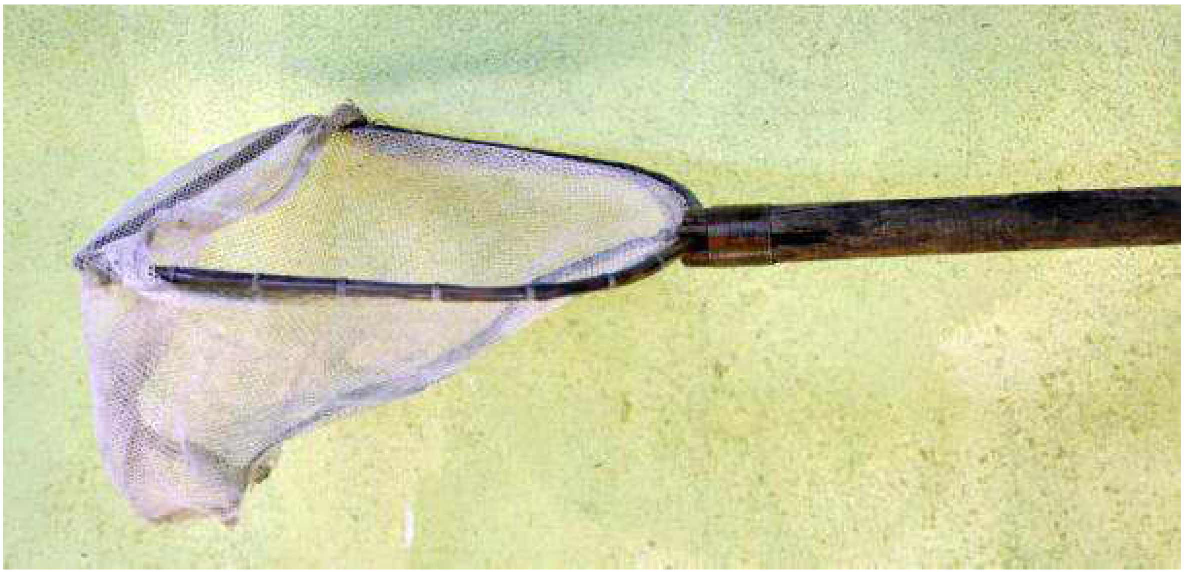


Fig. 2 a small net used to catch fish at the water's edges

Annex 12

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ADDITIONAL STUDIES ON NATURAL ENVIRONMENT FOR REVIEW OF FEASIBILITY STUDY AND PREPARATION OF DETAILED DESIGN AND BIDDING DOCUMENTS MORAGOLLA HYDROPOWER PROJECT SRI LANKA

Final Report 3

GROUNDWATER DISTRIBUTION AND QUALITY ALONG THE PROPOSED TUNNEL ROUTE OF THE MORAGOLLA HYDROPOWER PROJECT

Prepared by
The National Building Research Organization

Prepared for
NIPPON KOEI Co Ltd - Moragolla Hydropower Project

July 2013

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Contents

Annexure

List of Figures

Executive Summary

Introduction
The Ceylon Electricity Board (CEB), the institution responsible for electricity generation, transmission, distribution and retailing in Sri Lanka, plans to develop a new hydropower station in Moragolla, Kandy with a designed capacity of 30.0 MW. The proposed project involves construction of a 35 m high dam across the Mahaweli Ganga at Weliganga and a 3.1 km tunnel, surge shaft and penstock on the left bank of the river, plus a powerhouse and tailrace.

Nippon Koei Co. Ltd., the consultant appointed by CEB to review the feasibility study and prepare designs and bidding documents for the Moragolla Hydropower Project, appointed the National Building Research Organization (NBRO) to conduct additional studies on the natural environment. This is one of several studies conducted in order to update and upgrade the previous EIA study to comply with the ADB safeguard policy (Safeguard Policy Statement, ADB 2009).

The study investigated the distribution and quality of the groundwater located between the proposed dam site and the tailrace outfall, in the left bank of the Mahaweli Ganga, between the river and the Ulapane to Gampola Road. Subsurface strata, aquifer characteristics and the main directions of groundwater flow of the study area, likely impacts of construction of the tunnel and suitable mitigation measures for any negative impacts of tunnel construction on groundwater were also examined.

Description of the study area
The study area lies in the middle peneplain of Sri Lanka having heavily dissected ridges and valleys with steep rocky slopes, through which the river Mahaweli flows in the North-East direction with incised bends and meanders. The proposed tunnel intake and outfall structures are located on the isolated N-S oriented ridge of the left bank of the River. Geologically, the study area is in the western part of the Highland Complex consisting of high grade meta-sediments and granulitic orthogneisses and the proposed tunnel route is underlain by garnet sillimanite biotite gneiss with quartzite bands but due to the low dip angle the proposed tunnel will not be driven through the quartzite.

Monitoring groundwater level and the quality
All existing wells and springs in the study area were geo-referenced and plotted accurately on 1:10,000 scale map using ArcGIS software. A representative sample of 20 wells was selected to determine the present depth, water column height in the wells and quality of groundwater. A Dip Meter was used to measure the depth to groundwater level. Groundwater samples were collected in March and May to examine seasonal variations, and analysed for physicochemical and bacteriological parameters.

Groundwater distribution, aquifer characteristics and recharge potential of the study area
The topography and geology of the study area and ground survey observations suggest the occurrence of continuous and considerable water accumulations, but the conditions are unfavourable due to presence of shallow hard bedrock and relatively thin overburden. The porous and weathered overburden may however favour few isolated and discontinuous small shallow

aquifers. Recharge potential of groundwater is very poor since the percolation of rain water into deep aquifers is hindered by the tight joints in the bedrock.

Seasonal variation of ground water quality and suitability for drinking

The difference in variation of water quality between two seasons appears to be marginal with respect to many determinands and generally reflect conditions similar to rural residential setting. The Faecal and Total Coliform counts in several wells although do not comply with Sri Lanka Standard (SLS) for potable water in both seasons, their relatively low numbers suggest that this water would be suitable for drinking after boiling.

Anticipated impacts

Since the tunnel will be drilled through the solid bedrock, no loss of water from wells situated in shallow aquifers is anticipated during construction. Seepage into the tunnel could take place in areas where fracture intensity of bedrock is high. However the tunnel is located within the intact bedrock so seepage into the excavated area is unlikely and therefore no significant impact on the surrounding groundwater bodies is expected. Tunnel construction is unlikely to have any direct impact on groundwater quality, because there should be no major contact between the tunnelling activities and the surface aquifers. Ingression of contaminants such as waste oil, sanitary waste and organic matter into groundwater may result if the waste generated from construction and other project activities is not properly managed.

Mitigation measures

The following are recommended as mitigation measures during the construction phase: regular monitoring of groundwater level during tunnel construction, and provision of an alternative water supply for affected communities if reductions in well water level occur; formulation of an environmental management plan to minimize potential deterioration of groundwater quality due to seepage of waste oils and fuel, and human waste from insanitary practices.

1. Introduction

The Ceylon Electricity Board (CEB) plans to develop a new 30.0 MW hydropower project at Moragolla in Kandy District. The scheme involves construction of a 35 m high concrete gravity dam (with a 5 -gate spillway) across the Mahaweli Ganga at Weliganga, to create a 38.5 ha, 1.98 MCM reservoir with a Full Supply Level (FSL) at 548 masl. Water will be diverted through a 3.1 km underground tunnel, surge shaft and penstock on the left bank of the river, to a powerhouse and outfall located opposite the confluence with the Atabage Oya.

In this regard, CEB intend seeking international financial support for project implementation and potential funders include the Asian Development Bank (ADB). CEB has appointed Nippon Koei Co. Ltd in joint venture with Nippon Koei India Pvt. Ltd to review the feasibility study and prepare detailed designs and bidding documents for the project. Review of the EIA indicated that further studies were needed in order to update and amend the document to comply with ADB safeguard policy (Safeguard Policy Statement, ADB 2009).

The Nippon Koei Co, Ltd, Moragolla Hydropower Project appointed the National Building Research Organization (NBRO) to conduct additional studies the on natural environment as described in Terms of Reference (ToR) shown in **Annex 1**. These studies covered the following:

- Water quality in the Mahaweli Ganga
- Aquatic ecology in the Mahaweli Ganga
- Groundwater distribution and quality along the proposed tunnel route
- Updated land-use mapping

The aspects covered by this report are outlined as follows:

- Description of geology and hydrogeology of the survey area
- Distribution of groundwater extraction sources, groundwater level and quality along the proposed tunnel route of the Moragolla Hydropower Project
- A detailed map showing all wells in the survey area
- Photographs of sampling locations
- Sampling and analysis methods
- Quality Control procedures operated by the laboratory
- Discussion of the likely impacts of construction of the headrace tunnel
- Proposed mitigation for any likely negative impacts

2. Scope of the study

According to the ToR (**Annex 1**) the survey required following:

Mapping well locations
Locate and map all wells in the survey area, which is the left bank of the Mahaweli Ganga, between the proposed dam site and the tailrace outfall, between the river and the Ulapane to Gampola Road. Well locations shall be obtained from information provided by the Mahaweli Authority and Irrigation Department, if available, and by interviews with property owners and occupiers on site. All well locations to be geo-referenced via GPS receivers and plotted accurately on the map.

Monitoring groundwater quality
A sample of 20 wells to be selected at locations covering the whole survey area and with permission from the owners, for the measurement of present depth and water quality[1].

Samples are to be transported to a government-accredited laboratory under controlled temperature conditions prescribed by the laboratory. In the laboratory samples are to be analysed for: Conductivity, Total Suspended Solids, BOD_5, Nitrate, Phosphate, Total Coliforms, Faecal Coliforms and likely pesticides[2]. This survey shall be conducted twice; during February, 2013 and at the end of May, 2013, to give an indication of seasonal variations.

Examine the geology and hydrogeology
The geology and hydrogeology of the survey area are required to be studied using available data and prepare a description of the subsurface strata and aquifer characteristics and the main directions of groundwater flow.

[1] The requirement of duplicate samples mentioned in the ToR of Bid invitation document was later amended as to collect and analyze 1 sample from each location at the meeting held on 15.02.2013 between NBRO and Nippon Koei Pvt Ltd
[2] Agreed to exclude pesticide analysis at the meeting held on 15.02.2013 between NBRO and Nippon Koei Pvt Ltd

3. Description of the study area

3.1 General

The study area, which is located between Ethgala Junction and Ulapane Industrial Park, can be reached through Gampola – Nawalapitiya (A 113) Road. This area is situated within Grama Niladhari Divisions of Ulapane, Thembiligala and Ethgala of Ganga Ihala Divisional Secretary Division.

3.2 Topography

Morphologically, the area belongs to the middle peneplain [3] of Sri Lanka. The general topography consists of ridges and valleys with steep slopes. The ridges are heavily dissected by 1^{st} and 2^{nd} order streams. The streams flow in a dendritical pattern and join the Mahaweli River, which flows in North-East direction. In the study area, the River Mahaweli flows in a steep-sided valley with incised bends and meanders. The maximum relief of the study area is about 230 m. The local topography consists of the northerly flowing River Mahaweli with steep rocky embankments and meanders with an island close to the proposed tailrace outlet. The slope steepness of the river bank varies from 35º to 50º. The slope angle of the land area varies between 30º and 70º and the steepness is high along the Gampola – Nawalapitiya main road. The river shows typical youthful stage characteristics with steep ‘V’ shaped valleys, potholes and rapids. A few cross-cutting shallow valleys, which are oriented along the NW-SE direction, are situated on the slope. These valleys are the surface expressions of regional lineaments and they are located at much higher elevation in relation to the river bed level (data extracted from the 1:10,000 scale ABMP map; sheet number 61/13, published by the Survey Department of Sri Lanka).

The proposed tunnel intake and outfall structures are located on the isolated ridge of the left bank of Mahaweli River. The orientation of the ridge is North to South. The highest elevation of the ridge is 700 m. The elevations at the intake area (river level) and the power house area are 520 m and 470 m respectively.

[3] All technical terms are explained in the glossary in Annex 3

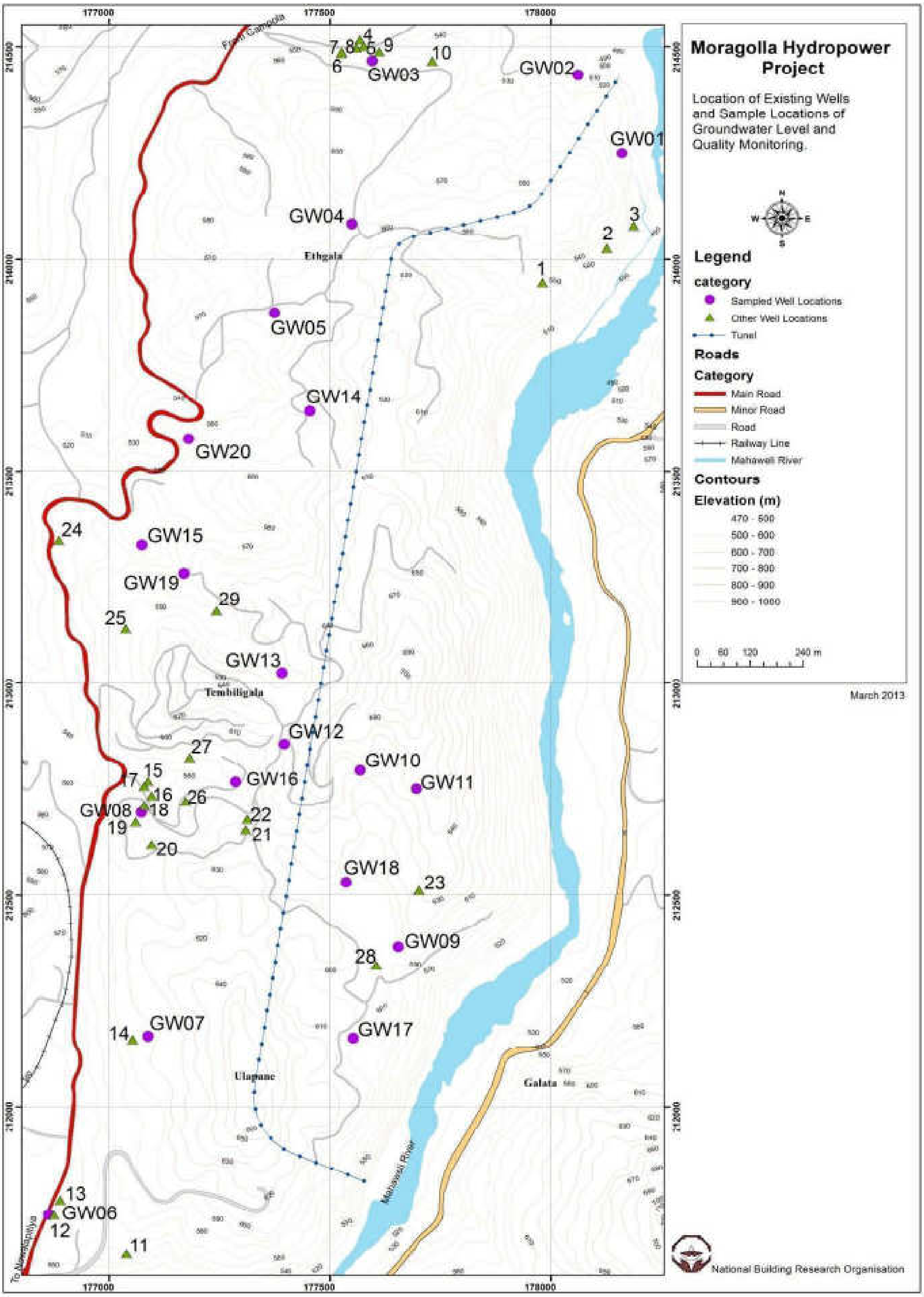


Fig. 1 Map of the study area

3.3 Geology

More than nine tenths of Sri Lankan basement is underlain by Late Proterozoic age high-grade gneissic rocks. This is sub-divided into major crustal units namely Highland Complex (HC), Wanni Complex (WC), Vjayan Complex (VC) and Kadugannawa Complex[4] (Fig. 2). The project area is in the western part of the Highland Complex; very close to the boundary between Highland and Kadugannawa complexes. The Highland Complex, which is comprised of the oldest rocks of the island, consists of high grade meta-sediments and granulitic orthogneisses. According to the geology map of the area; 1:100,000 Sheet No.14[5], the proposed tunnel route is underlain by garnet sillimanite biotite gneiss, with some bands of quartzite (refer **Annex 2**). However, the tunnel will not be driven through the quartzite due to the low dip angle. The rock strata show NE strike and dipping in the NW direction. The NW trending Kotmale Shear Zone crosses the project area at the middle of the proposed tunnel route. The left bank is identified as a scarp slope.

According to borehole log data[6], the country rock in this area is garnet biotite gneiss with prominent foliation plain with an attitude of N25ºE/27ºNW. The tunnel will be located in this rock, which represents the north limb of an antiform structure. The rock is dissected by two almost vertical joint sets, striking N80ºE and N30ºE. Many rock wedges created by the above joints appear and may have a strong capacity to be moved on the foliation plain along the right river bank as rock slides. This setting is therefore unfavourable from the rock slope stability point of view. In the left bank, the country rock dips into the left bank and is favourable for sliding failures. However, toppling may be possible, as the rock is dissected by discontinuities and the steepness of the slope, along the left river bank. Nevertheless, the above mentioned condition is not expected along the proposed tunnel route, as the joint intensity is poor and joints are tight in the fresh rock, through which the tunnel will be driven. The surface layers of the study area consist of mainly, residual gravelly clay soil with some sporadic distribution of colluvial materials. The thickness of overburden varies from place to place. This variation is related to underlying bedrock condition[4]. The glossary terms is given in **Annex 3.**

[4] Kroner, A., Cooray, P. G. and Vitanage. P. W., (l99l), Lithotectonic subdivision of the Precambrian basement in Sri Lanka. The Crystalline Crust of Sri Lanka. Part I. Summary of Research of the German-Sri Lankan Consortium. Geological Survey Department, Sri Lanka, Professional Paper 5: pp. 5-21.

[5] Geology map of the area is extracted from the 1:100,000 scale, Sheet No.14, published by Geological Survey & Mines Bureau (GSMB)

[6] For bore hole data, please refer the Feasibility study report on Moragolla Hydropower Project (Final report-Volume 4-Geology-February 2010), prepared by Central Engineering Consultancy Bureau/Al Habshi Consultants Office

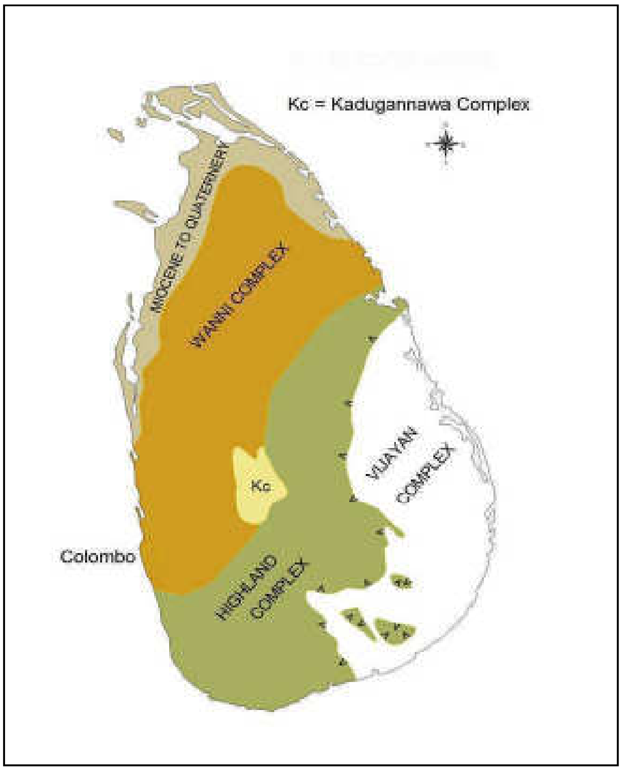


Fig. 2 Main litho-tectonic subdivisions of Sri Lanka

4. Mapping locations of wells in the study area

A team of Geologists of Landslide Research and Risk Management Division (LRRMD) of NBRO accomplished the task during the period from 05.03.2013 to 13.03.2013. All existing wells/springs within the study area were identified by an in-depth ground survey as updated data were not available in the Mahaweli Authority or in the Irrigation Department. The coordinates of identified groundwater wells/springs were then recorded using 1m accuracy GPS instrument[7]. A geo referenced map in the scale of 1:10,000 was prepared in ArcGIS software and then GPS coordinates of all wells/springs in the study area were plotted. The locations of the wells chosen for monitoring of water levels and groundwater quality were demarcated separately on the map plotted. Refer **Annex 4**; Map - Location of existing wells and sampled locations for groundwater level and quality monitoring, and **Annex 5** gives location description of all wells in the survey area.

[7] GPS instrument: make-Trimble, model-Geo XT 2005 series

5. Monitoring ground water levels and quality

The initial survey revealed that in this area the people use groundwater from two different sources: from dug wells and from springs. Shallow pits have been excavated to tap the spring water at the foot of slope cuts. The majority of the population uses dug wells and only a few residents use springs with excavated shallow pits.

The depth to groundwater level from the ground surface and present water quality of the selected wells/springs were then determined as follows. A total of twenty (20) wells were selected by obtaining permission from the owners to represent the ground water quality in the study area. Selection of wells was based on their construction type (protected or not), accessibility for sampling and existence for future reference. Accordingly, wells sealed with concrete slabs and those abandoned were not considered. More monitoring wells were selected above or in the vicinity of the proposed route of the underground tunnel since the groundwater regime can be disturbed specially during the construction of the tunnel.

The groundwater survey team (refer **Annex 6**) visited the site on 13th March 2013 to take measurements of ground water level and for the collection of water samples for water quality monitoring. The same was repeated on 21st May 2013 after showers.

The device called "Dip Meter" (Water Level Indicator –model BFK 200, Made in Italy (Fig. 3)) was used to measure the depth of groundwater level. Using this device the measurements were taken in a day. The Dip Meter consists of a long wire cord marked in metres with cm and mm divisions and a sensor connected to the rear end of the cord. During the measurement, the sensor was slowly dipped into the well and a "beep" sound was heard when the sensor touches the water surface. At this point the reading on the wire cord at the ground surface level was recorded as the depth to the groundwater level. **Annex 7** gives the location descriptions, water level and height of the water column of wells sampled during the survey.

Fig. 3 : Front view and side view of Dip meter

6. Sample collection, preservation and transportation for water quality testing

As instructed by the ToR, the samples were analysed for Conductivity, Total Suspended Solids, BOD_5, Nitrate, Phosphates, Total Coliforms, and Faecal Coliforms. In addition, Dissolved Oxygen (DO), Ammonia and Total Iron were also measured as low water levels in wells could lower redox conditions leading to: leaching of Iron, high levels of Ammonia and occurrence of low DO.

Sample collection, preservation, transportation and analysis for physicochemical parameters were carried out as per the international standards[8]. The bacteriological analysis (Faecal Coliforms, Total Coliforms) were done according to the Specification for potable water[9]. Accordingly, water samples were collected using specially wrapped sterilized sample bottles (Fig. 4). The bacteriology sample collection bottle is a narrow mouth bottle to which a sterile nylon cord is tied. The sample was collected by dipping the bottle up to the required water level by unwinding a nylon cord. Once the bottle was judged to be filled the thread was rewound to bring the bottle up. After collection, one third of the water in the bottle was discarded to leave sufficient air for microorganisms for their respiration. The groundwater samples for other parameters were collected from wells using a Depth Sampler: Lamotte water sampler – code 1060 (Fig. 5). The purpose of using this device is to collect representative samples from the mid water column. The sampler was lowered to a desired depth and immersed in the water completely, once the bottle was sufficiently filled, the cord was rewound and sampler was brought up. Water sample was transferred to a clean plastic beaker and pH, temperature, Conductivity and DO were measured on-site. Bottles having a ground-glass stopper and flared mouth were filled with water samples for the determination of Dissolved Oxygen (DO) and Biochemical Oxygen Demand (BOD), and bottles with samples for Dissolved Oxygen were fixed at site by adding $MnSO_4$ and alkali-iodize – azide reagents. The water samples collected for water quality parameters except for DO, BOD and bacteriological analysis were transferred securely into pre- cleaned screw-top plastic containers, All samples were labelled with location No, date and specific parameter to be analysed. Carefully packed samples in separate cooler boxes with ice were then transported to the NBRO laboratory, Colombo on the same day. A temperature of 4 -10^0 C was maintained during transportation. In the laboratory, the samples were stored at 4^0 C until analysis was performed. The analysis was commenced on the following day of sample collection and continued up to10 days.

[8] Standard Methods for the Examination of Water and Wastewater, American Public Health Association, 20^{th} Edition, 1998

[9] Specification for potable water SLS 614,1983, Bacteriological requirements (Part 2)

Fig. 4 - Sterilized sample bottle used for the collection of water samples for bacteriological analysis

Fig. 5 – Depth sampler used for the collection of groundwater samples from wells

7. Analysis of groundwater distribution, aquifer characteristics and recharge potential of the study area

The above analysis of the topography and geology of the study area, and observations made during the survey work suggest that in general, favourable conditions do not exist in the study area for the occurrence of continuous and considerable water accumulations. This is due to following factors:

- Presence of shallow hard bedrock in the majority of the area
- Presence of discontinuous shallow overburden with restricted extent
- Steep topographical nature of slopes of the area

Nevertheless, the existence of localized porous weathered overburden with gravelly and sandy nature at some places can create favourable conditions for a few isolated and discontinuous small shallow aquifers in the overburden. In addition, the presence of small low valleys and depressions also facilitate water accumulation on the ridges. Because of this, several springs can be observed in depressions at valley bottoms, discharging groundwater from their shallow aquifers. These springs prove the existence of bed rock at a shallow level, though it is not exposed in any of these valley bottoms. The presence of shallow solid bedrock forces groundwater to discharge at the surface as springs, restricting downward percolation. The inspected dug wells and springs are located within the above described setting within small discontinuous aquifers.

The recharge potential of groundwater in the study area is significantly poor. Percolation of water into deep aquifers is hindered, or occurs at a low rate through the existing tight joints in the bedrock. Further, the presence of relatively thin overburden and steep slopes in the project area significantly restrict the accumulation of groundwater. Recharge of these shallow isolated aquifers is therefore accomplished only by precipitation.

8. Seasonal variations of groundwater in the study area

8.1 Groundwater level

Fig. 6 shows the water level of each of the 20 surveyed wells in March 2013 (dry season) and May 2013 (beginning of the wet season). The data shows that, as expected, water levels were generally higher in the wet season, although the seasonal differences were not large (maximum around 3 m) and in around half of the sampled wells there was little seasonal variation. This survey was conducted in March and May and it covered the first inter monsoon period (March to April) and the beginning of the Southwest monsoon period (May to September). The study area receives relatively high precipitation, which is the only source for groundwater recharge in the area; and recharge mainly occurs during the longer Southwest monsoon (May to September) and in the second inter monsoon period (October to November). It is likely therefore that greater seasonal variation would have been apparent if the second period of sampling was conducted later in the year, during or after the main recharging period, when groundwater levels are generally greatly enhanced.

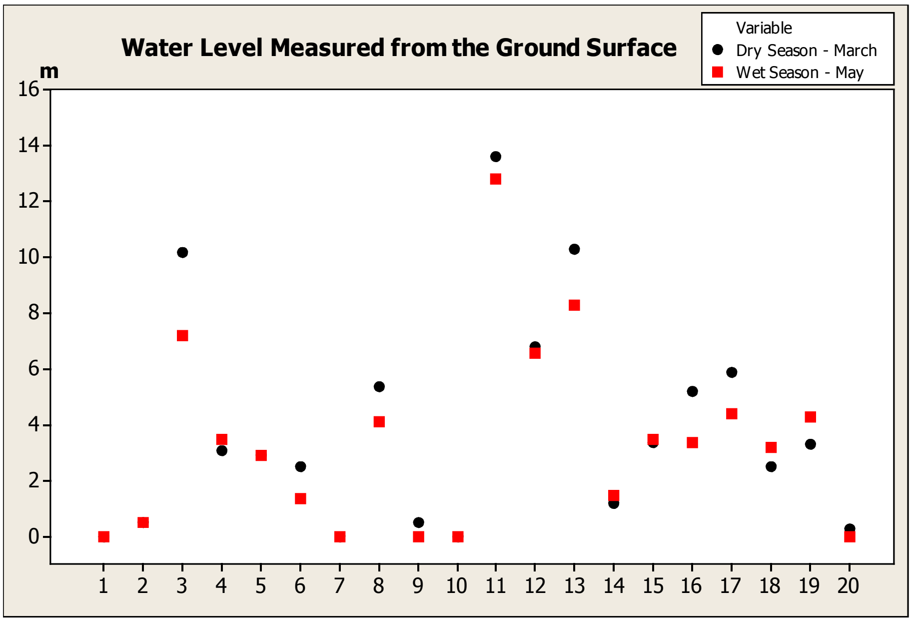


Fig. 6 - Water level measured in wells in March and May in 2013
(Level shown as m from the ground surface)

8.2 Groundwater quality

Seasonal variation in groundwater quality

The **Annex 9** contains the analysis of groundwater quality of the wells sampled during March and May 2013, and Fig.7 shows the variation in Conductivity, Total Suspended Solids, Ammonia, Phosphates, and bacteriological quality (Faecal and Total Coliforms) of the 20 wells in the two seasons. Conductivity in wet season was slightly low in most of the wells in comparison to dry season due to dilution of dissolved constituents in percolating rain water. In contrast, notably high conductivity values were reported in Well No. 6 and 9, but just two sets of samples are inadequate to explain the reason for this. Total Suspended Solids in all wells except Well No. 15 show no or little variation between two seasons. The values of Ammonia, Phosphates, Faecal and Total Coliform show mixed variation between two seasons in which some wells show low values for above determinands in the dry season in comparison to wet season while others show the opposite.

Suitability of water for different uses

SLS 614, 1983 is the national standard for potable water, including physical and chemical requirements (part 1) and bacteriological requirements (part 2). Accordingly, the levels of the tested parameters were compared with the limits given in this standard, because water in some wells is consumed directly for drinking.

The results of these comparisons are shown in **Annex 9**. The results indicate that the well water quality conforms to the SLS requirements with respect to Conductivity, Nitrates, Total Phosphates and Iron levels in both seasons. There are however some discrepancies with respect to the other parameters. Among the 20 wells tested, 4 wells in the dry season and 11 wells in the wet season do not conform to the prescribed Ammonia level. This is likely to be caused by seepage of runoff water contaminated with nitrogenous pollutants from diffused sources (animal urine and faces) in to groundwater during rains. The pH levels are slightly lower than the standard in some wells, but the values reflect natural variations in Carbon Dioxide dissolution, and have no health risk or aesthetic effect. The results also show that there are several wells where Faecal and Total Coliform counts do not comply with the standard in both wet and dry seasons, although the values are quite low and are generally within the range of what would be expected in groundwater in a rural setting. Other parameters, such as BOD and Total Iron are similarly low in most wells and also represent typical background conditions. These results suggest that groundwater in the study area should not be consumed raw because of the faecal coliform content, but would be suitable for drinking after simple treatment by boiling.

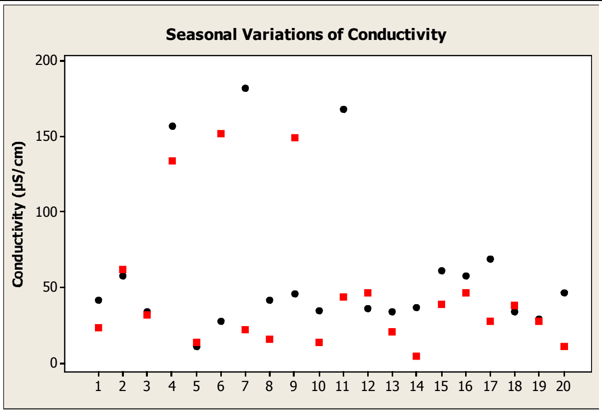


Fig 7.1 Seasonal Variations of Conductivity

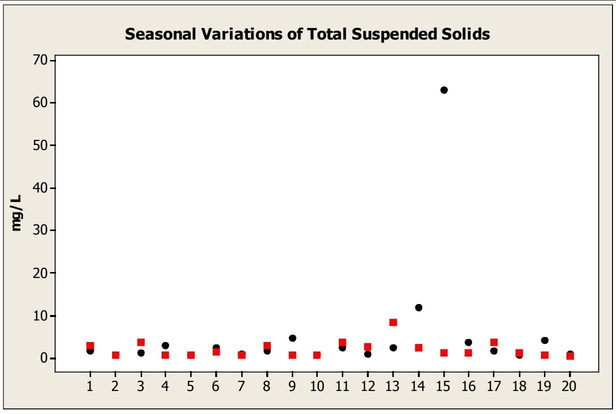


Fig 7.2 Seasonal Variations of Total Suspended Solids

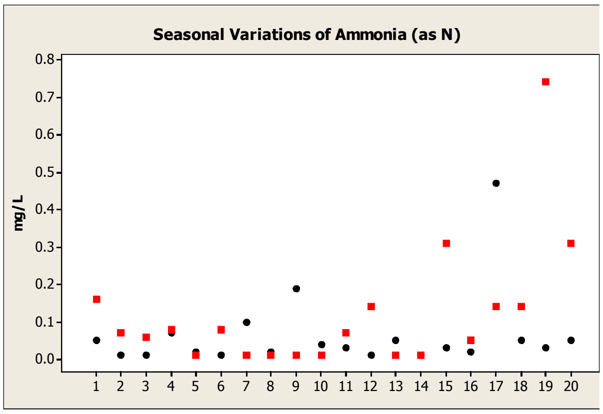


Fig 7.3 Seasonal Variations of Ammonia

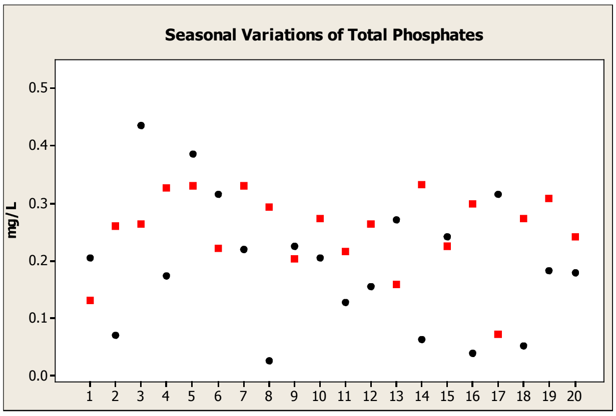


Fig 7.4 Seasonal Variations of Total Phosphates

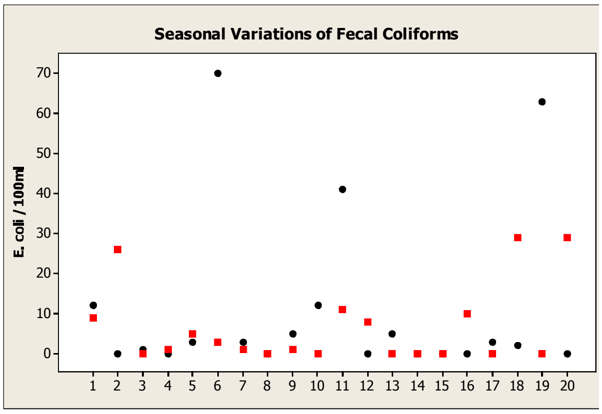


Fig 7.5 Seasonal Variations of Faecal Coliforms

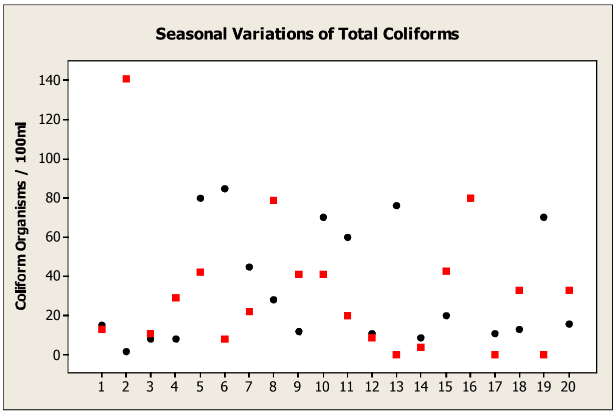


Fig 7.6 Seasonal Variations of Total Coliforms

Fig. 7 Seasonal variations in groundwater quality in 20 wells in the study area
(1-20 depicts the sampling locations GW1 – GW20.
Dry season data are shown in black and wet season data are shown in red)

9. Anticipated impacts

9.1 Groundwater level

Borehole log data[6] revealed that the natural groundwater level in the shallow discontinuous isolated aquifers located along the tunnel route is always above the proposed tunnel elevation and the full supply level of the reservoir. Since the tunnel will be driven through the intact bedrock, no loss of water from wells situated in shallow aquifers is anticipated during construction. However, seepage could take place into the tunnel during construction in areas where fracture intensity is high in the basement rock.

According to the drilling data, depths to the sound bedrock from the surface along three differently oriented sections of the tunnel route are: 10 m, 20 m and 25 m (at the surge chamber), and 10 m (at the outfall) respectively. The proposed tunnel route runs almost 50 m vertically below the crest line of the ridge on the left bank along most of the route. The tunnel is therefore located well below the bedrock, so there is very unlikely to be major seepage into the excavated area, and therefore the expected impact on the surrounding shallow isolated groundwater bodies will be insignificant.

9.2 Groundwater quality

The wells in the study area exploit percolating rainwater from discontinuous and relatively shallow aquifers near the surface and as explained above, the tunnel will be located below the layers of bedrock. Tunnel construction is therefore unlikely to have any direct impact on groundwater quality, because there should be no major contact between the tunnelling activities and the surface aquifers.

Nevertheless materials used or produced during the construction process (such as fuel oil, sanitary waste, and other organic matter) could enter and pollute groundwater if disposed of under poor waste management practices.

10 Mitigation measures

10.1 Mitigation of impacts of reduction in well water yield

As local communities depend almost entirely on groundwater for their potable supplies, it is recommended that water levels of existing dug wells are monitored during the tunnel construction period so that alternative water could be provided by tanker if any changes were to happen.

