Local Environmental Impact Assessment

February 2014

Sri Lanka: Green Power Development and Energy Efficiency Improvement Investment Program

Prepared by Ceylon Electricity Board, Ministry of Power and Energy, Democratic Socialist Republic of Sri Lanka for the Asian Development Bank.

DEMOCRATIC SOCIALIST REPUBLIC OF SRI LANKA

MINISTRY OF POWER & ENERGY

CEYLON ELECTRICITY BOARD

MORAGOLLA HYDROPOWER PROJECT

FEASIBILITY STUDY

FINAL REPORT

VOLUME 3 ENVIRONMENTAL IMPACT ASSESSMENT STUDY

NOVEMBER 2012

Lead Consultant
CENTRAL ENGINEERING CONSULTANCY BUREAU
415, BAUDDHALOKA MAWATHA
COLOMBO 07
SRI LANKA

Associate Consultant
AL-HABSHI CONSULTANTS OFFICE
PO BOX -27154
SAFAT -13132
KUWAIT

FINAL REPORT

LIST OF VOLUMES

Volume	Title
VOLUME 1	*EXECUTIVE SUMMARY*
VOLUME 2	*MAIN REPORT*
VOLUME 3	*ENVIRONMENTAL IMPACT ASSESSMENT STUDY*
VOLUME 4	*GEOLOGY*
VOLUME 5	*DRAWINGS*
VOLUME 6	*ANNEXES*

EXECUTIVE SUMMARY

Background to the Project

Estimated total hydropower potential in the country is about 2000 MW and already 1357 MW has been exploited. As at year 2008 statistics, the total installed capacity of the power plants (hydro, thermal and non-conventional renewable) was 2645 MW with gross energy generation of 9901 GWh. Out of this total installed capacity, 1357 MW has been from hydropower plants accounting to 41.8% of the gross generation while the balance 1288 MW was from other power plants accounting to 58.2% of the gross generation (CEB Statistical Digest 2008).

With the increase in demand for energy to provide for the country's economic and social development, the annual growth rate for electricity demand is expected to be about 6 – 8% (LTGEP 2009-2022).

Sri Lanka has been heavily depending on hydroelectricity during the past due to its relatively high rainfall availability in the central highlands where most of the Hydropower Projects are located. With the high costs involved and the social and / or environmental impacts associated with large scale hydropower developments, it is increasingly becoming difficult to further exploit hydro resources. And hence, future power generation is predominantly fossil fuel based and Sri Lankan power system which is predominantly hydro based will have to transform into a thermal based system while preparing hydropower systems for peaking duty (CEB's LTGEP 2009-2022)

Justification of the Project

Biomass and hydro are the only indigenous renewable sources of energy available in Sri Lanka and hydro is the main source of primary commercial electrical energy. All fossil fuel based electricity generation will have to continuously depend on imported primary energy resources for electricity generation. However, the world's oil prices are escalating rapidly and hence, developing of remaining hydropower potential even if they are of medium size is fast gaining attraction from CEB point of view.

Moragolla project is one such project that has been identified by CEB as a candidate hydropower project in their Long Term Generation Expansion Planning Studies. It is also one of the projects that have been identified for development under the Mahinda Chintana 10-year development plan of the Government of Sri Lanka.

This report produces the findings of the Environmental Impact Assessment (EIA) study for the Proposed Moragolla hydropower project carried out during the period February to April 2009 in accordance with the specific requirements of the Sri Lankan EIA process.

Environmental Impact Assessment (EIA) Process

The EIA study Identifies, predicts and evaluates the likelihood environmental impacts of the project on the Physical, Biological and Social Environment, Proposes measures to mitigate negative impacts and prepares a suitable environmental monitoring programme to monitor changes to the environment and to ensure due implementation of mitigatory measures. Therefore EIA study ensures that the development project is implemented while giving due consideration for environmental sustenance from the inception itself i.e. from planning and

designing of the project. The Environmental aspect addresses the common resources to be shared and possibly, protected in the area and therefore the EIA study looks beyond the immediate project interests.

EIA has to be carried out for all prescribed projects as listed in the National Environmental Act No. 47 of 1980 as amended by Act No. 56 of 1988 (NEA). NEA is the Sri Lanka's basic national charter for protection and management of the environment. The Central Environmental Authority (CEA) is the agency charged with the responsibility of implementing the provisions of the NEA.

The EIA process is implemented through designated Project Approving Agency (PAA) which is the Mahaweli Authority of Sri Lanka (MASL) for the proposed Moragolla hydropower project. Accordingly MASL has issued the Terms of Reference (ToR) for the EIA study.

The Ceylon Electricity Board (CEB) being the client has awarded the Feasibility Study including the EIA study to the Consultant, Central Engineering Consultany Bureau (CECB).

Introduction

The Proposed Moragolla hydropower project is located in the Kandy district in the Central Province of Sri Lanka closer to the Ulapane town. The project consists of a reservoir formed by constructing a dam across the Mahaweli Ganga to divert water via a conveyance system to a powerhouse located downstream on the left bank of the Mahaweli Ganga closer to Ethgala town.

In compliance with the ToR issued by the MASL, the EIA consultants have prepared the EIA report for the proposed Moragolla Hydropower Project covering all relevant issues identified therein by adopting the following procedures.

- Meetings with the project proponent (i.e. the Ceylon Electricity Board)
- Field visits to cover the project area, including reconnaissance visits to the various intervention locations for understanding the possible impacts in general
- Literature survey of the available printed material on the project area.
- Collection of data from government offices in and around the project area and Colombo.
- Collection of secondary information from relevant government agencies, i.e. Divisional Secretariats, Pradeshiya Sabhas and Grama Niladhari offices, and interviews with officers of these agencies
- Conducting discussions with communities living around the locations of project interventions.

The implementation of the Moragolla Hydropower Project shall be in conformity with the following policies and parliamentary enactments.

- National Environment Act. No. 47 of 1980 as amended by Act No. 56 of 1988
- Sri Lanka Electricity Act, No. 20 of 2009
- Mines and Minerals Act No. 33 of 1992
- Mahaweli Authority of Sri Lanka Act No. 23 of 1979
- Soil Conservation Act No. 25 of 1951 and No. 29 of 1953 and amended by Act No. 24 of 1996

- Irrigation Ordinance No. 32 of 1946, Act No.1 of 1951 and No. 48 of 1968, Law No. 37 of 1973
- Fauna and Flora Protection Ordinance as amended by Act No. 49 of 1993 and subsequent amends.
- The Antiquities Ordinance, No.9 of 1940 (now Act) and the subsequent amendments, particularly the Antiquities (Amendment) Act No. 24 of 1998 is the primary Act.
- Land Acquisition Act
- National Involuntary Resettlement Policy (NIRP)

In addition, approvals from the following agencies are required for the due implementation of the project.

- Mahaweli Authority of Sri Lanka (MASL) as the Project Proponent and the owner of the lands where locations of the project interventions will be
- Relevant Divisional Secretaries
- Relevant Pradeshiya Sabhas
- Road Development Authority (RDA)
- National Water Supply and Drainage Board
- Dept. of Archaeology
- Geological Survey and Mines Bureau (GSMB)
- Dept. of Agriculture
- The Department of Wild Life Conservation
- Department of Irrigation (ID)
- Dept. of Agrarian Development

Comparison of Alternatives

During the Engineering and EIA studies 03 alternatives have been considered. In selecting the best alternative, technical, economic, environmental and social aspects have been considered.

No Action alternative

The main purpose of the proposed project is to generate electricity to meet the electricity demand. If "No Action" alternative is opted, the proposed power project will not be implemented and hence will also not yield any of the positive impacts associated with the project implementation. Further, there will be no environmental impacts associated with any of the above three alternatives mentioned and the environment will remain intact as it is now.

However, if the project is not implemented, the country will have to forego 81.65 GWh of mean annual electric energy. Electric energy foregone in the absence of the proposed hydropower project will have to be generated from an alternative source namely a Thermal power plant with 13 MW diesel plant and 14 MW gas turbine to meet the electricity demand.

This means relying on fossil fuel imports resulting in the drainage of large sums of foreign exchange to the tune of US$ 11 million (Feasibility Study Report - Volume 5 : Appendix K) annually resulting in a loss to the national economy. Moreover, the operation cost of this power plant is vulnerable to fuel price fluctuations whereas the operation cost of the Moragolla Hydropower Project will be independent of such changes.

In addition, gaseous emissions from power plants using fossil fuels are a major contributor to climate change and resulting impacts. Limiting the extent of such change and its impacts will depend, among other things, on the continuing and increased use of renewable energy sources including hydropower.

This means, the implemention of the Moragolla hydropower project has a leverage over the "No Action" alternative which does not prove advantageous from environmental, social and economic point of view. Therefore, comparison of alternatives has been limited only to the above mentioned 3 alternatives.

Throughout the project, from the outset of initial planning, site selection and preliminary design, the approach to the EIA and engineering studies has been 'Mitigation by Planning and Design' whereby potential environmental impacts have been identified and measures introduced to reduce the adverse impacts as far as is practicable. This has reduced the overall potential for adverse impacts to occur as well as the need to apply mitigation measures.

Incorporating the findings of the EIA in the project designs ensures that the final design of the power project conforms to the principles of sustainable development (i.e. one which balances the effects of economic, environmental and social issues)

Preferred alternative

In this approach of "Mitigation by Planning and Design", site selection and selection of the project layout have been carried out to minimize the impact on environment. From the assessments carried out during feasibility studies, a location in proximity to that identified during Pre-feasibility study as given in Alternative 2 but with the reservoir FSL at 548m asl has been selected as the preferred alternative.

In the selection of this best alternative, possible loss of agricultural lands, inundation of populated areas and infrastructure, possible health hazards and environmental management aspects have been given consideration in addition to the costs of dam and waterways.

This approach of 'Mitigation by Planning and Design' can be further extended in the detailed designs of the project to minimize environmental impacts and the need to carry out mitigation measures and thus reducing the resulting costs involved.

The preferred alternative has been hereinafter referred to as the proposed project.

The proposed project

The proposedproject consists of a 35m high concrete gravity dam constructed across the Mahaweli Ganga and is located between the two confluences of Kothmale Oya / Mahaweli Ganga and Atabage Oya / Mahaweli Ganga,. Kothmale Oya and Atabage Oya are two major tributaries in the upper Mahaweli Ganga basin. The dam is provided with a spillway having 05 gates to discharge a 10000 year flood of 6000m^3/s.

The reservoir FSL is fixed at 548m asl and has an effective storage of 1.87 MCM and the surface area at FSL is 36.5ha. The waterways carrying 45 m^3/s consist of an underground tunnel and surface penstock located on the left bank of the Mahaweli Ganga in the project area which conveys water via a surge shaft and penstock to the surface Powerhouse located

near the confluence with Atabage Oya. The Moragolla Project has an installed capacity of 26.5MW with an average annual electricity generation of 81.65 GWh.

The salient features of the project are given at the end of the Executive Summary.

The reservoir with a surface area of 36.5 ha at the FSL will inundate a 400m stretch of road, Mawatura to Atabage (Galatha) at the right bank which passes over a low lying area immediately upstream of the proposed dam. A new road of nearly 1 km will be constructed in place of the inundated segment of the road.

Other infrastructure related to project will involve setting up of camps/housing both permanent and temporary for the use by workforce during construction as well as operation stage.

The project locations will be provided with construction power supply lines and water supply lines. Apart from the above, the construction camp needs to have a couple of other infrastructural facilities towards the well being of its inmates and the local inhabitants. Among these, health centre, reading room, garden/park, children's playground, nursery school/ creche, etc. are important. The medical centre should have adequate facilities for diagnosis and treatment of diseases (particularly waterborne and communicable diseases), fractures and burns (resulting from accidents) and to undertake vaccination programme

A check post, a police out post, extension counters of the local post office and Bank and a super market are the other requirements in the camp area. Further, fire extinguishers have to be established at different points within the project area towards preventing accidents from fire.

Study Area

The study area for the environmental impact assessment has been confined to the areas defined in the ToR and is as follows.

1. Project site [Area directly affected by the project itself and areas indirectly affected (maintenance area etc.)

2. Location affected by construction activities (quarries, refuse disposal area, traffic diversions, work camps, temporary access road, etc.)

3. Area beyond the project site where there is potential for environmental impacts.

4. Assessment of the present ecological status including biodiversity of the project area confined to the following areas.

- Fauna and flora in the river from 50m upstream of Dam to 50m downstream from the tailrace outlet.
- Fauna and flora in the inundation area up to the high flood level and in the 60m reservation area from high flood level
- Fauna and flora along the river reservation at a distance of 60m from the bank along transects at reasonable intervals, location of line transect determined according to habitat variation and 100 meter gradient contours.
- Fauna and flora in the spray zones

- Fauna and flora of the tunnel location, 25m on either side of the tunnel line at reasonable intervals. Positions of the line transects determined according to habitat variation and 100 meter gradient contours.
- Fauna and flora at the powerhouse, switch yard and other construction sites

Keeping in line with the above requirements of the ToR, the extent of the study area for the socio-economic surveys was taken to cover approximately a radial distance of 1Km from each of the geographic locations for proposed development interventions and covers even the areas beyond this for data collection where there are potential environmental impacts such as impacts on human settlements. A belt of 300m as the corridor of the proposed tunnel and a 50m wide belt as the corridor of the power transmission line were included as the study area.

Significant Impacts

Any project will have both positive and negative environmental impacts and these impacts can be expected during the project construction and also during the operation of the project. In evaluating the environmental impacts, the physical, ecological and social environments have been considered.

The EIA study has looked into the environmental impacts both positive and negative during both the construction and operation phases. Impacts have been identified as long term / short term impacts and where possible, effects have been quantified. Predictions that have been made are qualitative and are based on professional judgment supported by field investigations, meetings and discussions held with the stakeholders of the project and / or analysis by computer models.

Reservoir area of the proposed project being confined mostly within the steep river banks has proven to be one of the major advantages of the project thus limiting the resettlement effects and also the need for cutting of large number of trees. Non-existence of environmentally sensitive areas such as forest reserves or wildlife reserves in the project area are also some of the other factors which are of advantage to the project.

Based on field observations and information that has been gathered during landslide investigations carried out in the project area it has revealed that there are no landslides or earth slips been reported in the project area and no old landslides or potential landslides observed in the area except for several gully erosions and bank failures. Therefore the project becoming feasible without provoking landslides is also a positive factor for citing of the project components.

Table ES 1 gives the significant impacts.

With respect to Archeology, major observations revealed that there are no above ground monuments of archeological importance within the area where the project is going to be developed.

It is to be noted that with regard to the problem of the existing fecal pollution levels in the river water downstream, detailed studies including water quality covering different seasons is recommended to be undertaken by CEB in order to study this effect comprehensively immediately prior to construction work commence.

Table ES 1 Significant Impacts (not listed in any order of priority)

Type of Impact	Description of Impact
Negative Impacts	
1.	Enhanced water pollution in the river downstream due to drying of river.
2.	Soil erosion during heavy rains during construction and from spoil dumping sites
3.	Adverse effects on slope stability in the reservoir area due to water level fluctuations
4.	Inundation of 400m stretch of existing Mawathura – Galatha road
5.	Construction hazards including injury to workers and potential damages to nearby properties due to ground induced vibrations and shocks arising from blasting activities during construction
6.	Temporary lowering of ground water levels due to tunnel excavations causing disturbances to the drinking water wells and making it difficult for farmers to cultivate the paddy lands which depend on waters from natural streams
7.	Disturbance to the livelihood of about 210 farmer families depending on irrigation water from Dunhinda irrigation feeder canal
8.	Loosing employment of workers of Crysbro Poultry Processing Industry and the livelihood of people dependent on them, livelihood of poultry suppliers and maize out growers will be adversely affected.
9.	Loosing bathing and washing locations and sand mining locations for the people
10.	Evacuation of 26 families and acquisition of lands of people living in the project area for construction works.
11.	Increased traffic flow causing inconvenience to road users, wear and tear (damage) to road surfaces due to heavy vehicles visiting the site with plant, machinery and equipment and due to frequent movement of vehicles transporting materials. .
12.	Disturbance to humans and fauna from noise and vibrations
13.	Removal of 489 trees of DBH over 20 cm.
14.	Low flows of river downstream of river affecting aquatic species
Positive Impacts	
1.	Reduced gaseous emissions from the power plant and hence reduced impacts on climatic change and generation of clean energy, savings on foreign exchange otherwise have been used on importation of fossil fuels.
2.	Employment opportunities to people in the area
3.	Improved access facilities in the area
4.	Existence of a reliable supply of water for farming community in the Gampolawela irrigation scheme (conditional)
5.	Reliable and adequate supply of water for the activities of the Crysbro Poultry Processing industry (conditional)

With regard to the stability of slopes of the river banks due to reservoir water level fluctuations in the Ulapane Industrial Estate area, it is proposed that studies may be undertaken during detail design stage to assess the stability of the reservoir banks. Nevertheless measures to stabilize the embankments has been proposed.

Mitigatory measures

Table ES 2 gives the proposed mitigatory measures for the significant impacts.

Most of the impacts can be mitigated by following environmental best practices during design, construction and operation of the hydropower plant. Recommendations made by NBRO and NRMC which have also been incorporated into this report will be followed during carrying out mitigation measures. Mitigation of these impacts will have to be achieved through rigorous monitoring programmes that will be implemented before the project commencement, during and after the project construction.

It is also noteworthy of mentioning that although the project does not have any additional impact on ponding of Ulapane Oya which even at present, occasionally experiences certain ponding in some areas upstream of the bridge over Ulapane Oya on the road from Gampola to Nawalapitiya during floods of higher return period. It is seen that this flood plain is being gradually encroached and some buildings are coming up. In future, once the project is in place, such flooding can be conceived to be due to the project by the communities who will not remember it as an old feature. It is therefore proposed to mark the area of Ulapane Oya below contour of 550m asl as an area not permitted for construction. Nevertheless a 100m wide strip around the perimeter of the reservoir will be declared as a reservation area that will be managed by CEB and will maintain the reservation area as a green belt (wherever feasible) and appropriate action will be taken to prevent earth slip during , erosion etc. Any future constructions within this reservation will require CEB approval. With the assistance of the Attorney Generals Department, CEB will work out a suitable mechanism to exercise restrictions within the reservoir reservation area. This mechanism will be tied up to the current practice followed for obtaining required approvals from the local authority and / or any other authority.

Keeping in line with the requirements of the ToR, outlining of the Disaster Management Plan and the Emergency Action Plan in the event of a flood has been proposed.

Environmental Monitoring Programme

A Comprehensive Monitoring Plan including Compliance Monitoring and Impact Confirmation have been presented in this EIA report. The EIA study has given emphasis on the establishment of a reliable and sustainable institutional mechanism to monitor the impacts which is of primary importance for sustainable development.

Conclusions and Recommendation

On the assumption that the recommended mitigatory measures are duly implemented and monitored in accordance with the guidelines given in the EIA study, it is concluded that there are no major environmental impacts which are beyond control with the proposed construction and operation of the Moragolla Hydropower Project.

The Moragolla hydropower project is therefore capable of meeting the demand for electricity with least environmental impacts which are manageable. Therefore it is recommended that this project be implemented.

Table ES 2 Mitigatory measures for significant negative Impacts and enhancement measures for positive impacts (not listed in any order of priority)

Type of Impact	Description of Impact	Mitigatory Measures / Positive Impact Enhancement Measures
Negative Impacts		**Mitigatory Measures**
1.	Enhanced water pollution (with existing high fecal pollution levels) in the river downstream due to drying of river and due to presence of labour camps	Outlet from the Crysbro Processing Industry taken to a location downstream of the powerhouse, release of 1.5 m^3/s as environmental flow downstream, proper sanitary and sewerage facilities to be provided.
2.	Soil erosion during heavy rains during construction and from spoil dumping sites	Implementation of Soil Conservation Plan and construction of dykes at dumping sites with suitable provisions for drainage.
3.	Adverse effects on slope stability of the reservoir banks due to water level fluctuations	Provide suitable measures to prevent failure of soil slopes such as upslope drainage and suitable retaining structures and provide toe protections on steep slopes at vulnerable places along reservoir banks.
4.	Inundation of existing 400 m stretch of Mawathura – Galatha road	Provision of new diversion road.
5.	Construction hazards including injury to workers and damages to property, potential damages to nearby properties due to ground induced vibrations and shocks arising from blasting activities during construction	Tunneling operation needs to be carried out very carefully and tunnel excavation by blasting will be carried out in accordance with the blasting methodology investigation reports, provide proper supporting and dewatering systems, occupational health and safety plan to be followed, adopt proper material handling techniques and provide Emergency Centres.
6.	Temporary lowering of ground water levels due to tunnel excavations causing disturbances to the drinking water wells and making it difficult for farmers to cultivate the paddy lands which depend on waters from natural streams.	Affected people will be provided with drinking water from bowzers during the construction period where their drinking water wells are affected. The farmers who face difficulty of cultivation of paddy lands are to be paid compensation for the seasons affected during the period of tunnel construction.
7.	Disturbance to the livelihood of about 210 farmer families depending on irrigation water from Dunhinda irrigation feeder canal	From the environmental flow of 1.5 m^3/s released downstream, 0.29 m^3/s will be released continuously to satisfy the two major river users, namely the farming community in the Gampolawela scheme and the Crysbro Poultry Industry.
8.	Loosing employment of workers of Crysbro Poultry Processing Industry and the livelihood of people dependent on them, livelihood of poultry suppliers and maize out growers will be adversely affected.	