10.2 Mitigation of ground water quality impacts

Measures should be included in the project Environmental Management Plan to ensure that the aquifers and wells here and elsewhere in the project area are protected from potential sources of pollution, including disposal of construction waste, storage and usage of chemicals (including fuel, oils and waste oil) and waste from insanitary practices by workers.

Annexure

Annex 1

Terms of Reference

ToR FOR GROUNDWATER DISTRIBUTION AND QUALITY ALONG THE TUNNEL ROUTE

Objective

The EIA study suggested that groundwater levels could be lowered during construction of the tunnel, but provided no data on the distribution and quality of groundwater or the numbers of wells likely to be affected. These factors therefore need to be investigated to allow a more informed assessment of these impacts.

Scope of work

The Contractor shall first determine the location of all wells in the survey area, which is the left bank of the Mahaweli Ganga, between the proposed dam site and the tailrace outfall, between the river and the Ulapane to Gampola road. Well locations shall be obtained from information provided by the Ministry of Mahaweli and Irrigation if available, and by interviews with property owners and occupiers on site. All locations shall be geo-referenced via GPS receivers and plotted accurately on maps.

A sample of 20 wells should then be selected at locations covering the whole survey area and with permission from the owners the Contractor shall determine the present depth of water and will take samples for subsequent examination of water quality. Samples shall be transported promptly to Government accredited laboratory, under controlled temperature conditions as prescribed by the laboratory. In the laboratory, samples shall be analysed for; conductivity, total suspended solids, BOD5, nitrate, phosphate, total coliforms, faecal coliforms and likely pesticides. This survey shall be conducted twice; during February 2013 and at the end of May 2013, to give an indication of seasonal variations.

The Contractor shall examine the geology and hydrogeology of the survey area using available data and shall prepare a description of the subsurface strata and aquifer characteristics and the main directions of groundwater flow.

Programme and Reporting

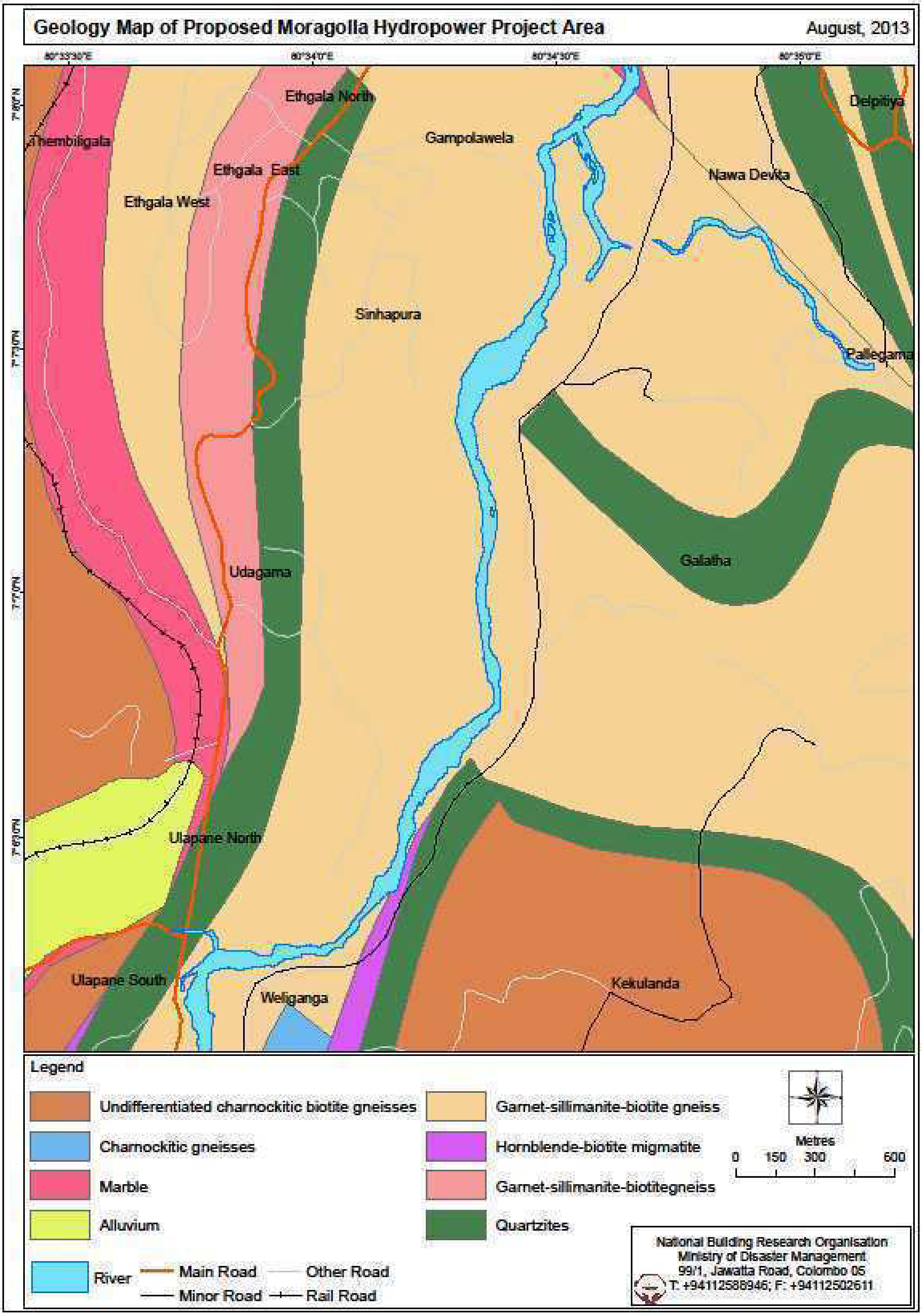
The Contractor shall submit a draft Interim Report on 31 March 2013 and a draft Final Report on 7 June 2013. Both reports will be reviewed by the Study Team and the Contractor shall amend the reports to address all comments and shall submit final report within two weeks of receipt of comments.

The Interim Report shall present and discuss all data collected in the first survey and the Final Report shall present all data from both surveys and shall include the following:

- A detailed and accurate map showing all wells in the survey area, plus site photographs and appropriate tables and illustrations of key data;
- Written descriptions of all survey and analysis methods (full details), quality control procedures operated by the laboratory, and all other methods of data collection and analysis;
- A detailed discussion of the results, including but not necessarily limited to:
  - A description of the geology and hydrology of the survey area, including the distribution and flow in aquifers, recharge characteristics, water depths and quality, and local and seasonal variations;
  - The likely impact of construction of the 3.1 km long, 4.5 m diameter tunnel, at an elevation of 528.25 msl (intake) and 510m as (outfall);
  - Suitable mitigation for any negative impacts of tunnel construction on groundwater;
  - Discussions of impacts shall explain the reasons for all conclusions and impacts shall be quantified to the extent possible.
  - Tables showing all data should be provided in an appendix.

Annex 2

Geology map of proposed Moragolla Hydropower project area



Geology map of Moragolla Hydropower project

Annex 3

Glossary of terms

Glossary

ABMP
Agricultural Base Mapping Project

Antiform
The descriptive term for any fold that is convex up

Basement
The thick foundation of ancient and oldest metamorphic rock that forms the crust of continents

Crust
Outermost solid shell of Earth planet, or of any other planet or moon.

Crustal
Made of the crust

Country rock
The geological term meaning the rock native in a certain area. The term is used to denote the usual strata of a region

Colluvial material
Mixture of soil and rock that has moved downhill to the bottom of the slope without the help of running water

Clay
A natural material with plastic properties, composed of particles of very fine, hydrous aluminium or magnesium silicate minerals

Dendritic drainage pattern

A drainage pattern in which the streams branch randomly in all directions and at almost any angle, resembling in plan the branching habit of certain trees. It is produced where a consequent stream receives several tributaries which in turn are fed by smaller tributaries.

Dike (Dyke)
A type of sheet intrusion referring to any geologic body that cuts discordantly across

Fault
Discrete planar rock fracture, which shows evidence of a displacement. A fault is a discrete surface

Fold
Stack of originally flat and planar surfaces, such as sedimentary strata, are bent or curved as a result of plastic (i.e. permanent) deformation.

Foliation plain
Surfaces of parallel alignment of textural and structural features of a rock

Garnet sillimanite biotite gneiss
Metamorphic rock composed chiefly of garnet, sillimanite and biotite minerals

Granulitic
The term implies the granulite facies rocks. The granulite facies is determined by lower temperature boundary of 700 +/- 50 °C and pressure range 5–15 kb

Gravel
Loose detrital material, composed chiefly of small rounded pebbles mixed with sand and clay

High-grade gneissic rock
Metamorphic rocks formed at temperatures greater than 320^0C

Lineament
A linear feature in a landscape, which is an expression of an underlying geological structure such as a fault. Typically a lineament will comprise a fault-aligned valley, a series of fault or fold-aligned hills, a straight coastline or indeed a combination of these features. Fracture zones, shear zones and igneous intrusions such as dykes can also give rise to lineaments. Lineaments are often apparent in geological or topographic maps and can appear obvious on aerial or satellite photographs.

Metamorphic rocks
Rocks formed by the solid state re-crystallization of pre-existing rocks due to changes in heat and/or pressure and/or introduction of fluids i.e. without melting.

Meta-sediments
Sediment or sedimentary rock that shows evidence of having been subjected to metamorphism. The overall composition of a meta-sediment can be used to identify the original sedimentary rock, even where they have been subject to high-grade metamorphism and intense deformation

Metamorphism
Solid state re-crystallization of pre-existing rocks due to changes in heat and/or pressure and/or introduction of fluids i.e. without melting

Orthogneisses
Metamorphic rocks formed by the metamorphism of igneous rocks

Overburden
The material that lies above the rock

Peneplain
A nearly flat surface of country produced by long period of subaerial erosion; almost a plain

Proterozoic age
The era of geologic time, 2.5 billion to 570 million years ago, during which sea plants and animals

Quartz
SiO_2, crystalline silica or oxide of silicon

Quartzite
Metamorphosed sandstone consisting of an interlocking mosaic of quartz crystals

Residual gravelly clay
In-situ clay soil formed by weathering of the parent rock rich in gravel

Scarp slope
The face of a ridge, facing in an opposite direction to the dip of the rock strata

Shear Zone
A tabular to sheet like, planar or curviplanar zone composed of rocks that are more highly strained than rocks adjacent to the zone.

Stream order
Numbering begins at the top of a catchment with headwater (‘new’) flow paths being assigned the number 1(**first order**). Where two flow paths of first order join, the section downstream of the junction is referred to as a **second order** stream. Where two second order streams join, the waterway downstream of the junction is referred to as a **third order** stream, and so on. Where a lower order stream (e.g. first order) joins a higher order stream (e.g. third order), the area downstream of the junction will retain the higher number (i.e. it will remain a third order stream).

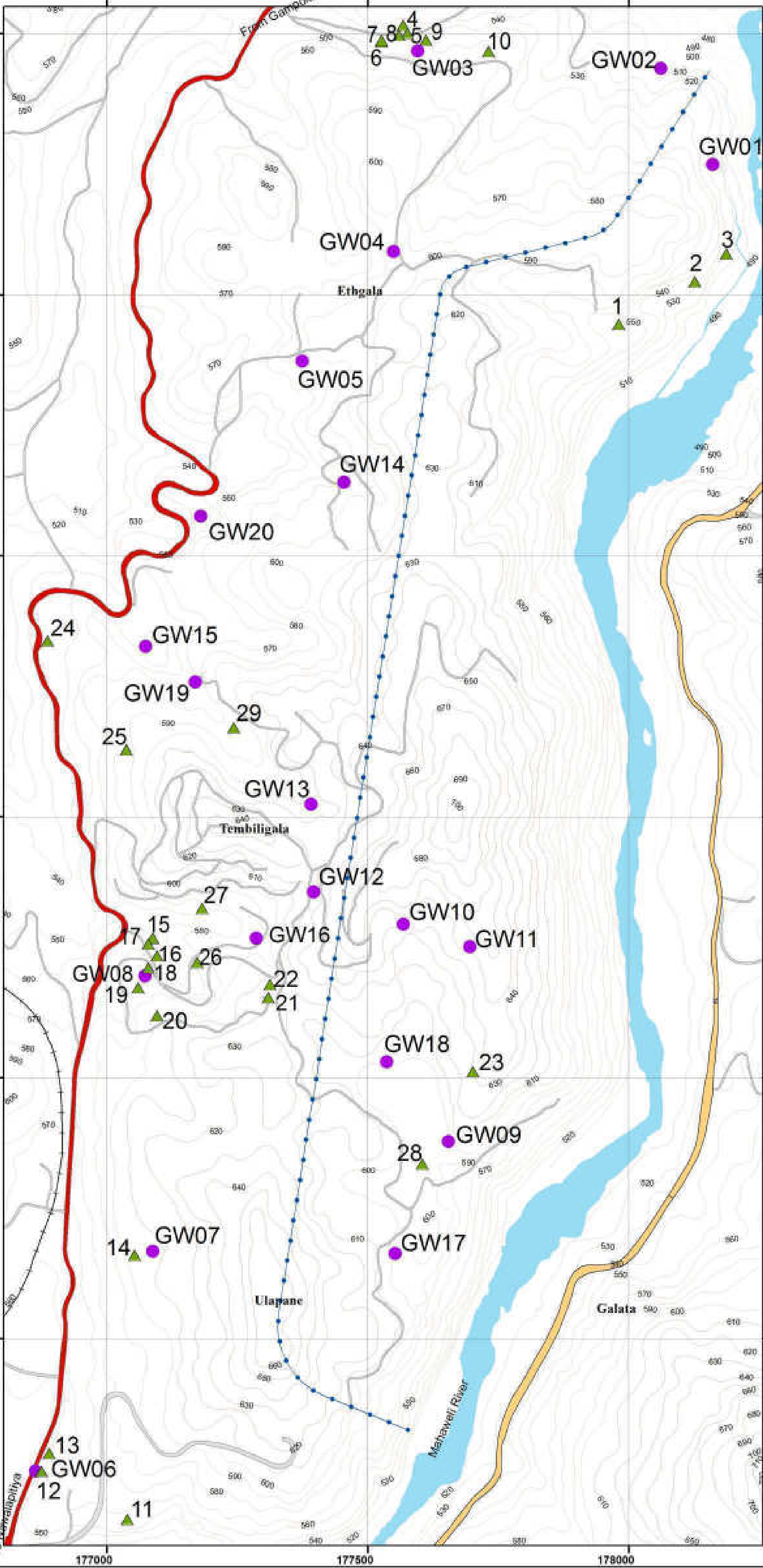
Strike
Bearing of the foliation plain of a rock

Annex 4

Map-Location of existing wells and sample locations for groundwater level and quality monitoring

Moragolla Hydropower Project

Location of Existing Wells and Sample Locations of Groundwater Level and Quality Monitoring.



Legend

category

- Sampled Well Locations
- Other Well Locations
- Tunel

Roads

Category

- Main Road
- Minor Road
- Road
- Railway Line
- Mahaweli River

Contours

Elevation (m)

- 470 - 500
- 500 - 600
- 600 - 700
- 700 - 800
- 800 - 900
- 900 - 1000

0 60 120 240 m

March 2013

National Building Research Organisation

Annex 5

Location description of all wells in the study area

Location description of all wells in the survey area

DW – Dug Well

Locations of well used for water level and quality monitoring

Well No.	Date Observed	Name & Address of Owner	Type of Source	Depth to GWL/m	Elevation of GWL/m	Northing/m	Easting/m	Elevation/m
GW-01	5.3.2013	H.M. Francis, 863/1, Dunhinda road, Ethgala watta, Gampola	Spring	0	528	214250	178161	528
GW-02	5.3.2013	Jayawardhena, Dunhinda road, Ethgala watta, Gampola	DW	0.5	508.5	214434	178062	509
GW-03	7.3.2013	Susantha Ileperuma, Bungalow road, Ethgala, Gampola	DW	10.2	544.8	214467	177596	555
GW-04	7.3.2013	Bandara Nissanka, 852, Bungalow road, Ethgala, Gampola	DW	3.1	590.9	214083	177550	594
GW-05	7.3.2013	B.S.M. Senarath Bandara, 851A, Bungalow road, Ethgala, Gampola	DW	2.9	574.1	213873	177375	577
GW-06	8.3.2013	K.M.Karunasena, 250, Gampola road, Ulapane	DW	2.5	543.5	211746	176864	546
GW-07	8.3.2013	Youth Council Premises, Gampola road, Ulapane	Spring	0	508	212167	177089	508
GW-08	9.3.2013	P. Marimuttu, 15, Thembiligala watta, Ulapane	DW	5.4	576.6	212695	177074	582
GW-09	10.3.2013	Common use, Mahawila watta, Ulapane	DW	0.5	600.5	212378	177655	601
GW-10	10.3.2013	Common use, SAARC village	Spring	0	545	212794	177569	545
GW-11	10.3.2013	Baby Nona, No 12, Denmark Colony, Ulapane	DW	13.6	539.4	212751	177696	553
GW-12	9.3.2013	Abesinghe, No. B5/A, Sri Dharan Pura, Ulapane	DW	6.8	516.2	212856	177397	523

Location description of all wells in the survey area – contd....

DW- Dug Well

Well No.	Date Observed	Name & Address of Owner	Type of Source	Depth to GWL/m	Elevation of GWL/m	Northing/m	Easting/m	Elevation/m
Locations of well used for water level and quality monitoring								
GW-13	11.3.2013	W.C Nimalsiri, 326, Handabima Ihala, Udagama, Ulapane	DW	10.3	502.7	213024	177392	513
GW-14	7.3.2013	Common use	DW	1.2	579.8	213641	177455	581
GW-15	11.3.2013	R.G.Leelawathie, 21, Handabima, Ulapane	DW	3.4	546.6	213326	177075	550
GW-16	12.3.2013	DGM Thiranjeewa, 61, Sarc Village, Ulapane	DW	5.2	582.8	212767	177287	588
GW-17	10.3.2013	Sunil, 321B, Mahawila watta, Ulapane	DW	5.9	584.1	212163	177553	590
GW-18	10.3.2013	C. Pandithathilaka, B7, Mahawila watta, Ulapane	DW	2.5	499.5	212530	177537	502
GW-19	11.3.2013	R.D.G. Wijeratne, 35/6, Handabima Ihala, Udagama, Ulapane	DW	3.3	566.7	213258	177170	570
GW-20	12.3.2013	Ruwan Jayawickrama, 900/1/2, Ethgala watta, Nawalapitiya road, Gampola	DW	0.3	544.7	213576	177181	545

Location description of all wells in the survey area- contd......

Locations of other existing wells of the project area

Well No.	Date Observed	Name & Address of Owner	Type of Source	Depth to GWL/m	Elevation of GWL/m	Northing/m	Easting/m	Elevation/m
01	5.3.2013	Mrs. De Silva, Dunhinda road, Ethgala watta, Gampola	Spring	0	551	213943	177981	551
02	5.3.2013	Ariyadasa, Dunhinda road, Ethgala watta, Gampola	Spring	0	530	214025	178127	530
03	5.3.2013	Dias, Dunhinda road, Ethgala watta, Gampola	Spring	0	523	214078	178187	523
04	7.3.2013	Hemachandra, Bungalow road, Ethgala, Gampola	DW	6.2	531.8	214516	177568	538
05	7.3.2013	Hettiarachchi, 859, Bungalow road, Ethgala, Gampola	DW	1.9	544.1	214501	177577	546
06	7.3.2013	N.P. Wickramasinghe, 851/2, Bungalow road, Ethgala, Gampola	DW	9.3	536.7	214484	177527	546
07	7.3.2013	W.E.C. Fernando, 836/2, Bungalow road, Ethgala, Gampola	DW	7.2	541.8	214487	177527	549
08	7.3.2013	W.A. Fernando, 836/3, Bungalow road, Ethgala, Gampola	DW	5.3	541.7	214497	177560	547
09	7.3.2013	W.M.T.B. Karunatilaka, 13Bungalow road, Ethgala, Gampola	DW	1.5	545	214488	177612	546.5
10	7.3.2013	Jayaruwan, Hapuarachchi, 831/1, Bungalow road, Ethgala, Gampola	DW	15.2	542.4	214466	177732	557.6
11	8.3.2013	Upali Wijetunga, 10, Gampola road, Ulapane	Spring	0	555.5	211653	177040	555.5
12	8.3.2013	G.W. Ariyadasa, 44, Gampola road, Ulapane	DW	2.3	547.7	211745	176876	550
13	8.3.2013	Mrs. Basheer, 60, Gampola road, Ulapane	Spring	0	550	211780	176890	550

Locations of other existing wells of the project area								DW – Dug well
	Date Observed	Name & Address of Owner	Type of Source	Depth to GWL/m	Elevation of GWL/m	Northing/m	Easting/m	Elevation/m
14	8.3.2013	K.M.C. Ulapane, 158, Gampola road, Ulapane	Spring	0	502.8	212159	177054	502.8
15	9.3.2013	K.A.R.L. Dharmaratne, 2, SARC Village, Ulapane	DW	Not able to measure	-	212767	177089	570
16	9.3.2013	Common Use, SARC Village, Ulapane	Spring	0	576	212733	177097	576
17	9.3.2013	R. Bogahawatta, 8, Subasiri, SAARC Village, Ulapane	TW	Not able to measure	-	212756	177080	574
18	9.3.2013	Karupan Rama, 18, 26Thembiligala watta, Ul27apane	DW	8.8	571.2	212710	177080	580
19	9.3.2013	Ruwan Chamara, 14, Thembiligala watta, Ulapane	DW	5.7	580.3	212672	177061	586
20	10.3.2013	Commom Use, SARC Village, Ulapane	DW	8.8	518.2	212618	177097	527
21	10.3.2013	D.U.Keerthisinghe, 56, Mahawilawatta, Ulapane	TW	Not able to measure	-	212653	177310	516.5
22	10.3.2013	M.S.S.Mohomad, 38, SARC Village, Ulapane	TW	6.1	506.9	212678	177313	513
23	10.3.2013	Subash Nirishan, 10, Denmark Colony, Ulapane	DW	2.2	527.8	212511	177702	530
24	11.3.2013	H.G.H.Samaranayaka, 21/2A, Handabima, Thembiligala, Ulapane	DW	3.1	541.9	213336	176887	545
25	11.3.2013	Common Use, Handabima, Thembiligala, Ulapane	Spring	0	585	213128	177038	585
26	12.3.2013	Gamini Bandara, 54, Mahawila watta, SARV Village, Ulapane	DW	5.7	574.3	212720	177174	580
27	12.3.2013	R.S.S.Chandrasekara, 107, Mahawila watta, Ulapane	DW	1.9	575.6	212824	177183	577.5
28	10.3.2013	Piyal Pushpakumara, 103B, Denmark North, Ulapane	DW	0.5	553.5	212334	177605	554
29	11.3.2013	W. Arthur Paul, 14/1, Handabima Ihala, Udagama, Ulapane	DW	7.8	581.2	213170	177244	58

Annex 6

Study team

Study team

Key staff

Name	Designation
Ms S V Dias	Senior Scientist / Water Quality Specialist
Mr Mahesh Somaratne	Senior Geologist
Mr NIC Peiris	Senior Geologist
Mr IAVP Iddamalgoda	Senior Scientist
Ms S A M S Dissanayake	Senior Scientist
Mr HDS Premasiri	Senior Scientist
Mr Vimukthi Sumanasekara	Scientist
Ms H.T.J. Seneviratne	Scientist

Laboratory analysis team

Name	Designation
Ms P D C Pathiraja	Technical Assistant
Ms P H D Silva	Technical Assistant
Ms Thilangika Gunawardena	Project Assistant

Support staff

Name	Designation
Mr N Krishnamoorthi	Field Assistant
Mr Chamath Vithanage	Field Assistant
Mr WA Weerasinghe	Field Assistant
Mr A Premaratne	Field Assistant

Annex 7

Location description, water level and the height of the water column of the wells sampled during the survey

Table 1 - Location description, water level and the height of the water column of the wells and springs sampled during the survey

Location reference				Water level measured from Ground (m)		Height of the water colomn in the wells (m)[10]	
Sample reference	**GPS reference**	**Name and Address of owner**	**Source**	**March**	**May**	**March**	**May**
GW 1	214250N 178161E	HM.Francis, 63/1, Dunhida road, Ethgala Watta, Gampola	Spring	0	0	0.5	0.5
GW 2	214434N 178062E	Jayawardhena, Dunhinda road, Ethgala watta, Gampola	DW	0.5	0.5	0.5	0.5
GW 3	214467N 177596E	Susantha Illeperuma, Bungalow road, Ethgala,Gampola	DW	10.2	7.2	1.5	4.5
GW 4	214083N 177550E	Bandara Nishsanka, 852,Bungalow road, Ethgala,Gampola	DW	3.1	3.5	3	2.6
GW 5	213873N 177375E	BSM Senarath Bandara 851 A,Bungalow road, Ethgala, Gampola	DW	2.9	2.9	1.2	1.2
GW 6	211746N 176864E	KM Karunasena, 250, Gampola road, Ulapane	DW	2.5	1.4	1.2	2.7
GW 7	212167N 177089E	Youth council Premises, Gampola road, Ulapane	Spring	0	0	2.5	2.5
GW 8	212695N 177074E	P.Marimuttu,15, Thembiligala watta, Ulapane	DW	5.4	4.1	0.5	1.8
GW 9	212378N 177655E	Common Use, Mahawila Waththa,Ulapane	DW	0.5	0	1.2	1.7
GW 10	212794N 177569E	Common Use, SAARC Village	Spring	0	0	0.5	0.5

DW- Dug well

[10] Height of the water column in wells

Table 1 - Location description, water level and the height of the water column of the wells samples during the survey –continued

Location reference				Water level measured from Ground(m)		Height of the water colomn in the wells (m)[10]	
Sample reference	GPS reference	Name and Address of owner	Source	March	May	March	May
GW 11	212751N 177696E	BD.Babinona, No 12, Denmarc Colony, Ulapane	DW	13.6	12.8	1	1.8
GW 12	212856N 177397E	Abesinghe, No.B5/A, Sri Dharanpura, Ulapane	DW	6.8	6.6	1.2	1.4
GW 13	213024N 177392E	WC.Nimalsiri,326, Handabima Ihala,Udagama, Ulapane	DW	10.3	8.3	1.5	3.5
GW 14	213641N 177455E	Common use	DW	1.2	1.5	1.5	1.2
GW 15	213326N 177075E	RG Leelawathie, 21, Handabima, Ulapane	DW	3.4	3.5	1.5	1.4
GW 16	212767N 177287E	DGM Thiranjeewa, 61, Sarc Villege, Ulapane	DW	5.2	3.4	1.5	3.3
GW 17	212163N 177553E	Sunil,312B, Mahawila watta, Ulapane	DW	5.9	4.4	0.7	2.2
GW 18	212530N 177537E	C Pandithathilake, B7, Mahawila watta, Ulapane	DW	2.5	3.2	2.2	1.5
GW 19	213258N 177170E	RDG Wijerathna, 35/6,Handabima Ihala,Udagama, Ulapane	DW	3.3	4.3	1.2	0.2
GW 20	213576N 177181E	Ruwan Jayawickrama, 900/1/2,Etgalawatta, Nawalapitiya road, Gampola	DW	0.3	0	1.5	1.8

DW- Dug well

Annex 8

Methods of analysis and quality control procedures

Method of Analysis

Parameter	Method Reference	Description of the Method
pH	APHA 4500 H-B Electrometric method	pH and Temperature were measured using ***pH meter, brand ; pH 5+ pH/^{0}C of EUTECH Instrument Singapore origin.*** The meter was first calibrated using NIST pH 4.01 and pH 6.86 buffer solutions (NIST; National Institute of Standard Technology). The pH and Temperature of water samples were taken after calibration by immersing electrode and the probe.
Temperature	APHA 2550 B Electrometric method	
Conductivity	APHA - 2510 B Electrometric method	Conductivity was measured using potable multi parameter instrument; ***HORIBA U-50 Multiparameter; Water Quality Checker Japan origin.*** The meter was first calibrated using standard of 0.005mol/L KCl solution (conductivity =0.718mS/cm) to match with the measuring conductivity range. Initially zero point calibration was conducted. The sensor probes were then washed 2 or 3 times in deionized water and all moisture was removed. Calibration of the instrument-The "Cond" mode was selected in the parameter selection screen. Then the number of calibration points was set and, "Cond" value was set into 0.000 mS/cm. After the "Measurement value" has been stabilized the calibration was started by pressing ENTER key. Taking measurements- The transparent calibration cup was washed 2 to 3 times with deionized water and filled to the reference line with 0.718mS/cm standard solution. The sensor probe was submerged in the transparent calibration cup. The "Cond" value was set to 0.718 mS/cm and the calibration was started. After the calibration was completed the calibration cup was washed again with deionized water and filled with sample. Then the measurement was taken after "Measurement value" was stabilized.
Dissolved Oxygen	APHA-4500-O-C Azide modification	Water samples were collected in a 300 ml bottles having a ground-glass stopper and a flared mouth without entrapping air bubbles. Dissolved oxygen in the sample was fixed by adding 2 mL of $MnSO_4$ and 2 mL of alkali-iodize –azide reagents to the bottle at the site. Then the bottle was stoppered carefully to avoid air bubbles and mixed well by inverting the bottle a few times. These bottles were transported to the laboratory at 4 to 10 ^{0}C. In the determination of DO, 2.0mL of conc. H_2SO_4 was added to the bottle and mixed well until dissolution of precipitate is complete. A 200 mL portion from this sample was titrated with 0.025M Na_2SO_4 solution to a pale yellow color. Then few drops of starch solution were added and titration was continued to first appearance of blue color. **Calculation** For titration of 200mL sample, 1mL 0.025N Na_2SO_4 = 1mg DO/L

Parameter	Method Reference	Description of the Method
Biochemical Oxygen Demand	APHAA 5210-B 5-Day BOD test	Water samples were collected in a 300 ml bottles having a ground-glass stopper and a flared mouth without entrapping air bubbles. To prevent entry of air in to bottles during incubation water was added to the flared mouth of the bottle and then capped with plastic cap. For each measurement two bottles were prepared in the above manner and transported to the laboratory at 4-10^{0}C. Of the two sets, the dissolved oxygen in one set was determined on the following day. This gives the Initial oxygen levels. The bottles in the other set were incubated at 20^{0}C for 5 days. After 5 days the DO was determined similar to first set. This gives remaining oxygen after five days Determination of BOD BOD mg/l = Initial dissolved oxygen level in the sample - Final dissolved oxygen level in the sample (Initial dissolved oxygen is the value measured as dissolved oxygen)
Nitrate	APHA 4500-NO2-B Photometry	10 mL of sample was taken to the sample vial and color was developed by crushing Nitrate test tablet supplied by the manufacturer. The developed color was then measured using Lovibond, Maxi Direct SN 10-1083 photometer made in Germany. The Method used is APHA 4500-NO2-B. The reading appeared on the meter was taken as the measured value
Ammonia	APHA-4500-NH_3 F	10 mL of sample was taken to a sample vial and color was developed using ammonia No.1 and No.2 tablets supplied by the manufacturer. The developed color was then measured using Lovibond Maxi Direct SN 10-1083 photometer made in Germany. The Method used is APHA-4500-NH_3 F. The reading appeared on the meter was taken as the measured value.
Total Iron	Photometric method	A disk type Lovibond comparator was used in the determination. First, two comparator cells were rinsed twice with deionized water and then deionized water and the sample were filled to each of the cells separately. For both cells Iron Low Range tablets supplied by the manufacturer were added, crushed and dissolved completely and allowed to develop color. Then the two cells were placed in the comparator. The color disc prepared with different color intensities was rotated while holding the comparator, facing good natural light until the colour of the sample marches with that of the sample. The iron level was expressed as mg/l. The value for concentration of the color standard in mg/l was taken as Total iron concentration of the test sample.

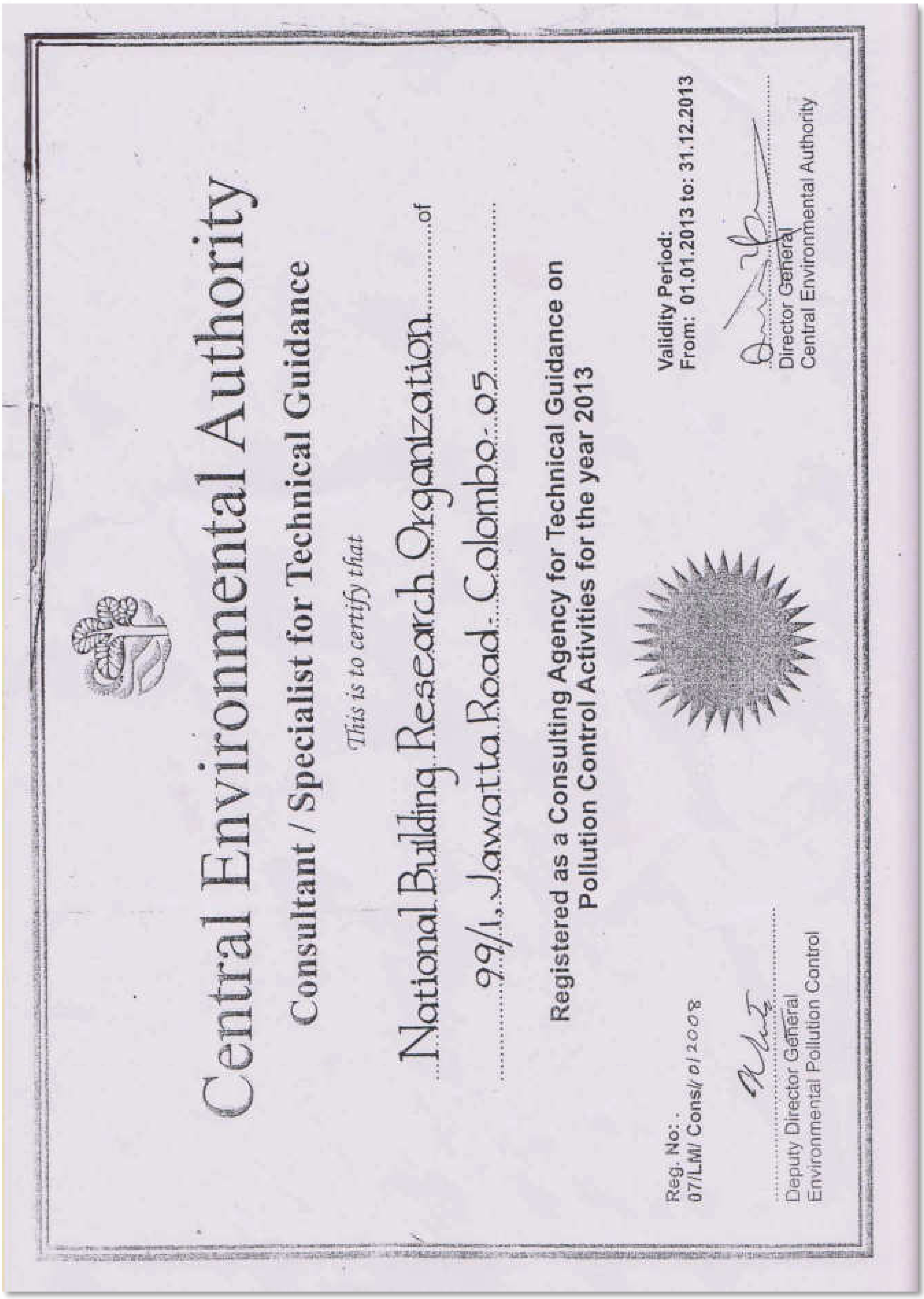
Parameter	Method Reference	Description of the Method
Total Phosphates	APHA 4500- P-D Stannous chloride method	In the laboratory 100 mL of sample was digested with 1mL of H_2SO_4 acid and 0.4 g solid $(NH4)_2S_2O_8$ until a final volume of 10 mL was reached. The digested sample was then cooled, diluted to 30 mL with distilled water, and neutralized with NaOH. The sample was made up to 100 mL in a volumetric flask with distilled water. Then the color was developed by adding 4.0 mL Ammonium Molybdate reagent I ($NH_4Mo_7O_{24}.4H_2O$) and 0.5 mL stannous chloride reagent I ($SnCl_2.2H_2O$). After 10 minutes, colour was measured at 690 nm using UV visible spectrophotometer and compared with a calibration curve prepared using series of standard phosphate solution of KH_2PO_4 and the distilled water blank. **Calculation** $\text{mg P/l} = \frac{\text{mg P (in approximately final volume)}}{\text{ml sample}} \times 1000$ The result phosphorus was expressed as PO4 mg/L.
Total Suspended Solids	APHA 2540 D	Glass-fibre filter paper was used in the determination of Suspended solids. First, the filter papers were washed with distilled water and dried in an oven at 103^oC to 105^oC for 1hour . Then the initial measurements were taken to 0.001g accuracy until constant weight is reached. The sample was then stirred with a magnetic stirrer at a speed to shear larger particles, if practical, to obtain a more uniform particle size. While stirring, a measured volume (100ml) was pipetted onto the pre weighed filter paper seated on glass-fiber filter. Vacuum suction was applied to filter the sample. The trapped suspended solids in the filter paper were dryed in an oven at 103^oC to 105^oC for 1hour and cooled in a desiccator to balance temperature and then weighed to 0.001g accuracy. This cycle of drying cooling, desiccating and weighing was repeated until a constant weight was obtained. The suspended solids content in the sample was then determined using following calculation **Calculation** $\text{mg total suspended solids/L} = \frac{(A-B) \times 1000}{\text{Sample volume, mL}}$ Where:

		A=weight of filter + dried residue, mg, and B= weight of filter, mg.
Parameter	**Method Reference**	**Description of the Method**
Faecal Coliforms and Total Coliforms	SLS 614: 1983 Part 2 Membrane filtration method	250 ml capacity sterilized glass bottles with attached twin thread were used for the collection of samples for analysis of Faecal and Total Coliforms. In the sampling, first the bottle was lowered to the water by unwinding the cord slowly. The bottle was immersed in the water completely, and once the bottle was judged to be sufficiently filled, the thread was rewound and bottle was brought up. Some water was discarded if the bottle was completely filled. In the laboratory, for the analysis of Faecal Coliforms, 100 ml of sample was filtered through a 0.45 µm grid marked membrane filter paper and the filter was placed in MFC agar and incubated at 44.5 ^{0}C for 24 hours. For the Total Coliforms, 100 mL of sample was filtered and filter was placed on M-Endo agar LES (Sigma origin) media and incubated at 36 ^{0}C for 24 hours. Colonies which showed a characteristic appearance of blue colour on the filter paper counted as Faecal Coliforms. No confirmation was done to Faecal Coliforms since MFC agar was used as the medium and it is specific for Faecal Coliforms (especially *E.coli*) as per SLS (1983). In detecting Total Coliform counts, colonies with metallic yellow sheen in M- Endo agar LES medium were sub cultured to phenol red lactose broth and all tubes showing acid and gas production were recorded as confirmed Total Coliforms after incubation of 36 ^{0}C for 48 hours. Confirmed Coliforms were expressed as Total Coliform counts per 100 ml Confirmed Faecal Coliforms were expressed as - Faecal Coliform counts per 100 ml.