Type of Impact	Description of Impact	Mitigatory Measures / Positive Impact Enhancement Measures
9.	Loosing bathing and washing locations of the people and livelihood of sand miners.	Provide a pool with steps near the new Ulapane bridge as an alternative place for bathing and washing. For sand miners affected, provide either compensation for the period affected or provide employment during project construction and operation.
10.	Evacuation of 26 families and acquisition of lands of people living in the project area for construction of the project.	Resettlement of families and provide compensation to people affected in accordance with the National Involuntary Resettlement Policy (NIRP). Affected families to decide the type of compensation they prefer (alternative land and houses or compensation in cash). Priority to be given to the affected families whose livelihood has been affected to provide employment during the Project implementation. A comprehensive Resettlement Plan to be developed during the detailed designs stage of the proposed project.
11.	Increased traffic flow causing inconvenience to road users, wear and tear (damage) to road surfaces due to heavy vehicles visiting the site with plant, machinery and equipment and due to frequent movement of vehicles transporting materials.	Proper traffic management practices, frequent wetting /wet spraying of dusty surfaces, immediately attend to the repair of damaged roads.
12.	Disturbance to humans and fauna from noise and vibrations	Construction works to be carried out in adhering to the environmental standards specified for noise and vibration, restrict construction works during night time
13.	Removal of 489 trees of DBH over 20 cm.	Re-plantation of a 100 m buffer zone as a green belt around the high flood level of the proposed reservoir
14.	Low flows of 400m river stretch downstream of dam affecting aquatic species	Environmental flow of 1.5 m^3/sec will be released downstream from reservoir.
Positive Impacts		**Impact Enhancement Measures**
1.	Reduced gaseous emissions from the power plant and hence reduced impacts on climatic change and generation of clean energy, savings on foreign exchange otherwise have been used on importation of fossil fuels.	CEB to investigate the possibility of obtaining carbon credit benefits.
2.	Employment opportunities to people in the area	Local people in the area to be given preference in employment during the construction and operation of the project.
3.	Improved access facilities in the area	Improving the existing roads and construction of new roads under the project.
4.	Existence of a reliable supply of water for farming community in the Gampolawela irrigation scheme (conditional)	Ensure minimum flow release downstream from the dam, improve the existing irrigation diversion facilities.
5.	Reliable and adequate supply of water for the activities of the Crysbro Poultry Processing industry (conditional)	Ensure minimum flow release from the reservoir to the downstream of the dam.

Salient Features of the Project

Hydrology

River Basin	:	Mahaweli
Catchment Area (Total)	:	809 km^2
Catchment Area(Effective)	:	247 km^2
Mean Annual basin rainfall	:	4000 mm (Effective Catchment)
Mean Annual inflow	:	21.95m^3/s, 690MCM, 2796mm
Net Reservoir Evaporation	:	1095mm
Sediment Yield	:	less than 250m^3/km^2/yr
Probable Floods at Dam site		
10,000 year	:	6000m^3/s (For Design of Spillway)
25 year	:	1058m^3/s (For Design of Temporary works)

Reservoir

Full Supply Level	:	548.00 m asl
Minimum Operating Level	:	542.00 m asl
Total capacity at FSL	:	4.23 MCM
Surface Area at FSL	:	36.50 ha
Mean Annual Energy Generation	:	81.65 GWh
Firm Energy Generation	:	66.12 GWh
Secondary Energy Generation	:	15.53 GWh

Dam & Intake

Type of Dam	:	Concrete Gravity
Height	:	35 m
Crest Length	:	214.50 m
Design Flood Q 10,000	:	6000 m3/s
Design Flood Level	:	548.25 m asl
Elevation at spill crest	:	534.00 m asl
No of Spillway bays	:	05
Type of Gates	:	Tainter (one with top flap gate)
Gate Dimensions	:	15m X 15m
Energy Dissipater	:	Stilling basin
Number of Trashracks	:	03
Size of Intake gate	:	4mX 6m
Bottom Outlet	:	01 No. (with 02 gates ; 01 no. revision gate and 01 no. service gate)
Capacity	:	260m^3/s

Size	:	4m X 4m
Facilitation of Environmental release	:	1.5 m^3/s through a separate pipe (at elevation 534m asl)

Waterways

Design Discharge	:	$45m^3/s$

Headrace tunnel

Length	:	2980 m
Length concrete lined	:	2835m
Length steel lined	:	145m
Internal Diameter	:	4.5m
Type	:	Concrete Lined
Slope	:	0.5 %
Sill elevation at inlet	:	530 m asl
Shape	:	Excavated- Horseshoe Lined -Circular

Surge shaft

Type	:	Restricted Orifice type
Shape	:	Circular
Height	:	73m
Diameter upper tank	:	13.50 m
Up surge water level	:	566.92m asl
Down surge level	:	526.67m asl

Penstock Tunnel

Length	:	145 m
Diameter	:	3.3 m

Surface Penstock

Length	:	185 m
Diameter	:	varies 2.7m to 1.5m
No. of lines	:	01

Powerhouse & Tailrace

Power house type	:	Surface
Length, L = 29.0 m,		width, W = 18.0 m
Tailrace channel	:	Open channel, 25 m long
Shape	:	Rectangular channel with a bed width of 14.8 m
Crest level at the outfall	:	471.6 m asl
Normal Tail water level	:	473.00 m asl
Maximum TWL	:	486.50 m asl

Power Generating Equipment

(1) Turbines

Type	:	Vertical Axis Francis
Speed	:	500 rpm
Rated output	:	13.25MW x 2 Units
Rated Head	:	69.38m

(2) Generators

Speed	:	500 rpm
Rated Voltage	:	11 kV
Rated Output	:	17.20 MVA x 2 units
Power factor	:	0.85
Rated Frequency	:	50 Hz

(3) Transformers

Type	:	Three phase oil immersed type
Rated Voltage	:	132 kV/11 kV
Rated Output	:	17.20 MVA x 2 units

(4) Switchyard : Outdoor, 132 kV

Transmission lines

(1) 132kV line to Kothmale Switchyard

Type	:	Overhead, double circuit with single mode OPGW
Length	:	500 m (connect transmission line from Moragolla switchyard to Tower No. 3, Circuit No. 1 of existing 132kV Polpitiya–Kiribathkumbura transmission line)

TABLE OF CONTENTS

		Page No.
Executive Summary		i - xiii
Table of Contents		xiv- xix
List of Annexures / List of Tables		xx - xxiii
List of Figures		xxiv- xxv
List of Appendices		xxvi
Abbreviations		xxvii - xxviii
CHAPTER - 1	**INTRODUCTION**	**1 – 22**
1.1	Background of the project	2
1.2	Objective and Justification of the Project	3
1.3	Objectives of the EIA Report	6
1.3.1	General Objectives of the EIA Process	6
1.3.2	Environmental Impact Assessment (EIA) Process	6
1.3.3	Specific Objectives of the EIA Report	7
1.4	Extent and the Scope of the Study	7
1.5	Methodologies adopted in EIA report preparation	8
1.6	Applicable Laws, Regulations and Approval Requirements affecting the Proposed Development	11
1.7	The Approval needed for the proposed development from state agencies	11
1.8	Any conditions laid down by state agencies in granting preliminary clearances for the project	15
1.9	Conformity with other development plans in the area	21
CHAPTER - 2	**DESCRIPTION OF THE PROPOSED PROJECT & REASONABLE ALTERNATIVES**	**23 - 48**
2.1	Evaluation of Alternatives	23
2.1.1	Alternative 1,2 &3 and comparison of alternatives	23
2.1.2	No action Alternative	25
2.1.3	Mitigation through Planning and Design	25
2.1.4	Conclusion on the preferred Option	28
2.2	Description of the project	29
2.2.1	Details with regard to Project Development	29
2.2.2	Project Layout	31
2.2.3	Major features / components of the project	31
2.2.4	Methodology of Construction	40
2.2.5	Site preparation activities	41

2.2.6 Details of any phased development activities and time schedule 41
2.2.7 Any infrastructure facilities required / provided by the project (Access road etc.) 41
2.2.8 Workforce 42
2.2.9 Investment and funding sources, total cost of the project, the time schedule of the construction period and details of phased development if any 42
2.2.10 In case of civil structures, dimensions , drawings etc. 43
2.2.11 Arrangement for discharge of forecasted probable maximum flood 43
2.2.12 Details required to check the adequacy of the proposed dam and associated structures considering probable failure conditions 43
2.2.13 Proposals for emergency action plan along with arrangements for early warning systems and details required to ensure the dam safety aspects. 44

CHAPTER - 3 DESCRIPTION OF THE EXISTING ENVIRONMENT 49 - 97

3.1 Physical Environment 50
3.1.1 Topography 50
3.1.2 Geology 52
3.1.3 Land Use within the Study Area 58
3.1.4 Hydrology and drainage 59
3.1.5 Ambient air quality in the Project area 65
3.1.6 Ambient noise levels in the project area 66
3.1.7 Ambient vibration levels in the project area 66
3.2 Biological Environment 66
3.2.1 Existing vegetation / habitat types 66
3.2.2 Description of vegetation characteristics in the areas identified for major project activities 68
3.2.3 The Fauna and Flora of the Area 75
3.2.4 Identification of Rare, Threatened and Endemic Species 79
3.2.5 Faunal Migration Patterns 81
3.2.6 Existing Environmental considerations / problems / issues in the area 81
3.2.7 Number of trees that will be felled due to the construction activities 82
3.3 Social Environment 82
3.3.1 Demographic and Socio Economic Status of the Communities 82
3.3.2 River Users 86
3.3.3 Income generation sources and patterns 89

3.3.4 Existing environmental considerations, problems or issues prevailing in the area 91
3.3.5 Cultural and Archeological aspects / considerations 91
3.3.6 Existing infrastructure facilities, transportation communications power supply etc. 92
3.3.7 Social / cultural and archaeological sensitive places 93
3.3.8 Brief descriptions of the Socio-economic environment in the 1 km radius of each location 94
3.4 Details of existing and planned projects in the area 95

CHAPTER - 4 ANTICIPATED ENVIRONMENTAL IMPACTS OF THE PROJECT 98 - 153

4.1 Soil Erosion and Siltation 98
4.1.1 Soil erosion and siltation hazards during constructions / establishment of dam penstock, power house and tunnel 98
4.1.2 River bank erosion during construction and operation of the project 100
4.1.3 Impact during construction of access road/ rehabilitation of access road to the dam, power house, switchyard, surge shaft, tunnel portals etc. 100
4.2 Water quality impact 100
4.2.1 Impact on water quality during construction of weir and power house 100
4.2.2 Waste generation and pollution from temporary workers camps 103
4.2.3 Impact on water quality of the proposed pond from existing and planned projects 104
4.3 Ecological Impacts 105
4.3.1 Impacts on terrestrial fauna and flora 105
4.3.2 Impacts on aquatic fauna and flora with special reference to migration of fish species and environment flow downstream of the Dam 107
4.4 Impacts on the discharge capacity of the river. 110
4.4.1 Backwater curves of the river reaches upstream of the proposed Moragolla dam 110
4.4.2 The flood surcharge owing to the Dam at the Dam site for the bank full discharge 113
4.4.3 The flood surcharge owing to the Dam at the Dam site for 50 and 100 year return period floods, with all the gates open. 114

4.4.4 Impacts on existing Polgolla and Kotmale water management area 114
4.4.5 Temporary diversion works, surveillance included in operation and management plan to face emergency situations and communication facilities in case of an emergency and possible health hazards due to ponding 114
4.4.6 Construction hazards that have been taken into account in project construction planning, especially those relating to silt runoff, health and safety of workers 117
4.4.7 Effect of project activities including tunneling on waterways and groundwater table, possible health hazards and effects on the vegetative cover 119
4.4.8 Effect of project activities on the normal water management operations of the Kotmale reservoir and the Polgolla diversion. 120
4.4.9 Dam design in respect of environmental flow downstream, facilitation of the drinking water requirement of Gampola and Peradeniya water supply intake and irrigation water requirement in case of severe drought 120
4.4.10 Impacts of the dumping of the tunnel muck (including the location of the dumping site of the tunnel muck) 121
4.5 Impacts on bedrock stability 124
4.5.1 Construction of dam 124
4.5.2 Penstock installation 124
4.5.3 Power house construction 124
4.5.4 Tunnel construction 124
4.5.5 Transmission Line trace 124
4.6 Sociological impacts 125
4.6.1 Impacts on existing water users 125
4.6.2 Impacts on land use pattern 130
4.6.3 Impact on commercial activities 133
4.6.4 Impacts due to material transportation 136
4.6.5 Noise, vibration and air pollution due to dust 137
4.6.6 Impacts on existing water extraction for drinking purposes by the National Water Supply & Drainage Board at downstream of the river 142
4.6.7 Impacts on irrigation and flood protection work. 142
4.6.8 Uncontrolled migration of people into the project area, and if so regulatory measures proposed and the basis. 143
4.6.9 Will the project activities create relocation of families? 143

4.7 Impacts of the existing and planned project activities in relation to the components of the project proposal 152

CHAPTER- 5 PROPOSED MITIGATORY MEASURES 154 - 216

5.1 General 154
5.2 Mitigation by Planning and Design and its Continuation in the Detailed Design 154
5.3 Mechanism for Implementation of the Mitigatory Measures 154
5.4 Mitigation measures to address Impacts on the Physical Environment 155
5.4.1 Soil conservation management plan including soil erosion / Siltation control and land stabilization measures 155
5.4.2 Mitigatory measures to avoid water quality deterioration 163
5.4.3 Mitigation measures to address air quality deterioration 166
5.4.4 Mitigation measures to address impacts due to noise and vibration 168
5.4.5 Mitigation of impacts on Bedrock stability 171
5.4.6 Debris/waste/tunnel muck/disposal facilities method and location 172
5.4.7 Restructuring of the surrounding environment including landscaping of the construction areas. 175
5.4.8 Public health measures to control vector and water born diseases 176
5.4.9 Disaster Management Plan 177
5.4.10 Re-establishment / restoration of infra structure 179
5.4.11 Mitigations measures for impacts on discharge capacity of the river 179
5.4.12 Mitigation measures to address possible Impacts due to breaching of coffer dam / dams and possible hazards that may arise due to disease outbreaks due to ponding 180
5.4.13 Facilitation of the environmental flow requirement down stream of the Dam 181
5.4.14 Mitigation measures to address construction hazards 183
5.4.15 Mitigation measures for stabilization of river banks close to Ulapane Industrial Estate 185
5.4.16 Mitigation measures for the impacts of the existing and planned project activities in relation to the components of the project proposal 187
5.5 Mitigation measures to address Impacts on the Biological Environment 188
5.5.1 Impacts on terrestrial fauna and flora 188

	5.5.2	Impacts on aquatic fauna and flora with special reference to Migration of fish species and environment flow downstream of dam	190
5.6		Mitigation measures to address Impacts on the Social Environment	192
	5.6.1	Impacts on existing water users upstream and downstream	192
	5.6.2	Impacts due to Access Roads	195
	5.6.3	Impacts due to various project interventions	196
	5.6.4	Mitigation of impacts on commercial activities	198
	5.6.5	Resettlement Plan	200
CHAPTER - 6		**ENVIRONMENTAL MONITORING PLAN**	**217 - 238**
6.1		General	217
6.2		Types of Monitoring	217
6.3		Institutional Framework for mitigation of impacts	217
6.4		Environmental Management Plan	218
6.5		Monitoring of the Impacts on the Physical Environment	219
	6.5.1	Monitoring soil erosion and siltation	220
	6.5.2	Environmental Monitoring Programme for Mitigation of Impacts on Water Quality, Air Quality, Noise and Vibration Levels, crack monitoring plan, solid waste disposal practices and waste water quality	220
6.6		Monitoring of the Biological Environment	232
6.7		Monitoring and Evaluation of the Social Impact Mitigation Process	232
	6.7.1	General	232
	6.7.2	Monitoring and Evaluation of the Resettlement Action Plan	232
	6.7.3	External Monitoring of Physical and Financial Progress of RP	233
	6.7.4	Tentative budget for monitoring of the social impacts mitigation process during project implementation phase.	236
6.8		Monitoring Costs	237
CHAPTER - 7		**CONCLUSIONS & RECOMMENDATIONS**	**239 - 242**

References
Annexures 1 – 8
Photographs
Figures
Appendices A - G

LIST OF ANNEXURES / TABLES

ANNEXURE NO.	TABLE NO.	DESCRIPTION	PAGE NO.
Annexure 1	**Table 1.3**	List of persons interviewed	1 - 1
	Table 1.4	GPS Locations of sampling points (Biological Environment - Transects)	1 - 2
	Group discussions with stakeholders		1 - 3
	Table 2.3	Present ownership of lands at the project site	1 - 6
	Table 3.22	Details of sand mining activities and sand mine Operators as at 01.10.2012	1 – 8
	Table 3.25	Existing Infrastructure Facilities	1 - 9
	Table 3.26	Socially, religiously and culturally sensitive locations.	1 - 10
Annexure 2	**Table 3.1**	General soil properties of representative Samples	2 -1
	Table 3.2	Un-drained and compaction properties of the representative soil samples	2 -1
	Table 3.3	Depths and thickness of the overburden soil deposits and bedrock conditions at proposed structures	2 - 2
	Table 3.4	Rock mass classification for interpretation of tunnel design	2 - 4
	Table 3.5(a)	Effective shear strength parameters for stability assessment.	2 - 4
	Table 3.5(b)	Factor of safety of critical slope sections	2 - 4
Annexure 3	**Table 3.6(a)**	Mean monthly discharges of the river (Talawakelle)	3 - 1
	Table 3.6(b)	Mean monthly discharges of the river (Nawalapitiya)	3 - 2
	Table 3.6(c)	Mean monthly discharges of the river (Morape)	3 - 3
	Table 3.9	Mean monthly flows at Moragolla dam site	3 - 4
Annexure 4	**Table 3.7**	Water quality measured at different locations in the Project Area	4 – 1
	Table 3.10	Ambient Air quality measured at different locations in the Project Area	4 – 1
	Table 3.11	Noise levels measured at different locations in the Project Area	4 - 2
	Table 3.12	Ambient vibration levels measured at different locations in the Project Area	4 - 2

ANNEXURE NO.	TABLE NO.	DESCRIPTION	PAGE NO.
Annexure 5	**Table 3.13**	Detailed list of flora observed in the immediate impact zone	5 - 1
	Table 3.15	Detailed list of fauna observed in the immediate impact zone	5 - 8
Annexure 6	**Table 3.27**	Details of industries at the Ulapane Industrial Estate	6 - 1
Annexure 7	**Table 4.3**	The trees likely to be removed or affected due to the project	7 - 1
	Table 4.4 (09 Tables)	Backwater computations for floods of different Return-Periods of 2, 5 and 10 years for Mahaweli Ganga, Ulapane Oya and Kothmala Oya	7 - 3
	Table 4.6 (03 tables)	Flood surcharge due to dam for bank-full discharge for Mahaweli Ganga, Ulapane Oya and Kothmala Oya	7 - 9
	Table 4.7 (06 Tables)	Flood surcharge due to dam for 50 year and 100year return periods for Mahaweli Ganga, Ulapane Oya and Kothmala Oya	7 - 11
	Table 4.10	Details of 06 nos. of access roads	7 - 15
	Table 4.11	Summary of impacts due to access roads	7 - 15
	Table 4.12	Impacts due to road from Ethgala to Powerhouse	7 - 16
	Table 4.13	Impacts due to road from Ethgala to Surge Shaft	7 - 16
	Table 4.14 (a)	Details of lands impacted due to road diversion (right bank)	7 - 17
	Table 4.14 (b)	Impact due to road diversion right bank	7 - 17
	Table 4.15 (a)	Details of residential lands impacted due to road diversion, residential camp/office and stores (including access road)	7 - 18
	Table 4.15 (b)	Details of residential lands impacted due to residential camp/office and stores (including access road)	7 - 18
	Table 4.19 (a)	Details of homesteads vulnerable due to proposed reservoir	7 - 19
	Table 4.19 (b)	Details of families in two line houses vulnerable due to reservoir	7 - 20
	Table 4.19 (c)	Details of non-residential land plots impacted due to Proposed Reservoir	7 - 20
	Table 4.20	Overall List of likelihood affected persons	7 - 21
Annexure 8	Google Images		8-1

Photographs

TABLES CONTAINED IN THE MAIN TEXT

TABLE NO.	DESCRIPTION	PAGE NO.
Table 1.1	Electricity Generation 1988- 2006	3
Table 1.2	Generation Expansion Plan 2007	4
Table 2.1	Comparison of Alternatives	26
Table 2.2	Locations of different projects interventions based on Administrative divisions	30
Table 2.4	Factor of Safety for Dam Design	44
Table 3.6 (d)	Values for flow-duration curve at dam site	61
Table 3.8	Flood peaks for different return periods	62
Table 3.14	Summary of plant species recorded at project site	75
Table 3.16	Summary of faunal species recorded at project Site	78
Table 3.17	Distribution of fauna and flora at the sites of project interventions	79
Table 3.18	Endemic and threatened and near threatened species of fauna recorded from project site	79
Table 3.19	Endemic and threatened species of flora recorded from project site.	81
Table 3.20(a) - 1	Population and Families in the Project related DS divisions	82
Table 3.20(a) - 2	Population and Families in the Project Area and in the vicinity	83
Table 3.20 (b) -1	Ethnic diversity in project related DS offices	84
Table 3.20 (b)- 2	Ethnic Diversity in the Project Area and in the vicinity	84
Table 3.20(c) - 1	Religious Diversity in project related DS areas	85
Table 3.20 (c)- 2	Religious Diversity in project area and in the vicinity	85
Table 3.21	Details of bathing and washing locations	87
Table 3.23(a) - 1	Income generation sources- Project related DS areas	89
Table 3.23 (a) - 2	Income generation sources – Project area and vicinity	89
Table 3.23 (b) - 1	Income levels of families – Project related DS areas	90
Table 3.23 (b) - 2	Income levels of families	90
Table 3.23 (b)- 3	Percentages of families belonging to different income Categories	91
Table 3.24	Sources of domestic water supply	92
Table 4.1	Slope class and slope areas within the immediate catchment (for soil conservation plan)	99
Table 4.2	Anticipated construction impacts on water quality	100

TABLE NO.	DESCRIPTION	PAGE NO.
Table 4.5	Summary of impacts due to floods	112
Table 4.8	Impacts on farming community of Gampolewela	125
Table 4.9	Impacts on Crysbro broiler processing industry / Farm's Pride poultry farm	127
Table 4.16	Details of families affected due to powerhouse /switchyard, surge shaft and penstock	135
Table 4.17	Exposure levels and time limit in UK (Noise levels)	139
Table 4.18	Potential no. of families affected by DS Division wise	144
Table 5.1	Land-use for immediate catchment (for soil conservation concerns)	156
Table 5.2	Soil Management Plan to address impacts due to various Project activities	158
Table 5.3	Necessary actions to control possible noise levels in certain areas of road traces	170
Table 5.4	Effect of power generation for various environmental flows	181
Table 5.5	Method of compensation for paddy lands affected	199
Table 5.6	Affected Properties needing mitigation during implementation of RAP	204
Table 5.7	Summary of major impacts and their magnitudes	205
Table 5.8	Process to be followed as per Sri Lanka Land Acquisition Act During RAP	209
Table 5. 9	Resettlement Budget and Monitory Compensation Costs	215
Table 6.1	Members of the proposed Monitoring Committee	219
Table 6.2	Proposed Environmental Monitoring Framework	222
Table 6.3	Social Impact Monitoring program	233
Table 6.4	Indicators for physical progress of Resettlement Plan (RP)	234
Table 6.5	Monitoring Indicators for financial progress of Resettlement Plan (RP)	235
Table 6.6	External Impact Indicators for evaluation of RP (beyond the project)	236
Table 6.7	Monitoring Costs	238