Quality Control procedures

- The NBRO is registered in the Central Environmental Authority (CEA)- Laboratory as Consultant/ Specialist for Technical Guidance (Reg. No. 07/LM/Cons/10/2008). Copy of certificate - 2013 and a Letter indicating participation in Proficiency testing programs with CEA are given below.
- Quality control for the analysis of all the parameters was carried as per the procedures given in the Standard methods for the Examination of water and wastewater, APHA, AWWA, WEF- 20th edition (APHA).
- The pH meter was calibrated before commencing the sample measurements using pH 4.01 and pH 6.86 buffer solutions (traceable to National Institute of Standards and Technology-NIST).
- The conductivity meter ***HORIBA U-50 Multiparameter; Water Quality Checker Japan origin.*** The meter was calibrated using prepared standard of 0.005mol/L KCl solution (conductivity = 0.718 mS/cm) to match with the measuring conductivity range.
- Dissolved Oxygen and BOD analysis -Glucose Glutamic acid (GGA) standard check solution was checked for reliability of the sample analysis. The GGA control is a standardized solution to determine the quality of the seed, where its recommended BOD_5 concentration is 198 mg/l ± 30.5 mg/l. The dilution water blank was used to confirm the quality of the dilution water that was used to dilute the samples. This is necessary because impurities in the dilution water may cause significant alterations in the results.
- In the Nitrates analysis, standard KNO_3 (strength was 1.00 mL= 100 µg NO_3^-) was prepared as per APHA and 0.1 mg/L solution as a known sample and deionized water was checked for an each set of sample analysis.
- In the ammonia testing standard solution of NH_4Cl was used as the standard (1.00 mL =1.22 mg NH_3). For each set of sample analysis 0.01 mg NH_3/L solution as a known sample and deionized water as a blank were checked.
- For the total phosphates analysis, standard phosphate solution of KH_2PO_4 was used to prepare the calibration curve (The strength was 1.00 mL=50.0 g PO_4^{3-}P). In each set of analysis, 6 samples at a time; 3 water samples, 1 known standard sample, 1 spiked sample and a blank sample (deionized water) were digested and analyzed.

- In the Faecal coliforms and Total coliforms quality control procedures were carried out according to APHA.
- This includes;
- Checking incubator temperatures,
    - Faecal coliforms -44.5^0 C Total coliform - 37^{0}C)
    - Performance of Autoclaves Sterilization using sterilization tapes - temperature 121^{0}C, pressure 15 lbs)
- Blank sample testing- Dilution water (KH_2PO_4 buffer) blanks were analyzed during the sample analysis. Three dilution blanks were filtered during the sample analysis for each set of analysis (beginning/ middle and at the end) and tested for faecal and total coliforms.
- All chemicals used in the analysis were of Analytical Grade (AR).
- The Balance (electronic top loading balance AUW 120 D, Shimazdu, Japan) used for the preparation of reagents was calibrated from an accredited institution. (Calibration date- 15 08.2012- Copy given below.



Central Environmental Authority

Consultant / Specialist for Technical Guidance

This is to certify that

National Building Research Organization of

99/1, Jawatta Road, Colombo 05

Registered as a Consulting Agency for Technical Guidance on Pollution Control Activities for the year 2013

Reg. No.: 07/LM/ Cons/ 01/ 2008

Validity Period:
From: 01.01.2013 to: 31.12.2013

Deputy Director General
Environmental Pollution Control

Director General
Central Environmental Authority

Certificate - NBRO registration in Central Environmental Laboratory as Consultant/ Specialist for Technical Guidance (Reg. No. 07/LM/Cons/10/2008)

ඔබේ යොමුව
உமது தொடர்பு
Your Ref.

අපේ යොමුව
எமது தொடர்பு
Our Ref. 19.08.2013

දිනය
திகதி
Date

මධ්‍යම පරිසර අධිකාරිය
மத்திய சுற்றாடல் அதிகாரசபை
Central Environmental Authority

"පරිසර පියස", 104, ඩෙන්සිල් කොබ්බෑකඩුව මාවත, බත්තරමුල්ල, ශ්‍රී ලංකාව.
"பரிசர பியச", 104, டென்சில் கொப்பேகடுவ மாவத்தை, பத்தரமுல்ல, ஸ்ரீ லங்கா.
"Parisara Piyasa", 104, Denzil Kobbekaduwa Mawatha, Battaramulla, Sri Lanka.
Web : www.cea.lk

To whome it may concern

This is to certify that the Environment Laboratory of the National Building Research Organization is a registered laboratory under CEA for environmental monitoring and analysis since the year 2008 up to date.

They have participated in proficiency testing programmes and will be taking part in the CEA PT programme, which is scheduled to be held in mid September 2013.

This letter is issued on request of Ms. S.V. Dias, Director (Environment Division), NBRO.

Yours faithfully,

Deputy Director General (EPC)
Envtl pollution Control Division
Central Environmental Authority

Chairman	Tel : 2872361, 2872348 Fax : 2872347	Director General	Tel : 2872359 Fax : 2872608	Gen. Office	Tel : 2872278, 2873447, 7877277-280, 2873448 Hot Line : 2888999	Media Unit : 2873449

Deputy Director Generals	HRD, Admin & Finance Division Tel : 2865296 Fax : 2872301	Envt. Pollution Control Division Tel : 2873453 Fax : 2872605	Envt. Mgt & Asses. Division Tel : 2872388 Fax : 2872296	Envt. Edu. & Awarness Division Tel : 2872297 Fax : 2872609

Directors Tel Fax	2872607 (Admin) 2872301 (HRD), 7877290 (Finance) 2872601 (Admin), 2863984 (Finance)	2873452 (EPC), 2872606 (Lab) 2882335 (WM)	2872346 (NRM), 2876643 (EIA) 2867263 (R&D)	2867266 (EEA) Fax : 2872609	2872604 (Legal) (Western Province) Tel: 2862851 Fax: 2865293

පරිසර හා පුනර්ජනනීය බලශක්ති අමාත්‍යාංශය | சுற்றாடல் மற்றும் புதுப்பிக்கத்தக்க சக்தி அமைச்சு | Ministry of Environment and Renewable Energy

Letter indicating participation in Proficiency testing programs with CEA

... Continuation Sheet

CALIBRATION CERTIFICATE
Issued by an Accredited
Calibration Laboratory

SWEDAC ACKREDITERING
1791
ISO/IEC 17025

Calibration Certificate

Certificate No. SS – 1208426

CUSTOMER
National Building Research
Organization
No 99/1
Jawatta Road
Colombo 05

DESCRIPTION
Electronic Top Loading Balance
(Dual range)

Capacity (Max.) : 120 g / 42 g
Resolution : 0 to 42 g: 0.01 mg
42 g to 120 g : 0.1 mg

SERIAL No.
D 449911128

IDENTIFICATION NO.
Not given

MANUFACTURER & MODEL NO.
SHIMADZU, AUW 120 D

RECEIVED CONDITION
Not applicable

REQUEST RECEIVED ON :
2012 June 19

REFERENCE :
C 1205218/03

CALIBRATION DATE
2012 August 15

LOCATION OF CALIBRATION
Laboratory
National Building Research
Organization

TEST CONDITIONS
Temperature : 24 ± 2^0C
Relative humidity : $55 \pm 10\%$

REFERENCE STANDARD
Set of weights of accuracy class E2 (Eqp. No. MA/004), traceable to Primary standard maintained at Korea Research Institute of Standards and Science, KRISS & Physikalisch Technische Bundesanstalt (PTB). (Our Ref: IML-344)

METHOD OF CALIBRATION
The balance was calibrated generally in accordance with the test method manual Ref. No MM/MA/01 – Calibration of Electronic Balance.

The balance scale was externally adjusted 50 g with weight of accuracy class E2 before the calibration.

Calibration certificate – Balance; AUW 120 D, Shimazdu, Japan

Annex 9

Groundwater quality of the wells monitored during March and May

Table 1- Groundwater quality of the wells monitored on 13th March 2013

Sample Reference	pH	Temperature (^{0} C)	Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	BOD at 20 ^{0} C BOD_5, mg/L	Ammonia (as N mg/L)	Nitrate (as N) mg/L	Total Iron (as Fe mg/L)	Total phosphates (as PO_4^{3-} , mg/L)	Total Suspended Solids mg/L	Fecal Coliforms (E.coli /100ml)	Total Coliforms (Coliform Organisms /100ml)
GW 1	7.4	24.6	42	6.9	< 1	0.05	0.29	0.1	0.205	1.6	12	15
GW 2	7.7	23.2	58	5.6	< 1	<0.02	0.04	<0.1	0.070	<1	0	2
GW 3	7.2	24.1	34	4.4	< 1	<0.02	0.19	0.1	0.435	1.2	1	8
GW 4	8.3	23.2	157	5.2	1.8	0.07	2.12	<0.1	0.174	3.0	0	8
GW 5	6.2	23.7	11	4.3	< 1	0.02	0.06	0.2	0.386	<1	3	80
GW 6	6.0	24.0	28	2.4	1.4	<0.02	0.22	0.2	0.315	2.4	70	85
GW 7	6.4	23.5	182	2.7	1.3	0.1	1.84	<0.1	0.220	1.0	3	45
GW 8	6.1	23.7	42	2.4	< 1	0.02	0.07	0.1	0.027	1.7	0	28
GW 9	6.0	23.1	46	3.9	1.8	0.19	0.99	0.1	0.226	4.8	5	12
GW 10	6.2	24.6	35	5.6	< 1	0.04	0.05	0.1	0.205	<1	12	70
**Desirable Level	7.0-8.5	-	750	-	-	-	-	0.3	-	-	0	10*
**Max permissible Level	6.5-9.0	-	3500	-	-	0.06	10	1	2	-	-	

**** For individual or small community water supplies*** ***indicates non compliances with the National Standard for potable water***

"<" indicates minimum detection level of methodology employed

** Specification for potable water Part 1- Physical and Chemical requirements, Part 2- Bacteriological requirements, SLS 614, 1983

Table 1- Groundwater quality of the wells monitored on 13th March 2013 –contd.....

Sample Reference	pH	Temperature ^{0} C	Conductivity µS/cm	Dissolved Oxygen (mg/L)	BOD at 20 ^{0} C BOD_5 mg/L	Ammonia (as N, mg/L)	Nitrate (as N, mg/L)	Total Iron (as Fe, mg/L)	Total phosphates (as PO_4^{3-} , mg/L)	Total Suspended Solids mg/L	Fecal Coliforms (E.coli /100ml)	Total Coliforms /00ml
GW 11	6.5	24.3	168	2.1	1.97	0.03	<0.01	0.3	0.128	2.5	41	60
GW 12	5.8	24.3	36	5.4	< 1	<0.02	0.06	0	0.156	1	0	11
GW 13	6.2	24.3	34	5.2	1.17	0.05	0.03	0.1	0.272	2.5	5	76
GW 14	6.1	24.2	37	3.9	1.24	0.01	0.02	0.1	0.064	12	0	9
GW 15	6.2	24.2	61	4.3	1.37	0.03	1.33	0.1	0.242	63	0	20
GW 16	6.1	23.5	58	6.3	1.12	0.02	0.72	0	0.039	3.8	0	80
GW 17	6.5	23.1	69	1.5	1.04	0.47	0.04	0.1	0.315	1.8	3	11
GW 18	6.1	23.3	34	3.9	1.45	0.05	0.54	0.1	0.052	<1	2	13
GW 19	6.6	23.3	29	6.5	< 1	0.03	0.53	0.1	0.183	4.3	63	70
GW 20	6.3	24.2	47	5.4	1.23	0.05	0.66	0.1	0.180	1	0	16
**Desirable Level	7.0-8.5	-	750	-	-	-	-	0.3	-	-	0	10*
**Max permissible Level	6.5-9.0	-	3500	-	-	0.06	10	1	2	-	-	

**** For individual or small community water supplies*** **-** ***indicates non compliances with the National Standard for potable water***

"<" indicates minimum detection level of methodology employed

**Specification for potable water Part 1- Physical and Chemical requirements, Part 2- Bacteriological requirements, SLS 614, 1983

Table 2- Groundwater quality of the wells monitored on 21st May 2013

Sample Reference	pH	Temperature ^{0}C	Conductivity µS/cm	Dissolved Oxygen (mg/L)	BOD at 20 ^{0}C BOD_5 mg/L	Ammonia (as N, mg/L)	Nitrate (as N, mg/L)	Total Iron (as Fe, mg/L)	Total phosphates (as PO_4^{3-} , mg/L)	Total Suspended Solids mg/L	Fecal Coliforms (E.coli /100ml)	Total Coliforms /100ml
GW 1	6.5	24.1	24	6.9	<1	0.16	0.10	0.3	0.132	2.9	9	13
GW 2	5.7	23.8	62	4.3	<1	0.07	0.02	0.1	0.261	<1	26	141
GW 3	7.0	25.1	32	3.9	<1	0.06	0.13	0.1	0.264	3.7	0	11
GW 4	5.9	23.1	134	5.9	<1	0.08	2.08	0.1	0.327	<1	1	29
GW 5	6.9	22.8	14	4.6	<1	<0.02	0.01	0.1	0.33	<1	5	42
GW 6	5.6	23.4	152	1.8	<1	0.08	2.15	0.1	0.222	1.5	3	8
GW 7	6.5	23.9	22	3.2	<1	<0.02	0.17	0.1	0.33	<1	1	22
GW 8	6.0	25.6	16	3.7	<1	<0.02	1.26	0.1	0.294	3.0	0	79
GW 9	6.9	23.4	149	4.7	<1	<0.02	0.35	0.1	0.204	<1	1	41
GW 10	6.4	24.7	14	5.6	<1	<0.02	0.12	0.1	0.273	<1	0	41
**Desirable Level	7.0-8.5	-	750	-	-	-	-	0.3	-	-	0	10*
**Max permissible Level	6.5-9.0	-	3500	-	-	0.06	10	1	2	-	-	

** For individual or small community water supplies - indicates non compliances with the National Standard for potable water*
"<" indicates minimum detection level of methodology employed

**Specification for potable water Part 1- Physical and Chemical requirements, Part 2- Bacteriological requirements, SLS 614, 1983

Table 2- Groundwater quality of the wells monitored on 21st May 2013, contd.................

Sample Reference	pH	Temperature ^{0}C	Conductivity µS/cm	Dissolved Oxygen (mg/L)	BOD at 20 ^{0}C BOD_5 mg/L	Ammonia (as N, mg/L)	Nitrate (as N, mg/L)	Total Iron (as Fe, mg/L)	Total phosphates (as PO_4^{3-}, mg/L)	Total Suspended Solids mg/L	Fecal Coliforms (E.coli /100ml)	Total Coliforms /00ml
GW 11	5.8	23.2	44	4.6	<1	0.07	0.19	0.3	0.216	3.8	11	20
GW 12	5.2	23.2	47	4.1	<1	0.14	1.28	0.1	0.264	2.7	8	9
GW 13	6.3	23.0	21	6.0	<1	<0.02	0.03	0.1	0.159	8.4	0	0
GW 14	6.2	23.4	5	4.1	<1	<0.02	0.92	0.1	0.333	2.4	0	4
GW 15	6.4	25.1	39	1.8	<1	0.31	1.05	0.1	0.225	1.3	0	43
GW 16	6.4	24.1	47	5.1	<1	0.05	0.07	0.1	0.3	1.3	10	80
GW 17	6.5	23.1	28	5.1	<1	0.14	0.04	0.1	0.072	3.6	0	0
GW 18	6.5	23.5	38	3.2	<1	0.14	0.08	0.1	0.273	1.3	14	19
GW 19	6.3	22.8	28	3.8	<1	0.74	0.08	0.1	0.309	<1	0	0
GW 20	6.4	23.9	11	4.7	<1	0.31	0.10	0.1	0.243	0.49	29	33
Desirable Level	7.0-8.5	-	750	-	-	-	-	0.3	-	-	0	10*
Max permissible Level	6.5-9.0	-	3500	-	-	0.06	10	1	2	-	-	

**** For individual or small community water supplies*** - ***indicates non compliances with the National Standard for potable water***

'<" denotes minimum detection level of the methodology employed

**Specification for potable water Part 1- Physical and Chemical requirements, Part 2- Bacteriological requirements, SLS 614, 1983

Annex 10

Photographs of sampled wells

Photographs of sampled wells

GW 1- spring

GW 2- Dug well

GW 3- Dug well

GW 4- Dug well

Photographs of sampled wells

GW 6- Dug well

GW 8-Dug well

GW 9-Dug well

GW 10- Spring

Photographs of sampled wells

GW 11-Dug well

GW 13- Dug well

GW 14-Dug well

GW 16-Dug well

ADDITIONAL STUDIES ON NATURAL ENVIRONMENT FOR REVIEW OF FEASIBILITY STUDY AND PREPARATION OF DETAILED DESIGN AND BIDDING DOCUMENTS
MORAGOLLA HYDROPOWER PROJECT, SRI LANKA

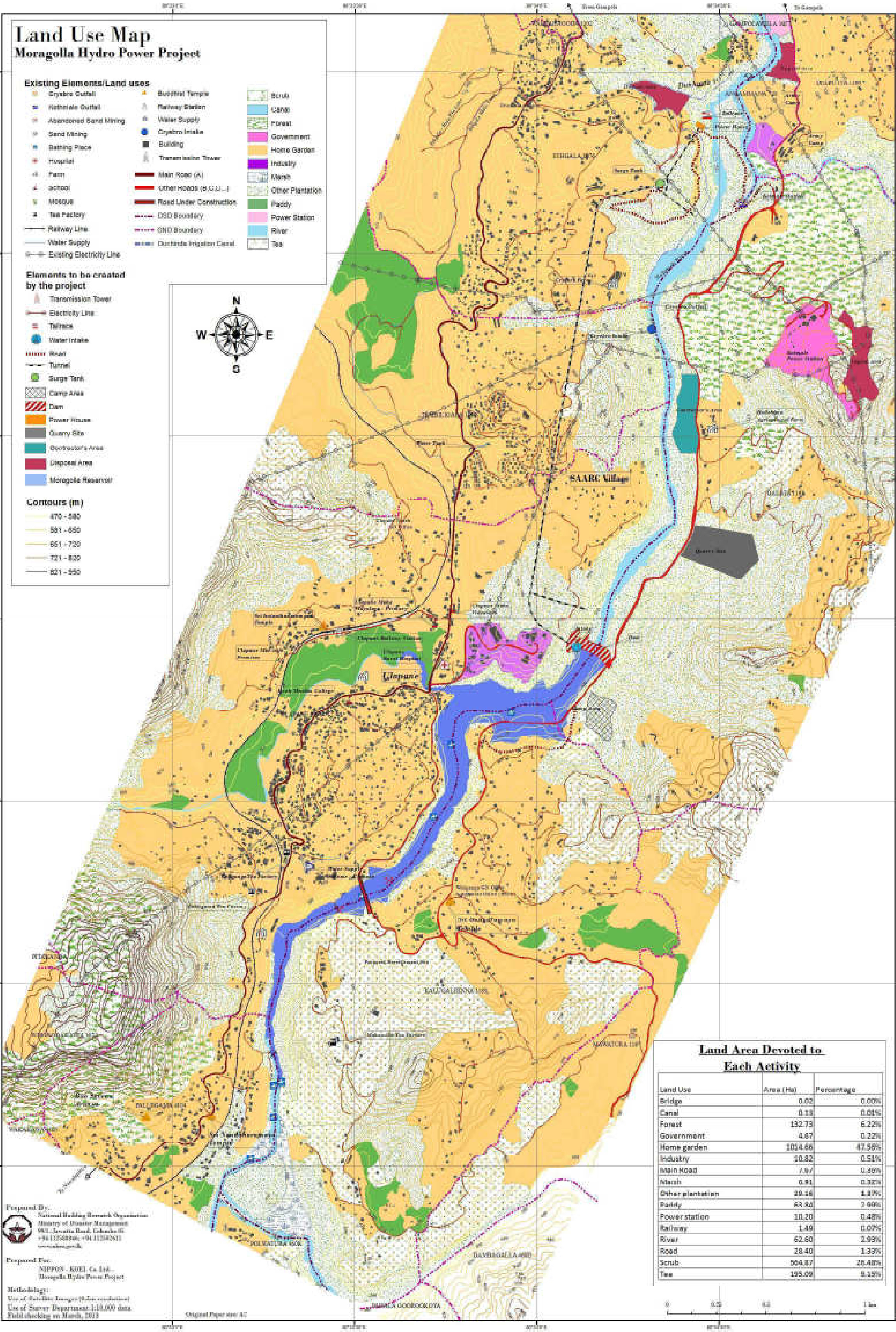
Updated Land use Map

Prepared by
The National Building Research Organization

Prepared for
NIPPON KOEI Co Ltd - Moragolla Hydropower Project

July 2013

National Building Research Organization
Ministry of Disaster Management
99/1, Jawatte Road, Colombo 05, Sri Lanka



Land Area Devoted to Each Activity

Land Use	Area (Ha)	Percentage
Bridge	0.02	0.00%
Canal	0.13	0.01%
Forest	132.73	6.22%
Government	4.67	0.22%
Home garden	1014.66	47.56%
Industry	10.82	0.51%
Main Road	7.67	0.36%
Marsh	6.91	0.32%
Other plantation	29.16	1.37%
Paddy	63.84	2.99%
Power station	10.20	0.48%
Railway	1.49	0.07%
River	62.60	2.93%
Road	28.40	1.33%
Scrub	564.87	26.48%
Tea	195.09	9.15%

Moragolla Hydropower Project

Study of the Rationale and Suitability of the Proposed Environmental Flow






November 2013

Contents

1. **Introduction**

The Moragolla Hydropower Project is designed to harness the hydropower potential of the water flow of Mahaweli Ganga near Ulapane to generate 30 MW of power. Average annual energy generation is estimated as 97.6GWh. The project consists of a reservoir formed by constructing a dam across the Mahaweli Ganga to divert water via a conveyance system (underground tunnel and penstock) to the powerhouse located on the left bank of the Mahaweli Ganga approximately 1 km east of Ethgala Town. The water conveyance system is designed to transfer a maximum flow of 50m^3/s to the power house. After passing through the turbines the water will be discharged back into the Mahaweli Ganga. River flow will therefore be reduced in the 3km stretch between the dam and the tailrace outfall, and farther downstream in the dry season, when little water will overflow the dam and there will only be sufficient water in the reservoir to allow power generation for a few hours per day.

As development of hydropower projects involves altering the natural flow regime of the surface water system, it is necessary to assess the impact of the changed flow regime on the river bed and river bank ecology and also on water uses, so that measures can be incorporated into the project to avoid or reduce any negative impacts to the extent possible. Although older hydropower systems were constructed and many still operate on the basis that all the available water can be retained for power generation purposes, it is now generally recognized that there should be at least some downstream flow in the river at all times, to reduce ecological and other impacts. This is generally referred to as "environmental flow", from the diversion dam, and is intended to ensure that the biological life in the affected stretch is maintained and the human livelihoods and well-being that depend on these ecosystems are sustained. Globally there is a variety of terminology that is used interchangeably[1][2], and they include:

- In-stream flow requirement
- Environmental water requirements
- Ecological reserve
- Ecological flows
- Environmental flows
- Reserved flow
- Environmental allocation
- Ecological flow requirement

In early discussions between the Project Proponent (Ceylon Electricity Board - CEB) and the Project Approving Agency (Mahaweli Authority of Sri Lanka - MASL), MASL proposed an E-flow of

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[1] Nigel Rossouw, , Dams and environmental flows managing releases for livelihood security and ecosystem protection: Overview of the literature and practical lessons from the Berg River Dam. (2009) (http://www.cdri.org.kh/shdmekong/11.Berg_Dams%20and%20Environmental.pdf

[2] Pradeep Kumar, Umesh Chandra Chaube and Surendra Kumar Mishra, Environmental Flows for Hydropower Projects – A Case Study, *International Conference on Small Hydropower - Hydro Sri Lanka, 22-24 October 2007*

4 m^3/s. However CEB advised that a rate in excess of 1.5 m^3/s would render the project financially non-viable, so this was agreed as the proposed E-flow.

The Environmental Impact Assessment (EIA) report[3] of the project, suggests that an E-flow of 1.5 m^3/s is sufficient for present uses by the Dunhinda Irrigation Canal (0.28 m^3/s) and the Crysbro Broiler Plant (0.01 m^3/s) and to maintain flora, fauna and biodiversity in the 3 km stretch of river between the dam and the tailrace outfall, which is the area in which flows will be reduced most significantly. There was however no clear explanation of the reasons for this conclusion regarding ecology and biodiversity, and no consideration of potential impacts farther downstream. Hence as part of the FS review, the consultants examined the appropriateness of the proposed environmental flow and the results are presented in this report.

2. Approach

This analysis draws on a variety of sources of information as follows:

a) Information in consultancy reports and other available documents detailing the flow regimes and environmental flows adopted in other large hydropower schemes in Sri Lanka and elsewhere in South Asia;

b) Information from the design-team hydrologists on the proposed downstream flow regime for this project during operation, and the existing flow regime in the river, showing in each case the seasonal variations;

c) Information from additional aquatic ecology studies[4] carried out during March – July, 2013 on the distribution, extent and importance of the aquatic habitats in the 3 km of river downstream of the proposed dam site and in a 30 km downstream length, which also may receive reduced flows during non-operation hours of the power plant.

d) Published information on the topic of environmental flows, their methods of calculation, and the degree of success in maintaining biodiversity under altered flow regimes.

e) Information obtained from the EIA consultant (Central Engineering Consultancy Bureau) and the client (CEB) regarding the background and rationale for the present proposal of 1.5 m^3/s (which is 41% of the seasonal minimum natural flow (Q_{95}) in the Mahaweli Ganga – EIA report Table 3.6 (d)).

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[3] Ceylon Electricity Board (November 2012): Moragolla Hydropower Project, Feasibility Study, Final Report: Volume 3-Environmental Impact Assessment (Central Engineering Consultancy Bureau, Sri Lanka and Al-Habshi Consultants Office, Kuwait).

[4] Additional studies on natural environment carried out for review of feasibility study and preparation of detailed design and bidding documents: Report No 2; Aquatic ecology in the Mahaweli Ganga, Prepared by the National Building Research Organization, July 2013

3. Results

While in principle the concept of environmental flows is now generally accepted uniformly, the methodologies for establishing the levels of environmental flows vary considerably amongst experts, environmental agencies or countries. In Sri Lanka, there is no specific legislation, ruling or instruction from relevant statutory bodies or regulatory agencies to establish a specific framework or methodology for determining environmental flow. Consequently, in development of hydropower projects, where the level of environmental flows has to be established, consultants rely mainly on existing precedents or use their own experience and understanding to propose such flow requirements

3.1. Historical Precedents

Flow regimes and environmental flows adopted in large hydropower projects in Sri Lanka and some other South Asian countries are presented in the table below.

Table 1: Comparison of e-flow adopted in large Hydropower Projects

Project Name	River	Capacity MW	Min. dry season flow m^3/s	e-flow m^3/s	e-flow as % of natural min flow	Funding	Reference
Sri Lanka							
Kotmale HPP[5]	Kotmale Oya	201	3.1	None	-	Gov. of Sweden	TAMS report (1980)[6] and various other sources. (USAID[7] funded for EIA of Accelerated Mahaweli Development Programme
Polgolla Barrage (Ukuwela Power Station[8])	Mahaweli Ganga	40	NA[9]	None	-		
Victoria Dam	MahaweliGanga	210	NA	None	-	British Gov. Grant	
RandenigalaDam	Mahaweli Ganga	126	1.9	None	-	Gov. Of Germany	
Rantambe Dam	Mahaweli Ganga	50	NA	None	-	Gov. Of Germany	
Kukula Ganga HPP (KGHPP)	Kukula Ganga	70	6	0.3	5	JBIC	EIA report of KGHPP
Upper Kotmale HPP (UKHP)	KothmalaOya	150	4	0.6	15	JBIC	EIA report of UKHP
Broadlands HPP (BHPP)	Kelani Ganga	40	12.1	0.2	2.5	JBIC for EIA report, Chinese Government for implementation	EIA report of BHPP
Moragolla HPP (MHPP) (this project)	Mahaweli Ganga	30	3.6	1.5	41.5	ADB	EIA report of MHPP

[6] TAMS report (1980) – Environmental Assessment of Accelerated Mahaweli Development Programme – October 1980- prepared by TAMS (Tippetts-Abbett-Mccarthy-Stratton)of New York

[7] USAID - United States Agency for International Development

[8] After trans basin diversion to Sudu Ganga

[9] Not Available

Project Name	River	Capacity MW	Min. dry season flow m^3/s	e-flow m^3/s	e-flow as % of natural min flow	Funding	Reference
Pakistan							
Patrind HPP	Konhar	147	24	2	8.3	Korean Investment	EIA report[10]
Shagharthong HPP	KachuraLangma	26	2.1	0.276	13	ADB	IEE report [11]
Nepal							
Tanahu (Upper Seti) HPP	Seti	127	23	2.4	10.5	ADB	EIA addendum 2012
Kali Gandaki "A" HPP	Kali GandakiRiver	144	40	4	10	ADB	[12]
Laos							
Nam-Ngiep 1 HPP	Nam Ngiep	272	26	5.5	21	ADB	EIA Report (Jan 2012)[13]
India							
Tidong HEPP	Tidong Khad	100	2.03	0.678	24.5	ADB[14]	EIA report[15]
Nathpa-Jhakri HEPP	Satluj River	1500	80 (Q^{16}_{95})	7	8.75	World Bank[17]	[18]

[10] Environmental Impact Assessment: Part 2; Patrind Hydropower Project; Prepared by Star Hydropower Limited for the Asian Development Bank; April 2011; (ADB Project Number: 44914); http://www.adb.org/sites/default/files/projdocs/2011/44914-01-pak-eia-02.pdf

[11] http://www.adb.org/sites/default/files/projdocs/2012/34339-043-nep-iee-01.pdf

[12] http://www.adb.org/documents/performance-evaluation-report-kali-gandaki-hydroelectric-project

[13] Draft Environmental Impact Assessment Report; Nam Ngiep 1 hydropower project , Prepared by The Kansai Electric Power Company, Inc., EGAT International Company, Ltd., and Lao Holding State Enterprise for the Asian Development Bank, January 2012, http://www.adb.org/sites/default/files/projdocs/2012/41924-lao-eia-draft.pdf

[14] http://www.hydroworld.com/articles/2013/05/india-s-100-mw-tidong-hydroelectric-project-gets-adb-backing.html and http://www.aecen.org/sites/default/files/india_eia_report_tidonghydroelectricpower_2012.pdf

[15] EIA report of 100 MW Tidong hydroelectric power project, India Prepared by AECOM India Private Limited for NSL Renewable Power Private Limited, March 2013, (ADB Project Number: 46919), http://www.adb.org/sites/default/files/projdocs/2013/46919-014-ind-eia-final.pdf

[16] Q_{95} , Flow which is equaled or exceeded for 95% of the time

[17] http://www.worldbank.org/projects/P009869/nathpa-jhakri-power-project?lang=en

[18] P Kumar, U Chaube and S K Mistra (2007), Environmental Flow for Hydropower Projects – A case study; International conference on small hydropower – Hydro Sri Lanka, 22-24 October 2007

3.2 Methods used in e-flow assessment (EFA)

More than 200 methods for estimating environmental flows have been developed globally[19][20]. Techniques differ widely in accuracy and required input information, and at present there is no single universally-accepted approach. Discussions on these techniques are found in many published sources[21,22]. Different EFA methods are used for different purposes – from general water resources planning to management of dam releases to maintain the ecological and social needs.

These methods are based on various approaches such as:[23][24][25]

a) Hydrological or statistical values;
b) Physiographic principles;
c) Formulas based on velocity and depth of water; and
d) Methods based on multi-objective planning, taking into consideration ecological parameters.

a) Methods Based on Hydrological or Statistical Values

Within these methods, a first subgroup of techniques refers to the average flow rate (MQ) of the river at a given cross section and calculates the E-flow as a percentage. These methods give values of between 5 and 60 % of the MQ, the latter being location where the fishery was of high economic importance. A second subgroup refers to the minimum mean flow (MNQ) in the river and utilizes values of between 33 to 100 % of MNQ. A third subgroup of methods refers to the prefixed values on the Flow Duration Curve (FDC), which shows the daily flow rate of the river against frequency of occurrence. In this group there are a wide variety of values: from a reserved flow equal to 20% of Q_{300} (flow rate exceeding 300 days of duration) to complex interpolating formulae.

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[19] Tharme, R. E. (2003), A global perspective on environmental flow assessment: emerging trends in the development and application of environmental flow methodologies for rivers. River Res. Applic., 19: 397–441. doi: 10.1002/rra.736

[20] Environmental Impact Assessment: Part 2; Patrind Hydropower Project; Prepared by Star Hydropower Limited for the Asian Development Bank; April 2011; (ADB Project Number: 44914); http://www.adb.org/sites/default/files/projdocs/2011/44914-01-pak-eia-02.pdf

[21] http://www.newater.uni-osnabrueck.de/caiwa/data/papers%20session/H2/ForslundAnnaCAIWAFINAL.pdf

[22] Tharme, R. E. 2003. A global perspective on environmental flow assessment: emerging trends in the development and application of environmental flow methodologies for rivers. River Research and Applications 19:397-441.Vol 19 Issue 5-6

[23] European Small Hydropower Association, ESHA 2004, http://dev02.semaforce.eu/fileadmin/esha_files/documents/publications/GUIDES/GUIDE_SHP/_UIDE_SHP_EN.pdf

[24] Environmental Integration of Small Hydropower Plants, ESHA – Europhian Small Hydropower Association (ESHA), Rue d'Arton, 63-65, 1040 Brussels, Belgium

[25] Reference: EIA report : part 2 – Patrind Hydropower Project and IEE report for Thak Nullah Hydropower Plant

The results obtained from these methods may not precise but they can be obtained in a short time and this method is normally considered acceptable for use in the planning stage of a water-related projects. The mostly widely used approach is the Tennant (or modified Tennant) method (see below).

b) Methods Based on Physiographic Principles

These methods basically refer to a prefixed specific flow rate expressed as $l/s/km^2$of catchment area. Values can vary from 1.6 to 9 or more $l/s/km^2$. The latter applies to rivers having excellent abundance of fish . These methods are easily applicable presuming there is good basic data. However no hydraulic parameters are considered and neither the effect of tributaries nor the length of the diversion reach is taken into account.

c) Formulae Based on Velocity and Depth of Water

In this group of methods there is also a wide range of variation. For example one study [26]suggests that water velocity in the case of reserved flow may not fall below a prefixed threshold value of 0.3-0.5 m/s and the minimum depth of water must be greater than a prefixed value of 10 cm. Another suggests 1.2 – 2.4 m/s and 12 - 24 cm water depth; and so on.

The great advantage of these formulae is that the shape of the river bed profile is included in the calculation and there is no need for hydrological data. Nevertheless diversion length and tributaries are again not considered.

e) Methods Based on Multi-Objective Planning Taking into Consideration Ecological Parameters.

These methods are generally very complex in their application and require considerable expertise to be used successfully. They require site-specific flow observations and take into account hydrological, hydraulic, ecological, and meteorological data, embracing both ecological and economic parameters. Methods are expensive in data collection and mathematical computing, and are suitable only for particular types of rivers. Their transferability is doubtful[27].

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[26] http://dev02.semaforce.eu/fileadmin/esha_files/documents/publications/publications/reserved_flow_-methods_of_Calculation.pdf

[27] Environmental Integration of Small Hydropower Plants, ESHA – European Small Hydropower Association. Rue d'Arlon, 63-65, 1040 Brussels

3.3 Application of Environmental Flow Assessment formulae for Moragolla HPP

The following two methods were used to ascertain the E-flow requirement of MHPP as they are widely used in ADB funded projects[28].

1. Formula developed for Minimum Flow for Ecological Requirements by the Agriculture and Environmental Research Institute, Antony, France (2006) CEMAGREF[29].The formula is: $\mathbf{Q=[(0.651Q_{mm}+2)/100]Q_{am}}$. Where, Q_{mm} = mean minimum monthly flow and Q_{am} = annual mean discharge of the river at the dam site. Q = Environmental flow.

Table 2 shows the monthly average natural flow throughout the year at the Moragolla site, estibated based on 42 years of data[30]. This shows that the average minimum monthly flow (Q_{mm})is 6.8 m^3/s and the average monthly flow (Q_{am})is 22.4 m^3/s. If these figures are incorporated into the CEMAGREF formula, the required flow for ecological requirements is calculated as 1.44 m^3/s.

Table2: Monthly Average (Estimated) Discharge at Moragolla Dam Site (m^3/s)

Month	Monthly Average Discharge (m^3/s)
January	10.1
February	**6.8**
March	7.0
April	11.1
May	20.0
June	33.9
July	34.9
August	26.5
September	30.6
October	34.0
November	35.3
December	18.1
Total discharge	268.3
Average	**22.4**
10% of Average	2.24

[28] Such as ThakNullah HPP, Shagharthong HPP- Pakistan, Patrind Hydropower Project - Pakistan

[29]CEMAGREF is a French public scientific research institute in agricultural and environmental engineering with a scientific and technological vocation under the responsibility of the ministries for agriculture and research.