LIST OF FIGURES

Figure	**1.2**	Archaeological Survey – Survey grids and observed locations
Figure	**2.1**	Layout for Alternative 1
Figure	**2.2**	Layout for Alternative 2
Figure	**2.2(a)**	Investigations made for outlet portal location of tunnel
Figure	**2.3**	Layout for Alternative 3
Figure	**2.4**	Rock profile along line 1
Figure	**2.5**	Rock profile along line 2
Figure	**2.6**	Rock profile along line 3
Figure	**2.7**	Project area and accessibility to Project area
Figure	**2.8**	Project area with surrounding developments (1:10000)
Figure	**2.9**	Project Layout
Figure	**2.10**	River cross section at the proposed dam axis
Figure	**2.11**	Upstream profile along the dam axis
Figure	**2.12**	Plan view of the dam
Figure	**2.13**	Spillway / Dam cross sections
Figure	**2.14**	Quarry site locations
Figure	**2.15**	Locations for spoil disposal areas.
Figure	**2.16 (a)**	Road layout at dam site area
	2.16(b)	Road Layout at power house site area
	2.16(c)	Road Layout – Project area
Figure	**2.17**	Proposed camp area
Figure	**2.18**	Construction Programme
Figure	**2.19**	Waterways - plan & profile
Figure	**2.20**	Water ways intake – plan & sections
Figure	**2.21**	Water ways – surge shaft
Figure	**2.22**	Water ways – penstock tunnel
Figure	**2.23**	Layout of power house and switchyard
Figure	**2.24(a)**	Power house sectional elevation
Figure	**2.24(b)**	Power house sectional elevation (alternative design)
Figure	**2.25**	Proposed Transmission line from Moragolla Switchyard
Figure	**3.1(a)**	Drainage pattern in the project area.
Figure	**3.1(b)**	Catchment area for the project.
Figure	**3.2**	Land slide Hazard zonation map of the project area
Figure	**3.3(a)**	Soil sample testing locations

Figure 3.3(b)-1 Borehole testing locations
Figure 3.3(b)-2 Borehole testing locations
Figure 3.3(b)-3 Geological section along the dam axis
Figure 3.3(b)-4 Geological section along the tunnel axis
Figure 3.3(b)-5 Geological section along the tunnel axis
Figure 3.3(b)-6 Geological section along the tunnel axis
Figure 3.4 Land use map
Figure 3.5(a) Testing locations of water quality
Figure 3.5(b) Testing locations of air quality
Figure 3.5(c) Testing locations of noise levels
Figure 3.5(d) Testing locations of vibration levels
Figure 3.6 Variation of annual flow at dam site
Figure 3.7 Community map of the project area
Figure 3.8 Archaeological sites within 5 Km buffer zone

Figure 4.1 Land use map for the immediate catchment
Figure 4.2 Slope map for the immediate catchment
Figure 4.3 Inundation area for 100 year flood
Figure 4.4 Method of river diversion
Figure 4.5 Water intake locations of NWS & DB

FIGURES CONTAINED IN THE TEXT

		Page
Figure 1.1	Project Location	1
Figure 3.1 (c)	Flow duration curves for the dam site	63
Figure 3.1 (d)	Flow duration curves at dam site for wet and dry years	64

LIST OF APPENDICES

Appendix A (i) List of participants at the awareness programme organized by the Ceylon Electricity Board for the stakeholder Government Agencies
(ii) Comments and observations by stakeholder agencies

Appendix B Archaeological Impact Assessment Report (Archaeology Dept.)

Appendix C ***Test reports on***

Water Quality	-	NWS & DB
Air Quality, Noise Levels, Vibration levels	}	NBRO
Water Quality	-	University of Moratuwa
Water Quality	-	ITI

Appendix D Report on Hydrological Studies
Landslide Investigation Report -NBRO
Soil Conservation Plan – Dept. of Agriculture

Appendix E EIA Team Composition and Task of members
Terms of Reference for the EIA

Appendix F List of correspondences made lately with stakeholder (s) /organizations

Appendix G Details of sand miners (during initial study period of year 2009)

Appendix H Comments by Public and Other Organizations after public hearing

ABBREVIATIONS

AH	Affected households
AIA	Archaeological Impact Assessment
AP	Affected Parties
BER	Bureau of Earth Reconnaissance
BOD	Biological Oxygen Demand
BOI	Board of Investment
BS	British Standards
CEA	Central Environment Authority
CEB	Ceylon Electricity Board
CECB	Central Engineering Consultancy Bureau
CFC	Chloro Fluro Chlorides
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
COD	Chemical Oxygen Demand
dB(A)	Decibel
Dept.	Department
DO	Dissolved Oxygen
DS	Divisional Secretariat
DWLC	Department of Wild Life Conservation
EAP	Emergency Action Plan
EAPP	Emergency Action and Preparedness Plan
EIA	Environmental Impact Assessment
EMEC	External Monitoring and Evaluation Consultant
EMF	Environmental Management Framework
EMP	Environmental Management Plan
FFPO	Fauna and Flora Protection Ordinance
FHWA	Federal Highway Association of USA
GBH	Girth at Breast High
GN	Grama Niladari
GOSL	Government of Sri Lanka
GSMB	Geological Survey and Mines Bureau
GTZ	German Technical Corporation
GWh	Giga Watt hours
HCs	Hydro Carbons
ID	Department of Irrigation
ITI	Information Technology Institute
IUCN	International Union for Conservation of Nature and Natural Resources
KFAED	Kuwait Fund for Arab Economic Development

km	Kilometer
kV	Kilo Volt
kWh	Kilo Watt hours
LB	Left Bank
LTGEP	Long Term Generation Expansion Planning
m^3	Cubic Meters
MASL	Mahaweli Authority of Sri Lanka
MCM	Million Cubic Meters
MMA	Mines and Minerals Act
MSL	Mean Sea Level
MSW	Municipal Solid Waste
MW	Mega Watts
NBRO	National Building Research Organization
NEA	National Environmental Act
NGO	Non-Government Organization
NIRP	National Involuntary Resettlement Policy
NO_2	Nitrous Oxide
NRMC	Natural Resource Management Centre
NW	North West
NWS & DB	National Water Supply and Drainage Board
OCP	Organochlorine Pesticides
PAA	Project Approving Agency
PP	Project Proponent
Ppm	Parts per million
RAP	Resettlement Action Plan
R&D	Research and Development
RCC	Reinforced Cement Concrete
RDA	Road Development Authority
RP	Resettlement Plan
SAARC	South Asian Association for Regional Cooperation
SIA	Social Impact Assessment
SO_2	Sulphur Dioxide
SW	South West
TCLP	Toxicity characteristics leaching protocol
ToR	Terms of Reference
TSS	Total Suspended Solids
UDA	Urban Development Authority
UK	United Kingdom
UN	United Nations
USEPA	United States Environment Protection Agency
WHO	World Health Organization

CHAPTER 1

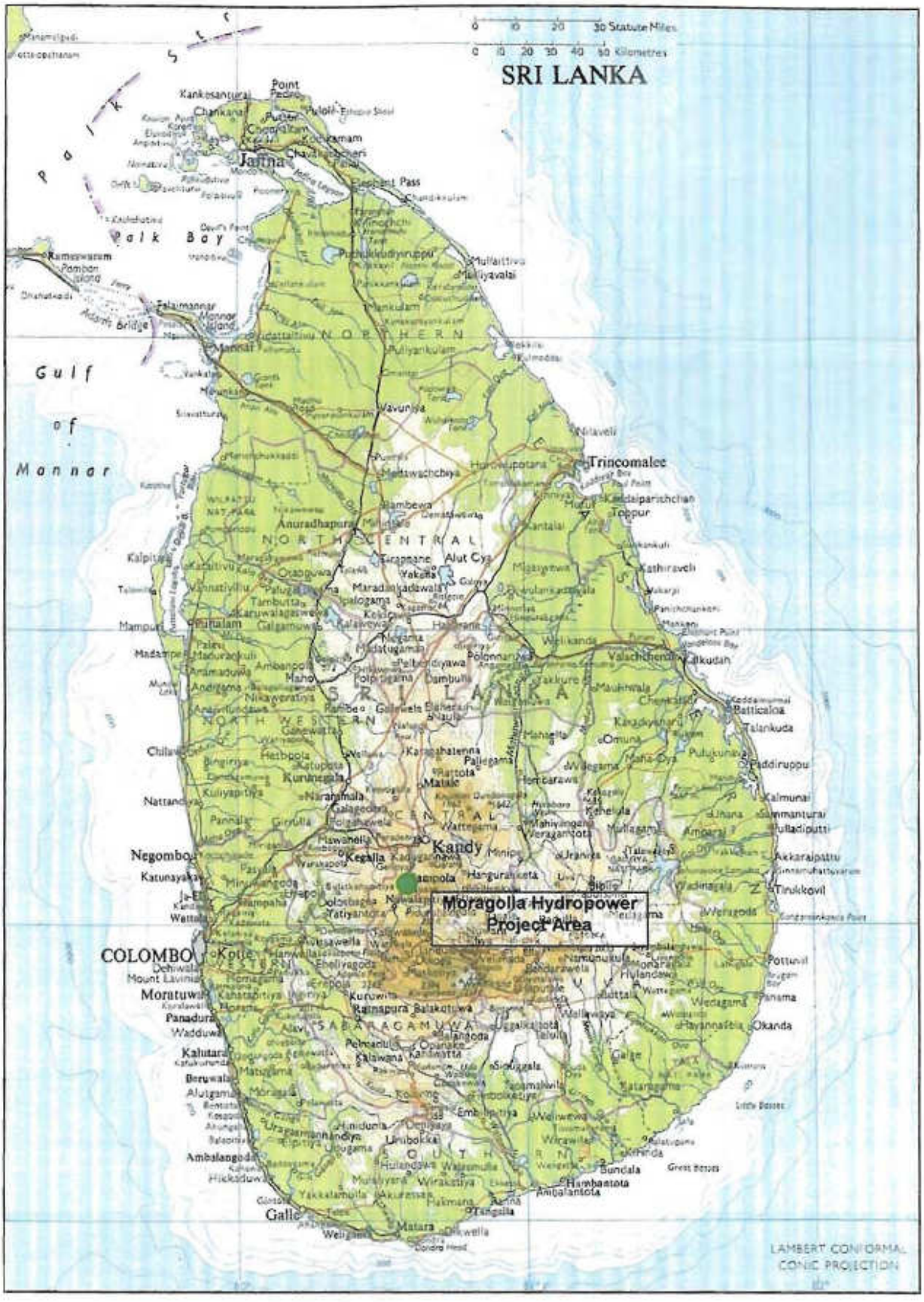

Figure 1.1 Project Location

Chapter 1

Introduction

1.1 Background of the Project

Ceylon Electricity Board (CEB) coming under the purview of the Ministry of Power and Energy is the main state sector agency responsible for generation, transmission and distribution of electricity. CEB has been entrusted with developing and maintaining an efficient, coordinated and economical system of electricity supply in accordance with any appropriate license issued by the Public Utilities Commission of Sri Lanka as per the Sri Lanka Electricity Act no. 20 of 2009. Policy directions by the Government for the Power Sector have made it possible even for private sector participation in power generation since 1996.

Moragolla hydropower project has been first identified in the Hunting Survey Corporation Study in 1962. It has later been studied during the Master Plan Study for Electricity Supply of Sri Lanka conducted in 1986-1988 by the Ceylon Electricity Board with the German Technical Corporation GTZ.

In this Master Plan Study, 27 potential hydropower sites have been identified as capable of generating electricity at a long term average cost of 15USCts/kWh (1988 prices). From these potential hydro projects, CEB has considered 04 prospective hydro projects as candidates in their Long Term Generation Expansion Planning studies (LTGEP 2009-2022). One such project is the Moragolla hydropower project.

In 2006, a review of the Moragolla Hydropower Project cost has been carried out by the Japan International Cooperation Agency (JICA) during "Master Plan Study on the Development of Power Generation and Transmission System in Sri Lanka" in response to a request made by the Government of Sri Lanka (GOSL). The Kuwait Fund for Arab Economic Development (KFAED) has offered a grant for the feasibility study of Moragolla Project (CEB's LTGEP 2009-2022).

The proposed dam site for Moragolla is located in the Mahaweli river and about 3km downstream of the confluence of the Mahaweli River and the Kothmala Oya and upstream of the tailrace outlet of the Kothmale Power Station. The Mahaweli Basin is the largest river basin in Sri Lanka covering a land area of 10448 Sq.km. and cutting across five provinces, nine districts and fifty seven Divisional Secretariat Divisions.

The proposed Moragolla Hydropower Project and its impacted areas lie in the Divisional Secretariats of Uda Palatha and Ganga Ihala Korale Divisions which are parts of the Kandy District of the Central Province of Sri Lanka.

The project location is given in ***Figure 1.1***

1.2 Objective and Justification of the project

Energy supply in the country is mainly based on three primary resources namely, biomass, fossil fuel and hydro. Biomass and hydro are the only indigenous renewable sources of energy available in Sri Lanka while all fossil fuels are imported. Biomass consumption is mainly for household cooking, small commercial and industrial applications.

Table 1.1 Electricity Generations 1988-2006

Year	Peak Demand (MW)	Installed Capacity (MW)	Hydro Generation (GWh, %)	Thermal Generation (GWh, %)	Self Generation (GWh, %)	Total (GWh)
1988	594	1208	2597 (92.8)	201 (7.2)	-	2798
1989	618	1240	2801 (98.0)	57 (2.0)	-	2858
1990	640	1289	3145 (99.8)	5 (0.2)	-	3150
1991	685	1289	3116 (92.3)	260 (7.7)	-	3376
1992	742	1409	2900 (81.9)	640 (18.1)	-	3540
1993	812	1409	3796 (95.4)	183 (4.6)	-	3979
1994	910	1409	4089 (93.2)	275 (6.3)	22 (0.5)	4386
1995	980	1409	4514 (94.0)	269 (5.6)	17 (0.4)	4800
1996	968	1409	3249 (71.8)	1126 (24.9)	152 (3.4)	4527
1997	1037	1585	3448 (67.0)	1463 (28.4)	235 (4.6)	5146
1998	1137	1636	3915 (68.9)	1654 (29.1)	114 (2.8)	5683
1999	1291	1682	4175 (67.6)	1901 (30.8)	97 (1.6)	6173
2000	1404	1764	3197 (46.7)	3486 (50.9)	158 (0.02)	6841
2001	1445	1874	3113 (46.9)	3407 (51.4)	105 (1.6)	6625
2002	1422	1893	2696 (38.8)	4114 (59.2)	136 (1.9)	6946
2003	1516	2180	3314 (43.5)	4298 (56.5)	0 (0)	7612
2004	1563	2280	2964 (36.3)	5080 (62.3)	115 (1.4)	8159
2005	1748	2411	3455 (39.4)	5314 (60.6)	0 (0)	8769
2006	1893	2434	4634 (49.4)	4751 (50.6)	0 (0)	9385
2007	1842	2444	3947 (40.2)	5864 (59.8)	0 (0)	9811

Note: Wind and small hydro generation is included in hydro generation figure.
Source: CEB Report on Long Term Generation Expansion Planning Studies 2009-2022

Estimated total hydropower potential in the country is about 2000 MW. As at year 2008 statistics, the total installed capacity of the power plants (hydro, thermal and

non-conventional renewable) was 2645 MW with gross energy generation of 9901 GWh. Out of this total installed capacity, 1357 MW has been from hydropower plants accounting to 41.8% of the gross generation while the balance 1288 MW was from other power plants accounting to 58.2% of the gross generation (CEB Statistical Digest 2008).

With the increase in demand for energy to provide for the country's economic and social development, the annual growth rate for electricity demand is expected to be about 6 – 8% (CEB's LTGEP 2009-2022).

Sri Lanka has been heavily depending on hydroelectricity during the past due to its relatively high rainfall availability in the central highlands. Thermal power plants consuming oil, steam / gas and diesel turbines also have been contributing for electricity generation. When the Country faced a severe power crisis in 1996 due to drought conditions the dependence on hydropower dramatically declined in its' share from 92.8% in 1988 to 40.2% in 2007. From 1996 onwards electricity generation from fossil fuels rapidly increased and the hydropower generation remained more or less static as can be seen in ***Table 1.1***.

Table 1.2 Generation Expansion Plan 2007

Year	Peak Demand (MW)	Capacity Additions (MW)							
		Diesel Medium Term (MW)	Gas Turbine		CCY	Coal	Hydro	Indo-Lanka Conn.	Total
			35 MW	75 MW					
2008	2032								-
2009	2221				*200*				200
2010	2408	200			*100*				300
2011	2655		175	150					325
2012	2880					**285+	*150		435
2013	3137					785			785
2014	3385					285			285
2015	3674					800			800
2016	3977					300			300
2017	4298					300			300
2018	4642					300			300
2019	5008					300			300
2020	5400					300			300
2021	5819					300			300
2022	6268							500	500
Total		200	175	150	300	3955	150	500	5430

Note : *200MW GT part and 100 MW ST part of Kerawalapitiya Combined Cycle plant (CCY) + **285 MW Puttlam Coal Power Plant + Committed Plants

Source : LTGEP 2009-2022, CEB

Moreover, most of the hydro potential in the country has already been exploited and the availability of economic hydropower resources is limited. With the high costs involved and the social and / or environmental impacts associated with large scale

hydropower developments, it is increasingly becoming difficult to further exploit hydro resources. And hence, future power generation is predominantly fossil fuel based as can be seen from ***Table 1.2***. Therefore the Sri Lankan power system which is predominantly hydro based will have to transform into a thermal based system while preparing hydropower systems for peaking duty (CEB's LTGEP 2009-2022).

All fossil fuel based electricity generation will have to continuously depend on imported primary energy resources for electricity generation. It has to be noted that the world's oil prices are escalating rapidly and even gaseous emissions from fossil-fuelled electricity generation are a major contributor to climate change. Limiting the extent of such climate change will depend, among other things, on the continuing and increased use of renewable energy sources including hydropower.

The National Energy Policy too promotes the development of Indigenous energy resources to minimize dependence on non-indigenous resources subjected to resolving economic, environmental and social constraints. Hence, developing of remaining hydropower potential even if they are of medium size is fast gaining attraction from CEB point of view.

In this backdrop Moragolla Hydropower Project can be considered as one of the most potential and attractive sites for development as the site is conducive for hydropower development with its favourable topography and geology as well as with its' hydrology. Furthermore, the reservoir with a total storage of 4.23MCM at its full supply level is confined mostly to the steep valley along the river and thus has only limited adverse impacts on the environment which are manageable through appropriate mitigation measures. The project would also generate positive environmental benefits as it will replace the need for Thermal power plant which would be the next generation alternative considering the capacity of the project.

Therefore, the project is capable of meeting the demand for electricity with least environmental impacts. It is also one of the projects that have been identified for development under the Mahinda Chintana 10-year development plan of the Government of Sri Lanka.

Registration under Clean Development Mechanism (CDM)

It may also be of advantage to note that, since Moragolla hydropower project produces cleaner energy than other options as it burns no fuel and does not produce greenhouse gas (GHG) emissions, other pollutants or wastes associated with fossil fuels, CEB could look into the possibility of considering Moragolla project for registration under Clean Development Mechanism (CDM) based on carbon credit revenues.

Under the Kyoto Protocol of the U.N. Convention on Climate Change, some listed industrialised countries have committed to reduce their emissions of greenhouse gases including carbon dioxide and methane through CDM. Through this mechanism, countries can reduce emissions by purchasing emission credits from

other countries that invest in projects and programs that avoid GHG emissions and produce a net global reduction in emissions.

1.3 Objective of the EIA report

1.3.1 General objectives of the EIA process

Feasibility of a project is based on technical, economic and environmental considerations. The technical and economic aspects address the specific project needs and the environmental aspects addresses the common resources to be shared and possibly protected in the area. Environmental Impact Assessment (EIA) is therefore an integral part of planning of the projects and it has the basic objective of providing the necessary information for the decision makers on the environmental sustainability of the project as it looks beyond the immediate project interests.

The EIA process identifies, predicts and evaluates the likelihood environmental impacts of the project and prepares a suitable environmental management plan (EMP) to mitigate the adverse impacts on the environment and spells out the requirement for proper implementation of the EMP.

The methodology for the study consists of ascertaining the existing environment for baseline data which is then compared with predicted changes. Consequently, the respective impacts of such changes are evaluated to ensure that all the planned benefits shall be achieved with minimum adverse impact to the environment. Based on this evaluation, planners and decision makers shall introduce modifications as required to achieve a more workable and reliable project.

1.3.2 Environmental Impact Assessment (EIA) Process

Environment is an essential element in the development process and is being recognized as a dimension in the decision making process. Therefore the Environment is being given due consideration from the planning stage itself of the project. Concern for the environment should not be seen as a constraint in development of a project but as a challenge to be met when planning the project.

Environmental Impact Assessment (EIA) is a process by which the potential impacts of development activities on the natural environment and the social environment are predicted, measures suggested to prevent or minimize negative impacts and enhance positive impacts. EIA has to be carried out for all prescribed projects as listed in the National Environmental Act No. 47 of 1980 as amended by Act No. 56 of 1988 (NEA). NEA is the Sri Lanka's basic national charter for protection and management of the environment.

Section 23CC of the NEA, regulations has been made by the Minister stating the procedures that should be followed in order to achieve the EIA requirements of the NEA. The Central Environmental Authority (CEA) is the agency charged with the responsibility of implementing the above provisions of the NEA.

The EIA process is implemented through designated Project Approving Agency (PAA) as prescribed by the Minister under Section 23 Y of the NEA in the Gazette

Extra Ordinary No. 859/14 of 23rd Feb. 1995 (Annex V) and Extra Ordinary No. 978/13 of 04th June 1997 (Annex VI). Accordingly for the proposed Moragolla hydropower project, the Project Approving Agency is the Mahaweli Authority of Sri Lanka (MASL) and therefore has issued the Terms of Reference (ToR) for the EIA study.

1.3.3 Specific Objectives of the EIA Report

The primary objective of this report is to present the findings of the EIA process undertaken to determine the potential environmental impacts associated with the construction and operation of the Moragolla Hydropower Project. Throughout the project, from the outset of initial planning, site selection and preliminary design, the approach has been one of "Mitigation through Planning and Design", whereby potential environmental impacts have been identified and measures introduced to reduce the adverse impacts as far as is practicable. This has reduced the overall potential for adverse impacts to occur as well as the need to apply mitigation measures.

Incorporating the findings of the EIA in the project designs ensures that the final design of the power project conforms to the principles of sustainable development (i.e. one which balances the effects of economic, environmental and social issues).

The Ceylon Electricity Board (CEB) being the client has awarded the Feasibility Study including the EIA study of the Proposed Moragolla Hydropower Project to the Consultant, Central Engineering Consultany Bureau (CECB).

CECB carried out the EIA study during the period February to May in 2009 and has prepared the EIA report for the Proposed Moragolla Hydropower Project. EIA has been carried out in accordance with the specific requirements as set out in the Terms of Reference (ToR) issued by the Project Approving Agency (PAA), the Mahaweli Authority of Sri Lanka (MASL). Submission of the draft final EIA report to the Client CEB was made in August 2010 for the submission to the PAA for approval.

Since then, revisions to the EIA report was made several times based on the comments received from the Technical Evaluation Committee (TEC) appointed by the PAA. To address all issues raised by the TEC on several occasions, correspondences with the stakeholders / agencies were continued until the final submission of the report in November 2012. All such correspondences have been incorporated into the report. It is noteworthy to mention that all data and information contained in the report correspond to those gathered as at the end of the study period, May 2009 though some of the correspondences refers to times beyond and until November 2012.

1.4 Extent and Scope of the study

- Review existing data and studies, site investigations relevant to the project area in order to characterise the baseline situation in relation to physical, ecological, socio-economic and cultural/archaeological resources;

- Build upon the feasibility study carried out almost parallelly with the EIA study and review the layout plan and including alternatives in terms of location, design, construction technology and select best layout in terms of minimum environmental impacts.
- Investigate and describe pertinent environmental regulations and standards affecting the Project at national, regional and local levels;
- Describe the process for involvement of the public in the project design and recommend measures for continued public participation;
- Identify any aspects of the Project likely to cause environmental effects;
- Identify any additional studies necessary to fulfil the requirements of the EIA study and implement them.
- Identify and describe the elements of the community and environment likely to be affected by the Project and/or likely to cause adverse impacts upon the Project;
- Recommend the most appropriate mitigation measures;
- Describe the institutional requirements for post-construction phase (operational) monitoring and management;

1.5 Methodologies adopted in report preparation

A number of methodologies have been adopted to facilitate the assessment of environmental impacts.

Desk Studies

The available literature and relevant information was collected, data, information and reports, survey maps from the feasibility study which is being carried out in parallel with the EIA study, available topographic maps, geological maps were studied and additional studies formulated and implemented to study the baseline situation to guide the EIA process.

Field Surveys and Investigations

To supplement the information derived from desk studies a number of field surveys and investigations have been carried out, as follows:

Water Quality, Air Quality, Noise and Vibration level measurements

These mesurements were carried out at specific locations identified as possible locations where there can be changes to the environment.

Geological and Geotechnical investigations

Reports from geological and geotechnical investigations carried out for the Feasibility Study was used for the EIA study. Among other, these investigations include 33 bore holes which were drilled covering the areas of dam site, intake, tunnel trace, surge shaft, outlet portal, penstock and the powerhouse site.

Further soil investigations were carried out to determine soil parameters to define stability conditions of the soils.

Archaeology and Cultural Heritage

This included surface surveys followed by the pedestrian survey technique within the proposed project area which may have archaeological and cultural heritage value and which may be affected by the project components.

During surface surveys, entire project development area was divided into 100X100 meter grid. The grid consists of 8667 individual sub-squares. Due to the thick vegetation cover, several random locations (160 nos.) accounting to 2% of the grid population were observed for investigations and such locations were considered adequate due to sterile condition of the internal stratigraphy. ***Figure 1.2*** shows the survey details.

Sub-surface investigations were made to check internal stratigraphy. 15 locations were selected so as to represent the entire project development area at which points excavation pits were made of the size 0.3mX0.3m and to a depth of 0.5m. Internal stratigraphy was recorded following the standards given by the British Museum Field Manual (Spence 1990) and the Munsel color chart.

Social Environment

A comprehensive profile of the existing socio-economic environment in the project area was first developed. The socio-economic profile includes, demographic features, livelihood activities of the people, cultural and social relations of the people in the project areas, the religious, historical and other significant features and all other infrastructure facilities available in the area studied. Then, likelihood impacts and their magnitude were analyzed based on features in the existing socio-economic environment. Certain key environmental parameters were used to evaluate the impacts. These parameters considered are related to the areas such as land use, human interest and economics etc. Thereafter, measures to mitigate adverse impacts are proposed. Finally, an environmental monitoring mechanism is proposed to monitor the environmental impact mitigation process suggested.

The proposed project involves some resettlement issues and CEB will prepare a comprehensive Resettlement Action plan (RAP) including all the details following the policies of National Involuntary Resettlement Policy (NIRP) document during the detailed design studies which is to be started in the near future. This plan (RAP) will be implemented during the project implementation phase. Although the present report includes substantial information on resettlement issues, an RAP is not appropriate as detailed surveys on the information related to the individual plots of homesteads and properties affected are liable to be changed between the timeframe now and the detailed design stage. Once the RAP is prepared and all the parameters are fixed under the detailed design stage, CEB will be able to implement the RAP during the project implementation stage.

The following methodology were adopted for data collection

- Reconnaissance visits with the other consultants of the EIA. This visit paved way to the social impact study team to identify the areas demarcated for project interventions and also the views of other members of the EIA team in other disciplinary on the likelihood impacts and other environmental considerations.

- In-depth interviews with relevant representatives of key stakeholders (community leaders who have better understanding of the project area, Grama Niladaries relevant to the project intervention areas, Agriculture Production and Research Assistants, Samurdhi Officers, representatives of relevant Pradesiya Sabas and Divisional Secretariats).

Table 1.3 in ***Annexure 1*** includes the names of the person's interviewed and consulted. Further, ***Annexure 1*** gives the notes on group discussions.

- Group discussions with communities in relevant project intervention areas (***Annexure 1***).
- Interviews with all likelihood project affected persons due to different development interventions (***Annexure 1***).
- Preparation of community map showing the locations of the residences and the other properties such as land of the Project Affected Persons (PAPs).
- Preparation of brief profiles of the likelihood affected persons in each location of proposed development interventions.

Biological Environment

A reconnaissance survey was carried out to identify major habitats / vegetation patterns in and around the immediate impact zone of the project. Detailed field investigations were carried out at sites identified along the identified impact zone of the project based on the findings of the reconnaissance survey, land use maps and satellite images of the study area. A total of 40 sites were sampled covering the entire span of the impact zone.

The main sampling methods used included the point count method and short transects placed at suitable distances within the identified impact zone. All the species observed were recorded with respect to its location and the results were pooled according to major activities. In addition to the species, the types of habitats were also recorded and a rough habitat map was constructed based on these observations.

All the sampling points were geo referenced with GPS coordinates so that the data can be linked to a GIS platform if necessary and is given in ***Table 1.4 (Annexure 1)***. Further, the same sampling sites can be repeated if post construction monitoring work is to be carried out. The current status of the ecosystem with respect to disturbance by humans and the existing threats were also recorded. Finally, the different habitats present in the immediate impact zone of the project site were determined. In addition, secondary information on biodiversity and environmental issues were collected through personal communication with villagers and relevant officers. This was also done by reviewing published documents and unpublished data. In addition, photographic records were made of the visual aspects of biodiversity.

Based on the primary and secondary information gathered during the field investigations and literature survey an environmental profile of the area was

constructed. Finally, existing environmental problems/ issues within the proposed project area and possible ecological impacts that may arise due to the project on the biological environment were identified and suitable mitigation measures proposed where possible.

Species identification and nomenclature of the species present was based on the latest literature published on the fauna and flora of Sri Lanka. The conservation status of the species was determined according to IUCN list of threatened fauna and flora.

1.6 Applicable Laws, Regulations and Approval Requirements affecting the Proposed Development

There are several enactments that has been passed by the Government of Sri Lanka to look into environmental concerns and such enactments directly of relevance to the Moragolla Hydropower Project are:

- National Environment Act. No. 47 of 1980 as amended by Act No. 56 of 1988
- Sri Lanka Electricity Act, No. 20 of 2009
- Mines and Minerals Act No. 33 of 1992
- Mahaweli Authority of Sri Lanka Act No. 23 of 1979
- Soil Conservation Act No. 25 of 1951 and No. 29 of 1953 and amended by Act No. 24 of 1996
- Irrigation Ordinance No. 32 of 1946, Act No.1 of 1951 and No. 48 of 1968, Law No. 37 of 1973
- Fauna and Flora Protection Ordinance as amended by Act No. 49 of 1993 and subsequent amends.
- The Antiquities Ordinance, No.9 of 1940 (now Act) and the subsequent amendments, particularly the Antiquities (Amendment) Act No. 24 of 1998 is the primary Act.
- Land Acquisition Act
- National Involuntary Resettlement Policy (NIRP)

1.7 The approval needed for the proposed development from state agencies

1. **Ceylon Electricity Board (CEB) for connection to National Grid (Transmission line) and for spoil dumping sites on CEB lands.**

   The project proponent is Ceylon Electricity Board itself and therefore there is no separate clearance required for the project from other state agencies in this connection.

   Four lands belonging to CEB will be used for spoil dumping and the possibility to use these lands has been recommended by the Chief Engineer, Kothmale Power Project (reference ***item no. 9*** in ***Appendix F***)

2. Divisional Secretaries

To implement the project, the project proponent needs to obtain the approval from the Divisional Secretariats of Uda Palatha and Ganga Ihala Korale, for the proposed development. These two state agencies have been already informed of the project and their approval / consent has been received (reference ***item nos. 4*** and ***5*** in ***Appendix F*** for Conditional approval of DS, Udapalatha and the consent letter of DS, Ganga Ihala Korale).

3. Pradeshiya Sabhas

To carryout construction activities of the project, the approval of the Pradeshiya Sabhas of Uda Palatha and Ganga Ihala Korale has to be obtained. Conditional approval of the Ganga Ihala Korale Pradeshiya Sabha and the Chairman, Uda Palatha Pradeshiya Sabha, Delpitiya-Atabage has been received for the project (reference ***item nos. 11*** and ***12*** in ***Appendix F***).

4. Mahaweli Authority of Sri Lanka (MASL)

The MASL as the responsible agency for Mahaweli River has been vested with the authority of granting permission for development works in the Mahaweli River and its reservation. Moreover MASL is the Project Approving Agency for the proposed Moragolla Hydropower Project.

Furthermore, a land belonging to the MASL will be used as a spoil dumping site. Concurrence has been obtained (reference ***item nos. 1, 6, 7*** and ***8*** in ***Appendix F)*** and the MOU between the MASL and CEB during the implementation of the project is given as ***item no. 1*** in ***Appendix F***.

5. Road Development Authority (RDA)

In the proposed development project, the existing roads are to be widened / improved and a stretch of the Mawathura-Atabage road will be inundated. Also, the foundations of the abutments and piers of the Ulapane bridge presently under construction by RDA will be submerged due to FSL of the reservoir. Hence, during the designs stage of the project, the approval of the RDA has to be obtained for the designs related to improvements of roads and bridges (reference ***item no. 3*** in ***Appendix F***). An MOU will be signed between CEB and RDA to ensure that all conditions stipulated by the RDA is met.

6. Dept. of Archaeology

It is the state agency responsible for conservation of archaeological artifacts and structures of historical interest whether lying or hidden beneath the surface of the ground or in any water / lake. Any development project on such land will have to be permitted by the Director General of Archeology.

Conditional approval for the project has been granted by the Director General of the Dept. of Archeology (reference ***Appendix B***).

7. Geological Survey and Mines Bureau (GSMB)

Quarry permit and EIA for quarry extraction, transport and unloading

Rock material excavated from tunnelling will be used for aggregate production needed in construction works. However an initial requirement of aggregates will have to be obtained from a quarry.

Three quarry sites have been identified under the feasibility study. However two of these quarry sites located on the left and right banks of the Kothmala Oya close to the existing Kothmale dam cannot be exploited due to safety measures and environmental concerns that have been prevailing in the area. The third site has been identified at Greenfield along the Nawalapitiya-Thalawakelle main road. The fourth quarry site was identified lately near Ramboda pass on route A5 close to Ramboda town. This site is far from the project site and there is no proper location for the crusher plant. Therefore the use of this fourth quarry site can be considered as only a remote possibility. However these quarry sites have been briefly discussed in Chapter 2.

The Contractor will be required to complete a formal EIA and hold a separate permit for the extraction and delivery of quarried rock for the project. The scope of the EIA for the quarry will be dependent upon the Contractor's preferred location and whether the selected location already operates under licence. Other issues include, the extraction technique, the overall nature of the work involved at quarry site, the number and the capacity of vehicles for transport, preferred route and strengthening of such routes if necessary. The Project Approving Agency (PAA) will be the Geological Survey and Mines Bureau, (GSMB) although close interaction will be maintained with the MASL in relation to the associated impacts with unloading points and other interactions within the project area.

The GSMB also require quarry operators to hold a separate permit for quarrying operations. Unless the sites(s) already hold such a Permit, the Contractor will be responsible for obtaining this Licence.

8. Dept. of Agriculture

The Department of Agriculture has been vested with the powers to survey and investigate so as to the nature and extent of soil erosion, to declare erodoble areas and to make regulations on erodible areas. The Department of Agriculture is responsible in increasing public awareness in better agricultural practices and the implementaion of the Soil Conservation Act.

With regard to this EIA study, the Natural Resources Management Centre of the Department of Agriculture, Peradeniya prepared the Soil Conservation Plan for Mitigation of erosion threats for the proposed project.

Also, the Botanic Gardens Ordinance has vested powers on the Department of Agriculture so as to not to grant permission for development projects that are proposed within a radius of 1 Km from the boundary of Botanic Gardens.

However there is no botanic garden within such distance of the proposed Moragolla Hydropower Project.

9. National Water Supply & Drainage Board (NWS&DB)

The water intakes of NWS&DB's Gampola Water Supply Scheme is located downstream of the proposed Moragolla Power House. Therefore clearance from NWS&DB is required for the Moragolla project as water is being diverted for the proposed project from an upstream location of the water supply scheme and thus will be of their concern. However, the diverted water will be discharged back to the Mahaweli river approximately 1 Km upstream of this water intake at Gampola.

Note: According to the letter received lately from NWS & DB, the current water demand to Gampola area is being catered by Ulapane, Gampolawatte, Paradeka, Nayapana, Dartry and 3rd Mile post intakes. Due to the on-going increasing demand, NWS & DB has long term plans in rehabilitating the existing water intake at Gampola (reference ***item no. 10*** in ***Appendix F***).

Conditional approval for the project has been granted by the Additional General Manager (Policy & Planning) of NWS & DB (reference ***item no. 2*** in ***Appendix A***) and a Memorandum of Understaing is to be signed between the NWS & DB and the CEB (reference ***item no. 3*** in ***Appendix A***) with regard to the conditions stipulated in respect of the quantity and quality of water at the extraction point.

10. The Forest Department

The Forest Department in it's role as statutory custodian of state forests and lands and the plantation of new forests, has been vested with powers so as to not granting permission for any development activity within any land declared, proposed or defined under the Forest Ordinance or within 1 Km radius from the boundary of such lands which includes forest reserves, village forests and state forests.

In this regard, the Forest Department has given their consent for the proposed project (reference ***item no. 7*** in ***Appendix A***).

11. The Department of Wild Life Conservation

The Department of Wild Life Conservation has been vested with the powers as to not grant permission for development projects which are proposed to be located within a 1 mile radius for National Reserves under the Fauna and Flora Protection Ordinance and 100 meters radius for sanctuaries under National Environmental Act.

However there are no such reserves within the specified radii.

12. Department of Irrigation (ID)

The Department of Irrigation has the controlling powers over medium and major irrigation schemes. It is necessary to work with close coorperation with them on irrigation releases. Conditional approval for the project has been granted by the

Director General of Irrigation and a Memorandum of Understanding is to be signed between the CEB and the ID, to ensure the conditions stipulated are met by the CEB (tentative MOU subjected to the approval of the Irrigation Dept. Is given as ***item no. 17*** in ***Appendix F***).

Also any new works or rehabilitation works affecting the irrigation releases will require the prior approval of the ID for the designs and for the estimates for such works (reference ***item no. 2*** in ***Appendix F***).

13. Dept. of Agrarian Development

Dept, of Agrarian Develeopment is responsible for the water releases to the farmers and hence the project proponent has to closely coordinate with the Irrigation Dept. who is responsible for the irrigation scheme and the Dept. of Agrarian Devlopement in issues related to irrigation water releases to the farmers.

Two farmer awareness meetings were held by CEB on 08th May 2012 and 18th October 2012. The attendance at those meetings and the Minutes of the meetings are given in ***item nos. 13*** and ***14*** in ***Appendix F***.

14. Urban Development Authority (UDA)

If the development activities of the proposd project have an impact on inundation of areas declared under the UDA Act, then the UDA has a regulatory power on the development of such project.

However, the proposed project does not fall within the area declared under the UDA Law (reference ***item no. 15*** in ***Appendix A***).

1.8 Any conditions laid down by state agencies in granting preliminary clearances for the project

The main agencies involved in the project are given in section 1.6 above. The project proponent shall be responsible to these agencies for the due awareness of the project. There is no doubt that each agency will cooperate with all relevant agencies in ensuring that the project will be executed to the satisfaction of each respective agency. All of the stakeholder Government agencies has been informed of the Moragolla hydropower project. An awareness programme also was organized by the project proponent to these stakeholder agencies. The participants list is given under ***item no. 1*** in ***Appendix A.***

MASL as the Project Approving Agency, with the assistance of the project proponent will monitor the progress of the project mainly during construction period in order to ensure that all environmental precautions and accepted mitigatory measures are being duly executed.

Comments and observations received from the state agencies are also given in ***Appendix A*** and has been summarised as follows.

(1) Divisional Secretaries

The project area belongs to the Uda Palatha and Ganga Ihala Korale Divisional Secretariat Offices. Divisional Secretaries (DS) of Uda Palatha and Ganga Ihala Korale have made proposals which have been summarized as follows.

DS, Uda Palatha

(reference ***item no. 14*** in ***Appendix A)***

(i) Provide alternate lands to the existing settlers and freehold land owners who will be affected by the construction of the reservoir.

(ii) Provide alternate lands to those who are affected due to the construction of the re-routed road stretch as the lands in this areas are steep.

(iii) Construction of the re-routed road stretch to be carried out with minimum negative impacts to the environment with paying due attention to avoid occurrence of landslides as the lands in the area are steep.

(iv) There are perennial streams and about six rivulets which become active only during rainy seasons which feed the river stretch between the dam and the powerhouse. Even though these streams feed the river stretch downstream of the dam up to the powerhouse, it is proposed that sufficient water is released to this stretch for the survival of the riverine eco system.

Permission has been later granted by the DS (reference ***item no. 4*** in ***Appendix F***) subjected to the fulfillment of the following conditions in summarize form.

(i) Resettlement of persons affected.
(ii) Re-forestation program to compensate for the number of trees felled in the reservation areas.
(iii) Adequate release of Environmental flow to cater to peoples' needs and of the fauna
(iv) Proper measures taken to mitigate disturbance to people and wildlife due to noise and vibration due to operation of machinery, pollution of air and water and soil erosion.

DS, Ganga Ihala Korale

(reference ***item no. 16*** in ***Appendix A***)

The proposed underground tunnel layout lies below the Ulapane Industrial Estate which comes under the purview of the Industrial Development Ministry.

Construction of all buildings in this industrial estate has been completed and industries are in operation. Therefore there are problems with regard to the construction of the underground tunnel. Therefore it is proposed that the

objections made by the relevant investors to be discussed and to carry out the future works of the project.

Based on the proposals made by the DS with regard to the concerns on the Ulapane Industrial Estate, discussions were made on 26th May 2009 by CEB and EIA Consultant with the relevant investors of the Ulapane Industrial Estate, DS (Ganga Ihala Korale) and the Divisional Director, Regional Industry Service Centre (Central Province). At the meeting, concerns were raised by the industrialists with regard to tunnel been aligned below the industrial estate and on the effects of water level fluctuations of the proposed reservoir on the nearby Industrial Estate Land.

Later, some recommendations were made by the DS for measures to be undertaken (reference ***item no. 5*** in ***Appendix F***).

Divisional Director, Regional Industry Service Centre (Central Province) claims that the Industries in the Ulapane Industrial Estate will not be discharging any waste water to the external water courses nearby (reference ***item no. 18*** in ***Appendix A***).

(2) Mahaweli Authority of Sri Lanka (MASL)

(reference ***item nos. 4*** and ***12*** in ***Appendix A*** and ***item nos. 1, 6, 7*** and ***8*** in ***Appendix F***)

MASL is the Project Approving Agency for the project and has accordingly issued the Terms of Reference (TOR) for the EIA. Therefore MASL states that the TOR indicates every aspect to be considered for the assessment including impacts on irrigation and flood protection works, impact on existing Polgolla and Kothmale Water Management area, method of diversion of water during construction stage and proposals for Emergency Action Plan along with arrangements for early warning systems and details required to ensure the dam safety aspects (reference ***item no. 12 in Appendix A***).

According to MASL, with respect to the quarry on the left bank of the existing Kothmale project as identified in the Moragolla project feasibility studies, GSMB has given recommendation only for extraction for IML-C (Industrial Mining License- Category C) without affecting the membrane of the dam where only a very small quantity can be extracted under this condition (reference ***item no. 4 in Appendix A***). If large scale blasting is to be carried out, an EIA for the quarry will be essential. It is also to note that there is no possibility to transport material along the road above the dam.

Extraction of water for various industries from the Mahaweli Ganga has to be made under the approval of the MASL. Since the existence of such industries are of interest to this project, MASL and other related institutions has to be consulted in this regard (***item nos. 17*** and ***19*** in ***Appendix A***).

Also as one of the spoil dumping sites, an area belonging to the MASL river reservation will be used. Conditions have been stipulated by the EIC, Kothmale Project, MASL with regard to the management of these spoil disposal areas (reference ***item no. 1*** for MOU between CEB and MASL and ***item no. 6*** in ***Appendix F***).