[30] Revised Feasibility Study Report, Moragolla Hydropower Project, Volume 2 Appendix - 2

2. Tennant flow method [31]

   In 1976 Donald L Tennant introduced a method for determining in stream flow (or e-flow) requirements for fish, known as the 'Montana method', or more commonly the Tennant method. From research on 58 cross sections from 11 streams in Montana, Nebraska, and Wyoming (USA), Tennant concluded that 10% of the average annual flow (AAF) is the minimum requirement for short term fish survival, 30% of AAF provides fair survival conditions, and 60% of AAF provides excellent to outstanding habitat. These quantities have been widely employed internationally, regardless of physical and hydrological setting, due to the simplicity of using only the average annual hydrograph.

The Tennant method is also based on the assumption that flows that are satisfactory for the needs of fish and other aquatic biota will also be sufficient for maintaining the recreational and aesthetic qualities of the system.

Application of the Tennant method to the Moragolla project would suggest that an E-flow of 2.24 m^3/s (see Table 2) would be needed to ensure the short-term survival of fish, and that 6.72 m^3/s (30% of AAF) would provide fair survival conditions. This needs to be qualified however by an evaluation of the ecology of the affected river reach, to determine the level of protection that is appropriate according to the quality of the ecological resource, given that an increase in E-flow produces a corresponding reduction of generation capacity. For the Moragolla project an up-to-date ecological evaluation is available, from aquatic ecology surveys conducted as a part of this study (see below).

3.4 Ecological Sensitivity of the study area

The EIA study for the project conducted surveys of fish and other fauna and flora in the river between the proposed sites of the dam and tailrace outfall in 2009, and found ten species of fish, of which five were endemic to Sri Lanka, and two were reported as threatened and one as vulnerable, according to national conservation criteria. A much more comprehensive ecological evaluation was conducted during the present study[32], which focused on the immediate project

[31] Tennant, D. L., 1976. In stream flow regimens for fish, wildlife, recreation and related environmental resources. Fisheries1(4):6-10.

[32] NBRO (2013): Additional Studies on Natural Environment for Review of Feasibility Study and Preparation of Detailed Design and Bidding Documents Moragolla Hydropower Project, Sri Lanka. Final Report 2: Aquatic ecology in the Mahaweli Ganga. National Building Research Organisation, July 2013, 81pp.

area, but also investigated the ecology of the river up to 30 km downstream, some of which will also be affected by reduced river flows.

The 2013 surveys found 49 fish species in the 30 km length (14 endemics), plus 3 indigenous aquatic reptiles, 12 aquatic bird species and one semi-aquatic indigenous mammal. There were also 17 aquatic flowering plant species (7 rare and endemic), 20 dragonfly/damselfly species (7 endemic), and one endemic crab. In the area between the dam and tailrace there were 40 species of fish (including two that are endangered and two near-threatened, according to the IUCN Red Data List[33]), 3 aquatic reptile species, 7 aquatic birds and the semi-aquatic mammal.

This is clearly an area with a quite diverse fish fauna; and because of the rarity and international importance of some of the species, the project will implement a specific conservation program to mitigate potential impacts on these and other species. This will involve habitat management in the upper Mahaweli catchment to protect and enhance the fish populations as an offset measure, along with translocation to mitigate additional construction-related impacts.

The other ecological features of the area are not especially sensitive, as the river and adjacent on-land areas are already greatly affected by the activities of man, in particular farming and power generation. None of the species and habitats recorded in the surveys are restricted only to this river; and the habitats in the immediate project area are relatively barren, comprising rock and boulders and with relatively few aquatic plants (four species).Impacts on fish will be mitigated by the habitat management and translocation program, which will be planned and conducted in cooperation with IUCN[34]. In the light of this and the limited sensitivity of the remainder of the ecological resource, this is not considered to be an area that requires additional protection by a relatively high rate of E-flow. The lower rate as calculated by the Tennant method or other formulae would therefore seem to be the most appropriate in this case.

3.5 Impact on downstream hydrology and water levels in the Mahaweli Ganga due to power plant operations.

Figure 1 shows the monthly variability in water release from the dam (environmental flow and spill releases), indicating the minimum expected in the lean season (when accumulating storage

[33]http://www.iucnredlist.org/

[34]IUCN (2013): Moragolla Hydropower Project. Additional studies in the natural environment: Expert report on mitigating the impacts of the Moragolla Hydropower Project on fish. International Union for Conservation of Nature, Sri Lanka Country Office, August 2013, 59 pp (Draft).

in the reservoir is required) at 1.5 m^3/s in February-March, and maximum discharge of about 9 m^3/s in the early monsoon (June-July). This combined flow, as well as that of a few other small tributaries between the dam site and the tailrace, will constitute the new discharge regime in the 3 km between the dam and the tailrace.

Figure 1: Monthly Water Release from the Dam (environmental flow and spill releases).

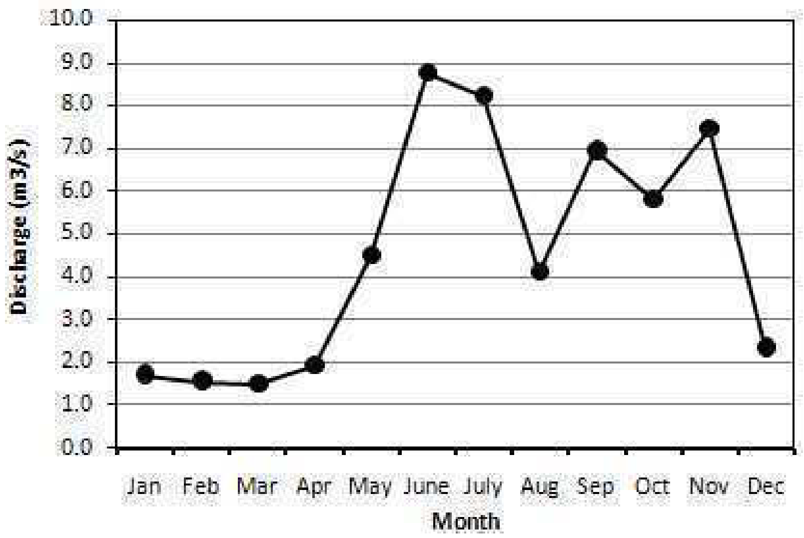
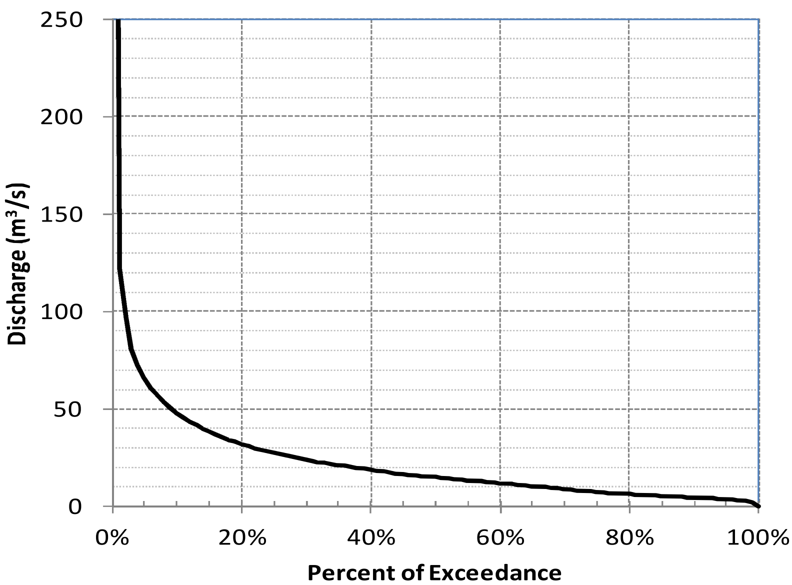


Figure 2: Flow Duration Curve



The combined effects of the Moragolla tailrace discharge, the environmental flow and spill releases, and also the Kotmale tailrace discharge will create variability in both the discharge rates and the water levels in the downstream section of the Mahaweli Ganga. However, this is not so different from the current annual variability, which indicates a one order-of-magnitude natural variability in discharge rates between dry and wet years, from 4 to about 66 m^3/s (see Figure 2 and Table 3). The combined effects of the Moragolla project and residual flow in the Mahaweli Ganga (from the Atabage Oya and the Kotmale tailrace) on discharge rates and water levels in the immediate downstream section of the Mahaweli Ganga are shown in Figures 3-6, and discussed subsequently.

Table 3: Percentage exceedance of Mahaweli Ganga discharge (95% of the time, the discharge in the river exceeds 3.6 m^3/s).

Percent of Exceedance	Discharge (m^3/s)
95%	3.60
90%	4.46
85%	5.34
80%	6.28
75%	7.33
70%	8.99
65%	10.43
60%	11.91
55%	13.31
50%	14.80
45%	16.49
40%	18.76
35%	21.12
30%	23.74
25%	27.19
20%	31.99
15%	38.47
10%	47.97
5%	66.07

Figure 3: Combined effect of the Moragolla and Kotmale tailrace discharges in the immediate downstream section of the Mahaweli Ganga.

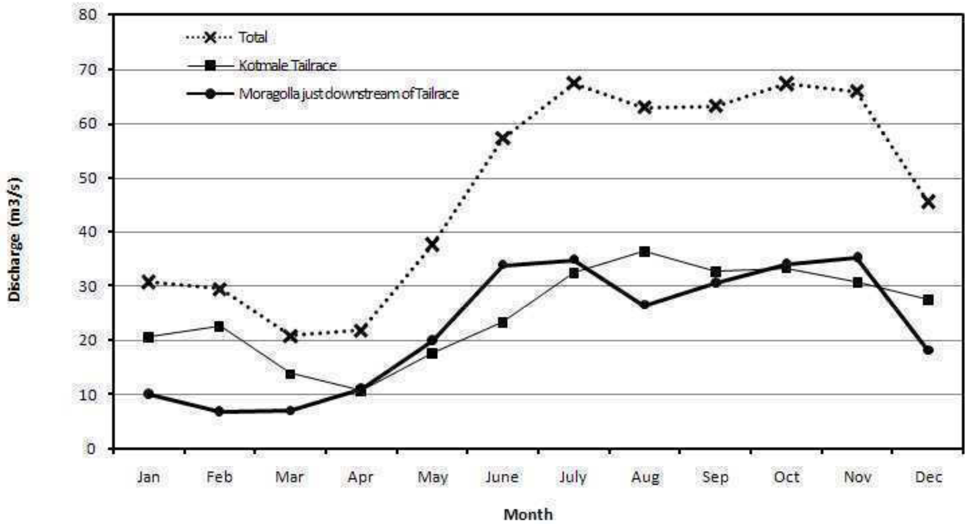
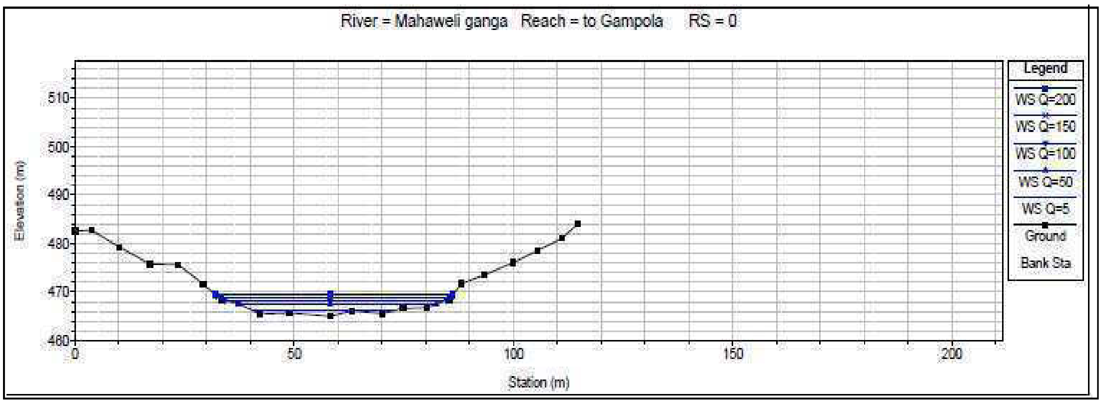
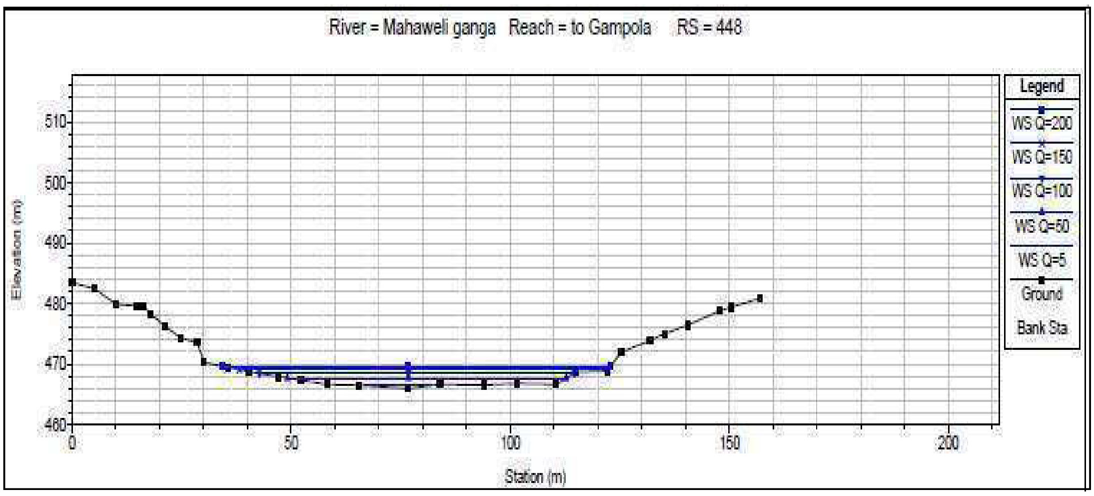


Figure 4: Cross-section of the river under different discharge regimes of the Moragolla project.

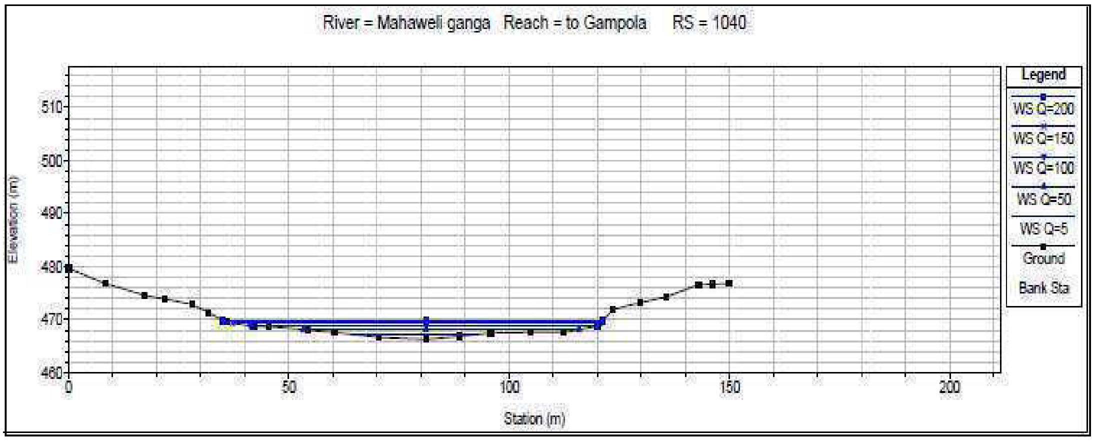
4(a): 3710m downstream from tailrace of MHPP (At Gampola Bridge)



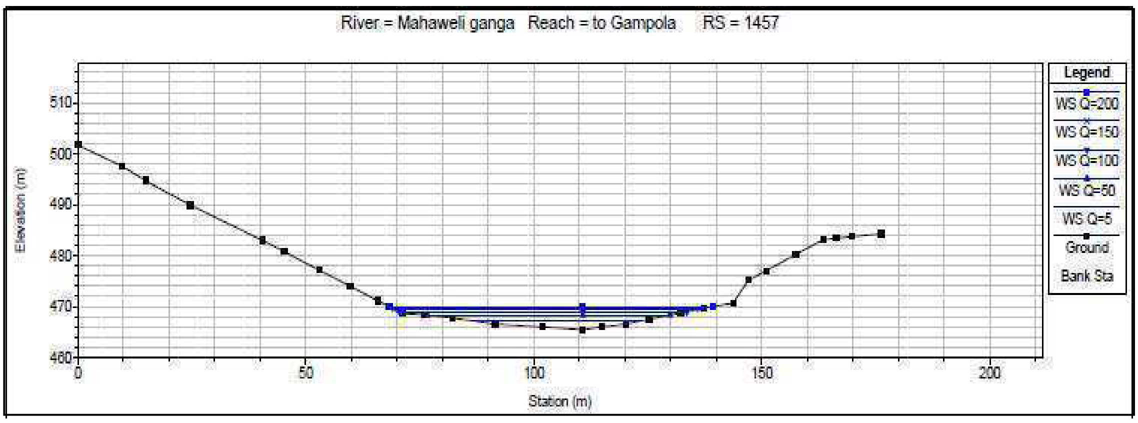
4(b): 3260m downstream from tailrace of MHPP



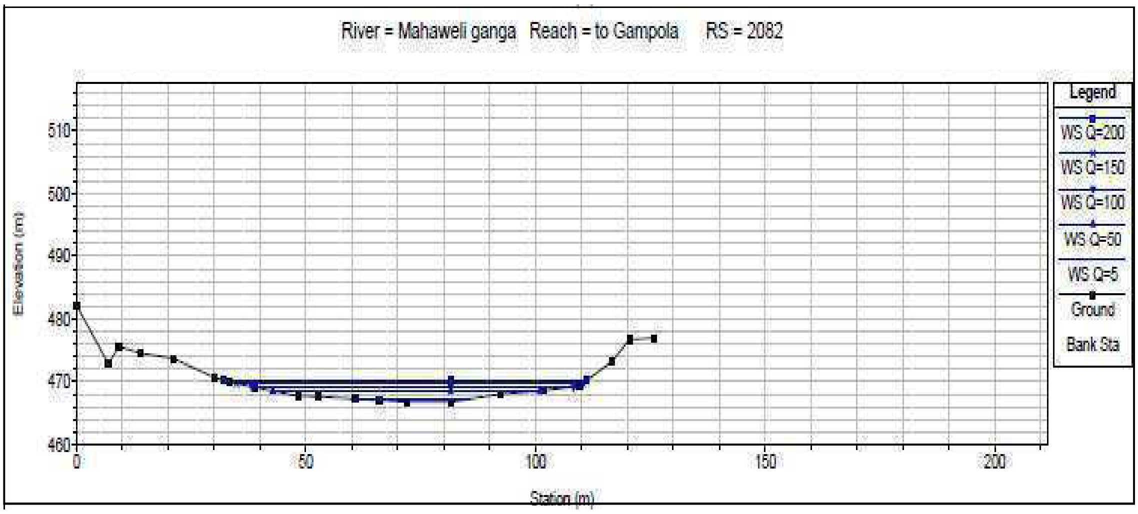
4(c): 2660m downstream from tailrace of MHPP



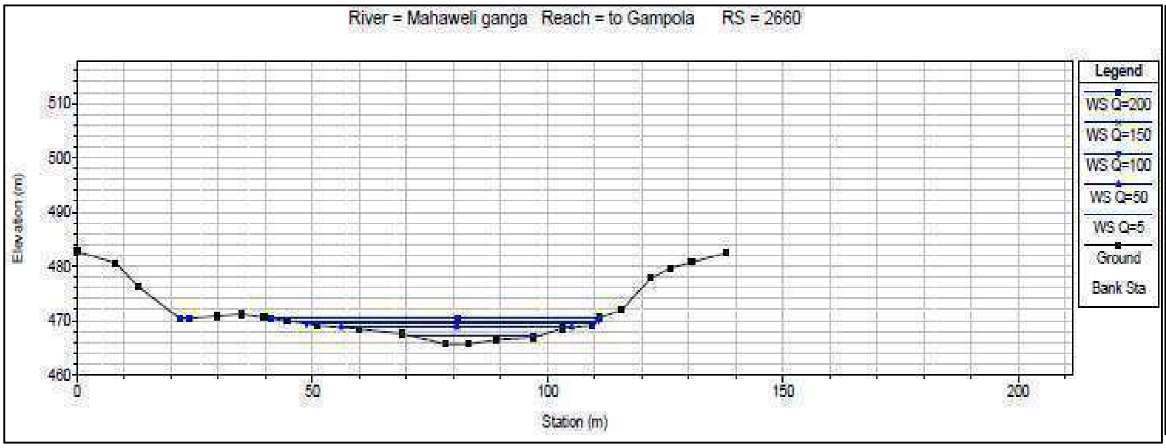
4d): 2250m downstream from tailrace of MHPP



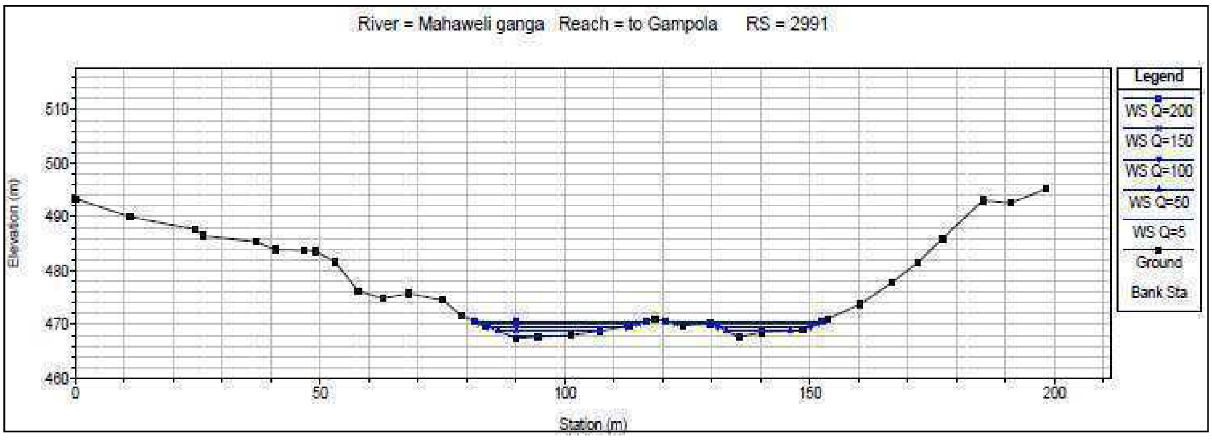
4(e): 1620m downstream from tailrace of MHPP



4(f): 1050m downstream from tailrace of MHPP



4(g): 720m downstream from tailrace of MHPP



4(h): 200m downstream from tailrace of MHPP

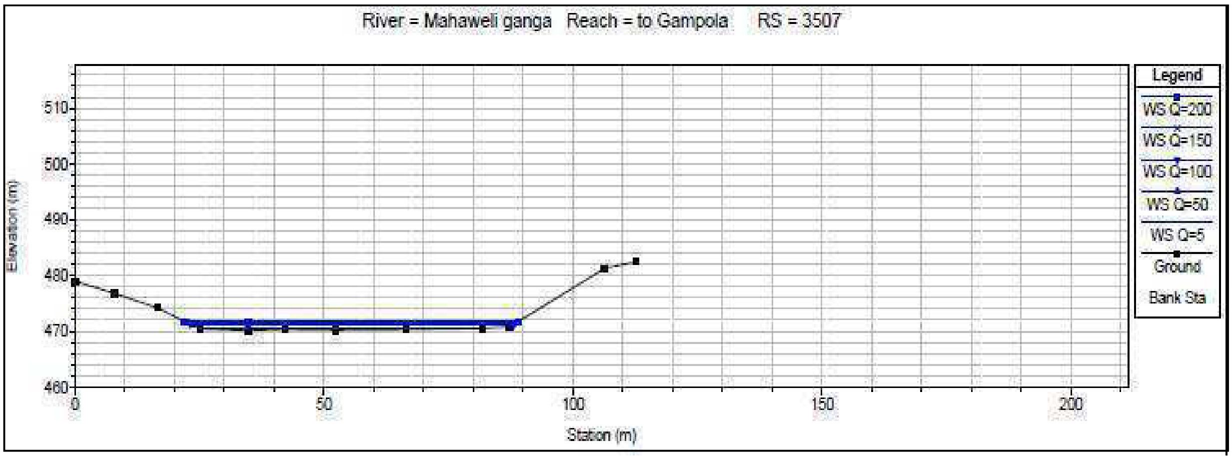


Figure 5: Variability of water levels in the downstream section of the Mahaweli Ganga under various discharge regimes of the Moragolla project.

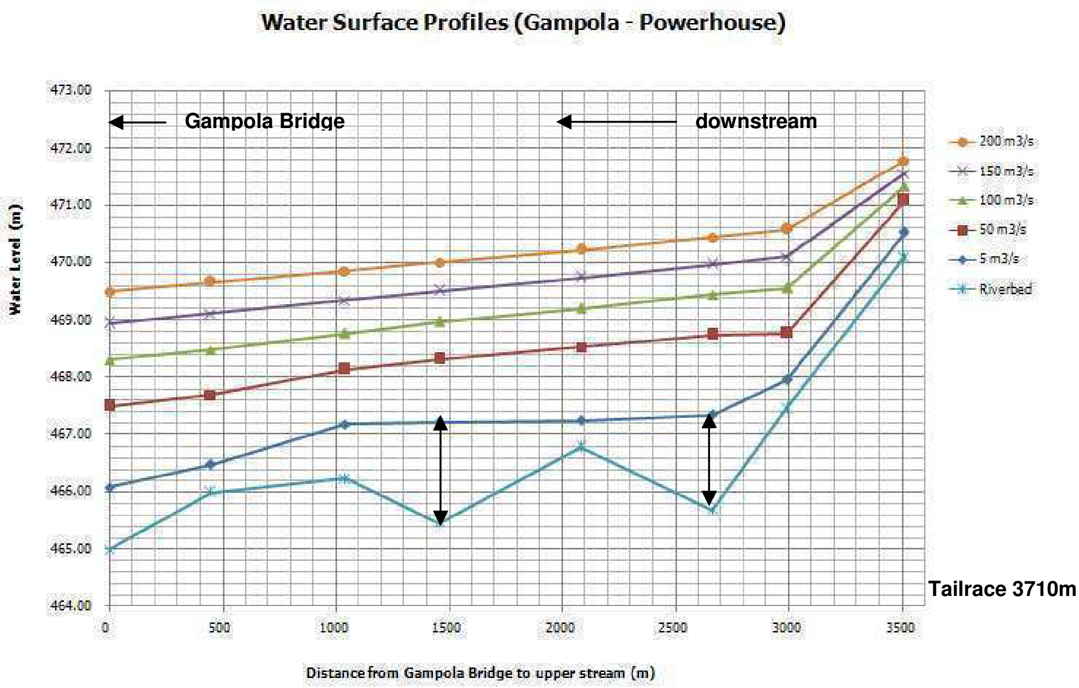
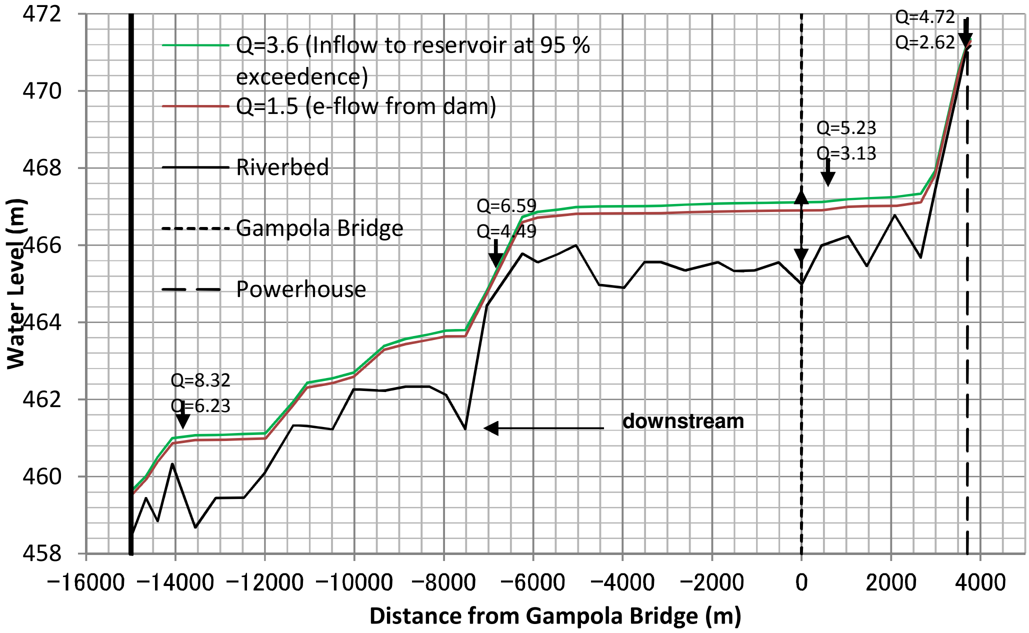


Figure 6: Comparison of environmental flow and existing minimum flow in the Mahaweli Ganga in terms of downstream water levels.



The minimum environmental flow of 1.5 m3/s, in terms of impact on water levels in the immediate downstream section of the Mahaweli Ganga, does not differ significantly from the previous low flow conditions (the 95% exceedance discharge of 3.6 m^3/s; see Figure 6). Ignoring contributions of water flow from the Kotmale and the Atabage Oya (and other downstream tributaries), the data indicate that low flow water levels in the Mahaweli Ganga can be maintained between 0.5 and 1.5 m depth (it would still be deeper in the pools, wherever they are located). Obviously, the lowest discharge rates and the shallowest water will occur in the area between the dam and the Molgolla tailrace.

The combined effect of the Molgolla and Kotmale tailrace discharges produces a minimum of about 20 m^3/s in the immediate downstream section of the Mahaweli Ganga and a maximum of about 70 m^3/s (monthly averages). Throughout the downstream section of the Mahaweli Ganga, the most frequent combined discharge (about 50 m^3/s, in eight months of the year) maintains water levels of at least 1 to 3 meters above the river bed. Even a variability of 3-4 times this discharge rate (up to 200 m^3/s) adds only 1.5-2 m to the water level, which reflects the wider cross-section of the river in the downstream stretch (see Figure 4 (a) to (h)).

4. Discussion

Table 1 shows that there are no E-flow releases from older hydropower schemes in Sri Lanka (and elsewhere), including several located on the Mahaweli Ganga. However most of the more recent schemes do include some provision for continuous downstream releases, and Table 1 shows that for the larger dams in Sri Lanka and elsewhere in Asia, E-flow ranges from 2.5% to 25% of the minimum dry season rate. The proposed release of 1.5 m^3/s from the Moragolla scheme (41% of the minimum dry season flow) therefore compares favourably with other schemes and is the highest of the sixteen examples given.

Of the very many methods that have been used elsewhere to calculate the appropriate level of E-flow, two of the more common approaches were used to examine the validity of the proposed Moragolla rate. According to the CEMAGREF Formula, a flow of 1.44 m^3/s would be required to maintain the ecology of the downstream area; and based on the Tennant method the required release to allow the short-term survival of fish is 2.24 m^3/s. Ecological studies conducted for this project suggest that the area that will be most affected by changes in river flow is not especially sensitive, and providing impacts on the fish fauna are mitigated (which will be done as outlined above) then there is no justification for adopting a relatively high rate of E-flow (such as provided by the Tennant 30% calculation for example).

If the Moragolla project was not realized, CEB would have to forgo 97.6 GWh of renewable energy annually, which is sufficient to supply over 100,000[35] households of average consumption. In the absence of a project of this nature, the forgone amount of energy will have to be fulfilled by other generation methods which would probably involve thermal power options, which not only absorb foreign currency but also cause greater environmental impacts than hydropower. Both thermal alternatives of oil fired and coal fired generation would result in long-term emissions of Carbon Dioxide(CO_2), Oxides of Nitrogen (NO_x), Oxides of Sulphur (SO_x) and particulate matter.

5. Conclusion and Recommendations

The e-flow proposed for the Moragolla HPP is significantly greater than the e-flow releases of other hydropower plants in Sri Lanka and many other Asian countries, when expressed as a

[35] Total consumers in domestic sector = 4,391,445 (Statistical Digest 2012 published by CEB)
Total annual energy consumption by the domestic sector = 3,522GWh (Statistical Digest 2012 published by CEB)
Annual per-capita energy consumption = 3,522,000,000/4.391,445 kWh = 802.5kWh
Number of households (Consumers) which could be supplied with energy using 97.6GWh = 97,600,000/802=121,697

percentage of the minimum dry season flow. E-flow calculated using two widely applied methods suggests that the flow required to sustain minimal ecological resources is between 1.44 and 2.24 m^3/s, which confirms the broad acceptability of the proposed rate of 1.5 m^3/s. Ecological studies for this project provided no justification for adopting a higher rate on ecological grounds, especially as impacts on fish will be mitigated by other action recommended by IUCN.

The environmental flow of 1.5 m^3/s is widely quoted in the EIA report of the MHPP, which assesses the impacts of the changes in river flow in detail. This EIA report was opened for public comments in April 2013 and no comments were received. Environmental approval for the Project was granted by the Project Approving Agency (MASL) on 13 August 2013, subject to several terms and conditions, including release of 1.5m^3/s as environmental flow through an unregulated opening to maintain the ecology and to fulfil the requirements of the downstream users.

The proposed E-flow of 1.5 m^3/s has therefore been subject to a great deal of scrutiny, both expert and public, and no objections have been raised. It has also been subject to considerable investigation, during the original Feasibility Study, and in the present FS Review and Detailed Design study, and no case for changing the E-flow has been made. The additional investigation presented in this report examines further evidence, including widely used E-flow calculation methods and current ecological studies in the project area, and also finds no case for amending the proposed rate. The conclusion is therefore that the proposed E-flow of 1.5 m^3/s is acceptable and is in-line with the limited ecological sensitivity of the project area, providing the impacts on fish are mitigated by the habitat management and translocation measures recommended by IUCN.

Moragolla Hydropower Project

The Stakeholder Consultation and Disclosure Process

Nippon Koei Co. Ltd

November 2013

Contents

1. CONSULTATION AND DISCLOSURE DURING EIA STUDY

The following informal consultations with project Affected Persons (APs), interested groups and civil society were held during the early stages of the EIA preparation as determined by the Project Proponent (CEB) and the Feasibility Study (FS) consultant (CECB)[1].

1.1 Consultation meetings and awareness programmes conducted by CEB and CECB

Event	Views/ Comments / Discussion	Response given / Action taken by CEB
Awareness programme for stakeholder government agencies. June 04, 2009: Kotmale Holiday Resort. No of participants: 30 (attendance list Annex 1)	The only information available on this meeting is the attendance list.	
Awareness programme for the Farmer Organisations of "Dunhinda Ela" irrigation scheme May 08, 2012: Maligapurana Temple, Gampola. No of participants: 27 (attendance list Annex 2	1. The lands cultivated under this irrigation scheme belong to the "Dalada Maligawa" - Temple of Tooth, Kandy. The farmers inherited the lands, which they have cultivated for generations; and they pay tax bi-annually to the Temple of Tooth for their hereditary land.	
	2. The National Water Supply and Drainage Board blocked the "Raja Ela" irrigation canal and diverted the water for their water supply scheme, but no water is released downstream for farmers' requirements. It is expected that a similar thing will not happen to the farmers of "Dunhinda Ela" and that CEB will act responsibly in this regard.	

[1]Central Engineering Consultancy Bureau – consultant who carried out the feasibility studies including EIA during 2009-20012.

Event	Views/ Comments / Discussion	Response given / Action taken by CEB
	3. When will this project be commissioned?	It will take 2 years for the detailed designs and another 4 years for construction. An EIA report is being prepared by CEB and it will be opened for public comments soon. Once the EIA approval is received, the lending agencies will release the required funds for the project.
	4. Water is leaking through the irrigation canal. It is expected that CEB will repair those leaks.	CEB agreed to do the required repairs to the irrigation canal and maintain the section which traverses through CEB premises.
	5. It is requested to have another meeting with the members of three farmer organisations, relevant Divisional Secretaries, Grama Niladaries of the area, tax officer of the Temple of the Tooth and officials of the Irrigation Department (ID).	Agreed
Awareness programme organised for the members of Community-Based Organisations. October 18, 2012: Auditorium of Ganga IhalaKorale Divisional Secretariat Office No of participants: 26 (attendance list and minutes of the meeting Annex 3)	1. A brief introduction about the project, its benefits to the people of the area, national importance and present position and future plans was given by the CEB Project Manager (Detailed Design), MHPP. 2. Potential environmental impacts of the project and the mitigation measures proposed to minimise such impacts were explained by the Head of Environmental Division of CEB. The water requirement for agriculture and human consumption and proposed solutions to minimise any impacts were also explained.	
	3. What is the guarantee that MHPP will not cause similar problem to that created by NWS&DB for the farmers of the 'Raja Ela" irrigation scheme?	Action has already been taken to sign an agreement between CEB and ID.

Event	Views/ Comments / Discussion	Response given / Action taken by CEB
	a.A substantial quantity of water entering into "Dunhinda Ela" is wasted due to the dilapidated condition of the canal. Can CEB repair the entire length of the irrigation canal?	The canal section which traverses through CEB premises will be repaired and maintained by CEB. Repairs of the rest of the canal will be attended to after having a discussion with ID.
	b. Priority should be given to repairs of the canal when project construction activities commence.	Repair work will be carried out along with the infrastructure development works.
	c. Uninterrupted water supply to "Dunhinda Ela" should be guaranteed during the construction period of the project.	Agreed
	4 Crysbro Farm discharges its effluent to Mahaweli Ganga without proper treatment. It contaminates the waters of "Dunhinda Ela" too.	The effluent discharge point will be extended up to the tailrace of the power house. It will be designed to allow the authorities to collect samples for analysis and check the effluent quality.
	5. Gampolawela paddy field belongings to the Temple of the Tooth - "Dalada Maligawa" and the farmers pay taxes for the land cultivated by them. Even if they are unable to cultivate, taxes need to be paid to "Dalada Maligawa". It is requested that CEB inform the Tax Officer about the project and possible problems the farmers will face during construction of the project.	Already this matter was discussed with the Tax Officer and the Revenue Collecting Company. A discussion is planned to be held with "Diyawadana Nilame" (incharge of the Temple of the Tooth) and the Board of Management.
	6. The reservoir area is used by the people for bathing. Water requirement for bathing is crucial during drought. What action is proposed to facilitate bathing places? Is there any suitable land for the resettlement of affected people?	Safe bathing places will be constructed by the project. A five acre plot of land within "MahawilaWatta" near SARC Village is identified for the resettlement of affected people.
	7. In order to solve the problem created by NWS&DM by extracting water from "Raja Ela", is it possible to release water for the NWS&DB scheme through Moragolla reservoir.	CEB agreed to discuss this matter with the relevant parties.

Event	Views/ Comments / Discussion	Response given / Action taken by CEB
	8.Land requirement for road widening shall be informed to the public in advance. The Right of Way should be marked on the ground.	Agree to take action after having a discussion with DS.
	9.What is the action taken by the project to minimise the inundation of arable land.	To minimise this impact the reservoir level has been lowered by 2 metres. (Originally it was at 550m and now it is reduced to 548m)
	10.It is requested to give priority to the members of the farmer organisations when recruiting workers for the project.	This request can be accommodated very easily.
Consultative meeting with the Management of Farm's Pride (Pvt) Ltd.,Crysbro Processing Plant August 21, 2012: Factory premises No of participants: 5 (minutes of the meeting Annex 4)	The purpose of the meeting was to discuss the issues in relation to relocating the waste water discharge outlet of Crysbro Farm to a suitable place. The following information was provided by the Crysbro representatives: 1. Effluent is kept for 24hrs in settling tanks before release to the outlet. 2. There are no solid particles, as the effluent is passed through several filters. 3. About 30,000 litres/day of effluent is released to Mahaweli Ganga during night time. 4. The diameter of the effluent discharge pipe is 6" and it is of 1000 grade PVC. 5. There will be a reduction of the river flow at the effluent discharge location due to MHPP.	It is necessary to direct the effluent to a place where there is sufficient flow. The cost of relocation of the effluent pipeline to a suitable place will be borne by CEB. The proposed design of the new outfall will be forwarded to Crysbro Farm.

Event	Views/ Comments / Discussion	Response given / Action taken by CEB
Consultative meeting with the Management of Farm's Pride (Pvt) Ltd., Crysbro Processing Plant September 21, 2012: Office of Farm's Pride (Pvt) Ltd. at Jayamalapura No of participants : 6 (minutes of the meeting attached Annex 5)	1. The management of Farm's Pride Pvt. Ltd. explained that the main reason for setting up Crysbro processing plant at Ethgala is easy access to Mahaweli River water which is pure enough and sufficiently available for the requirements of Crysbro processing plant even during severe droughts.	CEB is bound to release $1.5m^3/s$ as e-flow to maintain the ecology of the river stretch between the dam and the outfall of the powerhouse and for the requirements of the downstream water uses. CEB will also carry out necessary modifications to the existing water intake of Farm's Pride Pvt. Ltd. so that the required quantity of water would be properly diverted to the intake throughout the year.
	2. Whether the proposed tunnel will be routed under the processing plant?	The tunnel is so designed to avoid traversing beneath the Industrial zone and the Crysbro Processing Plant. The tunnel will be constructed about 60m below the ground surface in this area.
	3. Will there be any climatic changes due to the reservoir and will there be a possibility of formation of algae in the reservoir?	The proposed reservoir is not a storage type reservoir like Victoria, Randenigala and Kotmale power stations and hence such impact due to the proposed reservoir would be negligible. Unless reservoir water is mixed with biological substances produced by anthropogenic activities the possibility of formation of algae in the reservoir water would be negligible.
	4. Farm's Pride Pvt. Ltd. consented to the CEB proposal to relocate the wastewater outlet as proposed in letter No PM/MOGL/DD-EIA dated September 28, 2012 addressed to the Chairman, Farm's Pride Pvt. Ltd. on relocation of waste water outlet. Maintenance of the waste water discharge line would be a Farm's Pride Pvt. Ltd. responsibility.	

Event	Views/ Comments / Discussion	Response given / Action taken by CEB
	5.Farm's Pride Pvt. Ltd. requested an official letter from CEB assuring them that the river water will be available for the processing plant in all circumstances if they are allowed to pump water from the present location. They also queried the availability of water during extreme droughts.	Release of e-flow is clearly mentioned in the EIA report, which will be opened for public comments by the MASL in the near future. Copies will be available for public inspection at the Divisional Secretariats of Ganga Ihala Korale and Uda Palatha. CEB will examine the possibility of issuing such a letter after discussion with management. The present water requirement as previously indicated by the industry ie.,400,000/day (through their letter dated June 15, 2009) could easily be met by the proposed release and even if the Crysbro facility increase their production to three shifts per day, the maximum quantity needed would be $0.016m^3/s$, which is still within the $0.02m^3/s$ allocation.
	6.Farm's Pride Pvt. Ltd. would prefer to relocate the river water intake point to the down streamside of the outfall of the proposed powerhouse. The whole modifications of the newly proposed intake and pipe work will be carried out by Farm's Pride Pvt. Ltd. What they expect from CEB is only the funds allocated for the modification of the intake structure as mentioned in the letter No PM/MOGL/DD-EIA dated September 28, 2012 from CEB. The balance investment requirement for this modification and pumping arrangement, including maintenance costs, will be borne by Farm's Pride Pvt. Ltd. They opined that this would be a win-win solution for this issue and they will not be a stake holder (or affected party) of this hydropower project if this proposal is implemented.	The detailed designs of the modifications required to the existing water intake of Farm's Pride Pvt. Ltd. are already included in the detailed designs of the project. The cost estimates for this modification can be obtained from the design consultants and that is the maximum amount that can be paid as compensation by CEB if this proposal is implemented instead of modifying the existing water intake. This is also possible only if the management of CEB agree to transfer the estimated cost to Farm's Pride Pvt. Ltd. This will be discussed further with CEB management and Farm's Pride Pvt. Ltd. will be notified of the outcome in due course.

1.2 Communication with stakeholder government agencies

Reference	Summary of main relevant comments	Remarks
Letter ADGM/P&P/MHP/127/2010; March 22,2010;from Additional General Manager(Policy & Planning), NWS&DB to DGM (Tr& Gen Pl), CEB	NWS&DB grants approval for MHPP subject to the conditions of the Memorandum of Understanding signed between NWS&DB and CEB	In response to CEB letter PM/MOGL/FS of February 25, 2010
Letter PM/MOGL EIA; February 24, 2010 from CEB to NWS&DB	Agreed conditions: 1. A bottom outlet (draw off arrangement), which could be used to release water at critical situations, shall be incorporated into the structural arrangement of the dam. 2. Water supply shall be treated as a similar priority to electricity supply. Hence NWS&DB's right to obtain water for present or future water supply schemes from up/down stream or both is assured. 3. Subsequent structural modifications that shall increase the water storage capacity upstream will not be implemented without prior agreement with the NWS&DB. 4. Proper structural drawings to a suitable scale will be furnished to NWS&DB to visualise the cross sections of the structures to be constructed across the river before construction commences. 5. All step-up transformers will be provided with a contingency arrangement built-in at site to direct all coolant oils, chemicals etc., to a sufficiently protected water collection pit so that it could be removed from site for safe disposal elsewhere. 6. All body metal components in contact with high velocity raw water flow will not contain metals that are identified and given in Sri Lankan Standards as hazardous heavy metals (eg. Pb, Zn, Cr, Cd, Ni) 7. All used lubricants / bearing fluids will be collected in a sufficiently protected container for safe storage and removal from the site. 8. All mechanical seals and respective standards shall not be affected to bacteriological and chemical parameter of water quality of the discharge of the proposed hydropower project. 9. Periodical chemical testing of raw water before and after the generator facility shall be carried out by CEB as directed by the	

Reference	Summary of main relevant comments	Remarks
	NWS&DB, which would be required to maintain safe quality of raw water to be used in the treatment process and quality of treated water.	
Letter HW/KOT G/22; March 04. 2010;from Engineer in Charge, Kothmale, MASL to CECB EIA Team Leader	1.The existing quarry has only a IML-C category licence, and hence only a very small quantity of rubble can be extracted. If CEB intend to adopt large scale blasting, an EIA is essential. Transport of material across the existing Kotmale dam is not allowed. **2.**As far as the water supply for Farmers Pride Pvt. Ltd. is concerned, they are allowed to extract only up to 50,000 gallons of raw water from Kotmala Oya by MASL.	In response to letter CB/WR/WMR/P-05; February 18, 2010.
Letter RDA/ES/BD (XVIV);October 06, 2009;from Director, Engineering Services, RDA to CEB Additional GM (Water Resources)	Some sections of the piers and abutment foundations of the bridge over Mahaweli Ganga on Ulapane-Mawathura Road are placed on weathered rock layers. Hence, there would be a possibility to erode the soil overburden in foundation areas. It was therefore decided to protect the ground surface around the abutments and piers under the submerged area with rubble paving using cement-sand mortar. CEB shall bear the cost of this additional work.	
Letter Env/526(Kan ii) Moragolla; October 04, 2009;from Director General, Irrigation Department (ID) to Director General CEA	Conditions of consent letter dated April 04, 2009 is relaxed and the new conditions are: 1. A full EIA shall be carried out by CEB for the proposed project. **2.** No impact shall be caused to the command area of "Raja Ela" irrigation scheme. High Flood Level (HFL) of the reservoir shall be below the anicut and the irrigation scheme. **3.** The water requirement for Dunhinda anicut, which is located below the proposed reservoir, shall not be reduced. The power generation intake shall be designed in order to allow release of a minimum of 10 cusecs to the irrigation canal. A Memorandum of Understanding shall be signed between ID and CEB. If CEB decide to transfer the hydropower scheme to a third party, the ownership of the plant and the reservoir shall be transferred to CEB. **4.** If water shortage is experienced during the dry season, priority shall be given to providing sufficient water for the Dunhinda irrigation	Refer to letters CB/WR/WRM/P-11;March 02, 2009 and April 04, 2009 from CECB and Reply letter from ID dated August 10, 2009

Reference	Summary of main relevant comments	Remarks
	scheme. 5. Water for the environmental requirements shall also be released in addition to the water needed for irrigation purposes.	
Letter No.fla$àã$11$P.ú.jHdmD;s September 22, 2009 from Regional Officer, Forest Dept. to Additional General Manager (Water Resources) of CECB.	No forest reserve or forest plantations are involved in the proposed MHPP and hence we have no objection regarding the implementation of MHPP.	
Letter of 11.08.2009 from Director/ Geology, GSMB to Additional General Manager (Water Resources) of CECB.	It appears that the proposed quarry site has been operated to supply rock material to construct the Kotmale dam. If quarrying activities at the same site are commenced it would adversely affect the surrounding area because soil creeping and earth subsidence have been reported since impoundment of Kotmale reservoir. It is therefore suggested to identify a suitable alternative quarry site to obtain rock material for Moragolla Hydropower Project.	In response to letter of June 29, 2009 from Additional General Manager (Water Resources) of CECB.
Letter .bflda$m%df,a2/1/2009/1 ; June 25, 2009;from Divisional Secretary, Ganga IhalaKorale; to	Current development programmes in Ulapane area are as follows: 1. Raja Ela Development 2. Mahawelawatta Land and Housing Project 3. Ethgala New Town Development 4. Ulapane Industrial Zone 5. Kandy South Water Supply Scheme	
Letter No .bflda$m%df,a2/1/1/2009/1 August 07, 2009 from Divisional Secretary, Ganga Ihala Korale to Additional General Manager (Water Resources) of CECB.	Provides details of the above development programmes.	
Letter RDA/ES/H/CP; August 03, 2009 from Director/Highway Designs, RDA, to Additional General Manager (Water Resources) of CECB.	Comment of RDA to letter No. CB/WR/WRM/P-11 dated July 14, 2009 of Additional General Manager (Water Resources) of CECB	
Letter No.m%df,a$aWm/1/5/11/27; July 27, 2009from Divisional Secretary, Udapalatha, Gampola to Additional	There are no development programmes in the project area. However, the development programmes implemented in surrounding areas are as follows:	

Reference	Summary of main relevant comments	Remarks
General Manager (Water Resources) of CECB.	1. Pilawala- KalugalhinnaMawathuraPilawalaRoad 2. Mawathura –MawathuraNew Colony Road 3. Weliganga – KanapathyWattaRoad via the cemetery 4. Kekulandala – NayapanaWattaRoad via GalathaSchool 5. Mawathura – Remaining parts of MihinduMawatha 6. Water tank near Mawathura – MawathuraWelawattaGalmula	
Letter ED/TS/MH/MORA/14;June 18, 2009;from Director General, MASL To Additional General Manager (Water Resources) of CECB.	The ToR issued for the EIA study by the MASL covers all the required details to incorporate in the environmental study.	In response to letter CB/WR/WRM/p-11 of April 07, 2009
Letter No.m%df,a$aWm/1/5/11/27 ;June 19, 2009;from Divisional Secretary, Udapalatha, Gampola, to Additional General Manager (Water Resources) of CECB.	Proposed the following mitigation measures: 1. Provide alternative lands for the people who are living in theproposed reservoir area as the lands are either privately owned or colony lands. 2. Provide alternative lands for the people impacted due to the construction of proposed alternative roads. 3. Alternative roads shall be constructed without causing any environmental problems. **4.** Sufficient water to sustain the river system shall be released to the river stretch between the dam and the power house.	Reference letters dated February 20, 2009 and May 13, 2009
Letter 17/CP/N/UDA/1;July 11, 2009;from Deputy Director General (P1) – Zone II, UDA, to Additional General Manager (Water Resources) of CECB.	The proposed project site does not fall within the area declared under the Urban Development Authority Act.	
Letter No. .bflda$m%df,a2/1/2009/1; March 20,2009;from Divisional Secretary, Ganga Ihala Korale, to Additional General Manager (Water Resources) of CECB.	As the tunnel of the proposed project traverses beneath the Ulapane Industrial Zone, it is proposed by the DS to have a discussion with the industrialists of the zone regarding their concerns and come to an amicable solution.	
Letter LE 1479;September 29, 2009;from Director, Environment Management, Board of Investment (BOI) of Sri Lanka, to Additional	The BOI has granted an approval for M/S Farm's Pride (Pvt) Ltd to establish a Broiler Processing Plant at Davidson Estate Ethgala, Gampola after obtaining approval from the Committee for determining the sitting of High and Medium polluting industries outside the Export Processing	

Reference	Summary of main relevant comments	Remarks
General Manager (Water Resources) of CECB.	Zone (EPZ) and industrial estates. The initial water requirement was 450, 000 litres/day and now approximately 600,000 litres/day of waste water is said to be discharged into Mahaweli River after treatment to comply with the legal standard for industrial wastewater discharged into inland surface waters. Farm's Pride (Pvt) Ltd had requested an approval for their first expansion on July 04, 2009; however our records reveal that the above approval has been withdrawn on April 08, 2009. Contact M/S Farm's Pride (Pvt) Ltd to obtain information about future expansion as the required information is currently not available with BOI.	
Letter 109/12/01/71;July 30, 2009;from Regional Director, Regional Industry Service Centre – Central Province, to Additional General Manager (Water Resources) of CECB.	1. Proposed industries to be established with the industrial zone are as follows: • Diva Plastic Ltd – Polythene and Plastic • Fermtech Co. – Wooden frames • Jayalanka Furniture – MDF and steel furniture • Tharindu Products – Fruit drinks 2. No waste water discharge from the industrial zone. Solid waste is collected and disposed of through Ganga Ihala Korake Pradeshiya Sabah. 3. The only rain water is discharged into storm water drainage system. 4. An IEE report for Ulapane Industrial Zone is being prepared. It is authorised by MASL to discharge industrial waste water which conforms to MASL norms, within 60m from the river bank.	
Letter of July 15, 2009 from Chairman, Farm's Pride (Pvt.) Ltd. to Additional General Manager (Water Resources) of CECB.	We require 400,000 litres of water per day at present and we may need max of 1,000,000 litres per day for expansion of production in the future. The water used for the production facility is discharged to the river after treatment as per CEA specification.	
Letter RDA/ESD/CEB; January 13, 2012;rom Director General, RDA, to CEB	Grant consent for MHPP subject to several conditions. (Motor Traffic (dimensions and gross vehicle weights) Regulation, 2004 is attached.)	In response to letter PM/MOGL/EIA of December 29, 2011 from DGM (Tr and Gen. Pl)

Reference	Summary of main relevant comments	Remarks
Letter DS/UP/MHP/17; November 30, 2011;from Divisional Secretary, Udapalatha, Gampola to CEB	Grant consent for MHPP subject to the following conditions: • Proper resettlement of affected persons • Develop and implement a forestry programme. • Minimise the public nuisance caused due to dust, noise and vibration. • Minimise soil erosion, water pollution and air pollution.	In response to letter PM/MOGL/EIA dated October 10, 2011.
Letter .bflda$m%df,a/6/1/;October 25, 2011;from Divisional Secretary, Ganga IhalaKorale, to CEB	Propos e several mitigatory measures to minimise the potential social and environmental impacts: • Proper compensation shall be paid for the loss of land and property. • Any damage caused to Dunhinda Ela irrigation scheme shall be rehabilitated • Any impact on Ulapane Industrial zone shall be rectified.	In response to letter from CEB dated October 10, 2011.
tpÞvæ$fld;a$amS$22; August 03, 2011;from Engineer In charge of , Kothmale Project, MASL, to CEB	Considering that the proposed MHPP is an important national project, and as there is no other suitable land in the vicinity, we herewith grant approval for the proposed land to be used as a spoil disposal area subject to the following conditions: • Since the land is sloping towards the river, proper protection shall be taken in order to prevent damage to the river bank and minimise soil erosion. • The trees planted by MASL and other natural trees shall be protected and the river bank shall be protected by planting suitable tree species. • Runoff water shall be directed through a sediment trap and the resultant water shall meet the national standards. • Water quality test results shall be submitted periodically to MASL • A detailed plan shall be submitted to MASL taking into consideration of the above recommendations.	
Letter MC/KOT/RP/MHP; April 26, 2011;from Chief Engineer, Kotmale Power Project, CEB, to Deputy General Manger (Tr. and Gen. Pl.), CEB	The identified lands in four blocks (total area ~5ha) can be used for the disposal of spoil material.	

Reference	Summary of main relevant comments	Remarks
Letter No.fla$wdr®tia$bvi$fudrf.d,a, c,jÞ¥,Þ n,d.drh;June 02, 2011;from Resident Project Manager, Victoria /Kotmale Project, MASL, to …	Request CEB to prepare a survey plan of the proposed land for spoil disposal in order to obtain the consent of the physical planning committee of MASL and submit the same for the approval of Director General of MASL	In response to letters PM/MOGL/EIA dated March 23, 2011 and April 25, 2011.
Letter DGM/RSC-C/SP/08/01;February 14, 2011;from Deputy General Manager, Regional Support Centre, Central, NWS&DB[2], to CEB	As requested, the locations of NWS&DB water intake points in Gampola water supply scheme are provided.	In response to letter PM/MOGL/EIA dated December 16, 2010
Letter CPC/GIPS/01/07/fudrf.d,a, jÞ¥,s;November 04, 2010;from Chairman, Ganga IhalaKorale PradeshiyaSabha (PS) – Kurunduwatte Bazaar, to CEB	Inform CEB that the approval of PS is already granted through their letter No. CPC/GI/PS/07/fudrf.d,a, jÞ¥,s dated August 08, 2006 and they (PS) will send the revised approval letter based on a discussion held on October 07, 2010 at MASL.	In response to letter PM/MOGL/FS dated October 27, 2010

[2]NWS&DB = National Water Supply and Drainage Board

1.3 Disclosure – opening the draft final EIA report for public review and comments

The EIA report prepared by the EIA consultants (Central Engineering Consultancy Bureau and Al-Habshi Consultants Office, Kuwait) based on the Terms of Reference (ToR) issued by the Project Approving Agency (PAA), Mahaweli Authority of Sri Lanka, was opened for public comments on April 01, 2013 for a period of 30 working days, as required by NEA. The EIA report was made available in the following locations in Sinhala, Tamil and English languages for the inspection by the public:

- Divisional Secretariat Office, Udapalatha
- Divisional Secretariat Office, Ganga IhalaKorale
- Engineer-In-Charge Office, Head Works Administration, Operation and Maintenance Division, MASL, Riverside, Mawathura
- Library, Central Environmental Authority, 104, Denzil Kobbekaduwa Mawatha, Battaramulla
- Pradeshiya Sabha Office, Udapalatha
- Pradeshiya Sabha Office, Ganga Ihala Korale
- Central Environmental Authority, Regional Office, Dam Site, Polgolla
- Library, 6th Floor, MASL, 500, T B Jaya Mawatha, Colombo 10

Newspaper advertisements were published by the PAA, in *Dinamina* (Sinhala),*Thinakaran* (Tamil) and *Daily News* (English) on April 01, 2013 inviting the general public to submit their comments (if any) in writing on the project to the Director General of MASL. Scanned copies of the advertisements are attached in Annex 1(A), 1(B) and 1(C). The thirty day public commenting period ended on May 15, 2013. No comments were received from the affected parties, the general public, or any stakeholder agencies.

2. CONTACTS BY EIA TEAM DURING SOCIO-ECONOMIC SURVEY CARRIED OUT IN 2009

2.1 Meetings and Focus Group discussions with representatives of key stakeholder organisations.

Event	Views/ Comments / Discussion	Response given / Action taken
Divisional Secretaries of Udapalatha and Grama Niladaries of the area.	• The development interventions should be well guided by EIA report. • Project required land needs to be acquired from the private owners. According to the GN (Weliganga Division) required land can be acquired with compensation. • Many of these land plots hold annual permits issued by MASL.	EIA report will be prepared, opened for public comments and approval obtained from the Project Approving Agency. A Resettlement Plan (RP) is being prepared. All compensation matters will be discussed therein.
Divisional Secretary of Ganga Ihala Korale.	• The proposed project may not create serious negative impacts on the settlements in the division because the proposed tunnel is an underground construction and also other project interventions will be carried out in non-residential lands. However, project development activities should be implemented in accordance with the recommendations in the EIA Report.	Noted
National Water Supply & Drainage Board (NWS&DB): with Mr S P Rathnayake, Officer in charge and Mr A N B Heenkenda, Technical Assistant	• There are no domestic water supply projects located downstream of the proposed dam which will have impacts due to the proposed project.	Noted
Road Development Authority: Embilmeegama, Pilimatalawa Office: with Mr Dharmadasa, Executive Engineer	• If the proposed road diversion is established to replace the section of existing road that will be inundated due to the proposed reservoir, there will not be a problem for the users of the existing road located on the right side of Mahaweli River at the project location.	Noted
Department of Agrarian Services: at Ganga Ihala Korele office: with Mr Kamal Priyantha, Divisional Officer	• Generating power is a national need. Similarly agriculture in Gampola-Raja Ela irrigation scheme is also important and therefore, the irrigation canal (Known as DunhindaEla) located downstream of proposed dam should be provided with adequate water to deliver to the Gampola-Raja Ela Irrigation scheme.	The water requirement of the DunhindaEla has been assessed. Water release devises are incorporated into the project designs.

2.2 Group discussions with communities likely to be affected by the project.

Event	Views/ Comments / Discussion	Response given / Action taken
Discussion with sand miners likely to be affected.	▪ We have been involved in sand mining in the river at different locations for a long period of time. ▪ The labourers working in our sand mining sites are from local communities and are unemployed. We do not hire the same labourers regularly but those who work for us are from the local communities. ▪ We would like to propose that the project developer considers offering employment in construction sites to our labourers when they lose their work in our mining sites. ▪ We would also like to propose that Divisional Secretaries recommend issuing new permits to us in other feasible locations in the upstream and other downstream locations to start new sites for sand mining. ▪ Most of us are small scale sand miners involved in sand mining with the assistance of the local communities and therefore we insist that the authorities consider us as persons who will experience negative impacts due to the proposed project.	Employment for the labourers who will lose their jobs could easily be provided at construction sites once the project construction activities are commenced. In addition, a compensation programme will be provided through the resettlement planning process.
Focus group discussions with community members affected due to proposed reservoir	▪ Many of us were the people who were evacuated from Kotmale area due to Kotmale power project[3] and resettled in these present locations. Once again we are going to face the same fate. We do not mind losing current residences if we are given suitable alternative places and other assistance to re-establish our settlements. ▪ Some of the persons in the area will not have to move from their residences but portions of their land will be inundated due to the reservoir.	

[3] Located about 10km upstream of MPPP site. Construction work commenced in February 1979and commercial power generation began in June 1985.

Event	Views/ Comments / Discussion	Response given / Action taken
	▪ We have been told by some officers that only a section of our lands will be affected but we need to have the remaining portions of the land protected from landslides and other vulnerabilities due to the reservoir. Even though some of our houses will not be negatively affected, we do not like to take the risk of living in a hilly land upstream of the reservoir due to possible landslides. ▪ We must be properly compensated for our affected property (land). ▪ All potentially vulnerable houses must be evacuated from the area upstream of the reservoir although the houses will not be inundated.	
Focus group discussions with community members affected due to access roads (Ethgala to Powerhouse and other access roads).	▪ If the roads to the proposed project site are widened there will be some negative impacts on the lands in our home gardens. In most cases small sections of the lands will have to be acquired and also structures such as boundary walls, fences and gates will have to be removed. ▪ There will be disturbances to the local road users during the construction phase of the roads. However, in some cases the local communities have alternative access to reach their residences. ▪ We see/perceive expansion of local roads as benefits to the local communities from the project. ▪ We were told that the CEB will introduce certain conditions for the road development contractors to manage the construction sites in such a way so as to minimize the possible disturbances to the local communities.	Proper and fair compensation mechanism will be provided through the resettlement planning process for those who will lose their land or property. All public nuisances and inconveniences will be minimised through the implementation of the Environmental Management Plan (EMP).
Discussion with the stakeholders on potential impacts on Ulapane Industrial Estate	▪ Industries have not yet been established in a major portion of the land allocated for Ulapane Industrial Estate.	

Event	Views/ Comments / Discussion	Response given / Action taken
	▪ Water scarcity is a significant problem in the area since the ground water table is very deep in this hilly area. There are also no surface water sources to tap easily. ▪ The project will not require any land from the industrial estate. ▪ The only negative impact perceived is potential disturbance to the limited ground water due to construction activities during underground tunnelling works of the project. ▪ The impact will have to be carefully mitigated by the CEB who should introduce alternative measures to solve the problems during construction phase. This will have to be an obligation of the CEB as the project developer.	
Group discussions with people who use the river for bathing and washing purposes.	▪ We have been using these river locations for bathing and washing for a long period of time. These locations are important to us from many aspects. These locations can be accessed free of cost with no payments involved and the water in these locations is good for bathing and washing. ▪ The locations we use are the only places that can be reached with no serious access difficulties. ▪ Most of other locations of the river within the project area cannot be reached due to its steep river bed posing serious access difficulties. ▪ Only three locations upstream and one location downstream of the proposed dam are used for bathing. What we request is for CEB to establish alternative locations for bathing and washing and construct concrete steps to create safer access to these bathing spots.	Alternative locations for bathing will be established by the project.

3. CONSULTATION AND DISCLOSURE DURING PREPARATION OF THE ENVIRONMENTAL ADDENDUM

3.1 First multi stakeholder consultation meeting

On January 24, 2013 a formal consultation meeting was held at the Sri Gangarama Temple at Weliganga to create awareness about the Moragolla Hydropower Project and to stimulate discussion on the environmental and social impacts of the project among the local people and other relevant stakeholders. A total of 117 stakeholders attended the meeting. The meeting was commenced with religious observance performed by Ven. Kotikawatte Vipassi Thera. After the welcome address, opening remarks and keynote address by the CEB engineers, the Project Manager (PM) of the Moragolla Hydropower Project gave a comprehensive account on the project using a PowerPoint presentation. (A copy of the presentation is attached: annex 2(c)). He specially mentioned that the project has been planned in such a manner that it will not pose any threat to the environment. He also stated that the Project will bring about enormous benefits to the nation. Speaking on the entitlements of the affected people, the PM said that every effort will be made to safeguard these. In preparation of the Resettlement Plan (RP), the views and observations of the affected people and other stakeholders will be entertained as appropriate, he added.

During the subsequent discussion session the stakeholders raised several questions to obtain clarifications from the project team. Their opinion on the anticipated impacts and possible mitigation measures were also discussed.

Questions and issues raised by the participants and the clarifications made are as follows:

Question/Issue	Response Given
Would there be a 100 metre security zone on either side of the river coming within the proposed reservoir	The river reservation of the Mahaweli River differs from place to place depending on certain factors
It is learnt that the location of the proposed dam has now been changed and it would be located 50 metres downstream. With this change will the height of the Dam be raised	There is a possibility of moving the Dam by nearly 100 metres further downstream. Therefore height of the Dam may be changed by a few feet. However full supply level (FSL) will not be changed and hence there will be no significant change in the inundation area.
What is the method of resettlement of affected households and payment of compensation in respect of acquired properties?	Provision of alternative buildings in lieu of affected houses and business establishments is being considered. Payment of compensation in respect of land and other structures will be made to bona fide claimants. An entitlement package will be introduced shortly.

At present I am running a business. If that is affected what action would be taken restore the loss.	After a census survey and establishment of the ownership, either an alternative place will be provided or compensation will be paid depending on the circumstances.
If the Project is going to take some action against discharge of harmful effluents to the river by the Crysbro poultry farm	This issue is not directly relevant to the Project. However, the Project will discuss this matter with the management of the poultry farm and suitable action will be initiated.
In allocating alternative houses in lieu of those are to be affected, are there any arrangements to provide alternative lands in similar extents in lieu of those to be acquired along with the houses	There is no firm decision as yet whether to provide alternative lands in lieu of those are to be affected. However, action will be initiated to secure the rights of the affected people to the maximum. Development of an Entitlement Policy is underway.
Whether the same type of alternative houses will be provided to all affected households, in lieu of those affected.	Basis for the provision of alternative houses will be the floor areas of the affected houses. Therefore sizes of the alternative houses will depend on the floor areas of the existing houses.
Whether the alternative lands will be provided in lieu of the tea lands to be affected.	Development of an Entitlement Policy is underway. In developing the Entitlement Policy this request will also be taken into consideration.
Due to the construction work of the Moragolla Project I will stand to lose my land. What action would be taken by the Project to restore the loss.	All affected assets other than those that will be replaced by the Project, will be adequately and suitably compensated.
Whether future meetings of this nature could be held on week end days.	Some of the stakeholders such as public officers may not be willing to attend meetings on week end days due to different reasons. However, in future, attempts will be made to hold the meetings on week end days.
Due to the implementation of the Moragolla Hydropower Project the sand miners along the Mahaweli River, within the project area, will stand to lose their livelihood. What action will be taken by the Project to restore their livelihood.	Project has already collected information on the sand miners to be affected within the project area. The Project will implement an income restoration/enhancement programme covering all genuine sand mining people.

The minutes of the meeting, the list of participants and the photographs of the event are attached in Annex 2 (a), 2(b) and 2(d) respectively.

3.2 Second multi stakeholder consultation meeting

The second stakeholder consultation meeting was held on November 18, 2013 at the Sri Gangarama Temple at Weliganga to appraise the affected people and other concern parties about the additional studies carried out on natural environment during the Feasibility Study Review and Detail Design Preparation (FSR &DD) stage of the Moragolla Hydropower Project (MHPP) and to introduce the Entitlement Matrix to the affected people. A total of 128 stakeholders attended the meeting. The meeting was commenced with religious observance performed by Ven. Kotikawatte Vipassi Thera. After the welcome address, by the CEB engineers, the Project Manager (PM) of the Moragolla Hydropower Project presented the design changes incorporated into the MHPP during FSR process(PowerPoint presentation is attached as Annex 3(c)). Subsequently, the National Environmental Specialist of the FSR and DD team gave a comprehensive account on potential Environment Impacts of the project, proposed measures to mitigate of minimise such impacts and the Environmental Impact Assessment procedure followed by the Ceylon Electricity Board during 2009-2012. He further mentioned that the EIA report of the project was opened for public comments in April 2013 for a period of one month and approval obtained from the Project Approving Agency (ie., Mahaweli Authority of Sri Lanka – MASL). Since CEB intend to obtain financial assistance from Asian Development Bank (ADB) for the implementation of the project, a gap analysis based on the environmental safeguard requirements of ADB followed by the following additional studies were carried out during December 2012 – May 2013 to bridge the gaps;
Water quality in the Mahaweli Ganga - upstream and downstream of the proposed dam at Moragolla;
Aquatic ecology in the Mahaweli Ganga;
Groundwater distribution and quality along the proposed tunnel route of the Project;
Land-use map of the area in the vicinity of the proposed Project;
Survey of the Rationale and Suitability of the Proposed Environmental Flow;
The Stakeholder Consultation and Disclosure Process;
Institutional Arrangements for Project Implementation;
Survey of river water quality in the Moragolla project area in the monsoon season;
Survey of the New Project Sites proposed during FSR process;
Report on river users downstream of the proposed Moragolla Dam;
Mitigating the Impacts of the Moragolla Hydropower Project on Fish;
Habitat Creation and Management to enhance Terrestrial Biodiversity;
Afforestation and Watershed Management Plan;
(A copy of the presentation is attached: annex 3(d).

During the subsequent discussion session the stakeholders raised several questions to obtain clarifications from the project team. Their opinion on the anticipated impacts and possible mitigation measures were also discussed.

The minutes of the meeting, the list of participants and the photographs of the event are attached in Annex 3(a), 3(b) and 3(e) respectively.

Questions raised and suggestions given by the participants and the clarifications made by the project team are as follows:

Question / Suggestion	Response Given
Can the Dunhinda Ela be rehabilitated by the project as it is in a dilapidated condition?	Yes, it is taken a decision to rehabilitate 400m of the canal from the intake point.
All employment opportunities shall be provided to the people of the area.	Priority will be given to the affected people and the people of the area depending on their qualifications and capabilities.
The land which will be given to affected people shall be equal or better quality and the land shall be properly developed before handing over to the recipients.	Once the financial arrangements of the project are finalised, the resettlement land will be purchased and handover to the APs.
Who will be affected in Weliganga area?	The 10 households identified in the Weliganga area to be relocated are as follows: M A N Sarath Kumara, L R M karunawathi, M A Aberatne, M G Pushpa Gunatunga, P G R R Parakramage, M G gnnaappu, P G K P Parakramage A N M Naazik, Y G Thilakaratne and N G Prematunga
Have the lands which will be inundated are gazetted	Not yet, it will be done after the project finances are finalised
Can we opt for compensation in cash.	Yes, it is possible. But, it will be more beneficial to the affected people accept the land and the house instead of cash compensation as it can take longer period to finalise the legal procedures under land acquisition laws of the country and it is necessary to prove proper ownership to obtain proper compensation. However, the legal ownership will not be considered according to the compensation payment policy of the project.
Who will be affected in Ulapane area?	The 5 households identified in the Ulapane area to be relocated are as follows: S Krishnamoorthi, T L Ranjith Liyanage, M L Danials, W M Indika weerasinghe and R M Sumanadasa
Who will be affected in Ehgala area?	Two households identified in the Ethgala area to be relocated are as follows: H M Fransis and K N S Chandakanthi,

3.3 Third multi stakeholder consultation meeting

It is proposed to have a malty stakeholder consultation meeting immediately after the Environmental Addendum and the Environmental Management Plan are prepared. The reports in Sinhala, Tamil and English languages will be disclosed to the participants. The salient features of the environmental mitigation and management plans along with monitoring mechanisms will be explained to the local people and other relevant stakeholders and a discussion on the environmental and social impacts and proposed mitigation measures will be simulated

3.4 Public disclosure

Environmental Addendum and the Environmental Management Plan will be posted on websites of ADB and CEB. They will be made available in Sinhala, Tamil and English languages for the inspection by the public at the same locations where the EIA report was made available for public inspection in April 2013 (see section 1.3 above).

Newspaper advertisements will be published, in *Dinamina* (Sinhala),*Thinakaran* (Tamil) and *Daily News* (English) papers inviting the general public to submit their comments (if any) in writing on the Environmental Addendum and the EMP to the Project Manager of MHPP of CEB.

4. Future Consultation and Disclosure

CEB will continue to consult with relevant stakeholders throughout the life cycle of the Project i.e. pre-construction (from now until construction contract is offered), construction and operation phases of the Project. It will also report ongoing consultations as part of its regular reporting requirements to ADB. In addition, monthly environmental monitoring reports will be posted on the websites of ADB and CEB for the information of wider stakeholders.

Consultation during construction will be more focussed on information on safety, community development programs, environmental monitoring, employment issues, and health awareness which will include:

- Maintain regular communications with all stakeholders, including the media
- Provide local residents with regular information on the progress of work and related implications
- Provide local residents with information on employment and training opportunities
- Maintain awareness of health and safety issues specially through the local work force
- Maintain constructive relationships between local residents and project representatives by continuing regular information meetings and informal interactions
- Identify and respond to new stakeholder issues and concerns by reviewing the complaints file and listening to stakeholders
- Ensure complaints are addressed according to the established process, and that project affected persons are educated on appropriate grievance redress procedures
- Monitor implementation and effectiveness of community development initiatives, and other social investment programs
- Ensure gender sensitive and culturally appropriate processes are used in communication and interactions

ANNEXTURES

Annex 1 (A): Newspaper advertisement, which appeared in *Dinamina* on April 01, 2013

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අංක 500, ටී. බී. ජායා මාවත,
කොළඹ - 10

Annex 1 (B): Newspaper advertisement, which appeared in *Thinakaran* on April 01, 2013

இலங்கை மஹாவலி அதிகார சபை

தேசிய சுற்றாடல் சட்டத்தின் 23 BB பிரிவின் 2ஆம் உப பிரிவின் கீழான அறிவித்தல்

மஹாவலி கங்கையில் உத்தேசிக்கப்பட்ட மொரகொல்ல நீர்மின்சார செயற்திட்டம் (26.5MW)

சுற்றாடல் தாக்கம் தொடர்பான மதிப்பீட்டு அறிக்கை

இவ்விளம்பரத் திகதியிலிருந்து வாரஇறுதிகள் மற்றும் அரசாங்க விடுமுறைகள் நீங்கலாக, 30, நாட்களுக்கு மு.ப. 8.30 மணிக்கும் பி.ப. 4 மணிக்கு மிடையில் பின்வரும் இடங்களில், 1988ஆம் ஆண்டின் 56ஆம் இலக்கம் மற்றும் 2000ஆம் ஆண்டின் 53ஆம் இலக்க சட்டங்களினால் திருத்தம் செய்யப்பட்ட 1980ஆம் ஆண்டின் 47ஆம் இலக்க தேசிய சுற்றாடல் சட்டத்தின் 23 BB(1) ஆம் பிரிவின் கீழ் இலங்கை மின்சார சபையினால் சமர்ப்பிக்கப்பட்ட மஹாவலி கங்கையின் கண்டி மாவட்டத்திலுள்ள உடப லாத்த மற்றும் கங்க இஹல கோறளை ஆகிய இடங்களில் உத்தேசிக்கப்பட்ட 26.5 MW மொரகொல்ல நீர்மின்சார செயற்திட்ட சுற்றாடல் தாக்கம் தொடர்பான மதிப்பீட்டு அறிக்கை, பொது மக்களின் பார்வைக்காக வைக்கப்படும்.