(3) Road Development Authority (RDA)

(reference ***item nos. 5*** and ***10*** in ***Appendix A*** and ***item no. 3*** in ***Appendix F***)

RDA has given their comments with regard to the new road diversion from Mawathura-Galatha road and the improvements to the existing roads leading to the Powerhouse/ Switchyard, Surge Shaft and Outlet Portal area. The comments are related to road designs which are to be considered during detailed designs stage. It has been stated to communicate with the Director/Planning, RDA during detail designs of the proposed project.

Also with regard to the submergence of the foundations of the abutments and the piers of the Ulapane bridge presently under construction, a proposal was given by RDA for protection measures to be incorporated and implemented by CEB in consultation with RDA (reference letter RDA/ES/BD (XVIV) dated 06th October 2009).

Also, subjected to the following conditions, RDA has given the consent to the project.

(i) CEB to bear all costs associated with new road constructions, modifications to existing roads and bridges, repairing of existing roads and other road infrastructure with respect to the proposed project or any other national road (Class A or B) damaged due to any action pertaining to the above project.

(ii) Overloading of construction and transport vehicles for the project is strictly prohibited. All the project staff and contractors of the project should be made aware of the allowable lengths, widths, heights and loads permitted as per the relevant gazette notification attached.

(iii) All road infrastructure related developments carried out under the project should comply with RDA design standards.

(iv) CEB is to submit all details / designs of new road sections to by-pass inundated section of Mawathura – Atabage road and all proposed modifications to existing roads and bridges to RDA for approval well in advance of commencement of such work.

(v) Proper co-ordination should be maintained with the respective Chief Engineer and relevant Executive Engineers of RDA in road related activities and Environmental and Social Development Division of RDA during future major project activities.

(vi) Mitigation measures should be strictly followed as specified in the EIA report to minimize impacts on road infrastructure during construction phase of the project.

An MOU will be signed between CEB and RDA to ensure that all conditions stipulated by the RDA are met.

(4) Dept. of Archaeology

(reference ***Appendix B***)

Based on the study carried out by the Dept. of Archaeology, approval has been granted subjected to the following conditions.

(a) Implementation of the projcet has to be caried out under the supervision of an officer from the Dept. of Archaeology.
(b) In the event of the discovery of any archaeological artifacts during implementation and operation of the project, it should be immediately informed to the Director General of Archaeology.
(c) There should be freedom of access to the project site to any officer of the Dept. of Archaeology for site inspection

(5) Geological Survey and Mines Bureau (GSMB)

(reference ***item no. 8*** in ***Appendix A***).

Locate a suitable quarry other than that located at the right bank of the existing Kothmale Project as it would adversely affect the surrounding area as soil creeping and earth subsidence have been reported from the area since the impounding of the Kothmale reservoir.

(6) Forest Department

(reference ***item no. 7*** in ***Appendix A***).

There are no areas coming under the purview of the Forest Dept. where the proposed project is to be established. Therefore there is no objection from the Forest Dept.

(7) Irrigation Department (ID)

(reference ***item no. 6*** in ***Appendix A*** and ***item no. 17*** in ***Appendix F***).

The intake of the Dunhinda irrigation feeder canal which supplies the irrigation water to the Gampolawela Irrigation Scheme is located downstream of the proposed dam. Therefore there will be an impact on the flow of the Dunhinda canal.

If the approval for the project is given by the CEA to the client CEB, the approval has to be subjected to the following conditions stipulated by the Irrigation Dept. :

(i) An Environmental Impact Assessment has to be carried out.

(ii) There cannot be any detrimental effect on the command area of the Gampola Raja-Ela irrigation scheme. The HFL of the proposed reservoir to be fixed at a lower elevation than that of the Ulapane Anicut and to the level of the Gampola Raja-Ela irrigation scheme.

(iii) There cannot be any change to the quantity of water diverted along the Dunhinda feeder canal and this quantity should remain the same as at present. The project planning to be done to release at least 10 Cusecs for irrigation requirements. A Memorandum of Understanding (MOU) to be signed in this regard between the CEB (Project Owner/Operator) and the ID and in the event that CEB is taken over by a successor, then CEB should be bound to transfer the project ownership including the ownership of the reservoir to the ID.

(iv) In the event that water becomes deficient during the dry weather periods, the farmers using the Dunhinda canal for irrigation requirements has to be given priority.

(v) In addition to the water requirements as stated under (iii) above, the water for environmental requirements has to be released downstream of the proposed project.

(8) Urban Development Authority (UDA)

(reference ***item no. 15*** in ***Appendix A***).

The proposed project site does not fall within the area under the UDA Law. However obtain the details of any proposed projects from the relevant Padeshiya Sabhas and other Government agencies

(9) National Water Supply & Drainage Board (NWS&DB)

(reference ***item nos. 2*** and ***3*** in ***Appendix A***).

NWS&DB has granted the approval for the proposed project subjected to conditions laid down on the signed Memorandum of Understanding between the Ceylon Electricity Board and the NWS&DB with regard to the Proposed Moragolla Hydropower Project.

The Memorandum of Understanding between the CEB and the NWS & DB is given in ***item no. 3*** in ***Appendix A***.

Reference letter received lately from NWS & DB which is attached as ***item no.10*** in ***Appendix F*** states that required mitigatory measures need to be taken to ensure necessary dilution as NWS & DB has plans in rehabilitating the existing water intake at Ethgala.

(10) Pradeshiya Sabhas (PS)

Chairman, Ganga Ihala Korale PS- Kurunduwatte Kadeweediya

(reference ***item no.11*** in ***Appendix F***).

Some recommendations have been listed in the letter. One such recommendation relates to the spoil disposal from the proposed project. It is said that spoil disposal should not be done haphazardly without the required approvals from the necessary authorities and such soil to be used in constructing playgrounds in schools and in public places specified by the PS.

Chairman, Uda Palatha Pradeshiya Sabha, Delpitiya-Atabage

(reference ***item no.12*** in ***Appendix F***).

Subjected to the recommendations of the CEA, NRMC, NBRO and other relevant authorities and to the provision of alternate lands for resettlement and other services required for the places of resettlement, no objection has been made by the PS for the project.

1.9 Conformity with other development plans in the area

Udapalatha DS division (Item no. 11 in ***Appendix A)***

In the Udapalatha DS division there are no projects / development plans neither in the project area nor in the immediate vicinity which will have any interference with the proposed project. There are some road improvement projects in the Division.

Ganga Ihala Korale DS Division (Item nos. 9 and ***13*** in ***Appendix A)***

In the Ganga Ihala Korale DS Division, the following are the development projects in the area.

(i) Ethgala New Town Development

(ii) Ulapane Industrial Estate Development

(iii) Kandy South Water Supply Project

(iv) Raja Ela Development Project

(v) Ulapane Mahawilawatta Distribution of Lands and Housing Development Project.

There will not be any interference of the Project with the Ethgala New Town Development, Ulapane Mahawilawatta Distribution of Lands and Housing Development Project and Raja Ela Development.

The reservoir water level will be very close to a section of the land area of the Ulapane Industrial Estate premises. Due to water level fluctuations in the reservoir, the stability of the embankments can be affected and can become vulnerable to landslides. At the detail design stage, further geotechnical investigations are

recommended to be carried out to determine the stability of the embankment in this area.

Kandy South Water Supply Scheme once completed would be of benefit to those people living in the nearby areas of the project and the possible impacts during tunneling in the proposed project with regard to possible ground water level fluctuations will not be significant if water supply is made available to the would be affected communities. Road widening and improvements under the Moragolla project will result in better access facilities to the road users in the relevant project areas.

The proposed reservoir will extend beyond the Ulapane Pusselawa bridge over Mahweli Ganga that is presently being constructed by RDA. The water level in the river at this location will increase due to reservoir FSL and the foundations of the abutments and piers of this Ulapane bridge will be submerged. Necessary mitigatory measures will be taken with the approval of the RDA to avoid possible soil erosion in these areas of bridge foundations.

CHAPTER 2

Chapter 2

Description of the Proposed Project and Reasonable Alternatives

2.1 Evaluation of Alternatives

An area close to Ulapane having been identified in the pre-feasibility studies for locating the Moragolla hydropower project, the feasibility study team involved in the engineering studies for the proposed project embarked upon finding potential sites. Three alternatives were identified as follows for the selection of site and selection of layout considering technical / engineering, social and environmental concerns. These alternatives are discussed below.

2.1.1 Alternatives 1, 2 & 3 and comparison of alternatives

Alternatives 1, 2 and 3 have been considered in selecting a suitable layout for the project. The three alternative sites have been considered in and around the area identified in the Prefeasibility Study. Alternative 2 discusses the site identified in the Pre-feasibility study.

In order to compare the three alternatives on a common platform (same energy benefits), the full supply level was fixed at 550m asl as proposed in the Pre-Feasibility study. The tail water level was fixed at 480m asl for all three alternatives and therefore all three layouts would yield nearly the same energy benefits.

Alternative 1 : High Dam and Short Headrace Tunnel
(Dam location 477,979 E, 513,435 N)

Layout for Alternative 1 is shown in ***Figure 2.1.*** Reservoir is formed by a dam with a height of 49m which diverts water through a short tunnel of length 1.8km. The reservoir submerges about 3.5km stretch along the Mawathura - Galatha road and a large extent of the lands including paddy lands on the banks of the Ulapane Oya. The dam height is higher than that of Alternative 2 but the short tunnel length can be considered as an advantage in this layout.

A preliminary cost comparison of Alternative 1 with Alternative 2 has been made for the cost of dam and tunnel. The additional cost of high dam offsets the advantage gained by reduced tunnel length.

In this layout, resettlement effects and replacement costs due to inundation and due to re-routing of the 3.5 km road stretch will be comparatively higher than that of Alternative 2 and therefore could be considered as a disadvantage of this alternative.

Moreover, the reservoir will submerge considerable extent of lands on the banks of Ulapane Oya. Village of Ulapane is situated along road A113 from Gampola to Nawalapitiya and consists of a concentration of houses along narrow strips on either

side of the road. The shallow pool created adjacent to the village with the submergence of the Ulapane Oya will increase the threat of mosquito breeding while raising issues on sanitation. This is also a disadvantage of this alternative.

Alternative 2 : Layout proposed in the Pre-feasibility Study (Dam location 477,585 E, 511,667 N)

Layout for Alternative 2 is shown in ***Figure 2.2***.

Height of dam is about 32m and the tunnel length is about 3.1 km, which is 1.3km longer than that of Alternative 1. Alternative 2 also inundates part of Mawathura-Galatha road but the length inundated will be about 400 m and hence the need to be re-routed is less than that of Alternative 1. In addition, this alternative submerges paddy lands on the banks of Ulapane Oya.

The comparison of preliminary costs of Alternative 1 and 2 shows that Alternative 2 is preferred owing to less inundation of infrastructure for nearly the same overall costs of key project structures such as dam and tunnel.

In this alternative too there will be submergence of considerable extent of lands on the banks of Ulapane Oya and therefore will have the same issues that are raised as in Alternative 1 due to submergence of the Ulapane Oya, which is a disadvantage of this Alternative too.

Alternative 3 : Low Dam and Open Channel-Tunnel Headrace (Dam location 476,904 E, 511,030 N)

Layout for Alternative 3 is shown in ***Figure 2.3***.

Both above alternatives submerge considerable extent of lands on the banks of Ulapane Oya and issues such as the threat of mosquitoes breeding and problems of sanitation due to shallow pool created are some of the disadvantages common to the above two alternatives.

Alternative 3 was identified to avoid this situation. The dam site is located upstream of the confluence of Ulapane Oya with Mahaweli Ganga, thus avoiding the creation of shallow pool on Ulapane Oya.

Dam in this case will also be much lower and would be about 15m in height. However, the disadvantage of this layout is the inability to directly connect the tunnel to the proposed reservoir. The presence of Ulapane Oya valley prevents construction of a tunnel in this area. Therefore the alternative would be to have a pressure conduit to link the tunnel to the reservoir.

Length of a pressure conduit would be about 1.2km and it has to handle large flows in the order of 52m^3/s. Considering the size of the project, having a pressure conduit of this length and dimensions will not be economical. Besides, the construction and maintenance of the pressure conduit is difficult as it has to be placed on the river bank. Therefore this Alternative was not pursued further.

2.1.2 No Action alternative

The main purpose of the proposed project is to generate electricity to meet the electricity demand. No action alternative means that the proposed power project will not be implemented. If it is so, there will be no environmental impacts associated with any of the above three alternatives mentioned and the environment will remain intact as it is now. No action alternative will also not yield any of the positive impacts associated with the proposed project if it was implemented.

Further, if the project is not implemented, the country will have to forgo 81.65 GWh of mean annual electric energy. Electric energy foregone in the absence of the proposed hydropower project will have to be generated from an alternative source. CEB will opt for, namely a Thermal Power Plant with 13 MW diesel plant and 14 MW gas turbine to provide the annual energy equivalent in meeting the electricity demand.

Opting for Thermal Power Plant would mean relying on fossil fuel imports resulting in the drainage of large sums of foreign exchange to the tune of US$ 11 million (Feasibility Study Report - Volume 5 : Appendix K) annually resulting in a loss to the national economy. Moreover, the operation cost of this power plant is vulnerable to fuel price fluctuations whereas the operation cost of the Moragolla Hydropower Project will be independent of such changes. In addition, gaseous emissions from power plants using fossil fuels are a major contributor to climate change and its impacts. Limiting the extent of such change and its impacts will depend, among other things, on the continuing and increased use of renewable energy sources including hydropower.

This means, the implemention of the Moragolla hydropower project has leverage over the "No Action" alternative which does not prove advantageous from environmental, social and economic point of view and therefore has not been further discussed.

Therefore the comparison of only the alternatives 1 and 2 on Technical and Economic aspects as well as on Environmental and Social aspects have been listed as given in ***Table 2.1***.

Having investigated the potential sites as identified in the engineering studies and the No Action Alternative as discussed herein, the Alternative 2 is selected as the best considering the issues discussed.

2.1.3 Mitigation through Planning and Design

Throughout the project, from the outset of initial planning, site selection and preliminary design, the approach has been one of "Mitigation through Planning and Design", whereby potential environmental impacts have been identified and measures introduced to reduce the adverse impacts as far as is practicable. This has reduced the overall potential for adverse impacts to occur as well as the need to apply mitigation measures.

Table 2.1 Comparison of Alternatives

		Item	Alternative 1	Alternative 2
Technical and Economic Aspects	(i)	Dam height (m)	49	32
	(ii)	Tunnel length (km)	1.8	3.1
	(iii)	Effective head (m)	70.5	69
		Gross Head (m)	75	75
		Head loss (m)	4.5	6
	(iv)	Annual Energy (GWh)	83	82
	(v)	Topographic conditions	favourable	favourable
	(vi)	Geological conditions	favourable	favourable
	(vi)	Project costs (USD Million) *	42	35
Environmental and Social Aspects	(i)	Project impacted area	high	low
	(ii)	Inundation of existing roads (km)	3.5	0.4
	(iii)	Inundation of cultivated and other lands	high	low
	(iv)	Resettlement effects	high	low
	(v)	Sanitation problems and health hazards	same	same
	(vii)	Impacts on livelihood of people	high	low
	(viii)	Environmental Mitigation Costs	high	low

Note: 1 * Project costs have only been taken of the dam and tunnel

2 A ranking (low and high) has been used to compare the alternatives as the impacts have not been quantified. This ranking is based on relative comparison of the two alternatives and not against any absolute value.

Mitigation by Planning and Design has incorporated the following.

(i) Selection of Full Supply Level of the proposed reservoir resulting in reduced inundation areas and mitigation costs

Reservoir FSL as determined in the Pre-feasibility studies is 550m asl. This would mean the water level will extend beyond the confluence of Kothmale Oya with Mahaweli Ganga. The FSL at 550m asl would mean that a section of the Mawathura - Galatha road will get inundated. Lowest level of this road is at 534m asl, 24m above the river bed level at dam site. Therefore to reduce the inundation of this road, having the FSL at 534m asl has been looked into. This would result in a reservoir with 0.75MCM and the 534m asl level will not be adequate to provide the necessary submergence of the tunnel. This means the inundation of Mawathura-Galatha road cannot be avoided in planning the project. At 550m asl, the length of the road affected will be about 700m which could be relocated without much difficulty.

Reservoir FSL at 550m asl covers a large section of the Ulapane Oya valley onto the left of the Nawalapitiya –Gampola A113 main road. At some places water level will reach very close to this main road and will even inundate a small section of this road at Ulapane. Also, the Ulapane village consist of houses built on narrow strips on either side of this road and it is felt that the presence of a reservoir in the form of a shallow pool on the backside of this village would pose a threat of mosquito breeding and could also raise issues of sanitation due to accumulation of waste material.

When the areas of inundation of the Ulapane Oya valley was studied, it was seen that FSL at 547m asl will have less inundation while at 548m asl will be confined to the river banks with still a small inundation area. This led to plan the reservoir FSL at 548m asl reducing the extent of the pool created.

(ii) Selection of Tunnel alignment

(a) Selection of Intake location and layout of Initial part of the waterways resulting in arresting the problem of concerns of Investors of the Ulapane Industrial Estate

Investors of the Ulapane Industrial Estate had concerns regarding the tunnel being aligned beneath the Industrial Estate. It was decided to have the tunnel aligned as much as possible, away from the Industrial Estate area. As such, the intake was located very close to dam to avoid having any adverse impacts due to blasting on the industrial buildings as conceived by the Industrialists.

(b) Selection of Outlet Portal location for the Tunnel and penstock tunnel alignment resulting in reduced excavations and costs, better Environment Management and preserving the function of Dunhinda irrigation canal

Powerhouse location for above 03 alternatives discussed in section 2.1.1 was selected giving due consideration to the provision of easy access to the facility, the ability of utilizing the available potential to the maximum and the constraints that may be posed in construction etc.

How ever, the geological investigations revealed that favourable geological conditions for the tunnel outlet portal in Alternative 2, which was selected as the best is not available and therefore a new location for the Powerhouse has been investigated. ***Figure 2.2(a)*** shows the investigations made for the location of tunnel outlet portal and are indicated by lines 1, 2 and 3. The alignment indicated by line 1 is the alignment considered initially in Alternative 2.

As shown by the alignment of Line 2 in ***Figure 2.2(a),*** the possibility of locating the powerhouse by the minor stream has been investigated. The rock conditions along Line 2 is much favourable than that of Line 1 but it has been revealed that about 50m length of open cut excavation is required to reach a

suitable Portal. ***Figures 2.4*** and ***2.5*** shows the rock levels along Line 1 and Line 2.

This would mean that if this location is selected for the Outlet Portal, the damage to the Environment would be quite high in respect of the dumping of spoil material is concerned. This means, the resulting mitigation costs to meet the Environmental concerns would be high besides high costs that would be involved in such large excavations which would not be justifiable for the size of the Project.

Along the alignment of Line 3 as shown in ***Figure 2.2(a)*** the geological investigations has revealed reasonable rock levels and satisfactory conditions for location of the Portal. How ever, due to "not very favourable" conditions for alignment of the Penstock tunnel between the Outlet Portal and the Powerhouse, the possibility of locating the powerhouse at a location along the extended alignment of Line 3 has also been investigated. This would result in a loss of 7m head for power generation and high costs involved in providing an access road to this location In addition to severely disturbing the Dunhinda irrigation canal while providing access to the powerhouse. Hence the location of the powerhouse on the extended line 3 was discarded. ***Figure 2.6*** shows the rock levels along Line 3.

The aspect of effects on the Dunhinda irrigation canal was considered foremost and giving due consideration and priority for undisturbed functioning of the irrigation canal, powerhouse was sited at the originally identified location minimizing the interference of the project activities on the canal.

2.1.4 Conclusion on the Preferred Option

From the assessments carried out during feasibility studies, Alternative 2 has been identified as the best alternative for the Proposed Moragolla Hydropower Project. This alternative combined with the concept of "Mitigation through Planning and Design" has resulted in adopting the reservoir FSL at 548 m asl and the penstock tunnel aligned as given by line 3 (investigations made for outlet portal of the tunnel) as the Preferred Option for the Proposed Moragolla Hydropower Project.

The Preferred Option has been based on the evaluation of the following issues (which have been discussed in detail above).

(i) Environmental issues and concerns related to extent of inundation of cultivated areas, settlements and infrastructure.

(ii) Environmental issues such as potential health risks involved.

(iii) Environmental Management Concerns in terms of spoil dumping and effects on livelihood of people.

(iv) Project costs.

All the above issues are constraints in locating a hydropower project and issues (i) to (iii) have been adequately mitigated by the preferred option and the preferred option has a lower cost than the other alternatives.

This approach is further extended in the detailed design of the project via "Mitigation by Design" to minimize environmental impacts and mitigation.

2.2 Description of the project

2.2.1 Details with regard to Project Development

CEB in their generation planning studies has identified the Moragolla hydropower project as a candidate hydropower project. Government of Sri Lanka (GOSL) has received funding from the Kuwait Fund for Arab Economic Development (KFAED) to carry out a feasibility study for the Moragolla hydropower project. The Environmental Impact Assessment (EIA) study also is to be carried out during the study.

The implementing agency of the project on behalf of the GOSL is as follows.

Ceylon Electricity Board
5th Floor, No. 50,
Sir Chittampalam A. Gardiner Mawatha
Colombo 02.

Project Location

The project location is given in ***Figure 1.1***. The project area and accessibility to project area is given in ***Figure 2.7*** and the project area with the surrounding developments is shown in ***Figure 2.8***

The project is located in the Kandy district, in the central part of Sri Lanka. The project consists of a 4.23MCM capacity reservoir formed by the construction of a concrete dam across the Mahaweli Ganga at Weliganga which diverts water via an underground tunnel and penstock to a 26.5MW capacity surface power house located at the left bank at the confluence with the Atabage Oya and with a generation of 81.65GWh of mean annual electric energy.

The project area demarcated for development interventions under proposed Morogolla power project located in different administrative divisions are described in ***Table 2.2***

Present ownership of the project site

The ownership of the lands that will be used to establish different project components are given in ***Table 2.3*** in ***Annexure 1.***

MASL and RDA are the only state agencies besides private parties who owns lands where there will be project interventions. Most of the lands are owned by the MASL. According to a letter that has been issued by the MASL (Reference letter ED/TS/MH/MORA/14 of 18th June 2009: ***item no. 12*** in ***Appendix A***) a consensus has been reached among participants at a meeting held at MASL on 8th Feb. 2006, to accept the CEB's proposal to carryout the Feasibility Study for the Moragolla Project which will be constructed on the Mahaweli River. Furthermore, MASL is the Project Approving Agency for the Environmental Approval.