பிரதேச செயலக அலுவலகம்
உடபலாத்த

பிரதேச சபை அலுவலகம்
உடபலாத்த

பிரதேச செயலக அலுவலகம்
கங்க இஹல கோறளை

பிரதேச சபை அலுவலகம்
கங்க இஹல கோறளை

பொறுப்பான பொறியியலாளரின் அலுவலகம்
பிரதான வேலைகளின் நிருவாகம்.
செயற்பாடு மற்றும்
பராமரிப்புப் பிரிவு
இலங்கை மஹாவலி அதிகார சபை
ஆற்றுப் பிரதேசம்
மாவதுற

மத்திய சுற்றாடல் அதிகார சபை
பிராந்திய அலுவலகம்,
அணைக்கட்டுப் பிரதேசம்
போல்கொல்ல.

நூலகம்
மத்திய சுற்றாடல் அதிகார சபை
104, டென்சில் கொப்பேகடுவ மாவத்தை,
பத்தரமுல்ல

நூலகம் - 6ஆம் மாடி
இலங்கை மஹாவலி அதிகாரசபை
500 T.B. ஜாயா மாவத்தை
கொழும்பு 10.

எந்தவொரு பொது நபரும் இவ்விளம்பரத் திகதியிலிருந்து 30 வேலை நாட்களில் மேற்குறிப்பிட்ட செயற்திட்டம், தொடர்பாக அவர்களின் கருத்துரைகளை எழுத்து மூலம் இலங்கை மஹாவலி அதிகார சபையின் பணிப்பாளருக்கு சமர்ப்பிக்கலாம்.

பணிப்பாளர் நாயகம்
இலங்கை மஹாவலி அதிகார சபை
500, T.B. ஜாயா மாவத்தை
கொழும்பு 10.

Annex 1 (C): Newspaper advertisement, which appeared in *Daily News* on April 01, 2013

ADVERTISEMENTS

MAHAWELI AUTHORITY OF SRI LANKA

NOTIFICATION UNDER SECTION 23 BB SUB SECTION (2) OF THE NATIONAL ENVIRONMENTAL ACT

Proposed Moragolla Hydropower Project on Mahaweli Ganga (26.5 MW)

ENVIRONMENT IMPACT ASSESSMENT REPORT

The Environmental Impact Assessment (EIA) Report of the Moragolla Hydropower Project proposed at Mahweli Ganga at Udapalatha and Ganga Ihala Korale in Kandy District (26.5 MW) submitted by Ceylon Electricity Board, under Section 23 BB (1) of the National Environmental Act No. 47 of 1980 as amended by Act Nos. 56 of 1988 and No. 53 of 2000, will be available for inspection by the public at the following locations between 8.30 am and 4.00 pm for a period of 30 days (except on weekends & Public Holidays) from the date of this advertisement.

* Divisional Secretariat Office
  Udapalatha.
* Divisional Secretariat Office
  Ganga Ihala Korale.
* Engineer-In-Charge Office
  Head Works Administration,
  Operation & Maintenance Div.
  Mahaweli Authority of Sri Lanka
  Riverside, Mawathura.
* Library
  Central Environmental Authority
  104, Denzil Kobbekaduwa Mawatha
  Battaramulla.
* Pradeshiya Sabha Office
  Udapalatha.
* Pradeshiya Sabha Office
  Ganga Ihala Korale.
* Central Environmental
  Authority
  Regional Office, Dam Site,
  Polgolla.
* Library - 6th Floor
  Mahaweli Authority of Sri Lanka
  500, T.B. Jayah Mawatha
  Colombo 10.

Any member of the public may within 30 working days from the date of this advertisement submit their comments in writing on the above Project to the Director General, Mahaweli Authority of Sri Lanka.

Director General,
Mahaweli Authority of Sri Lanka,
500, T.B. Jayah Mawatha,
Colombo 10.

Annex 2 (a): Minutes of the Stakeholder Meeting held on January 24, 2013

Venue	: Sri Gangarama Temple at Weliganga
Date	: January 24, 2013
Time	: 2.00 PM
Participants	: 117 (List attached – annex 2-b)
Objective	: to create awareness about Moragolla Hydropower Project amongst the affected people and the other relevant stakeholders.

The meeting was presided over by Ven. Kotikawatte VipassiThera, Chief Incumbent of the Sri Gangarama Temple at Weliganga.

Proceedings of the meeting were conducted by Mr.S.Serasinghe, National Resettlement Specialist for the Feasibility Review and Detailed Design Study Consultant Nippon Koei Co. Ltd.

Proceedings of the meeting commenced with religious observances performed by Ven. Kotikawatte VipassiThera.

A welcome address was delivered by Ms.Hemali Samaradiwakara, Project Engineer of the Moragolla Hydropower Project.

Mrs. Kamani Jayasekera, Deupty General Manager of the Ceylon Electricity Board (CEB) delivered the Keynote Address. In her speech she made a brief but informative description about the proposed Moragolla Hydropower Project. She highlighted the importance of hydropower generation being the least cost per unit of generation and a more environmental friendly mode of power generation. She further said that the proposed project will be funded by the Asian Development Bank (ADB) and assisted by the Nipon Koei Company Ltd, by providing consultancy services. She added that the Project, once commissioned, will add 27 Megawatts to National Grid. Finally, she solicited the cooperation of the affected people and other stakeholders for successful completion of the Project.

Mr. R.K.B. Gunaratne, the CEB Project Manager of the Moragolla Hydropower Project made a PowerPoint presentation (see Annex 2-c) covering all the components of the Project. He elaborated on each of the following components.

- Details about the Proposed Dam and its inundation area
- Switch Yard
- Surge Chamber
- Under Ground Tunnel
- Transmission Line
- Access Roads

He specifically mentioned that the project has been planned in such a manner that it will not pose any threat to the environment. He also, stated that the Project will bring about enormous benefits to the nation. Speaking on the entitlements of the affected people, Mr. Gunaratne said that every effort will be made to safeguard these entitlements. In preparation of the Resettlement Action Plan (RAP), the views and observations of the affected people and other stakeholders will be entertained as appropriate, he added.

Mr. S. Serasinghe who spoke next elaborated on the importance of power for the economic development of the country, particularly, advantages of development of hydropower due to its low cost of generation and environmental considerations. Speaking on resettlement planning of the Moragolla Hydropower Project he reiterated that affected people will not be in a disadvantageous position due to the Project. The Project is already in the process of developing an attractive entitlement package for affected people, he added. He further said that unstinted support of all the stakeholders, particularly, affected people, would be imperative to achieve the desired results of the Project.

The next item on the agenda was the discussion session.

Questions and issues raised by the participants and the clarifications made were as follows.

Stakeholder	**Question or Issue raised**	**Response by : Reply**
Ms. L.M. DingiriMenike	Would there be a 100 metre security zone on either side of the river coming within the proposed reservoir	A representative from the Mahaweli Authority of Sri Lanka (MASL):The river reservation of the Mahaweli River differs from place to place depending on certain factors
Mr.KelumAmarasiri	1. It is learnt that the location of the proposed dam has now been changed and it would be located 50 metres downstream. With this change will the height of the Dam be raised 2. What is the method of resettlement of affected households and payment of compensation in respect of acquired properties?	Mr. R.K.B. Gunaratne, Project Manager, Moragolla Hydropower Project: There is a possibility of moving the Dam by nearly 100 metres further downstream. Therefore the height of the Dam may be changed by a few feet. However Full Supply Level (FSL) will not be changed and hence there will be no significant change in the inundation area. Mr. S. Serasinghe, Resettlement Specialist, Nippon Koei Study Team: Provision of alternative buildings in lieu of affected houses and business establishments is being considered. Payment of compensation in respect of land and other structures will be made to bona fide claimants. An entitlement package will be introduced shortly.
Mr.Asela Suran Pathirana	At present I am running a business. If that is affected what action would be taken restore the loss.	Mr.Gunaratne, Project Manager : After a census survey and establishment of the ownership, either an alternative place will be provided or compensation will be paid depending on the circumstances.

Mr. K. D. Wimalaratne	Is the Project going to take some action against discharge of harmful effluents to the river by the Crysbro poultry farm	Mr.Gunaratne, Project Manager: This issue is not directly relevant to the Project. However, the Project will discuss this matter with the management of the poultry farm and suitable action will be initiated.
Mr. Y.G. Thilakaratne	In allocating alternative houses in lieu of those that are to be affected, are there any arrangements to provide alternative lands in similar extents in lieu of those to be acquired along with the houses	Mr.Serasinghe, Resettlement Specialist : There is no firm decision as yet whether to provide alternative lands in lieu of those are to be affected. However, action will be initiated to secure the rights of the affected people to the maximum. Development of an Entitlement Policy is underway.
Mr.KelumAmarasiri	Will the same type of alternative houses be provided to all affected households, in lieu of those affected.	Mr. S. Serasinghe : The basis for the provision of alternative houses will be the floor areas of the affected houses. Therefore sizes of the alternative houses will depend on the floor areas of the existing houses.
Mr. S.G. Premathunga	Willalternative lands be provided in lieu of the tea lands to be affected.	Mr.Gunaratne : Development of an Entitlement Policy is underway. In developing the Entitlement Policy this request will also be taken into consideration.
Ms. Soma Samaraweera	Due to the construction work of the Moragolla Project I will stand to lose my land. What action would be taken by the Project to restore the loss.	Mr.Gunaratne : All affected assets other than those that will be replaced by the Project, will be adequately and suitably compensated.
Mr. M.G. Thilakaratne	Could future meetings of this nature be held on weekend days.	Mr.Gunaratne : Some of the stakeholders such as public officers may not be willing to attend meetings on week end days due to different reasons. However, in future, attempts will be made to hold the meetings on weekend days.
Mr. A.P.A. Jayaweera	Due to the implementation of the Moragolla Hydropower Project the sand miners along the Mahaweli River, within the project area, will stand to lose their livelihood. What action will be taken by the Project to restore their livelihood.	Mr.Serasinghe : The project has already collected information on the sand miners to be affected within the project area. The Project will implement an income restoration/enhancement programme covering all genuine sand mining people.

After the discussion session Mr.Samitha Midigaspe, Chief Engineer of the Planning Division of the CEB made a few observations on the involvement of the Planning Division in the power generation projects of the CEB. He said that the Planning Division has been involved in designing many power generation projects such as the recently commissioned Upper Kotmale Hydropower Project. He further said that in the implementation of these projects the CEB has been highly concerned about the rights and entitlements of the affected people. Similarly, in the implementation of the Moragolla Hydropower Project too, a favourable Entitlement Policy will be introduced, he added.

At this stage Mr.Serasinghe opined that it would be necessary to form a Housing Committee of the affected households,to function as a forum for exchange of views and opinions between the affected households and the officials of the project. He further opined that the committee can consist of eleven (11) members, which could include the positions of a President, a Secretary, a Treasurer and eight (08) committee members. He also suggested that Ven. Kotikawatte Vipassi Thera, Chief Incumbent of the Sri Gangarama Temple be requested to be the patron of the Committee. Accordingly, a Housing Committee was elected from among the affected households. A list of the Committee Members is attached.

Mr. B.M.N. Balasooriya, Divisional Secretary, Udapalatha addressing the meeting said that his unstinted support will be extended in the implementation of the Project and securing the rights and entitlements of the affected people. He explained how he had managed to settle disputes over the land acquisition for the road projects implemented by the Road Development Authority (RDA). In the implementation of Moragolla Hydropower Project too, all problems and issues can be solved by dialogue and mutual understanding, he said.

Mr. D.G. Gunasena, Chairman, Udapalatha Pradeshiya Sabha who addressed the meeting next said that the policy of Mahinda Chinthana of **"electricity for all'** could be achieved by implementing projects of this nature. He affirmed his fullest cooperation for the Moragolla project.

Ven. Kotikawatte Vipassi Thera delivered the exhortation. In his exhortation he said that the Moragolla Hydropower Project is a project of national importance. Therefore, blessings and support for this project should be extended by all concerned parties. Particularly he requested the cooperation of the affected people for the project. At the same time the project in reciprocation bears the responsibility of securing and safeguarding the rights and the livelihood of affected people.

Mr.Chandana Abeyratne, Electrical Superintendent attached to the Moragolla Hydropower Project delivered the vote of thanks speech. Proceedings of the meeting concluded at 5.30 pm.

Annex 2 (b): List of Participants of the First Stakeholder Consultation Meeting held on January 24, 2013

Moragolla Hydropower Project - Ceylon Electricity Board

Stake Holder Meeting No:0.. (2013/01/24)

Officers from Government / Non Government Institutes

	Name	Designation & Institutes / Company	Telephone No:	E-Mail Address	Signature
01	Mrs. AMSPK Senevirathne	Senior environmental officer CEA – Kandy	081-294884	ceaqoc@gmail.lk	
02	T.D.G. [illegible]	[illegible]	071-9872491	–	
03	A.H.A. Dissanayake	Divisional Environmental officer CEA – Kandy	081-2494884	–	
04	[illegible]	[illegible]	0724651624	–	
05	K A S [illegible]	[illegible]	0279877300		
06	U.B. [illegible]	[illegible]	0776091190	–	
07	A.D. [illegible]	[illegible]	0779313247		
08	CGS Gunasekara	Chief Engineer Kotmale Power Station CEB	0775076587	cekot@ceb.lk	
09	T.A.K Jayasekera	DGM (Tr. & Gen NL), CEB			
10	Upul Goonasekera	Deputy Team Leader / NK Moragolla Project	0777-253388		

	Name	Designation & Institutes / Company	Telephone No:	E-Mail Address	Signature
11	D. Seneviratne	Consultant, N/K	0777 253395		
12	KNSM Kudaligama	PM (Moragolla PG)	0714240482	pmmhpp@ceb.lk	
13	S.H. MIDIGASPE	CE(GDS) / CEB		cegds@ceb.lk	
14	Kelum Niranjana	Civil Eng / Env. unit - CEB	011 2320012		
15	B.K. Nawarathna	Civil Eng / HAOM of MASL Kotmale project		bnawarathna@gmail.com	
16	M.A.C Rajasinghe	DEO / central environmental Authority.	0716585600		
17	B.M.N. Balasooriya	Divisional Secretary - Udapalatha	0773229130		
18	K. VIPSSI THARO	GANGARAMAYA WALIGANGA. MAHATHER	071/6611508.		
19	K. Abeysoorye	NWSDB SEA	0812388086		
20	[illegible]	[illegible]	0724606920		

	Name	Designation & Institutes / Company	Telephone No:	E-Mail Address	Signature
21	S. Dilruk Dissanayake	E/O - Udapalath P/S	0718103811	dilrukdissanayake@yahoo.com	
22	P.M.C.A.K. Alagoda	CEB. (ES - Maragolla)			
23	H.W. [illegible]	EE, CEB			
24	H.M.N.B. Herath	ministry of industries	081-2205619		
25					
26					
27					
28					
29					
30					

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දැනුවත් කිරීමේ රැස්වීම 2013/01/24 (වැලිගම ප්‍රජාශාලාව)-මොරගොල්ල ජලවිදුලි ව්‍යාපෘතිය-ලංකා විදුලි බල මණ්ඩලය

ව්‍යාපෘති කලාපය තුල වැලි ගොඩ දැමීමේ නියුතු මහතුන්ගේ ලේඛනය

	නම	ලිපිනය	ග්‍රා: නි: වසම	දුරකථන අංකය	අත්සන
01	S.D.G. නිහාල්	5A, කොබ්බෑවෙල අම්පිටිය	[illegible]	0770317555	
02	S.D.N.S. කුමාර	කාමුවත්ත [illegible] අම්පිටිය	[illegible]	0772580855	
03	R.M.H. බංඩා	ඇල්වත්ත, [illegible] අම්පිටිය	[illegible]	0813 830 802	
04	S.D.ධ. ප්‍රනාන්දු	221/8 [illegible] පහල ගොඩ ගම්පොළ	[illegible]	0724330897	
05	D.M.A. ධ [illegible]	[illegible] පහල [illegible]	[illegible]	0776785606	
06	HA. අමරසිංහ	අංක 40 [illegible] ගම්පොළ	[illegible]	0770520 656	අමරසිංහ
07	වී. ඩී [illegible]	181/21 [illegible] ගම්පොළ	[illegible]	0777617881	

7

දැනුවත් කිරීමේ රැස්වීම 2013/01/24 (වැලිගඩ ප්‍රජාශාලාව)-මොරගොල්ල ජලවිදුලි ව්‍යාපෘතිය-ලංකා විදුලි බල මණ්ඩලය

ව්‍යාපෘති කලාපය තුල වැලි ගොඩ දැමීමේ නියුතු මහතුන්ගේ ලේඛනය

	නම	ලිපිනය	ග්‍රා: නි: වසම	දුරකථන අංකය	අත්සන
08	ආර්. එම්. [illegible]	129, මොරගොල්ල ගම්පොල	[illegible]	0777558067	[signature]
09	S.G. පුෂ්පා	36 [illegible]	[illegible]	0773125148	[signature]
10	J A D පද්මලතා	නො: 25/A [illegible], ගම්පොල	[illegible] ~~[illegible]~~ ([illegible])	077-3425743 081-2353204	[signature]
11	[illegible]	149 [illegible]	[illegible]	0723231[illegible] 0812350439	[signature]
12	A [illegible]	123 [illegible]	([illegible]) [illegible]	0723704615	[signature]
13	R P [illegible]	128 [illegible]	[illegible]	0776051910	[signature]
14	R.M. රත්නායක (P.D.M. [illegible])	18/3 [illegible] [illegible] - ගම්පොල	[illegible]	0723704314 0779067034 0715921788	[signature]

දැනුවත් කිරීමේ රැස්වීම 2013/01/24 (වැලිගහ ප්‍රජාශාලාව)-මො[illegible]ගොල්ල ජලවිදුලි ව්‍යාපෘතිය-ලංකා විදුලි බල මණ්ඩලය
ගොවිසංවිධාන නියෝජිත මහතුන්ගේ ලේඛනය

	නම	තනතුර සහ ගොවිසනවිධාන, ලිපිනය	දුරකථන අංකය	අත්සන
01	ඩී. ජී. සෝමරත්න	ප්‍රධාන සභාපති ගම්පොළ [illegible] වැව ගොවිසංවිධානය	0815682481	[illegible]
02	[illegible] සිරිසේන,	[illegible] ගොවි සංවිධානය - ගම්පොල [illegible]	[illegible] 2352437	[illegible]
03	[illegible] සෝමපාල	[illegible] ගොවි සංවිධානය ([illegible])	-	[illegible]
04	[illegible]	සභාපති ගම්පොළ [illegible] ගොවි [illegible]	0776925396	[illegible]
05				
06				
07				

දැනුවත් කිරීමේ රැස්වී 2013/01/24 (වැලිගඟ ප්‍රජාශාලාව)-මේ ගොල්ල ජලවිදුලි ව්‍යාපෘතිය-ලංකා විදුලි බල මණ්ඩලය

ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ ලේඛනය

	නම	ලිපිනය හා දුරකථන අංකය	ග්‍රා: නි: වසම	අත්සන
01	R.A. විජේසිංහ	588/1A මාවෙල පාර උලපනේ 081-3752373	[illegible]	[signature]
02	[illegible]	0726018695 මාවෙල පාර උලපනේ	2 [illegible]	[signature]
03	එල්. එම්. [illegible]	081-2356188 නො: 588/1, මාවෙල පාර, උලපනේ	[illegible]	[signature]
04	R.A. [illegible]	නො 688/ මාවෙල පාර උලපනේ	[illegible]	[signature]
05	[illegible]	863/1, [illegible] පාර - අඟ්ගොල වත්ත [illegible]	[illegible]	[signature]
06	කේ. [illegible]	20 ක 15 - වැලිගඟ - [illegible]	වැලිගඟ.	[signature]
07	[illegible]	20 ක 17 - වැලිගඟ - [illegible]	වැලිගඟ 071678 1726	[signature]

08 [illegible] | 615/2 [illegible] | උලපනේ | . W.M.A. [illegible] 9

09 [illegible] | උලපනේ 8. 40/3 [illegible] | [illegible] | [signature]

	නම	ලිපිනය හා දුරකථන අංකය	ග්‍රා: නි: වසම	අත්සන
08	ඩී. පී. ආර්. ආර්. පරාක්‍රම.	තො, 03/04 - වැලිගම - මාවනැල්ල 054-56815-	වැලිගල .	[illegible]
09	ඩී. පී. ප්‍රේමරත්න .	11 B " " 0815716284.	"	[illegible]
10	ඩී. පී. [illegible]	11 C " "	"	
11	[illegible]	06, වැලිගල, [illegible] 0815682526	වැලිගල	[illegible]
12	[illegible]	5/1 වැලිගල, මාවනැල්ල, 0726583550	වැලිගල	[illegible]
13	H.G [illegible]	[illegible], [illegible]	වැලිගල	[illegible] -
14	R.A [illegible]	689 මාවෙල පාර [illegible]	[illegible] ~~[illegible]~~	[illegible]
15	R. A. චන්ද්‍රිකා [illegible]	689/1, මාවෙල පාර [illegible]	[illegible]	චන්ද්‍රිකා
16	A. B. V. S. රන්ජිත් කුමාර	108 A, මාවෙල පාර [illegible]	[illegible]	[illegible]

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	නම	ලිපිනය හා දුරකථන අංකය	ග්‍රා: නි: වසම	අත්සන
17	ගම්පොළවෙල - වැව් ගොවි සංවිධානය සභාපති ප්‍ර.ජී. සෝමරත්න	නො. 38. රත්‍රලුගම, ගම්පොලවෙල, ගම්පොල	ගම්පොලවෙල	[illegible]
18	එස්. පී. ජී. නිමල් පුෂ්ප	0815613253 දොළ වත්ත, මාතලේ පාර, උලපනේ.	උලපනේ දකුණ	Nimal
19	W.A. ප්‍රදීප් කුමාර	0726502697 මාවෙල පාර උලපනේ	උලපනේ දකුණ	[illegible]
20	M.S. ප්‍රියංකා කුමාරි	මාවෙල පාර උලපනේ.	උලපනේ දකුණ	ප්‍රියංකා
21	පතිබා උම්මා	මාවෙල පාර උලපනේ.	උලපනේ දකුණ	[illegible]
22	සිත්ති උම්මා	මාවෙල පාර උලපනේ	උලපනේ දකුණ	සිත්ති උම්මා
23	W.A. ජයරත්න	මාවෙල පාර උලපනේ	උලපනේ දකුණ.	[illegible]
24	සුමනා ප්‍රිය.	මාවෙල පාර උලපනේ.	උලපනේ දකුණ.	[illegible]
25	K.A.D.R.J චන්ද්‍රසේන	මාවෙල පාර, උලපනේ	උලපනේ දකුණ	[illegible]

	නම	ලිපිනය හා දුරකථන අංකය	ග්‍රා: නි: වසම	අත්සන
26	M.G. කරුණාරත්න	081-4492263 107 මාවෙල පාර උලපනේ	උලපනේ ඉහළ	[illegible]
27	[illegible]	18/4 හැටිගල මාවත	[illegible]	[illegible]
28	[illegible] (සිරාජ්)	මාවෙල පාර [illegible] 0729422529	[illegible]	[illegible]
29	[illegible]	නො. 48 [illegible] 081-4492684	[illegible]	[illegible]
30	[illegible]	2/107 මාවෙල පාර උලපනේ ([illegible])	[illegible]	[illegible]
31	M.R.O. [illegible]	මාවෙල පාර, උලපනේ.	උලපනේ	[illegible]
32	S.G. [illegible]	615/4/බ මාවෙල පාර උලපනේ	උලපනේ	[illegible]
33	[illegible]	මාවෙල පාර උලපනේ	උලපනේ	[illegible]
34	[illegible]	1/107 මාවෙල පාර 081-2354471 උලපනේ	උලපනේ ඉහළ	[illegible]

0726436500

	නම	ලිපිනය හා දුරකථන අංකය	ග්‍රා: නි: වසම	අත්සන
35	M.G. රත්නසිංහ	අංක 401, වැලිගල, මාවතුර 0718383381	වැලිගල.	
36	A.R.M. [illegible]	0778884453 නො: 04. වැලිගල මාවතුර.	"	
37	[illegible] තිලකරත්න.	201, වැලිගල, මාවතුර	වැලිගල	
38	A.A. රවුෆ් -	123, බෝගොල්ල ජනපදය 0779060587	උලපනේ	
39	[illegible]	අංක 8/6 වැලිගල. මාවතුර 0770613300	වැලිගල	
40	Y.G. [illegible]	5, වැලිගල මාවතුර 0776042845	වැලිගල	
41	W.A. සමරවීර	නො 11/3 මාස්වෙල/පාර උලපනේ	වැලිගල ~~උලපනේ~~ ~~[illegible]~~	
42	D.G.S. වසන්ත කුමාර	NO: 679/21, වාවෙල පාර දේවාලවත්ත - උලපනේ	උලපනේ දකුණ	
43	මල්ලිකා පද්මිනි	නො 01 වැලිගල මාවතුර	වැලිගල	පද්මිනි.

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	නම	ලිපිනය හා දුරකථන අංකය	ග්‍රා: නි: වසම	අත්සන
44	W.M. ඉන්දික [illegible] [illegible]	615/2 . [illegible], උලපනේ.	උලපනේ දකුණ.	ඉන්දික.
45	W.M. [illegible] [illegible]	615/13 මහවෙල පාර උලපනේ	උලපනේ දකුණ	[illegible]
46	P.M. මාලනී [illegible]	615/2 මහවෙල පාර , උලපනේ	උලපනේ දකුණ	මාලනී .
47	M.G. කමලාවතී	මහවෙල පාර , උලපනේ ගොඩ: 49	උලපනේ දකුණ	කමලාවතී
48	P. MILTON	DANMARK ULAPANE	උලපනේ දකුණ	P. MILTON
49	S. கருப்பையா	[illegible]	[illegible]	கருப்பையா
50	G. Kumara velu	DANMARK Ulapane	උලපනේ දකුණ	Kumaravelu.
51	K.P. [illegible]	[illegible]	[illegible]	K.P. [illegible]
52	SELVARATNAM	DANMARK ULAPANE	ULAPANE	SELVARATNAM

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	නම	ලිපිනය හා දුරකථන අංකය	ග්‍රා: නි: වසම	අත්සන
53	[illegible]	නො/12 ½ [illegible] මාවත	[illegible]	[illegible]
54	S E M [illegible]	නො/12 [illegible] මාවත	[illegible]	[illegible]
55	D.J. [illegible]	නො:04 [illegible] මාවත	[illegible]	[illegible]
56	G.A. [illegible] උදය කුමාර	නො/11-A [illegible]. මාවත.	[illegible].	[illegible]
57	ආර්. කේ. සෝමාවති	0783355057 අංක 841 [illegible] පාර - [illegible]	[illegible]	R.D. [illegible]
58	[illegible]. [illegible]. සෝමලතා	අංක 841/1 [illegible] පාර, [illegible] 0783355058	[illegible]	[illegible]
59	Malik lawerence Daniels	075-5491509 kelehanda mahawela Rd ulapane	ulapane South	[illegible]
60	Kshiwan kishnamurthi	077-9876248 mahawela Rd ulapane	ulapane South	[illegible]
61	A. [illegible]	123 [illegible] පාර [illegible]	[illegible]	[illegible]

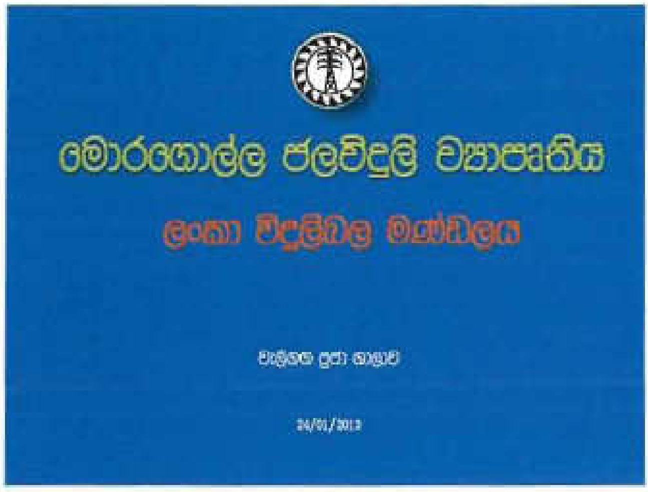
දැනුවත් කිරීමේ රැස්වීම 2013/01/24 (වැලිගඟ ප්‍රජාශාලාව)-මොරගොල්ල ජලවිදුලි ව්‍යාපෘතිය-ලංකා විදුලි බල මණ්ඩලය

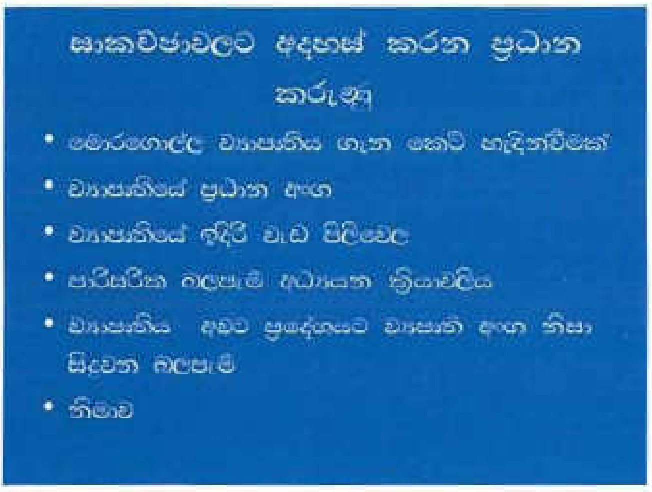
~~ව්‍යාපෘති කලාපය තුල වැලි ගොඩ දැමීමේ නියුතු මහතුන්ගේ ලේඛනය~~

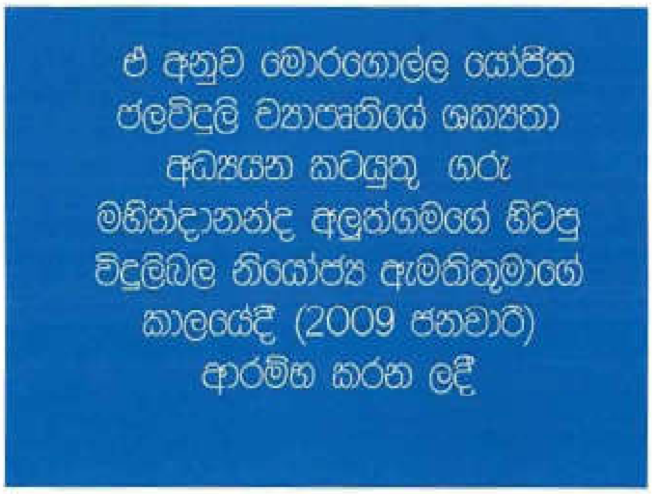
	නම	ලිපිනය	ග්‍රා: නි: වසම	දුරකථන අංකය	අත්සන
22	එච්. ගංගා කුමාර්	112 ද. මාවෙල්ලාර, උලපනේ	උලපනේ දිගන	0775528323	
23	[illegible]	අංක 29 [illegible] උලපනේ, 121 මාවෙල්ලාර උලපනේ	උලපනේ [illegible]	0723704386	
24	A.F.M. Nazik (Abesekara)	No 10 Mawathura waligaga	udapalatha	0773050092 0774030660	
25	[illegible] (ගැලීක)	[illegible] හර උලපනේ [illegible]	2: දිගන	0776051910	
26	K.P. [illegible] කුමාර්	නො. 59 වැලිගඟ [illegible]	වැලිගඟ	072-5569140	
27	M.W.A. [illegible]	නො. 72 වැලිගඟ [illegible]	වැලිගඟ	0711217551	
28	[illegible]	නො. 128 [illegible] හර උලපනේ	උලපනේ	0723704142	

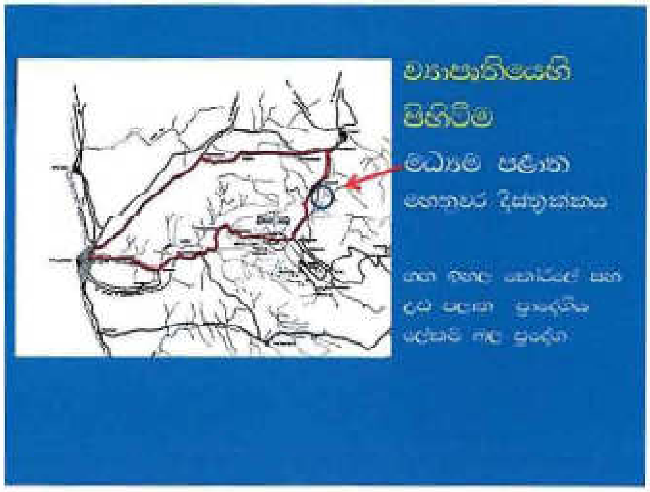
නම				
01. එම්.ඩී. දයාවතී.	අංක. 71. වැලිගල මාවත.	වැලිගල	0815732807	අත්සන (ශෝභා)
22- ග.අ.ග.ඩ.ක. ගාමිණී	අංක 17 (බ) නවින-කාරාපු	නවින	0817903644	
පී.ඩී. චන්ද්‍රසිරි කුමාර	අංක. 11 C	වැලිගොඩ		කුමාර

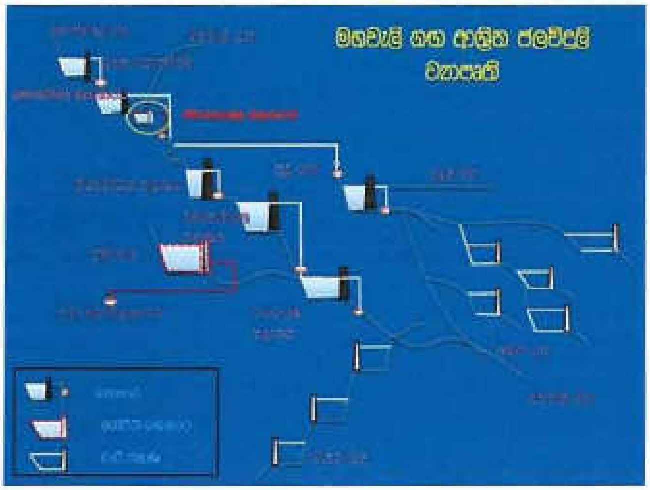
Annex 2 (c): Power Point Presentation of Project Manager at the first stakeholder consultation meeting

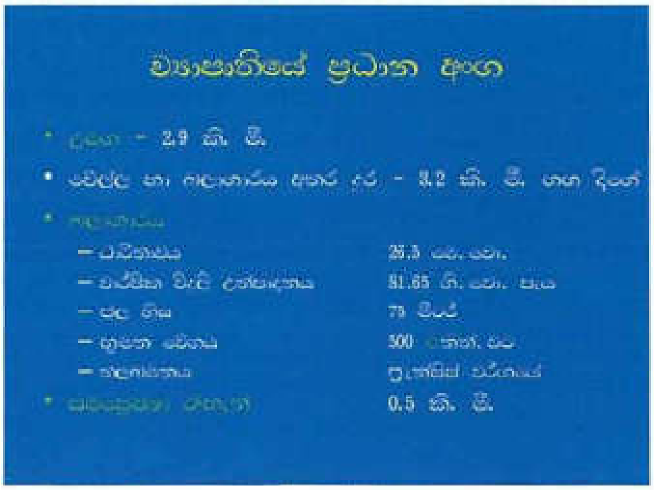


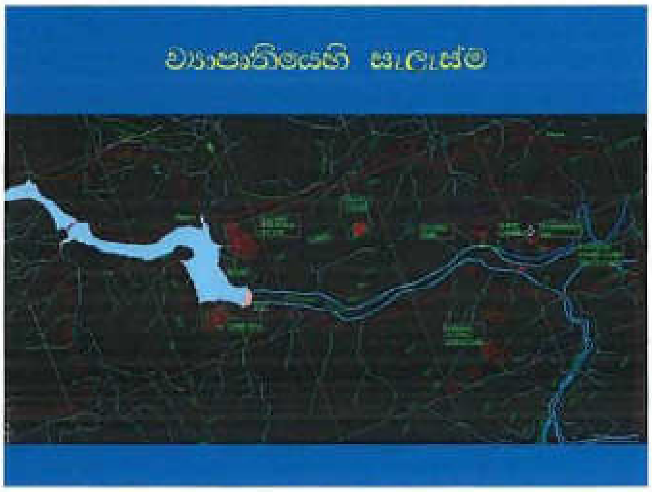







මහවැලි ගඟ ආශ්‍රිත ජලවිදුලි
ව්‍යාපෘති


ව්‍යාපෘතියේ ප්‍රධාන අංග
උමග - 2.9 කි. මී.
වේල්ල හා බලාගාරය අතර දුර - 3.2 කි. මී. ගඟ දිගේ
වාර්ෂික විදුලි උත්පාදනය 81.65 ගි. වො. පැය
ප්‍රැන්සිස් වර්ගයේ
0.5 කි. මී.


ව්‍යාපෘතියෙහි සැලැස්ම


යෝජිත ප්‍රධාන වේල්ල ඉදිවන
ප්‍රදේශය


ව්‍යාපෘතියේ ප්‍රධාන අංග
වේල්ල
උස 35 මීටර්
දිග 220 මීටර්
මුහුදු මට්ටමේ සිට උස 550 මීටර්
දොරටු 5
ජලාශය
ධාරිතාව 4.2 ඝන මීටර් මිලියන
ROR වර්ගයේ කුඩා ජලාශයක්
උපරිම ජල මට්ටම (FSL) 549 මීටර් මුහුදු මට්ටමේ සිට
අවම ජල මට්ටම (MOL) 546 මීටර් මුහුදු මට්ටමේ සිට


යෝජිත ප්‍රධාන වේල්ල ඉදිවන ප්‍රදේශය අහසේ සිට දිස්වන
අයුරු

ව්‍යාපෘතියේ ඉදිරි වැඩ පිළිවෙල

- සවිස්තරාත්මක අධ්‍යයන කටයුතු ආසියානු සංවර්ධන බැංකුවේ ආධාර සහ මේ වන විට ආරම්භ කොට ඇත
- මෙම අධ්‍යයනය අවුරුදු 1.5 ක පමණ කාලයක් ගතවේ
- ඉදිකිරීම් කටයුතු සඳහා ණය මුදල නිකුත් කිරීමට පෙර ආසියානු සංවර්ධන බැංකුව විසින් ද පාරිසරික අධ්‍යයන වාර්තාව හා සෙසු අවශ්‍යතා ඇත්දැයි විශේෂිත උපදේශකයින් ලවා පරීක්ෂා කෙරෙනු ඇත
- දැනට සැලසුම්කර ඇති ආකාරයට ඉදිකිරීම් කටයුතු 2016 වසරේ ආරම්භ කරනු ඇත

පාරිසරික බලපෑම් අධ්‍යයන ක්‍රියාවලිය

- ව්‍යාපෘතියේ ශක්‍යතා අධ්‍යයනය 2009 දී ඉංජිනේරු කාර්යය පිළිබඳ මධ්‍යම ඉංජිනේරු උපදේශක කාර්යාංශය (CECB) මගින් ආරම්භ කරන ලදී
- පසුව සම්පූර්ණ පාරිසරික බලපෑම් අධ්‍යයනයද ආරම්භ කෙරිණ
- ඒ සඳහා ව්‍යාපෘති අනුමත කිරීමේ බලධාරී ආයතනය ලෙස මහවැලි අධිකාරිය මගින් විෂය නිර්දේශ (TOR) නිකුත් කරන ලදී

පාරිසරික බලපෑම් අධ්‍යයන ක්‍රියාවලිය

- ඒ අනුව පිළියෙල කළ පාරිසරික අධ්‍යයන වාර්තාව (EIAR) මහජන ගත කිරීමේදී දක්වන ලද අදහස් හා යෝජනා අනුව ප්‍රතිශෝධනය කර අවසාන අදහස් විමසීම සඳහා නැවත ඉදිරිපත් කිරීමට නියමිතව ඇත
- මෙම වාර්තාව අපේක්ෂිත පාරිසරික හා සමාජයීය බලපෑම පිළිබඳ සියලු විස්තර ඇතුළත් වාර්තාවක් ලෙස සිංහල, දෙමළ හා ඉංග්‍රීසි භාෂා 3 න්ම පොදුජන අදහස් සඳහා ඉදිරිපත් කෙරෙනු ඇත

ව්‍යාපෘතිය ආශ්‍රිත ප්‍රදේශයට ව්‍යාපෘති අංග නිසා සිදුවන බලපෑම්

ව්‍යාපෘතිය මගින් ඇතිවන පාරිසරික බලපෑම

- නැවත පදිංචි කරවීම
  - ජලාශය පිරවීම නිසා
  - බලාගාරය සහ අධිපීඩන නල මාර්ග ඉදිකිරීම නිසා
  - අලුතින් ඉදිවන පාරවල් නිසා
  - අනිකුත් හේතූන් නිසා (අවදානම් සහගත බව)

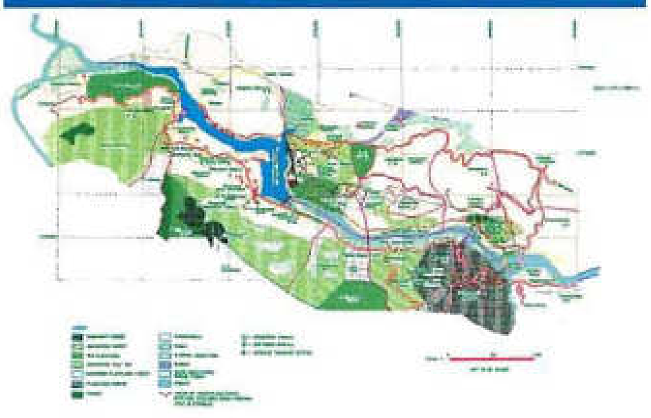
ව්‍යාපෘති අංග

ව්‍යාපෘති අංග	ග්‍රාම නිලධාරී කොට්ඨාශය	ගම
වේල්ල	උඩපලාත් උතුර සහ වැලිගංග	උඩපලාත් සහ වැලිගංග
ජලාශය	වැලිගංග, [illegible], උඩපලාත් උතුර සහ දකුණ	වැලිගංග, [illegible] සහ උඩපලාත්
ජල පිවිසුම් දොරටුව, උමග, සැලැඹුම් ළිඳ, Penstock	උඩපලාත් උතුර, සිංගප්පූරු, [illegible], [illegible]	උඩපලාත්, [illegible], සිංගප්පූරු සහ [illegible]
බලාගාරය සහ පාර, [illegible], අංගනය, පිටවුම් ඇළ	[illegible]	[illegible]
සැලැඹුම් ළිඳ පාර	උඩපලාත් දකුණ	[illegible]
සම්ප්‍රේෂණ රැහැන්	[illegible]	[illegible]

නැවත පදිංචි කරවීමට යෝජිත පවුල් සංඛ්‍යාව

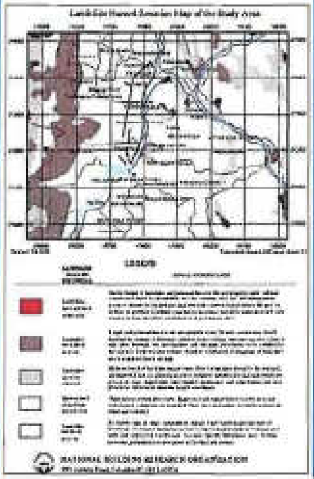
ව්‍යාපෘති අංග	නිවාස ඇතුළු දේපළ	ඉඩම් පමණක්
ජලාශය	04	02
ජලාශය, සංවේදනශීලී [illegible], [illegible]	27	05
බලාගාරය සහ පාර, [illegible], අංගනය, පිටවුම් ඇළ, සැලැඹුම් ළිඳ, Penstock	02	03
එකතුව	33	10

ජනාවාස සිතියම



ව්‍යාපෘතිය මගින් ඇතිවන පාරිසරික බලපෑම...

- වේල්ල සහ පිටවුම් ඇළ අතර ජලය අඩුවීම නිසා
  - පරිසර පද්ධතියට සිදුවන බලපෑම
  - උතුරු ඇළ වරිමාර්ග ව්‍යාපෘතියට ජලය නොලැබී යාමේ අවදානම
  - ඇඹිස් ප්‍රයිව් කර්මාන්තය සඳහා වන බලපෑම
- උලපනේ කර්මාන්තපුරයට සිදුවන බලපෑම
- ජලාශයට යටවන නාන තැන්
- නාය යෑම, පාංශු ඛාදනය



අපේක්ෂිත පාරිසරික හා සමාජයීය බලපෑම් අවම කිරීම සඳහා යෝජිත ක්‍රමෝපායයන්...

- [illegible] (1.5 m³/s)
  - [illegible] (1.21 m³/s)
  - [illegible] (0.28 m³/s) [illegible]
  - [illegible] (0.01 m³/s)

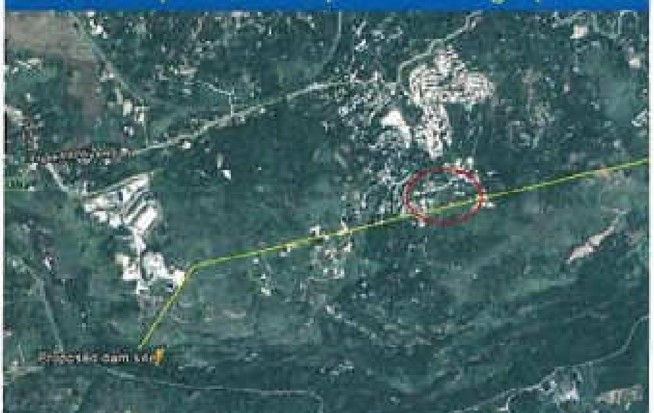
අපේක්ෂිත පාරිසරික හා සමාජයීය බලපෑම් අවම කිරීම සඳහා යෝජිත ක්‍රමෝපායයන්

- අවම පරිසර හානියකින් ව්‍යාපෘතියේ සියළුම අංග සැලසුම් කිරීම
- නැවත පදිංචි කරවීම
  - [illegible]
  - [illegible]
  - [illegible]
  - [illegible]

අපේක්ෂිත පාරිසරික හා සමාජයීය බලපෑම් අවම කිරීම සඳහා යෝජිත ක්‍රමෝපායයන්...

- උලපනේ කර්මාන්තපුරයට සිදුවන බලපෑම්
  - [illegible]
  - [illegible]
  - [illegible]

නැවත පදිංචි කිරීම සඳහා යෝජිත ප්‍රදේශය



ලංකා විදුලිබල මණ්ඩලය මගින් දුන්හිඳ ඇල ව්‍යාපෘතියට වන වාසි

- දුන්හිඳ වාරිමාර්ග ඇළ සඳහා සම්පූර්ණ ජල අවශ්‍යතාවය (0.28 m³/s) ලබා දීම
  - [illegible]
  - [illegible]
  - [illegible]
  - [illegible]

ව්‍යාපෘතිය නිසා බලාපොරොත්තුවන සමාජමය සංවර්ධනය

- ව්‍යාපෘති කලාපය තුල
  - ප්‍රදේශයේ මාර්ගයන් ඇතුළු මූලික පහසුකම් වැඩි දියුණුවීම
  - කෘෂිකර්මාන්තය හා බීමට අවශ්‍ය ජලය අඛණ්ඩව සැපයීමට දායක වීම (ස්ථාවර ජල මුදා හැරීම)
  - සෘජු හා වක්‍ර රැකියා උත්පාදනය (ඉදිකිරීම් අදියර තුල)
  - ජලාශය නිසා භූගත ජල ස්ථරය පෝෂණය වීම
- රට තුල
  - නිවාස ඒකක 120,000 ප්‍රමාණයන් විදුලිබලය නිපදවීම
  - රටේ ආර්ථිකයට දායක වීම
  - පරිසරය ආරක්ෂා වීම
  - නව කර්මාන්ත බිහි වීම හා නව රැකියා අවස්ථා

ඔබගේ අදහස් හා යෝජනා යොමුකල යුත්තේ

නියෝජ්‍ය සාමාන්‍යාධිකාරී
(සම්ප්‍රේෂණ හා ජනක සැලසුම්)
5 වන මහල
තැ.පෙ. 540
ලංකා විදුලිබල මණ්ඩලය
කොළඹ 02

011 2324842

Annex 2(d): Participants of the Stakeholder Consultation Meeting held on January 24, 2013

Annex 3 (a): Minutes of the Second Stakeholder Meeting held on November 18, 2013

2013/11/18 දින කොත්මලේ, වැලිගඟ, ශ්‍රී ගංගාරාම ධර්මශාලාවේදී පවත්වන ලදයෝජිත මොරගොල්ල ජලවිදුලි ව්‍යාපෘයේ බලපෑමට ලක්වන්නන්ගේ දෙවන රැස්වීමේ වැඩකටයුතු සහ සාකච්ජාකරන ලද කරුණු.

- ❖ න්‍යායපත්‍රයට අනුකූලව නිපෝන් කොයි ආයතනයේ එස්.සේරසිංහ මහතා විසින් සභාවේ වැඩකටයුතු මෙහෙයවන කරන ලදී.

- ❖ වැලිගඟ ශ්‍රී ගංගාරාම විහාරාධිපති කොටිකාවත්ත විපස්සි නාහිමියන් විසින් පැමිණිසිටි සියලුදෙනා පංචශීලයේ පිහිටවීම සිදුකරන ලදී.

- ❖ පිළිගැනමේ කථාව ලංකා විදුලිබල මණ්ඩලයේ විදුලි ඉංජිනේරු හේමාලි අමරදිවාකර මහත්මිය විසින් සිදුකරන ලදී.

- ❖ ලංකා විදුලිබල මණ්ඩලයේ මොරගොල්ල ව්‍යාපෘති කළමනාකරු ආර්.කේ.ඩී.ගුණරත්න මහතා විසින් ව්‍යාපෘතියේවත්මන් තත්වය පිළිබඳවවිස්තර කරන ලදී.

- ❖ නිපෝන් කොයි ආයතනයේ ඩබ්ලිව්.ඒ.ඩී.බී.විජේසූරිය මහතා විසින් ව්‍යාපෘති ප්‍රදේශයේ වර්ථමාන පාරිසරික තත්වය සහ ව්‍යාපෘතිය නිසා ඇතිවිය හැකි පාරිසරික බලපෑම් පිළිබඳ පැහැදිලි කරන ලදී. විශේෂයෙන් පරිසරයට සිදුවන හාණි අවම කරගනිමින් ව්‍යාපෘතිය ඉදිරියට කරගෙන යාහැකි ආකාර විස්තර කරන ලදී. මහවැලි ගඟ ආශ්‍රිතව වෙසෙන ජලජ ජීවීන්ට වන බලපෑම් සහ ඔවුන් සංරක්ෂණය කිරීම සඳහා යෝජිත උපායමාර්ග ද පැහැදිලි කරන ලදී. ජාතික පාරිසරික පනතේ විධිවිධාන යටතේ සකස් කරන ලද පාරිසරික බලපෑම් ඇගයීමේ වාර්ථාව (EIAR)සහ මෙම ව්‍යාපෘතියට මූල්‍යමය ආධාර ලබාදෙන ආසියානු සංවර්ධන බැංකුවේ (ADB)අවශ්‍යතා පිළිබඳවදපැහැදිළි කරන ලදී.

- ❖ අනතුරුව වැලිගඟ ශ්‍රී ගංගාරාම විහාරාධිපති කොටිකාවත්ත විපස්සි හිමින් විසින් අනුශාසනාවක් පවත්වමින් කියා සිටියේ,

  - ➢ මීට ප්‍රථම පවත්වන ලද රැස්වීමේදී ඉදිපත් කළ සැලැස්මට වඩා මෙවර ඉදිරිපත් කල සැලැස්ම සතුටුදායක බවත් සැමටම සාධාරණය ඉටුවී ඇති බවත්
  - ➢ රැකියා අවස්ථා ලබාදීමේදී ව්‍යාපෘති ප්‍රදේශයේ අයට ප්‍රමුඛතාවය ලබාදීම සුදුසු බවද උන් වහන්සේ ප්‍රකාශ කර සිටියහ.

- ❖ ඉනිපසු අදහස් දැක්වූ නිපෝන් කොයි ආයතනයේ එස්.සේරසිංහ මහතා විසින්බලපෑමට ලක්වන පවුල් ප්‍රතිස්ථානය කිරීම සම්බන්ධ විස්තර ඉදිරිපත් කළේය.

- ❖ මීලගට එළඹියේ විවෘත සාකච්ජා අවස්ථාවයි.

ඉඩම්,නිවාස ලාභීන්ගේ සහ ගඟ ආශ්‍රිතව ව්‍යාපාර කරන අයගේ ප්‍රශ්න,ගැටළු සහ යෝජනා සාකච්ඡා කිරීම.

ඉඩම්,නිවාස ලාභීන්ගේ සහ ගඟ ආශ්‍රිතව ව්‍යාපාර කරන අයගේ ප්‍රශ්න,ගැටළු සහ යෝජනා.		පිළිතුරු	
ප්‍රශ්නය සහ යෝජනාව ඉදිරිපත් කළ අයගේ නම	ප්‍රශ්නය සහ යෝජනා	පිළිතුරු ලබාදුන් මහතාගේ නම	පිළිතුර
කේ.ඩී.විමලරත්න (ගොවි සංවිධාන සාමාජික-ගම්පලවෙල).	01.ඇත්ගාල දුන්හිඳ ඇල දැනට කැඩී බිඳී ගොස් ඇති හෙයින් එය ප්‍රතිසංස්කරණය කරදෙනවාද යනවග	01.ආර්.කේ.ඩී.ගුණරත්න මහතා (ව්‍යාපෘති කළමනාකරු-CEB)	01.දුන්හිඳ ඇල විශාල වශයෙන් හානියට පත්වීඇති බවත් පසුගිය සතියේ වාරිමාර්ග සහ ගොවි සංවිධාන සමග එය නිරීක්ෂණය කරන ලද අතරඑය ප්‍රතිසංස්කරණය කිරීම අනිවාර්යයෙනම සිදුකරන බවත් ගුනරත්න මහතා පැවසීය. ඇල පටන්ගන්නා ස්ථානයේ සිට මීටර 400 ක් දක්වා දුර ප්‍රමානයක් අළුත්වැඩියා කර දීමටත් ඉතිරි කොටසේ ජලය ලබාගන්නා ස්ථාන සකස්කරදීමට කටයුතු කරන බවත් ඒ මහතා තව දුරටත් කියා සිටියේය.
	02.විමලරත්න මහතා තව දුරටත් යෝජනා කර සිටියේ ව්‍යාපෘතියේ රැකියා ලබාදීමේදී ප්‍රදේශයේ සිටින රැකියා අපේක්ෂකයින්ට ප්‍රමුඛත්වය ලබාදිය යුතුය යන්නයි.	02. ආර්.කේ.ඩී.ගුණරත්න මහතා (ව්‍යාපෘති කළමනාකරු-CEB)	02.රැකියා ලබාදීමේදී හැකි පමණ ව්‍යාපෘති ප්‍රදේශයේම ජීවත්වනජනතාවට අවස්ථාව ලබාදීමට අදහස්කර තිබෙන බවත් එසේ සිදුකරන්නේ සුදුසුකම් සැළකිල්ලට ගැනීමෙන් බවත් ගුනරත්න මහතා කියා සිටියේය.

එම්.ජී.තිලකරත්න මහතා	මෙම ව්‍යාපෘතිය ඉදිරියට කරගෙන යාමට කිසිම ඉඩම් ලාභියෙක් විරුද්දත්වයක් ප්‍රකාශ වී නැති බවත්,එම නිසා ලබාදෙන ඉඩම් හොඳ ඉඩම් වියයුතු බවත් එසේම මෙමඉඩම් සංවර්ධනය කර ඉක්මනින් ලබාදීමට කටයුතු කලයුතු බවත් තිලකරත්න මහතා කියා සිටියේය.	ආර්.කේ.ඩී.ගුණරත්න මහතා (ව්‍යාපෘති කළමනාකරු-CEB)	ව්‍යාපෘතිය සඳහා ඉඩම් අත්කරගත හැක්කේ අමාත්‍ය මණ්ඩලය විසින් ව්‍යාපෘතිය සඳහා අනුමැතිය ලබාදීමෙන් අනතුරුව බවත් ඊට පෙර ව්‍යාපෘතිය සඳහා අවශ්‍ය අරමුල් ලබාදීම පිළිබඳව ආසියානු සංවර්ධන බැංකුවේ එකගත්වය ලබාගතයුතු බවත් ව්‍යාපෘති කළමනාකාර මහතා කියා සිටියේය. එසේම අනුමැතිය ලබාගැනීමෙන් අනතුරුව අදාල අයට ඉක්මනින් ඉඩම් ලබාදීමට කටයුතු කරන බවත් ඒ මහතා කියා සිටියෙය.
අනෝජා ප්‍රියදර්ශනී මහත්මිය.	වැලිගග ප්‍රදේශයේ ඉවත්වන නිවාස ප්‍රමාණය සහ ඒවායේ අයිතකරුවන්ගේ නම් ප්‍රකාශයට පත්කරන ලෙසත් ඉල්ලාසිටින ලදී.	ආර්.කේ.ඩී.ගුණරත්න මහතා (ව්‍යාපෘති කළමනාකරු-CEB)	හඳුනාගෙන ඇති නිවාස 10 ක් බව ප්‍රකාශ කළ ව්‍යාපෘති කළමණාකාර තුමා පහත සඳහන් පරිදි ඔවුන්ගේ නම් ප්‍රකාශයට පත් කරන ලදී. 01.එම්.ඒ.එන්.සරත් කුමාර. 02.එල්.ආර්.එම්.කරුනාවතී. 03.එම්.ඒ.අබේරත්න. 04.එම්.ජී.පුෂ්පා ගුණතුංග. 05.ජී.ජී.ආර්.ආර්.පරාක්‍රමගේ. 06.එම්.ජී.දොනප්පු. 07.ජී.ජී.කේ.ජී.පරාක්‍රමගේ. 08.ඒ.එන්.එම්.නාසික්. 09.වයි.ජී.තිලකරත්න. 10.එන්.ජී.ප්‍රේමතුංග. අනෙකුත් නිවාස වලට හානියක් සිදුනොවන බවත් තවද ජලයෙන් යටවන ප්‍රදේශය දැනට නිවැරදිව අදාල ස්ථාන වල ලකුණුකර ඇතිබවත් කියා සිටියේය. එමෙන්ම යටවන මාර්ගය වෙනුවට ඉදිකරන මාර්ගය වෙනුවෙන් යම් ඉඩම් ප්‍රමානයක් හානියට ලක්විය හැකියි බවත්බලපෑමට ලක්වන ඉඩම් අක්කරයට නොවැඩිනම් හා පර්චස් 40 ට වැඩිනම් අදාල ප්‍රමාණය අනුව විකල්ප ඉඩම් ලබාදෙන බවත් එම ගුණයට අයත් නොවන ඉඩම් වෙනුවෙන් වන්දි මුදල් ලබාදීමට

			කටයුතු කරන බවත් ව්‍යාපෘති කළමණාකාර මහතා කියා සිටියේය
සිලක් අබේසේකර මහතා	01.ව්‍යාපෘතියට යටවන ඉඩම් දැනට ගැසට් කර තිබේද යනවග විමසා සිටියේය.	01. ආර්.කේ.ඩී.ගුණරත්න මහතා (ව්‍යාපෘති කළමනාකරු-CEB)	01.ව්‍යාපෘතියට යටවන ඉඩම් පිළිබඳව තවමත් ගැසට්කර නොමැති බවත් එම කටයුතු මූල්‍ය ආධාර ලැබීමෙන් පසු සිදුකරනු ලබන බවත් ව්‍යාපෘති කළමණාකාරතුමා කියා සිටියේය.
	02.මෙම ව්‍යාපෘතිය ආරම්භ කිරීමට තව අවුරුදු 02 ක් පමණ ගතවිය හැකි බවත් එතෙක් තමන්ගේ ඉඩම්වල ව්‍යාපාරයක් කරගෙන යාමට නොහැකි බවත් අබේසේකර මහතා කියා සිටියේය.එම අවුරුදු 02 ක කාලයේ අපට මෙම ඉඩම්වලින් ලැබීමට තිබෙන ආදායම් නොලැබීම අසාධාරණ බවත් එතුමා ප්‍රකාශ කළේය.	02. ආර්.කේ.ඩී.ගුණරත්න මහතා (ව්‍යාපෘති කළමනාකරු-CEB)	02.මෙම කරුණ පිළිබඳව නොබෝ දිනකින් පැවැත්වෙන නිවාස කමිටු රැස්වීමේදී සවිස්තරාත්මකව සාකච්ඡා කළහැකි බව ව්‍යාපෘති කළමනාකාර මහතා කියා සිටියේය.
	03.යටවන ඉඩම් සඳහා විකල්ප ඉඩම් ලබාදීමේදී පෙර ඉඩමේ පැවති පහසුකම් නොතිබුනහොත් සිදුවන්නේ අසාධාරණයක් බැවින්, එහෙයින් ඉඩමට ඉඩමක් නොව අහිමිවන ඉඩමට වන්දියක් ලබාදීම සුදුසු බවත් ඔහු වැඩිදුරටත් කියා සිටියේය.	03.එස්.සේරසිංහ මහතා (නිපෝන්කොයි ආයතනය)	03.බලපෑමට ලක්වන ජනතාවගේ හිමිකම් පිළිබඳව පැහැදිලි කරමින් කතාකළ සේරසිංහ මහතා කියා සිටියේ බලපෑමට ලක්වන නිවාස දැනට තිබෙන ස්ථානට ආසන්නයේ ප්‍රතිස්ථාපනය කිරීමට සැළසුම්කර ඇති බවයි. තව දුරටත් අදහස් දැක් වූ ඒ මහතා කියා සිටියේ බලපෑමට ලක්වන ඉඩම් වෙනුවට විකල්ප ඉඩම් දීමේ ප්‍රතිපත්තියක් අනුගමනය කරන ලද්දේ බලපෑමට ලක්වන ජනතාවගේ යහපත සඳහා බවත් ඉඩම් වලට වන්දි ගෙවීමේදී මෙම ඉඩම් සඳහා නීතිමය හිමිකම් තහවුරු කළයුතු බවත් ය. විකල්ප ඉඩම් ලබාදීමේදී බලපෑමට ලක්වන ඉඩම් සඳහා නිත්‍යානුකූල අයිතිය පිළිබඳ

			තැකීමක් නොකරන බැවින් සීමා දිනිය වනවිට එම ඉඩම් පරිහරණය කළ බවට තහවුරු කරගැනීම පමණක් සිදුකරනු ලබන බවත් ඔහු කියා සිටියේය.
එච්.එම්.කේ.බන්ඩාර මහතා (ග්‍රාමනිළධාරී-අමුණුපුර)	දැනට වැලි ගොඩ දමන අය සඳහා අහිමිවන විකල්ප වැලි ගොඩදමන ස්ථාන ලබාදෙන බවට ව්‍යාපෘතිය මගින් පොරොන්දු වී ඇති බැවින් එසේ විකල්ප වැලි ගොඩදමන ස්ථාන ලබාදෙන්නේ කෙසේද යනවග විමසා සිටියහ.	එස්.සේරසිංහ මහතා (නිපෝන්කොයි ආයතනය)	මෙයට පිළිතුරු දෙමින් කතාකළ සේරසිංහ මහතා කියා සිටියේ බලපෑමට ලක්වන වැලි ගොඩදමන අය සඳහා විකල්ප ස්ථාන නොව විකල්පආදායම් මාර්ග හඳුන්වාදෙනු ලබන බවය.
ඉන්දික මහතා	උලපනේ ප්‍රදේශයේ ඉවත්වන නිවාස ප්‍රමාණය සහ ඒ ඉවත් වන අයගේ නම් දැනගැනීමට සළස්වන ඉල්ලා සිටියේය.	ආර්.කේ.ඩී.ගුණරත්න මහතා (ව්‍යාපෘති කළමනාකරු-CEB)	හඳුනාගෙන ඇති නිවාස 05 ක බවත් එම නිවාස හිමිකරුවන්ගේ නම් පහත සඳහන් පරිදි වන බවත් ගුනරත්න මහතා කියා සිටින ලදී. 01.එස්.ක්‍රිෂ්ණමූර්ති. 02.ටී.එල්.රන්ජිත් ලියනගේ. 03.එම්.එල්.ඩැනියල්ස්. 04.ඩබ්ලිව්.එම්.ඉන්දික වීරසිංහ. 05ආර්.එම්.සුමනදාස.
රවින්ද්‍ර සමරසිංහ මහතා	01.ඇත්ගාල ප්‍රදේශයේ ඉවත්වන නිවාස ප්‍රමාණය සහ ඒ ඉවත් වන අයගේ නම් දැනගැනීමට සළස්වන මෙන් ඉල්ලා සිටියේය.	01.ආර්.කේ.ඩී.ගුණරත්න මහතා (ව්‍යාපෘති කළමනාකරු-CEB)	01.හඳුනාගෙන ඇති නිවාස 02ක් බැවින් ඒවායේ හිමිකරුවන්, 01.එච්.එම්.ෆැන්සිස් 02.කේ.එන්.එස්.චන්ද්‍රකාන්ති. යන අය බවත් ගුනරත්න මහතා කියා සිටියේය. තවද දැනට කර තිබෙන සමීක්ෂණ අනුව ෆැන්සිස් මහතාගේ නිවාසය පමණක් බලපෑමට ලක්වන බව සොයාගෙන තිබෙන බවත් බොහෝවිට චන්ද්‍රකාන්ති මහත්මියගේ නිවාසය අහිමි නොවීමට ඉඩ ඇති බවත් ඔහු කියා සිටියේය.

	02. බලපෑමට ලක්වන නිවාස සඳහා විකල්ප නිවාස ලබාදීම වෙනුවට වන්දි මුදල් ලබාගත හැකිද යන්න විමසා සිටියේය.	02.එස්.සේරසිංහ මහතා (නිපෝන්කොයි ආයතනය)	02.බලපෑමට ලක්වන නිවාස සඳහා වන්දි මුදල් ගෙවනු ලබන්නේ ඉඩම් අත්කරගැනීමේපනතේ විධිවිධාන අනුව අදාල ප්‍රාදේශීය ලේකම් විසින් බවත් එසේ වන්දි ලැබීමට නම් එම නිවාස දේපල සඳහා නීත්‍යානුකූල අයිතිය තහවුරු කළයුතු බවත් සේරසිංහ මහතා කියා සිටියේය. විකල්ප නිවාස ලබාදීමේදී නීත්‍යානුකූල අයිතිය සැළකිල්ලට නොගන්නා බැවින් සීමා දිනය වන විට බලපෑමට ලක්වන නිවාස වල පදිංචිව සිටීම පමණක් ප්‍රමාණවත් වන බවත් ඒ මහතා තවදුරටත් කියා සිටියේය.
	03.දැනට තිබෙන සැලැස්ම අනුව මෙම ව්‍යාපෘතියේ,බලාගාර ප්‍රදේශය ඉදිවන විට ඒ අදාල පස් සහ ගල් ගොඩ කිරීමට බලාපොරොත්තුවෙන් සිටින්නේ තමාගේ ඉඩමෙ බැවින් එහිදී එකවරම ඉඩම සම්පූර්ණයෙන් පිරවුවහොත් තමාගේ හරිතාගාර ව්‍යාපාරය කරගෙන යා නොහැකියි බවත් ඊට හේතුව එවා සම්පූර්ණයෙන්ම කඩා දැමියයුතු වීම බැවින් ඒ නිසා එයට පිළියමක් වශයෙන් මෙය කොටස් දෙකකට පිරවිය හැකිද යන්න ගැන විමසා සිටියේය.	03.ආර්.කේ.ඩී.ගුණරත්න මහතා (ව්‍යාපෘති කළමනාකරු-CEB)	03.මෙමෙ ඉඩම් කොටස ව්‍යාපෘතියේ ඉදිරි වැඩකටයුතු වෙනුවෙන් ලබාදීම ගැන සමරසිංහ මහතාට ස්තුති කළ ගුනරත්න මහතා කියා සිටියේ යෝජනා කරන ලද ආකාරයට කටයුතුකළ හැකි බවත්ය.

- ❖ සාකච්ඡා වාරයෙන් අනතුරුව කතාකළඋඩ පළාත ප්‍රාදේශීය ලේකම්තුමා කියා සිටියේ රට තුල සිදුකරගෙන යන සංවරධන කටයුතු සඳහා සියළු දෙනාගේ සහයෝගය අවශ්‍ය බවත් ව්‍යාපෘතිය සඳහා ඉඩම් අත්කරගැනීම ඇතුළු ප්‍රතිස්ථාපන කටයුතු සඳහා තමාගේ හා තම කර්‍ය මණ්ඩලයේ සහයෝගය ලැබෙන බවත් ඔහු කියා සිටියේය
- ❖ ඉන්පසු අදහස් දැක්වූ ගග ඉහල කෝරලේප්‍රාදේශීය ලේකම්තුමා කියා සිටියේරටේ සංවර්ධන කටයුතු සඳහා බලශක්තිය අත්‍යාවශ්‍ය වන බවත් මෙවැනි ව්‍යාපෘති සඳහා සියයට සියයක් සහයෝගය ලැබියයුතු බවත් ඔහු කියා සිටියේය.
- ❖ ලංකා විදුලිබල මණ්ඩලයේ,මොරගොල්ල ව්‍යාපෘතියේ, සිවිල් ඉංජිනේරු අශාන්දිසානායක මහතා විසින් ස්තුති කථාව කිරීම.
- ❖ පස්වරු 5.30 ටසභාවේ වැඩ කටයුතු අවසන් විය.