RDA has also issued a letter (Reference letter RDA/ES/H/CP of 03RD Aug. 2009: ***item no. 5*** in ***Appendix A***) in relation to the stretch of road being inundated due to the proposed reservoir and proposed road improvements.

The process to be followed in acquisition of land for the project has been discussed in detail under section 5.6.5. CEB needs to develop a harmonious approach to reach owners of the plots of lands that need to be acquired for the project. Proper negotiations has to be held with all the affected parties highlighting the need of the project while giving due consideration to the concerns of the land owners.

Table 2.2 Locations of different projects interventions based on administrative divisions

Project component	District	DS divisions	GN divisions	Villages
Dam	Kandy	Ganga Ihala Korale and Udapalatha	Ulapane North & Weliganga	Ulapane and Weliganga
Reservoir	Kandy	Ganga Ihala Korale and Udapalatha	Weliganga, Kalugalhinna, Ulapane North, Ulapane South	Weliganga, Kalugalhinna & Ulapane
Tunnel/Inlet and Outlet Portals, Surge Shaft and penstock	Kandy	Ganga Ihala Korele	Ulapane North, Singhapura, Gampolawela, Udagama	Ulapane, Denmark village, Singhepura & Gampolawela
Power house, Access road to P/H, Switchyard area, tailrace canal	Kandy	Ganga Ihala Korale	Gampolawela	Gampolawela
Access road to surge chamber	Kandy	Ganga Ihala Korale	Ulapane South	Denmark Watta
Power Transmission Line	Kandy	Ganga Ihala Korale	Gampolawela	Mariawatte (part)
Residential camp / office area & stores	Kandy	Udapalatha	Weliganga	Weliganga
Labor camps at left bank near dam site	Kandy	Udapalatha	Ulapane	Ulapane
Alternative Access road	Kandy	Udapalatha	Weliganga	Weliganga
Spoil dumping sites	Kandy	Uda Palatha	Galatha, Angammana	Kaulpana, Galata watta, Orwelwatta

Access to Project Site

The project site can be reached by two major routes as described below.

Route 1

Along Colombo–Peradeniya, A1 highway and from Peradeniya to Ethgala (where Power House and Surge Chamber access roads start) on AB 13 Highway.

Starting from Peradeniya, the dam site could be accessed through Peradeniya - Nuwara Eliya A5 highway turning off at Atabage and proceeding on Atabage - Mawathura road to Dam site at Galatha.

Route 2

Along Colombo- Avissawella on A4 highway and from Avissawella to Ginigathhena on A7 highway and then from Ginigathhena to Nawalapitiya on B 319 Highway and from Nawalapitiya to Ulapane on AB 13 Highway.

Dam site can be reached from Ulapane to Mawathura on B 431 Highway and then from Mawathura to Galatha on Mawathura - Atabage road.

From Ulapane, proceeding further on AB 13 Highway towards Gampola from Nawalapitiya, at Ethgala the starting point of access to Power House and Surge Shaft can be reached.

These existing public roads in the project area provides easy access to the project sites. Heavy equipment for the construction of Kothmale hydropower project and the on-going Upper Kothmale hydropower project are transported along the above mentioned two major routes.

Access to Project Site is given in ***Figure 2.7***

2.2.2 Project Layout

The final project layout is as shown in ***Figure 2.9***

2.2.3 Major features / components of the project

The major features /components of the Moragolla project are as follows.

(a) General

Catchment Area at the Dam	:	247 km^2
Mean Annual inflow	:	21.95 m^3/s
10,000-year Return Period Flood	:	6000 m^3/s
25-year Return Period Flood	:	1058 m^3/s

(b) Diversion facilities

The details with regard to the dam are shown in the following Figures.

(i) Cross-section of the river taken at the proposed dam site is shown in ***Figure 2.10***

(ii) Elevation of the proposed dam showing the existing ground levels, levels of excavation and crest level and openings is shown in ***Figure 2.11***

(iii) Plan of the proposed dam including design, length and type etc. is shown in ***Figure 2.12***

(iv) Spillway (to accommodate impact of the releasing flood waters of the Kothmale dam) is given in ***Figure 2.13***

Dam & Intake

Type	:	Concrete gravity
Height	:	35 m
Crest Elevation	:	550 m asl
Crest length	:	214.50 m
Design flood	:	6000 m^3/s
Design flood level	:	548.25 m asl
Size of intake gate	:	4 m X 6 m
No. of gates	:	03
Bottom Outlet	:	01 No. (with 02 gates ; 01 no. revision gate and 01 no. service gate)
Capacity	:	260m^3/s
Size	:	4m X 4m
Facilitation of Environmental release	:	1.5 m^3/s through a Separate pipe (at elevation 534m asl)

Spillway

Type	:	Radial (Steel)
Crest elevation	:	534.0 m asl
Crest height	:	19 m
Spillway length	:	60.0 m
Gate size width/height	:	15m X 15m
No. of gates	:	05 (01 no. gate with top flap)

Reservoir

Full supply level	:	548 m asl
Minimum operating level	:	542 m asl
Total capacity at FSL	:	4.23 MCM
Effective capacity	:	1.87 MCM
Surface area at FSL	:	36.5 Ha

Possible inundation areas due to the reservoir

About 400m stretch of the Mawathura-Atabage (Galatha) road which passes over a low lying area will be inundated due to the proposed reservoir. A new road from the existing road as a road diversion with a length of 998m will be constructed to bypass the inundated segment of the road which will be connected back to the existing Mawathura- Atabage (Galatha) road.

There will be no impact on the existing Gampola-Nawalapitiya road or the railway track including Ulapane railway station due to the proposed reservoir as levels of proposed reservoir during normal and flood conditions are well below these infrastructure.

Abutments and arches of the new arch-bridge over Mahaweli Ganga on Ulapane-Mawathura road will be partially submerged due to the proposed reservoir. The water level will be well below the bridge deck level.

Area of inundation is shown in ***Figure 2.9*** together with the important roads and structures.

According to RDA, Bridge piers and abutments are on spread footings which are founded only on weathered rock layers at some places where sound rock was not encountered during construction. RDA propose that the ground surface around the abutment and piers submerged be protected with rubble paving up to a height of 1.0m above the FSL of the reservoir using cement sand mortar as shown in RDA drawing CP/B/0722/02 in ***item no. 5*** in ***Appendix A***.

(c) Waterways

Headrace tunnel

Length	:	2980 m
Length Concrete lined	:	2835 m
Length Steel lined	:	145 m
Design discharge	:	45 m^3/s
Diameter, Φ = 4.5 m		
Shape	:	Horse shoe (excavated), Circular (lined)

Surge Shaft

Type	:	Restricted Orifice (Circular)
Shape	:	Circular Diameter, Φ = 13.5 m
Height	:	73 m
Up surge water level	:	566.92 m asl
Down surge water level	:	526.67 m asl

Penstock Tunnel

Length	:	145 m
Diameter	:	3.3 m

Surface Penstock

Length	:	185 m
Diameter	:	Varies 2.7 m to 1.5 m
No. of lines	:	01

(d) Powerhouse & Tailrace channel

Power house type	:	Surface
Length, L = 29.0 m,		width, W = 18.0 m
Tailrace channel	:	Open channel, 25 m long
Shape	:	Rectangular channel with a bed width of 14.8 m
Crest level at the outfall	:	471.6 m asl
Normal Tail water level	:	473.00 m asl
Maximum TWL	:	486.50 m asl

(e) Electrical and Mechanical Equipment including Power Generation Equipment

Turbines

Type	:	Vertical axis Francis
No. of Units	:	02
Rated Discharge (per unit)	:	22.5 m^3/s
Speed	:	500 rpm
Rated Output	:	13.25 MW X 2

Generators

Speed	:	500 rpm
Rated Voltage	:	11 kV
No. of Units	:	02
Rated Output	:	17.2 MVA X 2
Rated frequency	:	50 Hz

Transformers

Type	:	Three phase oil immersed
Voltage	:	132 kV / 11 Kv
Rated Output	:	17.2 MVA x 2

(f) Power Generation

Maximum discharge	:	45 m^3/s
Rated head	:	69.38 m
Installed capacity	:	26.5 MW
Annual energy	:	81.65 GWh

(g) Transmission Line

Type	:	Overhead, double circuit with single mode OPGW
Length	:	500 m

The new transmission line from Moragolla switchyard is to be connected to the Tower No. 3, Circuit No. 1 of existing 132kV Polpitiya –Kiribathkumbura transmission line. Since the Tower No 3 is a Suspension tower, a new Terminal Tower of appropriate capacity will be erected closer to the existing Tower. New Moragolla Switchyard will be connected to the existing circuit No. 1 through a Short line section of 500 m and will be connected to the new Tower erected below the existing line. The new line section consists of a Suspension Tower and a second Terminal Tower at Moragolla Switchyard (***Figure 2.25***).

(h) Temporary Structures

A Memorandum of Understanding between the Ceylon Electricity Board and the Mahaweli Authority of Sri Lanka will be made in relation to provision of necessary general specifications for the relevant contractors for the management of such areas providing all temporary facilities (such as spoil dumping sites, temporary huts including labour camps within the 60m river reservation) during and after the project and adhering to any requirements / restrictions by the MASL (a sample MOU is given as ***item no. 1*** in ***Appendix F***).

Coffer dams

Prior to construction of the main dam a coffer dam will be constructed across the river section immediately upstream of the proposed dam site thus paving way for the construction of the main dam.

Contractors and Engineer's site offices, Contractor's store building and store yards, labour camps

All theses temporary buildings will be constructed both at the dam site area and power house site area.

Quarry sites

Large quantities of construction materials will be required for the Dam, Tunnel, Inlet and Outlet Portals and other construction works related to the project. It has been estimated that the total aggregate requirement is around 89000m^3. It has also been estimated that the rock excavation volume in Dam, Tunnel and Penstock and Powerhouse areas will be around 195000m^3.

This means sufficient amount of rock material will be available at the site itself for construction works. How ever there is a need to obtain the initial material requirements of aggregates until the materials are available from construction areas at the site. Environmental conditions prevailing has posed restrictions on opening up of new quarry sites or use of old quarry sites in the vicinity of the project area for extraction of large quantities of materials. Therefore project activities will have to be planned so as to use as much as possible the material that

will be available from construction activities thus reducing the need of large quantities from quarries.

Three quarry sites have been identified in the feasibility study (***Quarry sites 1 to 3***). There are constraints in exploitation of two of those sites (***Quarry sites 1 and 2)*** due to environmental concerns prevailing in the area and safety of the existing Kothmale dam. A fourth quarry site (***Quarry site 4***) was identified lately.

It is to be noted that MASL does not permit transportation of quarry material along the road above the Kothmale dam. The closest quarry site to the proposed Moragolla project site via public roads is Quarry no. 3. Subjected to the restrictions / conditions mentioned hereunder with respect to each of these quarry sites, most optimistic site is considered as ***quarry site no. 3***.

Quarry No.1 (7^0 03' 55", 80^0 36' 00")

The quarry site is located at the right bank of the existing Kothmala Oya. This quarry cannot be exploited as according to the Geological Survey & Mines Bureau, it would adversely affect the surrounding area if further quarry activities are carried out because soil creeping and earth subsidence have been reported since impoundment of the Kothmale reservoir. Ownership of this site lies with the MASL and presently it is in operation in a small scale by a private party.

According to EIC, Kothmale, MASL, GSMB approval has been granted to use the boulders available at site but not for fresh extraction by blasting (reference. ***item no. 4*** in ***Appendix A***).

Quarry No.2 (7^0 03' 21", 80^0 35' 54")

The quarry site is the old quarry site at the left bank of Kothmale Oya and is located close to the dam within the high security zone. GSMB has recommended only for IML-C (Industrial Mining License – Category C) without affecting the membrane of the dam. That is, only a very small quantity of rubble can be extracted under this condition. If large scale blasting is to be done, an EIA for the quarry site will be essential.

In respect of material transportation, access to Moragolla project site from this quarry site is far along the public roads but the use of the shortest route is over the Kothmale dam which is not permitted by the MASL (reference ***item no. 4*** in ***Appendix A***).

Quarry No.3 ($7^0$02'10", 80^0 33' 33")

This is an existing quarry located about 6 km from Nawalapitiya along Nawalapitiya-Talawakelle main road. There are two adjoining quarries at this location which are in operation. One is owned by the Pasbage Pradeshiya Sabha while the other is owned by a private party.

To reach the proposed Moragolla project site from this quarry site, there is a total distance of about 19 Km of material transportation up to the turnoff at Mawathura and it is the closest quarry site. Since this quarry site is presently under operation, access to this site is already available and Moragolla site can be reached through

Ulapane via Nawalapitiya. Attention shall be paid to the allowable limits of loads for transportation of quarry material on Ulapane Pusselawa bridge over Mahaweli River.

Quarry No.4 (7^0 03' 00", 80^0 41' 31")

An old quarry site was identified lately near Ramboda pass on route A5 along Nuwara –Eliya Gampola main road close to Ramboda town. Proposed Moragolla project site can be reached by turning off at Nawakandura along Nuwara –Eliya Gampola main road. From this quarry site there is a total distance of about 27 Km of material transportation up to the turnoff at Mawathura. This site is far from the project site and there is no proper location for the crusher plant. Therefore the use of this fourth quarry site can be considered as only a remote possibility.

Quarry sites and Crusher Plant sites shall have no adverse effects on the environment and hence all precautions will be taken to minimize the hazards from blasting, noise pollution and dust emissions.

Locations of the quarry sites are shown in ***Figures 2.14***. Based on the above facts use of Quarry site 1 and 2 is restricted and it is possible to use only Quarry sites 3 and 4.

How ever, the site for quarrying the rock required for the construction works of the project will be decided by the selected construction contractor and carry out the necessary testing to determine the suitability of the materials for intended purposes. All necessary approvals and licenses for the operation of the quarry and transport of materials have to be obtained by the construction contractor.

Spoil Disposal Areas

The proposed alignment of head race tunnel, surge shaft, powerhouse and tunnel outfall area are along the left bank. The tunnel will be excavated from the two ends and there will not be any adits. Part of the materials extracted from rock excavation will be used in the coarse aggregate production for construction works. Material from earth excavations will be used in backfilling and landscaping works. Therefore only the excess material will have to be placed in spoil dumps.

Arrangements have been made to dump excess spoil in five state owned Lands. Four of these lands with a total extent of 5.0 ha is coming under the purview of Chief Engineer (Kothmale Power Station), CEB and a land with an extent of 2.05 ha belonging to MASL will be used as spoil dumping sites. These dumping sites will be utilized for dumping the excess spoil after having the spoil disposed off in other permitted places ; in granting approval for the EIA for the project, Chairman, Ganga Ihala Korale PS - Kurunduwatte Kadeweediya in his recommendations (reference ***item no.11*** in ***Appendix F)*** has stated that spoils be disposed off in constructing playgrounds in schools and in public places specified by the PS. Chairman, Udapalatha PS, Delpitiy – Atabage has also given his consent and has mentioned that the spoil disposed from the project could be used by the PS for land reclamation works under it's authority (reference ***item no. 12 in Appendix F)***.

The proposed locations of spoil dumping sites are as follows and are shown in ***Figure 2.15.***

Dumping Site	*Latitude (N)*	*Longitude (E)*	*Ownership of land*	*Landmark*
1	513700	478483	CEB	Near the existing road
2	513553	478741	CEB	Close to Kothmale Power House and Switch Yard
3	513372	478952	CEB	Near the existing road
4	513037	478980	CEB	An old dumping site of Kothmale Project
5	514721	478579	MASL	Near the Army Camp

Both CEB and MASL consent has already been received for the use of all spoil dumping areas (reference ***item nos. 1, 6 , 7, 8*** and ***9*** in ***Appendix F***).

Google Images of these dumping sites are shown in ***Annexure 8***.

All five sites identified as spoil dumping sites (for both, soil and rock) lie downstream of the proposed Moragolla dam and on the right bank of the Mahaweli Ganga and have been described below.

Dumping site 1

The proposed site is fully covered with vegetation and is in Galata Watta area by the side of the road that runs from Ulapane to switch yard of the Kothmale power house.

Dumping site 2

The proposed site is covered with vegetation and is the largest of the sites proposed for spoil dumping and is situated just below the Kothmale switch yard. The slope of the area is about 40^{o} – 50^{o}.

Dumping site 3

The proposed site is situated just passing the switch yard of the Kothmale Powerhouse and it is a nearly flat terrain with a gentle slope. High tension electric line crosses the land. Access to the site is possible with existing conditions.

Dumping site 4

The proposed site is located in front of the Kothmale surge tower. This site has been used previously also as a dumping site and it can be extended if required..

Dumping site 5

The proposed site has been used previously as a dumping yard. The area is close to the Army camp and is located by the side of the Atabage Road (road connected to Gampola – Pussellawa (A05) road). Mahaweli River is one of the boundaries of the site

A Memorandum of Understanding between the Ceylon Electricity Board and the Mahaweli Authority of Sri Lanka will be signed at the time of construction of the project in relation to provision of necessary general specifications for the relevant contractors for management of spoil disposal in Mahaweli river reservation areas within 60m including regulation of impacts to the Mahaweli river. A sample MOU in this regard in accordance to the conditions stipulated by the MASL is given as ***item no. 1*** *in* ***Appendix F***.

Labour Camps

Labour camps will be located at the dam site / intake areas and powerhouse site area. After the completion of the project, the contractor will restore areas utilized for labour camps to a condition prior to putting of such camps. A Memorandum of Understanding between the Ceylon Electricity Board and the Mahaweli Authority of Sri Lanka will be signed to this effect.

(i) Access Roads

Access roads are to be provided to the dam site, intake site, surge shaft, penstock, power house, tailrace, tunnel outlet, construction camp site and also for quarries and crusher plant site. While giving alignments to the road construction works, the slope stability to be given adequate care; Some retaining walls and toe walls will be constructed at the new road formations to retain embankment fillings, existing road drainage systems will be improved, existing culverts shall be re-constructed or re-habilitated where necessary.

Access roads in the project area are given in ***Figures 2.16 (a), 2.16 (b)*** and ***2.16 (c)***

(j) Permanent Residential Camps for staff, Offices and Facilities

The residential camps and offices for the construction supervisory staff of the Client, Consultant and the Contractors during the construction period of 52 months and as quarters and offices for the operation and maintenance staff of the Client after completion of construction of the Project.

The camp area is located 300m upstream of the proposed dam and at the right bank. The land is 2.7 ha in extent and has a gentle sloping terrain. Access to the camp area will be a deviation from the proposed realigned section of the Mawathura - Atabage road and the length of the deviation road is about 184m.

The camp area will house the following permanent buildings.

3 bed residence (Type A)	-	4 Nos.
3 bed residence (Type B)	-	7 Nos.
2 bed residence (Type C)	-	7 Nos.
Dormitory 5 rooms (Type A)	-	1 No.
Dormitory 5 rooms (Type B)	-	2 Nos.
Dormitory 5 rooms (Type C)	-	2 Nos.
Total		**23 Nos.**

Access roads, power distribution, water supply and sewage system will be provided for the camp. Social and welfare facilities such as Club house etc. and medical care facilities also will be provided at the camp premises.

In addition to the above, part of the land in the camp site will be allocated to the Contractor to build their staff residential quarters. These houses are categorized as semi-permanent buildings and the estimated number of units is 15.

Proposed camp area is shown in ***Figure 2.17***

2.2.4 Methodology of Construction

Project construction will comprise mainly of concrete structures. The dam across Mahaweli will be a concrete gravity structure. The dam construction will be done in two stages with diversion of the water flow in the river and protecting the dam construction area using coffer dams. The intake tunnel lining, outfall etc. will be concrete structures.

Conventional drilling and blasting method will be used to excavate the underground tunnel from the two ends without an adit and the rate of progress will be 125 m / month. Headrace tunnel will be excavated with the full face tunneling using 3- boom wheel jumbos, side dump type muck loaders and dump trucks. Electric detonators with delays and gelignite will be used as blasting materials and controlled blasting technique will be used.

Shotcrete and rock bolts will be used as tunnel supporting work. Steel rib supports will be used as the support system in weak rock sections if found necessary. Where necessary, the tunnel will be concrete lined. Dewatering in the tunnel is done by gravity through an excavated drainage ditch downstream excavation face and by pumping at the upstream excavation face. After completion of excavations tunnel concreting will be done.

Leg drills, overhead loader, dump trucks, telescopic formwork, concrete pump, concrete truck mixers, raise climber, excavators, track drills, tower/truck cranes will be used in the construction works.

Concrete structures will be constructed using traditional methods, by placing them inside steel or timber formwork. Once concrete structures will be installed using mobile or gantry cranes.

The aggregates which will be available from the tunnel excavations can be well utilized for the construction of the dam. Metal crushers have to be installed at the quarry site as well as tunnel site so that aggregates can be sized to suit the requirements.

All the construction materials like Cement, river sand, aggregate, rubbles, bricks, timbers, steel etc have to be used in the construction of structure.

Gates, valves and penstocks will be made of steel of appropriate grade. Powerhouse will be a reinforced concrete structure, while turbine and generators are of steel.

2.2.5 Site preparation activities

Site clearing will take place first and all surface constructions will be carried out after open cut excavations to appropriate levels as shown in the drawings. Materials from excavations will either be reused or disposed in a careful manner.

Temporary structures will be constructed mainly for river diversion in the form of coffer dams. Details of construction of coffer dams are discussed in section 4.4.5

Underground construction activities will involve excavation of tunnel in rock and concrete lining. Pre construction activities will include development of access roads, construction power lines, workers camps, water supply schemes for construction work, setting up of crushers, concrete batching plants, bar bending yards, formwork construction yards, material storage areas, housing for work force.

A Memorandum of Understanding between the Ceylon Electricity Board and the Mahaweli Authority of Sri Lanka will be made in relation to provision of necessary general specifications for the relevant contractors for environmental protection and soil conservation measures, clearing of work sites and landscaping of the areas affected by construction activities (of both permanent and temporary facilities) etc. and any requirements / restriction by the MASL in the MASL reservation areas.

2.2.6 Details of any phased development activities and time schedule

The construction programme drawn up for the project covers 52 months period and is shown in ***Figure 2.18*** The preliminary activities such as access roads, camps etc. will be constructed during early period of construction.

2.2.7 Any infrastructure facilities required /provided by the project (access road etc.)

In addition to the Access Roads mentioned under section 2.2.3 part of the road from Mawatura to Atabage (Galatha) at the right bank which passes over a low lying area immediately upstream of the proposed dam will be inundated due to the proposed reservoir. Length of road inundated will be about 400 m.