Annex 3 (b): List of Participants of the second stakeholder consultation meeting held on November 18, 2013

Moragolla Hydropower Project - Ceylon Electricity Board

Second Stake Holder Meeting (2013/11/18)

Attendance List - Officers From Government & Other Institutes / Organizations

3

No.	Name	Designation & Intitute	Telephone No	E - Mail Address	Signature
8	K M. Geetha Malkanthi	Colonization officer, Divisional secretariat Ganga Ihala Korale.	0812352604.	geethabugma@yahoo.com.	
9	Mallika - M. Abeykoon	Grama Niladhari, Singhapura 1076	0779216674		
10	B.K. Hewawithana	Civil Engineer, Mahaweli Authority kotmale projects	0776301143	HAOMkotmale @yahoo.com	
11	A.H.A. Dissanayake	Divisional Envi. officer, CEA, Polgolla (Gangaihala D/Dsion)	077-9783539	—	
12	A.D. Heleruma.	Sevijanaseva	0779313267	—	
13	Sanan Perera	OGEL Shee (Pvt) Ltd	0722220355		
14	H.M.K [illegible]	[illegible]	0718009265		

2

Moragolla Hydropower Project - Ceylon Electricity Board
Second Stake Holder Meeting (2013/11/18)
Attendance List - Officers From Government & Other Institutes / Organizations

No.	Name	Designation & Intitute	Telephone No	E - Mail Address	Signature
15	D.M. [illegible]	ග්‍රාම නිලධාරි 1167 [illegible]	0725388797		[signature]
16	M M S [illegible]	[illegible]	0778197278		[signature]
17	PS 45134 [illegible]	[illegible]	0776513S		[signature]
18	[illegible]	ග්‍රාම නිලධාරි / [illegible]	0724655624		[signature]
19	I.D. Bandara	Land officer udapalatha Div. Sec. office	0718357484		[signature]
20	D. B. Rathnayake	R.M.A.S. Divisional Secretariat Udapalatha	0776992211		[signature]
21	U.B. [illegible]	[illegible], 1072-[illegible]	0776091190		[signature]

Moragolla Hydropower Project - Ceylon Electricity Board

Second Stake Holder Meeting (2013/11/18)

Attendance List - Officers From Government & Other Institutes / Organizations

No.	Name	Designation & Intitute	Telephone No	E - Mail Address	Signature
22	T. D. [illegible]	[illegible]	071-9872491	—	
23	K A S [illegible]	[illegible]	0779877300		
24	J. M. D. K. [illegible]	[illegible]			
25	S. Batikotuwa	Human Resource & Institutional Development officer MASL - Kotmale	0772429374		
26	T. A. D. W. Dayananda	Divisional Secretary Div. Sec. - Ganga Ihala Korale	071 4400317		
27	B. M. P. G. P. R. Bandara.	Divisional Secretary (Acting) Udapalatha -	0719003096	pobandara@gmail.com	
28	T. N. Amman	Sri Lanka Administrative Officer	0713307056	amantn@gmail.com	

Moragolla Hydropower Project - Ceylon Electricity Board

Second Stake Holder Meeting (2013/11/18)

Attendance List - Officers From Government & Other Institutes / Organizations

No.	Name	Designation & Intitute	Telephone No	E - Mail Address	Signature
29	A.H. Dissanayake	Civil Eng. CEB - MOGL .	0718418014	hansike039@yahoo.com.	Ahun
30	P.M.C.A.K. Alagarath -	" " "	0718014022	pimcak@gmail.com	[illegible]
31.	H.W. Amaradiwakara	EE , CEB	.	eemdd@ceb.lk.	[illegible]
32	U.S Goonasekera	Deputy Team Leader Nippon Koei	0777-252388	upulg77@yahoo.co.uk	[illegible]
33	R.C.B Gunaratne	CEB, PM .	071-4530922	pmmdd@ceb.lk.	[illegible]
34	S. Baranasingha	N/K , Sociologist	0777 215331		[illegible]
35	W.A.D.D. Wijesooriya.	N/K National Environment Specialist.	0777 253397	wijesooriya.wadd@gmail.com	Dijesooriya

Govt. officials

Attendance - Stake holder meeting

2013 - 11 - 18

Name නම	Designation & Institute තනතුර	Address ලිපිනය	Contact Number දුරකථන අංකය	Signature අත්සන
36. S. [illegible]	[illegible]	[illegible]	081235321[illegible]	[illegible]
37 [illegible]	[illegible]	[illegible]	081 - 2352222	[illegible]
38. [illegible]	[illegible]	[illegible]	0716611508	[illegible]

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)

ව්‍යාපෘති කලාපය තුළ පදිංචිකරුවන්ගේ නාම ලේඛනය

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
01	සරෝජනී චන්ද්‍රකාන්ති	අංක 205 දුනගම්මන, ගම්පොල	අංගම්මන හැංගුනාපිට	0813812578	S. Chandrakanthi
02	ජී.ජී.කේ.ජී. [illegible]	අංක 88 වැලිගඟ, මාවතුර	වැලිගඟ	0814870100	[illegible]
03	ඩබ්.R.G. ප්‍රියාණි	උළුපනේ, මාවතුර	උළුපනේ	—	[illegible]
04.	U.H.G. [illegible]	අංක 30/2 වැලිගඟ, මාවතුර.	වැලිගඟ	077-4812951	[illegible]
05.	P.G. [illegible]	අංක 30/1 වැලිගඟ, මාවතුර.	වැලිගඟ.	054-4904213	[illegible]
06.	W.G. ජයවර්ධන.	අංක 29 වැලිගඟ මාවතුර.	වැලිගඟ.	081-2353916	[illegible]
07.	M.G. [illegible]	අංක 1/5 වැලිගඟ මාවතුර	වැලිගඟ.	072-6583550	[illegible]

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගල ගංගාරාම විහාරස්ථානය)

ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ නාම ලේඛණය

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අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
08	ආර්. ආර්. ජයසුන්දර.	නො: 3/4 වැලිගල කාවතුර.	වැලිගල.	0545681597.	
09.	ජී. ජී. රත්නප්‍රිය විජය කුමාර විජේකෝන්	11-A, වැලිගල, කාවතුර	1188 - වැලිගල	077-6686203	
10.	ජී. ජී. ප්‍රේමලතා	11-B, වැලිගල, කාවතුර	1188 - වැලිගල	081-5716284	
11	[illegible]	26/1 වැලිගල, කාවතුර	1188 වැලිගල	0812353788	
12	[illegible]	17/1 [illegible]	1188 - [illegible]	0817903644 071[illegible]	
13	D.G.S. [illegible]	679/21 [illegible]	[illegible]	0718288821	
14.	L.R.M. [illegible]	නො: 04 වැලිගල කාවතුර.	වැලිගල	0813753713	

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මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය
දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)
ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ නාම ලේඛණය

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
15	W.A. සමරවීර	නො 113, මාස්වෙල/වාර උලපනේ	උලපනේ දකුණ		
16	[illegible]	83/2 [illegible]	[illegible] (දකුණ)	[illegible] 2788831 0724163208	
17	M.A.S.M. මාපලගම	අංක 01 වැලිගල මාවත	වැලිගල	0752708274	
18	[illegible]	[illegible] වැලිගල මාවත	වැලිගල 1188	0729310853	
19	W.M.I.W. විරසිංහ	65/2 මාවෙලවාර උලපනේ	උලපනේ දකුණ	077-6224243	
20	D.M. [illegible]	[illegible]	[illegible]	[illegible]756	
21	[illegible]	උලපනේ දකුණ	උලපනේ දකුණ	0778587218	

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)

ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ නාම ලේඛණය

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අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
22	[illegible]	නං 113 B මාවෙල පා/උඩ	උ. දකුණ		[illegible]
23	[illegible]	මාවෙල [illegible] [illegible]	දකුණ		[illegible]
24	M.G. [illegible]	මාවෙලවත්ත උලපනේ	උ. දකුණ.		[illegible]
25	K.G. කරුණාරත්න	107, මාවෙලාර උලපනේ	උ. දකුණ.		[illegible]
26	K.G. කරුණාරත්න	වැලිගල, උලපනේ	වැලිගල		[illegible]
27	[illegible]	113 මාවෙලවත්ත උලපනේ	උ. දකුණ		[illegible]
28	M.M.M. [illegible]	123 මාවෙල පාර උලපනේ	උ. දකුණ	0812353716 0778346768	[illegible]

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)

ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ නාම ලේඛණය

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අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
29	ARM HASSM	[illegible]			[illegible]
30	A. Raufh.	123/D, Mawela Road U/P.		0779060587	[illegible]

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මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)

ගොවි සංවිධාන නියෝජිතයන්ගේ නාම ලේඛණය

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
1	[illegible]	18 [illegible]	[illegible] 1188		[illegible]
2	[illegible]	[illegible]	[illegible]	077-9097207	[illegible]
3	[illegible]	73 [illegible]	[illegible]	0776921396	[illegible]
4	[illegible]	[illegible]	[illegible]	081 5611803	[illegible]

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගල ගංගාරාම විහාරස්ථානය)

ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ නාම ලේඛණය

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අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
1	[illegible]	[illegible]	[illegible]	0813813715	
2	[illegible]	73 [illegible]	[illegible]	0776925396	
3.	[illegible]	05, වැලිගල, මාවතුර	වැලිගල.	071 8067878	
4.	[illegible]	අංක 17 වැලිගල මාවතුර	වැලිගල	0776781726	
5	[illegible]	අංක 31 වැලිගල මාවතුර	〃	081 2353797	[illegible]
6.	[illegible]	〃 〃 〃 〃	〃	〃	
7.	[illegible]	〃 〃 〃	〃	081 2353880	[illegible]

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය
දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)
ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ නාම ලේඛණය

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
8	[illegible]	වැලිගඟ [illegible]	වැලිගඟ	[illegible] 613	[illegible]
9	එච්.ජී. [illegible]	NO-06, වැලිගල, [illegible]	වැලිගල	081-[illegible]	[illegible]
10	[illegible]	[illegible]	" "		[illegible]
11	[illegible]	[illegible]	[illegible]	051,2250 1112	[illegible]
12	[illegible]	නො: 40/1 වැලිගල [illegible]	වැලිගල.	071 8383381	[illegible]
13	R.M. [illegible]	[illegible]	[illegible]	077-1941340	[illegible]
14	[illegible]	28, වැලිගල [illegible]	වැලිගල.	0815680290	[illegible]

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)

ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ නාම ලේඛණය

15

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
15	එච්.ජී. ධම්සිරි	100, වැලිගඟ, මාවතුර, ගම්පොල.	වැලිගඟ	0815682094	[illegible]
16	B.M. තිලකසිරි දිසානායක	මාවෙල පාර උලපනේ.	ගඟහිහල	081-4997435	දිසානායක
17	ගමගේ ප්‍රදීප් කුමාර පෙරේරා	10, වැලිගඟ, මාවතුර	වැලිගඟ	072-1822259	[illegible]
18	L. R. සමරසිංහ	[illegible] පාර, [illegible], ගෙරගල	ගෙරගල [illegible]	077 098146 61	Samarasinghe
19	R.A විජේසිංහ	නො 1/588 මාවෙල පාර උලපනේ	ගඟහිහල		[illegible]
20	R. A. රෝසමරත්න	නො: 688/6, මාවෙල පාර උලපනේ	ගඟ හිහල	0523528112	[illegible]
21	S. Jayakumar	No 688/6 Mawela Road Ulapane	Ganga Hihala	0523528112	[illegible]

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)

ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ නාම ලේඛණය

15

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
22	W A [illegible] කුමාර	108 A මාවෙල පාර උලපනේ	උලපනේ දකුණ		[illegible]
23	[illegible]	679/17 මාවෙල පාර උලපනේ			[illegible]
24	[illegible]	107/මාවෙල පාර උලපනේ	උලපනේ උතුර		[illegible]
25	A - [illegible]	123, මාවෙල පාර, උලපනේ	උලපනේ දකුණ		FAREED n.
26	A A [illegible]	123, මාවෙල පාර, උලපනේ	උ/දකුණ.	0779632837	[illegible]
27	P.G. [illegible]	11/C වැලිගඟ [illegible]	වැලිගඟ		[illegible]
28	A. B. [illegible] රංජිත් කුමාර	108/A, මාවෙල පාර, උලපනේ	උ/දකුණ		[illegible]

4

<u>මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය</u>

<u>දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)</u>

<u>ව්‍යාපෘති කලාපය තුල පදිංචිකරුවන්ගේ නාම ලේඛණය</u>

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
29.	M.L. [illegible]	43, මාවෙලපාර, උලපනේ	[illegible]		[illegible]
30	M.L Daniels.	Kelehanda mahawela Rd ulapane	ulapane south	075-5491509	[illegible]
31	[illegible]	114 මාවෙල පාර උලපනේ	උලපනේ දකුණ	0771360660	[illegible]
32	[illegible]	මාවෙල පාර ගොවාලවත්ත - උලපනේ	උලපනේ දකුණ	072-404928 9	[illegible]
33	[illegible]	112.3 වැලිගල	[illegible]	072672092	[illegible]
34	A.F.M NAZIK	30/3 NAWALAPITIYA ROAD. GAMPOLA	ULAPANE.	077-3050092	[illegible]
35	W.M. [illegible]	මාවෙල පාර උලපනේ.	උලපනේ දකුණ	0724812405	W.M. [illegible]

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය
දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගල ගංගාරාම විහාරස්ථානය)
ව්‍යාපෘති කලාපය තුළ පදිංචිකරුවන්ගේ නාම ලේඛණය

15

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
36.	[illegible]	[illegible]	[illegible]	[illegible]	
37.	T.G. රංජනී [illegible]	[illegible]	[illegible]	075-6257636	[illegible]
38.	H. සන්ධ්‍යා කුමාරි	නො: 47. වැලිගල [illegible]	වැලිගල.	0	Sandana.
39.	[illegible]	[illegible]	[illegible]		[illegible]
40.	K.P තරංග සම්පත්	අංක 48 වැලිගල	වැලිගල		සම්පත්
41.	[illegible]	[illegible]	වැලිගල		[illegible]

මොරගොලල් ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය
දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)
වැලි ගොඩ දැමීමේ නියුතු අයගේ නාම ලේඛණය

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
01	SAD පද්මලතා	නො: 85/A [illegible], ගම්පොල	[illegible]	0773425743	
02	[illegible]	නො: 149, [illegible], ගම්පොල	[illegible]	0774743978	
3	H A [illegible]	නො: 40 [illegible] ගම්පොල	[illegible]	0770520656	
04	[illegible]	නො 14/1 A [illegible] [illegible]	[illegible]	0770568083	
05	[illegible]	36. [illegible] [illegible]	වැලිගඟ	0779067034 0723704314	
06	R P [illegible]	126 [illegible], [illegible]	[illegible]	0776051910	
07	A. M. A. U. [illegible]	442 [illegible]	[illegible]	0776725606	

මොරගොල්ල ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)

වැලි ගොඩ දැමීමේ නියුතු අයගේ නාම ලේඛණය

අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
08	S.D.J. [illegible]	22/8 කුඹුරු පහල කොටස [illegible]	[illegible]	0724330897	
09	නිහාල් සිසිර කුමාර	4/1 කුඹුරු පහල කොටස [illegible]	නවදේවිට	0772580855	
10	B.D. [illegible]	18/21 [illegible] [illegible]	[illegible]	0777617881 ~~[illegible]~~	
11	[illegible]	[illegible], [illegible], [illegible]	නවදේවිට	0913 830 802	
12	D M ජයසේකර	නවදේවිට [illegible]	නවදේවිට	0775882756 ~~[illegible]~~	
13	S.B [illegible]	නවදේවිට ගල්බොඩ	නවදෙවිට	59	
14.	S.D.G. නිහාල්	5/A, [illegible], [illegible]	[illegible]	0720317555	

2

මොරගොලල් ජල විදුලි ව්‍යාපෘතිය ලංකා විදුලි බල මණ්ඩලය

දැනුවත් කිරීමේ දෙවන රැස්වීම 2013/11/18 (වැලිගඟ ගංගාරාම විහාරස්ථානය)

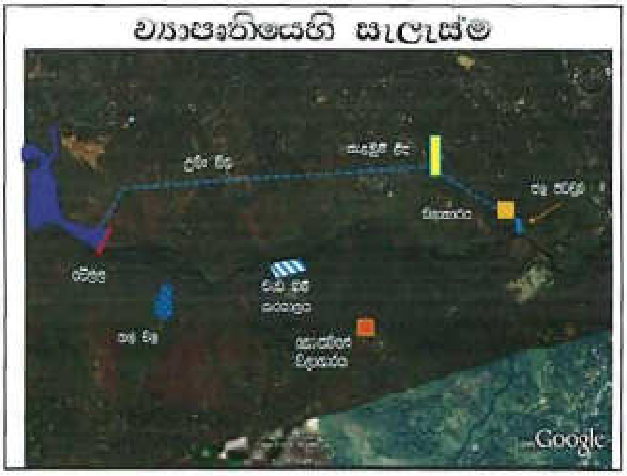
වැලි ගොඩ දැමීමේ නියුතු අයගේ නාම ලේඛණය

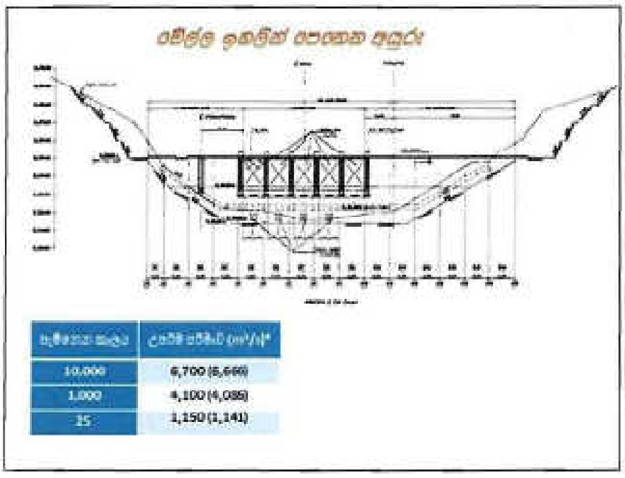
අංකය	නම	ලිපිනය	ග්‍රා.නි.වසම	දුරකථන අංකය	අත්සන
15	ආර්.එම්. ජයරත්න	35 වික්ටෝ [illegible] ගම්පොල	අඹුපුර	0777558067	[illegible]

Moragolla Hydropower Project - Ceylon Electricity Board
Second Stake Holder Meeting (2013/11/18)
Attendance List - Officers From Government & Other Institutes / Organizations

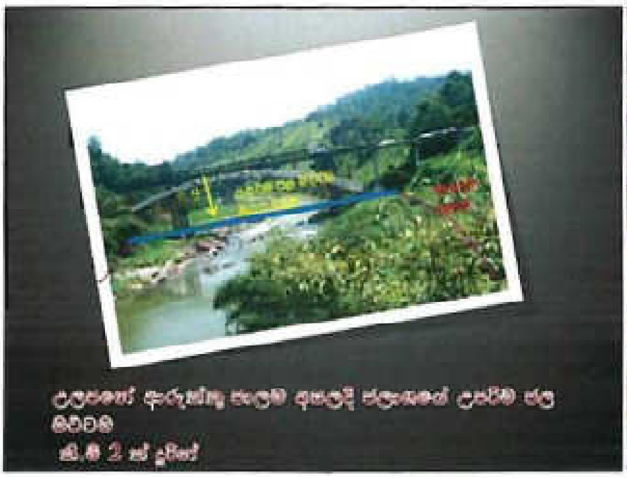
No.	Name	Designation & Intitute	Telephone No	E - Mail Address	Signature
01	[illegible]	[illegible]	0777640218	-	
02	Seetma Bandara	Plant Engineer	0773865486	ppl2@crysbro.net	
03	[illegible] Herath	D/O ministry of Industrial & [illegible]	078-[illegible]	asokab[illegible]@-[illegible]	
04	Major A G U J Dharmasena	Army Camp, 2SLRC Gampola	0773141969 0812420744		
05	A M S P K Seneviratne	Senior Environmental Officer CEA - Polgolla	081-2494884.		
06	G.W. Nimalsiri	Ad-RFO Nawalapitiya.	0542223054,		
07	G W N R Wadugе	CEB - Nawalapitiya.	0715313872	Aist	

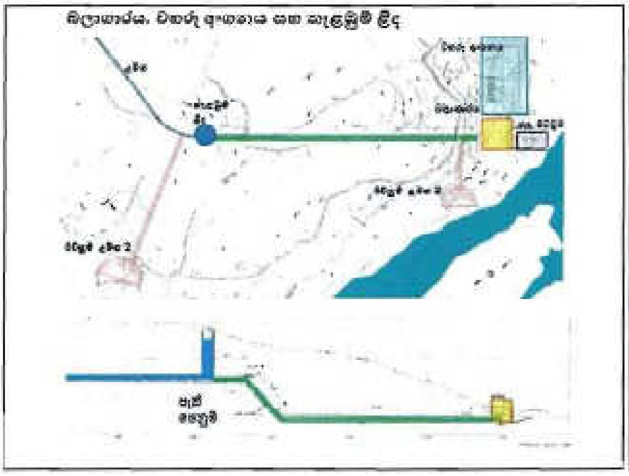
Annex 3 (c): Power Point Presentation of the Project Manager (MHPP) at the second stakeholder consultation meeting held on November 18, 2013



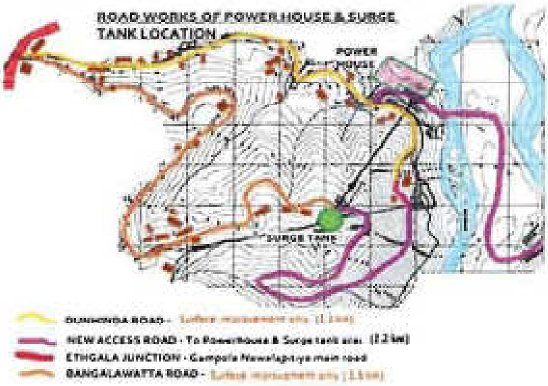


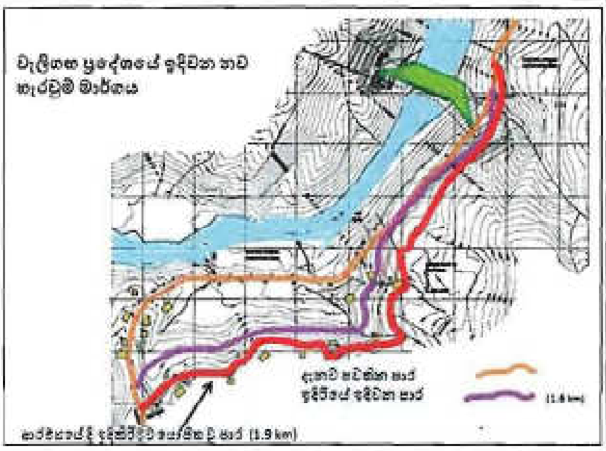
පැමිණෙන කාලය	උපරිම පරිමාව (m^3/s)*
10,000	6,700 (6,660)
1,000	4,100 (4,086)
25	1,150 (1,141)



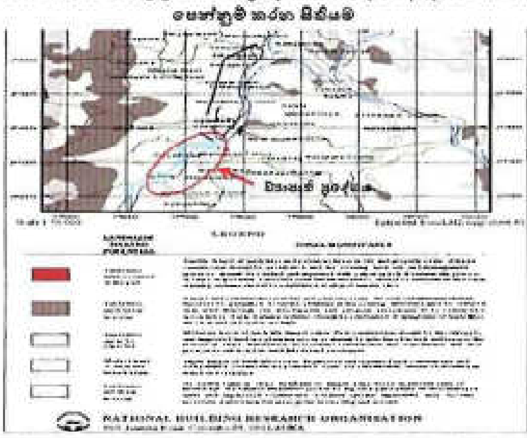


යෝජිත පිවිසුම් මාර්ගය: බලාගාරයට හා කැළඹුම් ටැංකියට





යෝජිත මොරගොල්ල ව්‍යාපෘති ප්‍රදේශයේ හා ආශ්‍රිත අවදානම් කලාප පෙන්නුම් කරන සිතියම



පාරිසරික බලපෑම් අවම කිරීමට ව්‍යාපෘතියෙන් කරන ලද සැලසුම්

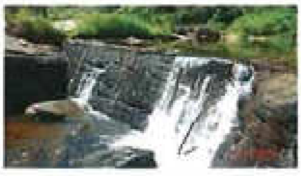
1) *ව්‍යාපෘති අංග සැලසුම් කිරීම මගින්*

- පොළොව මට්ටම සිට මී 30 කින් පහලට යන පාර.
- උමං ජල මාර්ගය මීටර 348 දක්වා අඩු කිරීම.
- බලාගාරයට අවශ්‍ය භාණ්ඩ ප්‍රවාහනය සඳහා තාවකාලික මාර්ගයක් ඉදිකිරීම
- වැලිගම ප්‍රදේශයට යෝජනා කරන ලද හැරවුම් මාර්ගය ප්‍රදේශවාසීන්ට අවම බලපෑමක් වන ලෙස නැවත සැලසුම් සකස් කිරීම.
- ජලාශය වටා ආරක්ෂිත කලාපය [illegible]
- ඉංජිනේරුමය විසඳුම් ජලාශය වටා [illegible] ජලාශය නිර්මාණය කිරීමට සැලසුම් සකස් කිරීම.

2) පාරිසරික හා අනෙකුත් අවශ්‍යතා සඳහා ජලාශයෙන් අඛණ්ඩව තත්පරයට ඝ.මී. *1.5* ක් මුදා හැරීම

[illegible]

දුන්හිඳ ඇල ව්‍යාපෘතියට ලැබෙන වාසි

ව්‍යාපෘතිය මගින් සිදුවන ආර්ථික සාමාජීය සංවර්ධනය

<u>ව්‍යාපෘති ප්‍රදේශය</u>

1. ජන ජීවිතයට අවශ්‍ය මූලික පහසුකම් සංවර්ධනය වීම
2. ගඟෙහි පහල ප්‍රදේශයට වාරි ජලය හා බීමට අවශ්‍ය ජලය අඛණ්ඩව සැපයීමේ හැකියාව තහවුරු කිරීම
3. සෘජු හා වක්‍ර රැකියා ජනනය වීම
4. භූගත ජල ස්ථර සවිමත් වීම

<u>මුළු රටටම</u>

1. නිවාස ඒකක 150,000 කට පමණ විදුලිය සැපයීමට අවශ්‍ය විදුලිය ජනනය කිරීම
2. ජාතික ආර්ථිකයට සවිමත් ලෙස දායක වීම
3. පරිසරයට හිතකාමී විදුලි ජනනය කිරීමක් වීම
4. අලුතින් කර්මාන්ත හා එමගින් නව රැකියා බිහිවීම

ස්තූතියි

Annex 3 (d): Power Point Presentation of the National Environmental Specialist at the second stakeholder consultation meeting held on November 18, 2013

Moragolla Hydropower Project

Stakeholder Meeting

Natural Environment

ව්‍යාපෘතියේ ස්වභාවික පරිසරය

November 15, 2013

Venue

History of Environmental Initiatives of the Project (Contd....)

- **EIA report reviewed by a Technical Evaluation Committee (TEC) appointed by MASL**
- Environmental approval for the implementation of the Project was granted by MASL in August 13. (Subject to certain conditions and proper implementation of mitigation measures proposed in EIA report)

ව්‍යාපෘතිය සඳහා පාරිසරික අනුමැතිය 2013 අගෝස්තු මසදී ජාතික පරිසර පනතට අනුව මහවැලි අධිකාරිය මගින් ලබාදෙන ලදී

History of Environmental Initiatives of the Project

- Environmental Impact Assessment (EIA) carried out (as part of the Feasibility Studies) during 2009 and 2012 based on a ToR issued by the Project Approving Agency (ie.,Mahaweli Authority of Sri Lanka) under the National Environmental Act
- EIA report opened for public comments in all three languages (Sinhala, Tamil and English) in April 2013

The EIA was opened for public comments in April, 2013

- CEB appointed Nippon Koei Co. Ltd of Japan to review the Feasibility Study report and prepare detailed designs of the project.
- Financial assistance for the project is expected from Asian Development Bank (ADB)
- In order to fulfil the requirements of ADB environmental and social safeguard requirements, additional studies were carried out in 2012-2013

1 (Water Quality)
2 (Aquatic Ecology)
3 (Ground Water)
4 (Land Use Map)

5 Public consultation and disclosure
6 Environmental flow analysis
7 Institutional assessment including grievance redress mechanism (GRM)

Anticipated Environmental Impacts during construction

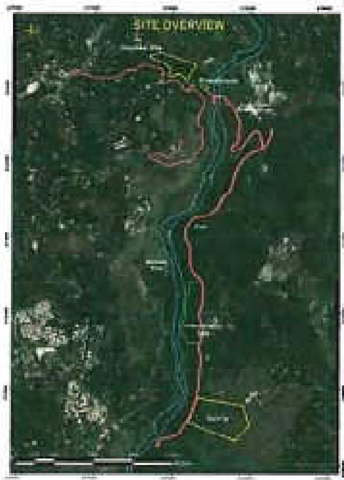
- Excavation of Soil – Erosion and muck (excavated Material) disposal
- Rock Blasting - Noise and Vibration
- Surface Water- Pollution and Depletion
- Ground Water – Pollution and Depletion
- Bio diversity – Impact on Fauna and Flora
- Air Pollution - Dust and other physical disturbances
- Noise and Vibration
- Increased Traffic

Studies carried out to plan and design mitigation measures.

8 mitigating the impacts of the Moragolla HPP on fish
9 habitat creation and management to enhance terrestrial biodiversity
10 afforestation and watershed management plan
11
12
13

Excavation of Soil – Erosion and muck (excavated Material) disposal

- Most aggregate requirement for construction will be obtained from the tunnel excavation materials
- Tunnel muck and excavated soil will be used for back filling and slope stabilization.
- All debris and residual spoil material including left earth will be disposed only at designated locations (Spoil Banks).



Metal Quarry

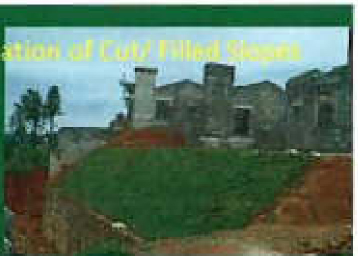
UKHP Experience

Domestic Solid Waste Management

Kotmale National School Play Ground

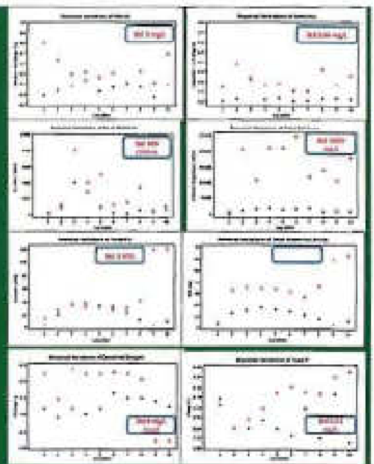
Surface Water- Pollution and Depletion

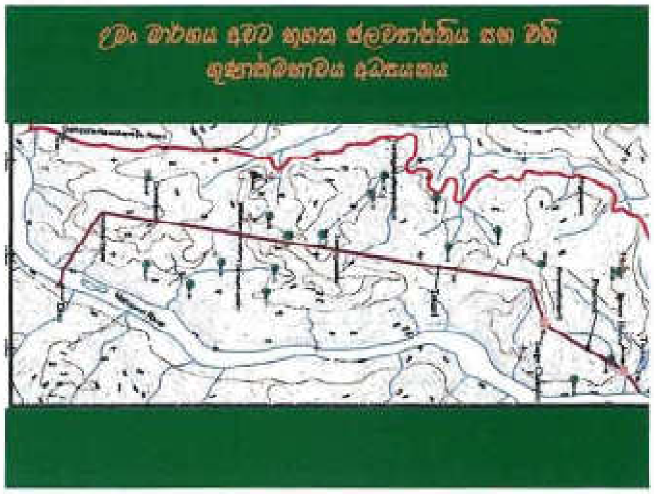
Progressive Rehabilitation of Cut/ Filled Slopes

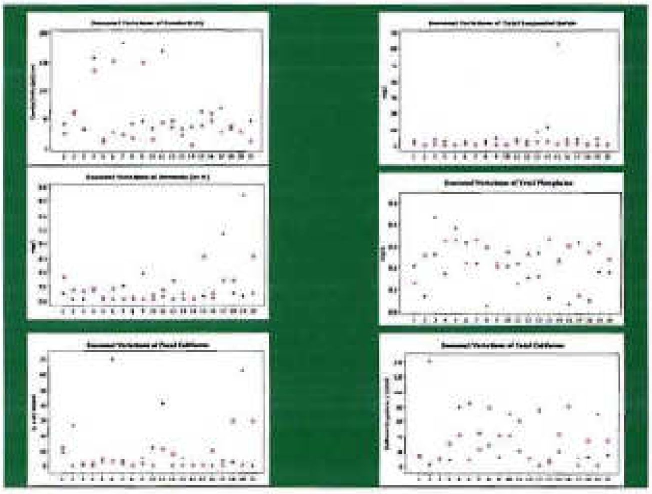


ජලයේ ගුණාත්මකභාවය අධ්‍යයන සාධක

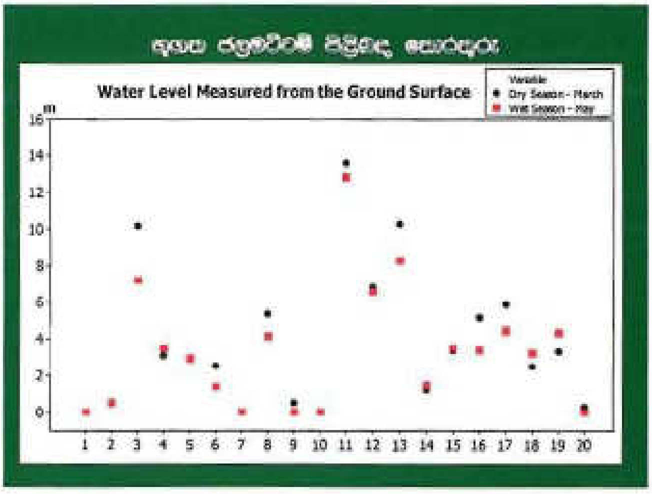
- pH
- Temperature
- Dissolved Oxygen
- Turbidity
- BOD
- Ammonia
- Nitrate
- Total Phosphorus
- Total Suspended Solids
- Faecal Coliforms
- Total Coliforms







Ground Water – Pollution and Depletion



Air Pollution - Dust and other physical disturbances

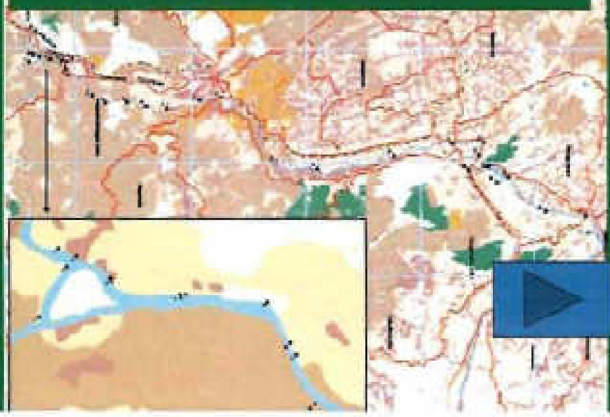
Bio diversity – Impact on Fauna and Flora

- මහවැලි නදියේ ජලජ පරිසර අධ්‍යයනය (Aquatic Ecology)
  - මත්ස්‍යයන්ට සිදුවන හානි අවම කිරීම - mitigating the impacts of the Moragolla HPP on fish

ව්‍යාපෘතිය ක්‍රියාත්මක වීමේදී ඇතිවිය හැකි පාරිසරික බලපෑම්

- ජලාශ පූර්ණ මට්ටමේ දී වන වගා- ළඳුකැළෑ- ගෙවතු ජලාශයට යටවීම (30.5 ha), (no unique, critical, or limited habitats for wildlife).
- වේල්ල මගින් මත්ස්‍යය සංචරණයට බාධාවීම
- වේල්ල හා බලාගාර ජලනිටවුම අතර ජලපහර අඩුවීම :Reduced flow (about 1.5 m^3/s which is the e-flow) below dam to confluence with Atabage Oya (3 km);
- ගඟේ හුදකලා ජල වලවල් ඇතිවීම isolation of pools

මහවැලි නදියේ ජලජ පරිසර අධ්‍යයනය



ජලාශයෙන් යටවන ප්‍රදේශය

- Fish encountered throughout project area;
- only one is endemic, limited distribution, and threatened (Green or Mountain Labeo: *Labeo fisheri*); everything else has wider distribution in Sri Lanka.
- *Labeo fisheri* is not presently found above confluence of Atabage Oya and Mahaweli Ganga; it is not a long-range migrator.

වනපෙතියේ කටයුතු නිසා වන වැස්මට ඇතිවිය හැකි ප්‍රධාන බලපෑම්

තාවකාලිකව ද්විතීක වන වගා, ලඳුකැලෑ, හේනවගා ඉවත්කිරීම

- වැඩබිම් ප්‍රදේශ සඳහා
- අපද්‍රව්‍ය තොගත් බැහැරකිරීම සඳහා
- පිවිසුම් උමං සඳහා
- පිවිසුම් මං-මාවත් සඳහා
- ගල් වල ප්‍රදේශ සඳහා

(to be rehabilitated/ replanted after construction).

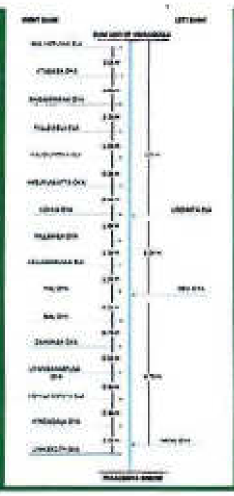
ස්ථිර ලෙස ද්විතීක වන වගා ලඳුකැලෑ හේනවගා ඉවත්කිරීම

- ජලාශපතුල ප්‍රදේශ සඳහා
- බලාගාර ප්‍රදේශ සඳහා
- සාරයකණ්ඩල වාසස්ථාන ප්‍රදේශ සඳහා

(to be re-vegetated accordingly);

no incursion into unique, critical, or limited habitats.

MAJOR DOWNSTREAM TRIBUTRIES of MAHAWELI RIVER



- [illegible]
  habitat creation and management to enhance terrestrial biodiversity
- afforestation and watershed management plan

Proposed Mitigation for *Labeo fisheri*...

- Avoid / control blasting at Moragolla tailrace area.
- "Catch-and-haul" as each fish is encountered (or pre-empt; do an echo-sounder fish survey of whole river section, before construction, and possibly catch some to move to other areas).
- Technical study of nearby alternative locations for placing *Labeo fisheri* (but, do not move all to new locations, in case this stresses the Mahaweli Ganga population).
- Undertake a "pool connection" analysis from dam site to tailrace; establish connections between pools that will maintain water exchange during lean season minimum environmental flow (allow fish to move between dam and tailrace at all times).
- Fish pass not warranted (*Labeo* not encountered upstream at the moment, and their possible use of a fish pass unknown).

The Moragolla and Kotmale tailraces will ensure high discharge rates and suitable habitat in Mahaweli into the river section that currently supports most of the *Labeo fisheri* population (downstream of project site)

Mitigation

[illegible]

- No unique, critical, or endangered vegetation will be impacted; mostly scrub and secondary forest that will be cleared; nevertheless, accurate tree counts and then replacement in the reservoir buffer (more than 2:1, in 100-meter strip) and other selected areas (focus on habitat enhancement for 5 selected wildlife species: 3 mammals; 2 butterflies).
- These species are not under threat at the project site (they occur elsewhere in Sri Lanka); but they can be helped, as they have national conservation status.
- Will maintain a "find-and-move" program for "moveable" species before and during land clearing.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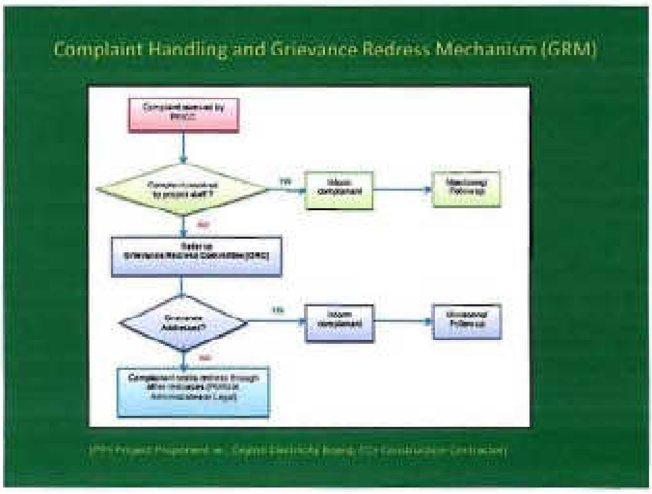
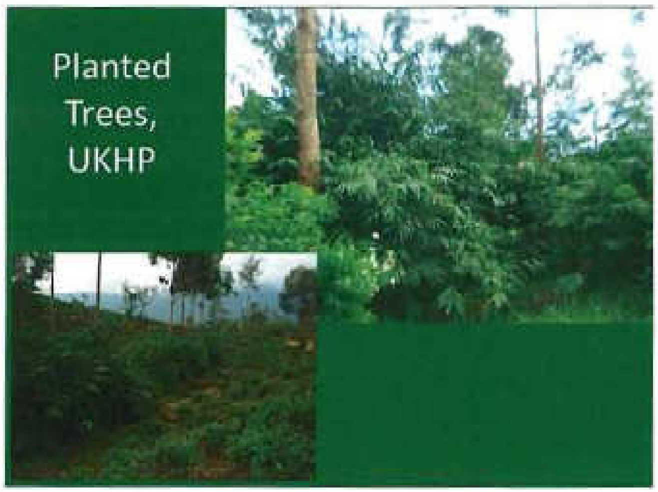
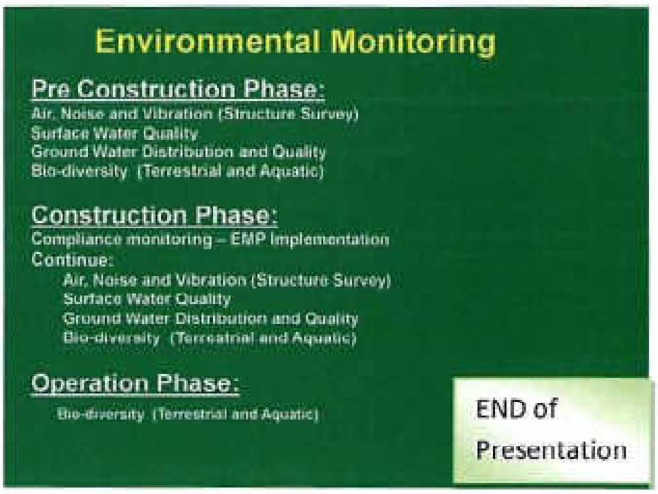
Plant
Nursery,
UKHP


Complaint Handling and Grievance Redress Mechanism (GRM)


Planted
Trees,
UKHP


Environmental Monitoring
Pre Construction Phase:
Air, Noise and Vibration (Structure Survey)
Surface Water Quality
Ground Water Distribution and Quality
Bio-diversity (Terrestrial and Aquatic)
Construction Phase:
Compliance monitoring – EMP Implementation
Continue:
Air, Noise and Vibration (Structure Survey)
Surface Water Quality
Ground Water Distribution and Quality
Bio-diversity (Terrestrial and Aquatic)
Operation Phase:
Bio-diversity (Terrestrial and Aquatic)
END of
Presentation

Annex 3(e): Participants of the Stakeholder Consultation Meeting held on November 18, 2013