A new road will be provided in place of the inundated segment of the road. The new road will be a diversion from the existing RDA road which will be connected back to the existing RDA road by passing the inundated part. The length of new diversion road is about 998 m between the points of diversion.

Area of inundation is shown in ***Figure 2.9*** together with the important roads and structures. While giving alignments to the road construction works, the slope stability will be given adequate care; some retaining walls and toe walls will be constructed at

the new road formations to retain embankment fillings, existing road drainage systems will be improved by re-constructing or re-habilitating the existing culverts where necessary and new culverts will be constructed at stream crossings and valleys.

Other infrastructure related to project will involve setting up of camps/housing both permanent and temporary for the use by workforce during construction as well as

operation stage.The project locations will be provided with construction power supply lines and water supply lines.

Apart from the above, the construction camp needs to have a couple of other infrastructural facilities towards the well being of its inmates and the local inhabitants. Among these, health centre, reading room, garden/park, children's playground, nursery school / creche, etc. are important. The medical centre should have adequate facilities for diagnosis and treatment of diseases (particularly waterborne and communicable diseases), fractures and burns (resulting from accidents) and to undertake vaccination programme in association with the nearby local hospital at Ulapane.

It is also necessary to have adequate parking space for vehicles.

Also due to the impoundment of the reservoir area, the local people who used to take bath in the river will be deprived of their bathing sites at the river stretch. Therefore a small pool will be constructed near the bridge with steps to reach the water. At present 03 locations in the upstream and 01 location in the downstream of the proposed dam are used for bathing.

A check post, a police out post, extension counters of the local post office, Bank and a super market are the other requirements in the camp area. Further, fire extinguishers have to be established at different points within the project area towards preventing accidents from fire.

It is also important to ensure adequate supply of fuel (LPG) or kerosene/ or firewood.

2.2.8 Workforce

The workforce requirement depends on the way the construction works will be carried out by the contractor. However, based on the past experience on similar projects, the workforce requirement can be around 800 during peak times during the 2nd and 3rd years of construction.

It is likely that unskilled labourers could be recruited locally from the project area as well as from other nearby areas. Unemployed and persons who were involved in sand mining operations in the project area too will be able to work in the project.

2.2.9 Investment and funding sources, total cost of the project, the time schedule of the construction period and details of phased development if any

Total cost of the project	: US$ 85 Million
Construction period	: 52 months
Phased development (if any)	: No. Construction will follow the construction programme given in ***Figure 2.18***

2.2.10 In case of civil structures, dimensions, drawings etc.

The following Figures give the details of all civil structures.

Figure 2.19 shows the waterways – plan and profile
Figure 2.20 shows the waterway intake – plan and sections
Figure 2.21 shows the waterway – Surge Shaft
Figure 2.22 shows the waterway – Penstock Tunnel
Figure 2.23 shows the Layout of Powerhouse and Switchyard
Figure 2.24(a) & 2.24(b) show the Powerhouse sectional elevations

2.2.11 Arrangement for discharge of forecasted probable maximum flood

The probable maximum flood (PMF) expected at the dam site is taken as a flood of 10,000 year return period. The peak flow is estimated as 6000 m^3/s. The spillway provided at the dam consists of 05 nos. of steel radial gates of each dimensioned 15m wide and 15m high. Each spillway gate bay is capable of passing a flow of 1550 m^3/s with gates in fully opened position and without any rise in the water level above the full supply level of 548 m asl. Thus when all gates are in fully open position, the spillway is capable of discharging 7750 m^3/s without a rise in water levels above the full supply level.

Thus there is ample capacity provided in the spillway and even if one gate bay is non-operational during a flood event, flood can be passed safely without undue rising of water levels in the reservoir above full supply level.

2.2.12 Details required to check the adequacy of the proposed dam and associated structures considering probable failure conditions.

Dam failure can occur due to a variety of reasons such as overtopping and due to specific shortcomings of the dam itself. A dam can fail in three different ways. They are; over-turning due to applied forces, sliding along the foundation or weaker planes in foundation material and failure of the foundations due to excessive loading.

If the dam does not have adequate discharge capacity and storage capacity to safely pass the probable maximum flood, overtopping flows can impinge on the downstream abutments and toe and scour foundation material from an area critical to the stability of the dam. Then it is likely to cause sudden and complete failure of the structure. The failure by overtopping would occur as sliding or overturning due to undermining and loss of toe support.

Dams constructed of earth or rock-fill could fail due to excessive seepage. The dam proposed for Moragolla hydropower project is made of concrete and is founded on sound rock which carries almost no seepage through it. However, foundation failure can take place due to seepage through areas of weak zones despite curtain grouting being done to seal the weak zones. This can result in disintegrating the dam leading to the collapse of the dam.

The proposed dam has been designed for adequately resisting overturning and sliding with acceptable margins of safety. Factors of safety are tabulated in ***Table 2.4***

Table 2.4: Factor of Safety for the dam design

Mode of failure	Factor of safety
Overturning	2.0
Sliding	1.5

Also, as discussed under section 2.2.11 above, Moragolla dam and the spillway has been designed with adequate provisions been made to safely discharge the PMF without the dam being overtopped. The spillway has a discharge capacity of 7750 m^3/s whereas the PMF is estimated as 6000 m^3/s. Even if one gate bay is non-operational during a flood event, flood can be passed safely without undue rising of water levels in the reservoir above full supply level. Therefore no condition will arise so as to have the dam overtopped.

2.2.13 Proposals for Emergency Action Plan along with arrangements for early warning systems and details required to ensure the dam safety aspects.

Emergency situation

An emergency situation can be a condition of serious nature which develops unexpectedly and endangers downstream property and human life and requires immediate attention. In such an emergency situation, external interventions will be required to cope with the situation as the local communities and groups will not be able cope with the situation on their own.

In case of the Moragolla project, in relation to dam safety aspect, such emergency situations can arise due to catastrophic flooding that may occur in the event of a dam failure in which life and property in the potentially inundated reaches downstream of the structure will be at risk.

Dam Break Analysis and Inundation Mapping

In fact the evaluation or determination of the emeging wave of dam break due to extreme flood events is an initiative needed for defining the risk of submergence of areas located downstream of the existing dams and consequently to prepare protective measures, both active (Reservoirs, dikes) and passive (emergency and evaluation plans) in the areas affected.

The topographic characteristic varies significantly within the project area. The river passes through deep gorges, terrains with pebbles and boulders and then through alluvial plains. Most of the portion on downstream of the dam lies in the plains. The expected flood due to the failure of the proposed dam has to be analyzed by dam break study considering both dams; Kothmale and Moragolla.

Inundation mapping for the Dam breach of the existing Kothmale dam has been done by the MASL. Inundation mapping can be undertaken for the Moragolla Project during the detail design stage. Land-uses and significant development or improvements within the area of inundations has to be clearly indicated in the inundation maps.

These maps will have to be distributed among the members of the Emergency Action Committee who will use these maps in the development of evacuation plans and procedures in case of failure of the dam. The maps should indicate the travel time of the flood wave on every significant habitation area along the river.

Emergency Action Plan (EAP)

Emergency Action Plan includes all potential indicators of likely failure of the dam, since the primary concern is for reliable identification and evaluation of existing or potential emergency. The Emergency Action Plan identifies potential emergency conditions at the dam and specifies pre-planned actions to be followed to reduce property damage and loss of life.

EAP will need to identify the probable areas likely to be affected, population and structures likely to be affected due to catastrophic floods in the event of dam failure. The EAP should include prevention action, notifications, warning procedures and coordination required with relevant agencies. It should also include evacuation plans and procedures for implementation based on local needs. These comprise demarcation / prioritization of areas to be evacuated, notification procedures and evacuation instructions, safe routes, transport and traffic control, Shelter areas, functions and responsibilities of members of evacuation team.

Preventive action

Once the likelihood of an emergency situation is suspected, action has to be initiated to prevent a failure. The point at which each situation reaches an emergency status shall be specified and at that stage the vigilance and surveillance shall be upgraded both in respect of time and level. At this stage a thorough inspection of the dam should be carried out to locate any visible sign(s) of distress.

Engineers responsible for preventive action should identify sources of equipments needed for repair, materials, labour and expertise for use during an emergency. The amount and type of material required for emergency repairs should be determined for the dam, depending upon its characteristics, design, construction and past behavior.

It is desirable to stockpile suitable construction materials at the dam site. As mentioned above. The anticipated need of equipment should be evaluated and if these are not available at the dam site, the exact location and availability of this equipment should be determined and specified. The sources/agencies must have necessary instructions for assistance during emergency.

Because of uncertainties about their effectiveness, preventive actions should usually be carried out simultaneously with appropriate notification on alert situation or a warning situation.

Also, in the Moragolla Project area there are some MASL declared river reservations where the community members have already encroached. For the safety of the community living in the project area it is advised that action be taken to declare the entire project area as a protected zone by CEB.

Notifications

Notification procedures are an integral part of any emergency action plan. Separate procedures should be established for slowly and rapidly developing situations and failure. Notifications would include communications of either an alert situation or an alert situation followed by a warning situation.

An alert situation would indicate that although failure or flooding is not imminent, a more serious situation could occur unless conditions improve. A warning situation would indicate that flooding is imminent as a result of an impeding failure of the dam. It would normally include an order for evacuation or delineated inundation area.

Communication System

An efficient communication system and a downstream warning system are absolutely essential for the success of an emergency preparedness plan. The difference between a high flood and a dam-break situation must be made clear to the downstream population. Whenever discharge is to be increased, a notice must be issued to the residents in the downstream area through radio, TV. and cable net works and preferably through all channels of TV net work. If failure is likely alert and warnings should be necessarily be communicated to the Emergency Action committee and the downstream

Evacuation Plans

Emergency Action Plan includes evacuation plans and procedures for implementation based on local needs. These could be:

- Demarcation / prioritization of areas to be evacuated.
- Notification procedures and evacuation instructions.
- Safe routes, transport and traffic control.
- Safe areas/shelters.
- Function and responsibilities of members of evacuation team.

Early Warning System

Early warning system will be established in Mahaweli Ganga and Gorok Oya sub basins to obtain advance information on adverse weather conditions in the upper catchment and a flood forecasting model will be developed for the unregulated part of the river basin. Forecasts from this model are coordinated with the early warning and flood forecasting systems of Kothmale and Upper Kothmale reservoirs.

In addition to these measures, early warnings will be issued to the relevant downstream areas before any operation of Moragolla reservoir that could raise water levels in the downstream reaches.

In the case of breach of the concrete gravity dam the following measures can be taken as early warning system to avoid loss of lives properly.

Emergency Action Plan Committee

In order to ensure co-ordinate action, an Emergency Action Plan Committee is required to be constituted. The committee may consist of the Engineers in charge of the Morogolla Project dam and Kotmale Project dam, the Chief Engineer of CEB in charge of both the projects, Superintendent of Police of the Kandy District, District level officers of the Kandy District Disaster Management Coordinating Unit, Dept. of Information / Public Relations, Health, Transport, Railways, Industries / Installations in downstream areas, Army, Red Cross and other non- governmental organization active in the area. Divisional Secretaries of Uda- Palatha and Ganga Ihala Korale are also to be made responsible in disaster management monitoring activities under the direction of the Kandy District Secretariat.

Emergency Action Committee will prepare the evacuation plan and procedure for implementation based on local needs and facilities available. Such plans should include Demarcation of the areas to be evacuated with priorities; Safe routes to be used, adequacy of transport for evacuation, and traffic control; safe areas and distress shelters; security of property left behind in evacuation area; functions and responsibilities of various members of evacuation team and setting up of joint control room.

All personnel involved in the emergency action plan should be thoroughly familiar with the elements of the plan and their respective responsibility. They should be trained in the implementation of the Emergency Action Plan.

It is essential to communicate; by who a declared emergency shall be terminated. There should be proper notification to the public on de-alert signals regarding termination of emergency. The notification should be clear so that the evacuees know precisely what to do while re-entering or approaching the affected areas.

Details required in ensuring the dam safety aspects

Moragolla reservoir is proposed to be constructed downstream of existing Kothmale reservoir. Kothmale is a large reservoir which has a capacity of 175 MCM and regulates nearly 562 km^2 of Mahaweli Ganga catchment. Probable maximum flood peak for Kothmale reservoir is estimated as 5500 m^3/s. The catchment of Mahaweli Ganga not regulated by Kothmale reservoir upstream of Moragolla is only about 247 km^2.

Floods in the total catchment of 802 km^2 has been considered in the flood studies of Moragolla reservoir and the flood of 10,000 year return period is estimated as 6000 m^3/s.

Kothmale reservoir is operated and maintained by the Mahaweli Authority of Sri Lanka (MASL) and when large quantities of water are to be released downstream through the dam gates, settlers and river uses in the downstream areas are informed well in advance by the Authority.

With the construction of Moragolla reservoir a small storage reservoir of about 4.23MCM capacity will be created downstream of the Kothmale reservoir. Flood flows released from Kothmale reservoir along Kothmale Oya or the floods originated in the unregulated part of the Mahaweli Ganga catchment upstream of the Moragolla reservoir will pass through Moragolla reservoir. Therefore the gates in Moragolla reservoir has to be opened in tandem with the opening of the gates of Kothmale reservoir in case if floods originate from that part of the river basin.

Proposed Moragolla reservoir will be operated and maintained by the Ceylon Electricity Board (CEB). Although Kothmale and Moragolla reservoirs will be operated and maintained by different organizations, both organizations are well versed in operating reservoirs in cascades over many years in the island.

CEB who will be operating the Moragolla reservoir has ample experience in operating Kehelgamu Oya and Maskeliya oya reservoir cascades. Similarly, MASL too has considerable experience in operating Victoria-Randenigala Rantembe cascade.

A combined team of two organizations will be responsible for operation of Kothmale and Moragolla reservoirs and the operation rooms of the two dams will be linked by dedicated radio and telecommunication lines to co-ordinate the operations of the two reservoirs.

Operational staff of MASL and CEB will be in close contact round the clock regarding the operational matters related to the two reservoirs. A manual of operational procedures will be prepared and standing orders will be formulated. All operational staff of the two organizations will be made aware of these procedures.

CHAPTER 3

Chapter 3

Description of the Existing Environment

Study Area for the Environmental Impact Assessment Study

The study area for the Environmental Impact Assessment has been confined to areas that are directly and indirectly affected by the project, areas affected by construction activities such as quarries, refuse disposal areas, traffic diversions, work camps, temporary access road, etc. and areas beyond the project site where there are potential for environmental impacts. Such areas studied in respect of different environmental characteristics are as follows.

Socio-*Economic and Cultural Aspects*

The extent of the study area for the socio-economic surveys covers approximately a radial distance of 1Km from each of the geographic locations for proposed development interventions and covers even the areas beyond this for data collection where there are potential environmental impacts such as impacts on human settlements.

The geographical locations studied include:

- Proposed dam site and up stream and downstream areas of the proposed dam
- Land identified for establishing the power house / switchyard, surge shaft
- A belt of 300m as the right of way (corridor) of the proposed tunnel to divert water to the power house via the surge shaft
- A 50m wide belt as right of way (corridor) of power transmission line
- Land proposed for establishing the residential camp /office and stores.
- Right of way (corridor) of the proposed alternative road
- Potential lands for resettlement

Archaeological and Cultural Aspects

The study area for archaeological considerations covers a buffer zone of a 5 Km radius from the project site.

A separate study was conducted by the Department of Archeology to investigate the impact of proposed project on archeological sites if there are any (***Appendix B***).

Ecological Aspects

The extent of the study area for the ecological surveys covers the following areas as stipulated in the ToR.

- An area 50m downstream from the dam site and the tail race
- The area that will be inundated by the resulting reservoir
- The river reservation to a distance of 60 m from the banks

- A 50 m strip along the proposed tunnel trace
- The powerhouse and switch yard
- Other sites which include road expansion and new road construction sites, temporary camp sites and raw material storage areas and spoil dump sites
- Although the ToR has included the study of spray zones, no significant spray zones were identified during the field investigations.

The existing environment of the study area has been described below.

3.1 Physical Environment

3.1.1 Topography

The physiography of Sri Lanka can be best described briefly by the existence of three well-marked plains of erosion cut namely "peneplain" ie. highest peneplain, the central highlands at an average height of 1500-2000m above sea level, stepping down about 1000m is the middle peneplain and surrounding it on all sides and stepping down about 300m and extending to the sea is the third peneplain which has an average height less than 30 m.

Morphologically the Moragolla Hydropower Project area belongs to the middle peneplain of Sri Lanka and its general topography consists of ridge and valley with steep slopes. The ridges are heavily dissected by 1st and 2nd order streams in addition to the main river, the Mahaweli. The streams flow in a dendritical pattern and join the Mahaweli Ganga which flows NNE direction.

In the project area Mahaweli Ganga flows in a steep-sided valley with incised bends and meanders. Left bank slopes are the steepest with slopes ranging from 30° to 35° with shallow overburden. On the right bank, slopes are around 18°.

Moragolla Hydropower project will be located in Mahaweli Ganga between the confluences of Kothmale Oya and Atabage Oya which are two major tributaries in the upper Mahaweli Ganga basin. Notable feature within the project area is Mahaweli river flowing N042^{0}S direction from the upper mountains of the hill country through the existing morphology to its confluence with Kotmala Oya which flows in N238^{0}NW direction and confluence with the Atabage Oya well below the proposed dam site. Within the reach defined by the confluences of Kothmale Oya and Atabage Oya river valley of Mahaweli Ganga is narrow, and therefore the reservoir formed will be largely confined to the river valley.

Left bank of Mahaweli Ganga in the project area is formed by the low hills which rise up to 950m asl separating Mahawaeli Ganga basin and the Maha Oya basin. Right bank of the project area is formed by the northernmost edge of the mountain range which forms the water divide of Kothmale Oya and Atabage Oya sub basins. The water divide rises up to 850m asl.

Figure 2.9 shows the project layout including contours.

River bed of Mahaweli Ganga drops from about 551m asl at its confluence with Kothmale Oya to about 473m asl at the confluence with Atabage Oya. Gross head of about 78m is thus available within this reach. River bed levels are mild both upstream as well as downstream of this reach.

Ulapane Oya, a minor left bank tributary of Mahaweli Ganga joins the river immediately upstream of the dam site. Lower part of Ulapne Oya valley is wide up to about 600m asl.

Downstream of the confluence of Ulapane Oya with Mahaweli Ganga, a low hill which rises up to about 650m forms the water divide of a small left bank tributary named Halagama Oya which runs nearly parallel with Mahaweli Ganga and enters downstream of confluence with Atabage Oya.

Figure 3.1(a) shows the drainage pattern of the project area and ***Figure 3.1(b)*** shows the catchment area of the project.

The local topography consists of northerly flowing Mahaweli River with steep rocky embankments and the river bends at a location of about 500 m upstream of the dam location and meanders with an island form close to the tail water outlet. The river shows characteristic of steep narrowing 'V' shaped valleys in many areas, many potholes and rapids.

The upper end inland delta is created due to the existing flow regiments of the river flows and the FSL of the impounding reservoir is closer to this naturally formed sedimentation area. Middle portion of the existing major flow is directing towards N039^{0}S in a stretch of 3km and meets proposed dam section as shown in ***Figure 2.8***. The River then changes the direction of flow to the N009^{0}E at a stretch of 2.5 km length and confluence with the Atabage Oya. Left bank has been selected for proposed power house and the surge shaft locations of the proposed Moragolla Hydropower project.

Headrace tunnel, underground powerhouse and tailrace tunnel of Kothmale Hydropower Project is located within the hill on the right bank of Mahaweli Ganga in the project area. Therefore, the hill on the left bank becomes the location of choice for placing the headrace tunnel of Moragolla hydropower project.

The highest elevation of the ridge is 700m and the lowest elevation is 520m (River level) at the intake and 473 m at the power house location. The initial section of the tunnel alignment is about N80^{0}W and oblique to the mountain ridge and also oblique to the foliation. In this initial section mountain crest level is 650m. Following a sharp bend, the tunnel alignment is N10^{0}E and is almost in the centre of ridge which is almost parallel to the foliation strike with crest level at about 700m.

After following another sharp bend towards the end, the tunnel alignment is along N78^{0}E direction and is oblique to the foliation. The outfall of the tunnel is in a rocky nose that marks the NE end of the mountain ridge. The entire tunnel crosses two regional narrow shear zones.

Relatively undulated topography with mixed vegetation is a prominent character of the area. The tea lands, abandoned tea, homesteads and shrubs are dominating patterns of the existing land use today. However, industrial zone namely Ulapane Industrial Estate is also situated very closely and bounded by the reservoir at a relatively low elevation. Most of the slopes within the industrial estate are uncovered or with grass. Area seems to be an old or abandoned tea estate. Number of constructed slopes within the area seemed to be disestablished due to excavation and dumping of soil without any appropriate soil protection measures.

Numbers of non engineered constructed slopes are also significant along the road and earth cuts within the Ulapane Industrial Estate. Unstable earth masses created due to the excessive heights and unstable geological setting of some locations are still visible within the project sensitive areas. In general, some of the developments are already active and no appropriate slope protection measures have been adopted so far.

Site drainage measures need to be upgraded and protected against soil erosion. The existing vegetation is not resisting soil erosion. The surface layer of the upper slope may consist of silty sand which generally gets unstable, once it's saturate due to high rainfall intensities.

Figure 3.2 shows the landslide hazard zonation map of the project area.

3.1.2 Geology

Sri Lanka consists of more than 90% of Pre-cambrian crystalline rocks. These pre-Cambrian rocks have been subdivided considering lithology and the age of the rocks to three major groups; Highland complex with Kadugannawa complex as a subordinate unit, Wanni complex and Vijayan complex.

The vast majority of the area of the island is underlain by Precambrian Highland complex, as a belt with 50 to 100 km width and stretching approximately in the direction of north South along the central part of the country. The Precambrian Wanni and Vijayan complexes about 50 km of width are located either side of the Highland complex.

Project area falls within the highland complex and close to its western boundary, very close to the boundary between Highland and Kadugannawa complexes. The general geological structure of the area underlying the project components is simple though the regional structure represents a series of North westerly plunging synforms and antiforms. The area occupies the South eastern limb of the "Aranayaka" double plunging synform. "The Strike trend is North-South with slight deviations to the northwest and north east. Dip direction is to the west with moderate to gentle (10° -40°) angles.

The rock strata show N to NNW (North-South) strike and dipping into NW (West) direction. The NW trending Kotmale Shear Zone is crossing project area at the middle of the tunnel trace.

The Garnetiferous/Charnockitic gneiss and Quartzite are the most dominant rock types of the area underlying almost all the areas of main project components. The composition of the rock varies across the strike and the rock mass occurs as inter bedded bands of dark coloured fine to medium grained charnokitic gneiss and light coloured medium grained garnetiferous gneiss layers.

Bedrock outcrops are common along the river bed, river bank and at a number of places on slopes. Quartzite is the other rock type present in the area. Quartzite is exposed in the surface in the left bank of the river upstream of the dam. The rock is also exposed as a solid form in few locations in the reservoir area.

3.1.2.1 Overburden Geological Conditions at site

Overburden mainly consists of soils, talus deposits and colluviums (transported soil). Number of undisturbed soil samples was collected from the surface soil formation at locations indicated in ***Figure 3.3 (a)***. A number of slopes in the study area revealed that the soil formation consists of materials ranging from silty-sand, clayey silty sandy to clayey sand. The liquid limits are 40% between 59%. The natural moisture content and the plasticity is also significantly high comparatively to the residual soil formations found in Sri Lanka.

Properties of representative soil samples collected are given in ***Tables 3.1*** and ***Table 3.2*** in ***Annexure 2***.

The total density and dry density increase marginally with depth with an average value of 1.6 mg/m3, respectively. The specific gravity of the soil averages from 2.4 - 2.6. The relatively thick over burden and other subsurface soil properties revealed in exploration works are as indicated in the ***Table 3.3*** in ***Annexure 2***. The fine content of the soil ranges from 35% to 40% and unconfined compressive strength (at unsaturated conditions) is also significantly high in both side slopes of the reservoir impounding area.

3.1.2.2 Details of geological investigations at the locations of Project Components

The borehole locations during geological investigations are marked in ***Figure 3.3 (b)-1*** and ***Figure 3.3 (b)-2***.

National Building Research Organization (NBRO) was requested to make a Landslide Hazard Investigation for the proposed Moragolla Project. Their observations on the existing engineering geological conditions of the selected sites and the subsurface geological conditions of the soil overburden and bedrock has also been incorporated into this report.

Dam Site

The dam site location is at a broad "V" shaped valley and both banks are somewhat convex consisting lesser slope at the up and close to the river steep undercutting of the rock. In the right bank a steep slope of 35-45^0 is extending about 40m from the river and then the upslope reduces to 20-25^0 and continue about a kilometer. The slope on left bank close to the river is about 25-30^0, for about 150m and then reduces to about 15^0 at the upslope until the hill crest at about another 200m away to the NW.

The bed rock of the surrounding area of the dam consists of garnet biotite silimanite gneiss and foliation plane strikes N15^{0}W and dips 27^{0}westwards. The beds are dipping towards the left bank and thereby right bank is the dip slope. Close to the river the rock had been undercut to form a steep slope.

According to the borehole loggings at the dam axis, the bed rock is at about 4m below the river-base. The left bank consists of very deep 15-30m thick residual overburden and right bank rock spread out at about a depth of 1m to 13m thickness. Number of boulders can be observed on the river and mostly the rock surfaces are well worn due to river aberration. The outer surfaces are slightly to moderately weathered.

The geological section along the dam axis is given in ***Figure 3.3(b)-3***.

Reservoir Area

The reservoir area extends about 3km upstream from the proposed dam along the river and it will cover about 36.5 ha surface area with 7100m perimeter. The proposed filled up elevation will be 548 m MSL (in section 6.2.2 of the NBRO report, the FSL stated as 248 masl has to be 548 masl as described in Project Features under section 4 of the NBRO report in ***Appendix D***).

Both banks consist of steep to very steep rocky slopes (30-50^0). The slope consists of mainly residual soil with some sporadic distribution of some colluvial materials. The rock type in this area is garnet biotite gneiss with prominent foliation plane with an attitude of N15^{0}W/27^{0}SW. The rock again dissected by two almost vertical joint sets striking N80^{0}W and N30^{0}E. Many rock blocks and wedges created by above joints were observed and may have strong capacity to be moved along the foliation plain. The next 400m stretch of the proposed reservoir is widens from its usual width of about 150m to about 250m. The average slope of the right bank is about 10^0 to 15^0. A part of the existing road will be inundated.

In contrast to that the country rock is dipping into left bank and more favorable against sliding failure. However, toppling may be possible as the rock is dissected by above discontinuities and the steepness of the slope. The average slope is varying from about 40^0 to 50^0. These slopes continue in the left bank for about 500m from the dam location.

Inundation of the bank toes of the first 500m upstream stretch from the dam is another significant effect on the banks. The water level will be increased about 25-30m in this area thus increasing the height of the saturated soil mass and reducing soil strength. However, the optimum drawdown of the reservoir is only 2m thus reducing the impact on the submerged slopes.

The Ulapane Industrial Estate is at the left bank and the right bank accommodates the main road. Ulapane Oya joins the river Mahaweli at this bend from the left bank from the point of confluence, about 126m of a section of this tributary is also inundated. The upstream of the river Mahaweli from this bend will also be inundated gradually decreasing the depth. Most of the banks are steepy and rocky.

Underground Tunnel / Penstock Trace

The inlet portal of the tunnel is in the left bank at about 75m upstream of the proposed dam location. The average elevation of the portal is about 528m MSL. It is located on a moderately steep slope of 30^0. The initial 350m of the tunnel trends NW direction and then turns NNE direction and traces about 2 km. Then again the tunnel turns to NNE direction and travels about 500m to the outlet portal. The total length of the tunnel is about 2964m.

From the inlet portal within the first 125m it is assumed that rock support corresponding to classes III and IV is required due to the expected effect of weathering on rock strength; fracturing etc. the next 800m section is assumed to be composed of strong and poorly fractured rock mass where very little or no support required for the tunnel. The next 200m of the tunnel traverse across the narrow valley containing lineament and need supports corresponds to classes III and IV. Class I and II rock types are expected to be found in the tunnel sections between 1000-1950m and 2050-2875m.

The tunnel length between 1900 and 2050m is assumed to be requiring supports corresponding to class II and IV.

The tunnel portion from 2875 to outlet is also be supported corresponding to classes III and IV.

Rock mass classification for the interpretation of Tunnel design aspects is given in ***Table 3.4*** in ***Annexure 2***.

The elevation of the outlet portal is about 519m asl and located at NE trending steep slope of about 35-40^0. The tunnel travels through a NNE trending ridge with more or less gentle slope at the NW while steep SE facing slope ends at the river Mahaweli. The ground surface elevation varies from 480m MSL at the river close to the powerhouse location to 660m asl in the middle of the tunnel trace.

07 nos. of bore holes were drilled along the tunnel trace and MT- 01 & 02 are about 100m away from the new trace and no bed rock was encountered. According to the borehole logs of MT- 03 to 06 the tunnel is about 80m below the ground surface and about 60m in the bed rock of garnet biotite gneiss with about 20m thick overburden of residual soil.

The geological section along the tunnel trace are given in ***Figure 3.3 (b)-4*** to ***Figure 3.3 (b)-6***

Surface Penstock

The proposed penstock line is about 145 m along and roughly trending at NNE direction. It is descending at an elevation from 518m asl to 474m asl on a slope of about 25-30^0 from outlet portal and surge shaft to the powerhouse site. The soil in this area is residual soil with sporadic boulders. According to the borehole log (MT-08), the bedrock of garnet biotite gneiss is at 490m asl in the middle part of the penstock line. No unstable soils masses were observed in this location.

Powerhouse and Switchyard location

The proposed powerhouse and the switchyard will be located about 3km downstream of the proposed dam site and on the left bank opposite to the confluence of Mahaweli River and the outfall of the Kotmale powerhouse and in two adjacent lands on the left bank of the river Mahaweli. The elevation of this area is about 475 MSL. The proposed area is having 15-20^0 slope towards NE. The steepness of the slope increases towards the river bank to about 35-40^0. The soil type is mainly residual with some alluvial deposits at the NE part of the site.

The site is underlain by garnetiferous gneissic rocks. Overburden consists of a mix of colluvial and alluvial types of gravelly and sandy clay deposits. According to the borehole data, the overburden is about 6.5 to 9 meters deep.

Bedrock also can be observed in the river along with many boulders.

Spoil Dumping Sites

The dumping sites 1 to 4 are on CEB owned lands and dumping site 5 is owned by the MASL. For convenience in identifying, the locations are shown in the Google Images given in ***Annexure 8***.

Dumping site 1 (513700N, 478483E)

The proposed site is fully covered with vegetation and is in Galata Watta area by the side of the road that runs from Ulapane to switch yard of the Kothmale power house. The land below the road which slopes about 45° – 55° is proposed for dumping. According to the Landslide Hazard Zonation map prepared by NBRO, the dump site is located in an area where 'landslides are to be expected'. The River is flowing about 275 m away from the proposed dumping area.

Dumping site 2 (513553N, 478741E)

The proposed site is the largest proposed site, situated just below the Kothmale switch yard. The slope of the area is about 40° – 50°. This location is also covered with vegetation. Drainage path from road crosses the land. River flows about 700 meters away from the proposed land. Therefore siltation will not be a significant problem. Access to the lower parts of the dumping area could be difficult for the dumping trucks due to the steep slope. Therefore access roads should be prepared before dumping is carried out. According to the Landslide Hazard Zonaion map, the dump site is located in a safe area. Therefore the risk of landslides is less.

Dumping site 3 (513372N, 478952E)

The proposed site is situated just passing the switch yard of the Kothmale Powerhouse and it is a nearly flat terrain with a gentle slope. High tension electric line crosses the land. Access to the site is possible with existing conditions. Some springs initiate from this area and flow to the river. Nearest distance to the river is around 650 m from the location and siltation could not be a problem. According to the Landslide Hazard Zonation Map, the dump site is located in a safe area.

Dumping site 4 (513037N, 478980E)

The proposed site is located in front of the Kothmale surge tower. This site has been used previously also as a dumping site and it can be extended if required. River is about 1km away from the location and siltation could not be a problem. The dump site is located in a safe slope area as per the Landslide Hazard Zonation Map. High tension electric line is to be constructed across the land.

Dumping site 5 (514721N, 478579E)

The proposed site too has been used previously as a dumping yard. The area is close to the Army camp and is located by the side of the Atabage Road (road connected to Gampola – Pussellawa (A05) road). Mahaweli River is one of the boundaries of the site and two small streams flow through the land to Mahaweli River. Therefore, special attention will be made to mitigate siltation effects. Part of the area is cultivated and the other part is used as a playground by the Army. The proposed site is almost on a flat terrain with a gentle slope close to the existing road. The area proposed is almost on a flat area and is in a safe area on Landslide Hazard Zonation Map.

3.1.2.3Evaluation of the Slope Stability of Critical Sections

The evaluation of slope stability is important for some of the proposed structures and locations of the project. The following are considered to be important for revised geotechnical analysis

1. Right bank upper slope stability of the dam site (with or without the fluctuation of water table)
2. Left bank upper slope stability of the dam site (with or without the fluctuation of water table)

Laboratory investigations of shear strength parameters are important information for the entire analysis. However, in the absences of effective shear strength test results of overburdened soils, various correlations available for similar types of soil such as fine-grained residual soils and weathered rock formations were considered for the evaluation of strength parameters and are given in ***Table 3.5(a)*** in ***Annexure 2***.

Also, according to the U.S. Army Corps of Engineers manual for seismic design of new dams recommends use of a seismic coefficient of 0.1 in Seismic Zone 3 and 0.15 in Seismic Zone 4 in conjunction with a minimum factor of safety of 1.1.

The subsurface along the dam axis was modeled using the investigations carried out. The results of slope stability analysis obtained using the Bishops method are given in the ***Table 3.5 (b)*** in ***Annexure 2***.

Stability of river banks of the reservoir

By studying the geology maps and subsurface information derived from the geotechnical investigations it is found that there is no direct threat for stability of the river banks. Local failure can occur at some locations where loose soil deposits exist but the impacts will not be significant. Also as the reservoir drawdown is only 2m, the impact on the submerged slopes is reduced.

3.1.3 Land use within the study area

3.1.3.1 Methodology

The land use map given in ***Figure 3.4*** has been based on the available 1:10000 topographical maps prepared in 1987 by the Survey Department of Sri Lanka and field checked in 1989 also by them.

The land area has undergone lot of changes since then and some of the areas including those in the vicinity have been cleared and developed for residential purposes, small scale agriculture, Industrial Estate and housing schemes, cultivation of tea and later abandoned, plantation forests and community forests etc. Therefore, the existing land-use patterns as observed by the Sociologist and the Ecologist during the walk-through surveys and Google Images (***Annexure 8***) have also been incorporated in describing the land-use within the study area. The land use pattern so developed for the project area is shown in the community map given in ***Figure 3.7***.

- **Area around proposed Dam (and Reservoir)**

The dam will be constructed across the Mahaweli Ganga and will extend into the river banks from either side. As the valley is steep in this area, the reservoir with a surface area of 36.5 ha will be more or less confined to the narrow and steep river valley of the Mahaweli Ganga in the proposed project area. Therefore 90% of the land area that will get inundated due to proposed reservoir will be the river bed and the unutilized river reservation. This portion of the river near the dam is not being used by any body for activities such as sand mining, bathing and washing and domestic consumption. This is mainly due to the access difficulties to reach river bed to use the water.

The balance 10% of the land that will get inundated consists of a 8m wide and 410m long RDA road stretch, residential lands, lands grown with mixed crops and owned by private parties. About 25% of the land area is bare land.

The commonly observed crops in these highlands include, pepper, coffee, cardamom and also fruit trees such as mango, jack and avocado. Another common feature of the land use of the limited area which gets inundated is the existence of trees such as Sapu, HavariNuga, Tuna, Mahogany which has a timber value. The social impact assessment survey team during their walk through survey found that crops in the home gardens in the area are not so economically productive due to improper management. Only scattered bushes of pepper, coffee, cardamom and few fruit trees with no or negligible yield are observed.

- **Corridor of the proposed underground tunnel / penstock trace**

The following common land use patterns are observed in the corridor of the proposed Tunnel.

* Neglected tea crops
* Land allocated for small industries
* Settlements created
* Traditional villages (Purana villages)

Ulapane Industrial Estate, settlements called Denmark Watta, Ethgala Watta village and Ulapane village are the specific places located on the ground surface on the corridor of the tunnel trace. About 35-40% of the land extent in this area is bare land and the rest is cultivated with mixed crops and small tea patches and a small extent of paddy lands to the extent of about 1Ac. The area in general is hilly terrain.

Although, a substantial extent of land of this area has been allocated for the Ulapane industrial village that land extent has not yet been fully utilized for the industries.

- **Area around Surge Shaft and surface Penstock**

These will be located in open areas which are abandoned lands. Surge shaft will be in an area containing weedy herbs and seedlings of trees like Havari Nuga. Penstock will be on grass dominated land. There are two homesteads nearby which will have impacts due to the proposed project.

- **Area around Powerhouse and Switchyard**

These will be located in abandoned land near the river where the owner of these lands do not live in the area. No agricultural activities take place in this area.

- **The land to be used for power transmission line**

About 80% of the length of the transmission line traverse above home gardens and the rest is passing over abandoned lands.

Cadju, Havari Nuga, Ruk Attana, Puwak, Kenda, Huriya Mara, Kaha Kona, Mahogani, Mahogani and Daminiya are the common plant species observed along the transmission line trace while herbaceous / shrubs which are either native or introduced are also common to this trace.

- **Area for Residential Camp / Office and Stores**

This land is located in a village called Weliganga. Except some scattered patches of bare land, other lands are cultivated with mixed crops such as pepper, coffee, cardamom and also fruit trees such as mango, jack and avocado. Another common feature of the land use of this area is the existence of trees such as Sapu, HavariNuga, Tuna, and Mahogany etc. which has a timber value. Similar to many other home gardens and other crop lands in the area, the crops in this area is also not properly managed and low productivity is the common factor observed.

3.1.4 Hydrology and drainage

Hydrological studies carried out in the feasibility study has been used in the EIA studies and the study report on Hydrology is given in ***Appendix D***.

3.1.4.1 Drainage pattern of the study area

Mahaweli Ganga originates at an attitude of 1300m around Hatton and flows past Ginigathhena and Nawalapitiya in its travel to the project area. Mahaweli Ganga flows in a northwardly direction through the project area.

About 3.5km upstream of the proposed Moragolla dam site, Mahaweli Ganga is joined by one of the largest tributaries of upper Mahaweli basin named Kothmale Oya. About 6.5km downstream of confluence of Kothmale Oya with Mahaweli Ganga, a moderate sized right bank tributary named Atabage Oya joins Mahaweli Ganga.

Mahaweli Ganga flows in a narrow river valley between the confluences of these two tributaries. Minor streams on the right bank within this reach are relatively of short length. The drainage pattern in the left bank is similar except for the minor tributary named Ulapane Oya which joins Mahaweli Ganga on its left bank close to Ulapane town. ***Figure 3.1(a)*** shows the drainage pattern of the project area.

Kothmale reservoir which has a capacity of 172.5 MCM completely regulates the flows of Kothmale Oya except for the large flood flows. Flow of Kothmale Oya intercepted by the Kothmale reservoir is channeled through the Kothmale underground power house and released back to Mahaweli Ganga close to its confluence with Atabage Oya.

Hence normal flows of Kothmale Oya will not be available to the Moragolla reservoir. Only the flood flows released through the spillway of Kothmale reservoir will be passed downstream towards Moragolla reservoir.

The river length between the confluences of Kothmale Oya and Atabage Oya is about 6.5 km. River bed level drops by about 78 m over this reach in several cascades. In between these cascades there are short reaches of river which have relatively mild slopes. Downstream of the confluence of Atabage Oya with Mahaweli Ganga river bed slopes become mild and lower parts of the river valley widens up towards Gampola area.

Upstream of the confluence with Kothmale Oya too river bed slopes of Mahaweli Ganga are less steep although not as mild as the reach downstream of confluence with Atabage oya.

Ulapane Oya is a left bank tributary which directly discharges into proposed Moragolla reservoir. The confluence of Ulapane Oya with Mahaweli Ganga has a unique feature of near 13m drop in river bed immediately upstream at its confluence with Mahaweli Ganga.

This feature was well utilized in planning the Moragolla reservoir and it prevents submergence of useful areas of Ulapane Oya while allowing the construction of a fairly deep reservoir just at its confluence.

3.1.4.2 Mean annual flow of the river

Mean annual flow of the river at the dam site is 21.95 m^3/s.

3.1.4.3 Mean monthly discharges of the river

Mean monthly discharges of the river at gauging sites of Talawakelle, Nawalapitiya and Morape are given in ***Table 3.6 (a)*** to ***(c)*** in ***Annexure 3***.

Figure 3.1(b) shows the catchment area for the project. ***Table 3.6 (d)*** gives the values for the flow duration curve at the dam site.

Table 3.6 (d) Values for the flow duration curve at dam site

Flow (m^3/s)	Percentage of occurrence (%)	Flow (m^3/s)	Percentage of occurrence (%)
3.0	100.0	18.0	33.7
4.0	99.0	19.0	31.4
5.0	91.0	20.0	29.5
5.5	84.8	25.0	23.7
6.0	77.7	30.0	19.7
6.5	72.6	35.0	16.8
7.0	70.3	40.0	14.3
7.5	68.5	45.0	12.4
8.0	66.7	50.0	10.7
9.0	63.6	55.0	9.2
10.0	60.5	60.0	7.8
12.0	54.1	65.0	6.8
13.0	50.7	70.0	5.9
14.0	47.2	75.0	5.1
15.0	43.2	100.0	2.5
16.0	39.6	120.0	1.5
17.0	36.5	150.0	0.7

3.1.4.4 Water quality of river regime

Water quality of the Mahaweli River was analyzed in March 2009 by National Water Supply and Drainage Board and the results are given in ***Table 3.7*** in ***Annexure 4*** (see ***Appendix C*** for full report on water quality measurements).

The locations in which measurements are done are marked in ***Figure 3.5 (a).*** The results manifested that in many places the coliform count is high indicating faecal pollution in the river particularly for contact recreational activities such as bathing etc. The other parameters are acceptable for recreational activities from proposed dam site up to power house.

Subsequent tests on water quality samples carried out in the vicinity of Crysbro Broiler Processing Industry by University of Moratuwa and Industrial Technology Institute showed that the fecal coliform levels are in the order of 10^5 indicating fecal pollution is on the rise (***Table 3.7*** in ***Annexure 4***). The nearby residential development and industries may perhaps be responsible for elevated levels of fecal coliforms (usually 150 MPN per 100 ml is the maximum level of fecal coliforms accepted for primary recreational activities such as bathing etc.) and drinking without proper treatment at least boiling may not be recommended. Based on past records that are available for the Mahaweli Ganga, it has been noted that during wet weather flow after torrential raining, the levels are much lower mainly due to natural phenomenon of dilution and flushing.

3.1.4.5 Highest Flood experienced at the Site

Dam site is located at appoint in the river where there are no human settlements. There is a considerable variation of the river bed levels both upstream and downstream of the dam site.

Therefore reliable information on highest flood levels experienced at the site could not be obtained from the residents in the project area. On the other hand, the highest known floods have occurred in the area during the cyclone of 1978.

In the absence of other means of determining the highest flood levels experienced at the dam site from human services, flood marks and deposition levels at the site were used as a guide to determine the highest flood level at the dam site, which is 526m asl.

3.1.4.6 Flood Frequency Analysis

Floods in the upper Mahaweli Ganga basin could occur due to annual monsoon events as well as tropical cyclonic storm events centred on the island. Historical flood events show that floods due to cyclonic events have produced largest flood peaks although they are rare.

Table 3.8 Flood Peaks for Different Return Periods

Return Period (yrs)	Peak Flow (m^3/s)
2	600
5	788
10	909
50	2304
100	2692

Kothmale reservoir project with a total storage of 172.5 MCM which was completed in 1985 regulates 562 km^2 of the total catchment of 809 km^2 at Moragolla dam. Having such a large capacity reservoir with nearly 69% of the catchment at Moragolla can expect to lower the threat of flooding due to short recurrence periods. The same cannot be expected for floods of higher return periods as reservoir could be full at the time of occurrence of such events.

Therefore the basic approach in determining the flood peaks in the catchment of Mahaweli Ganga up to Moragolla is to consider only the unregulated part of the catchment (247 Km2) for flood events of lower return periods and to consider the entire catchment (809 km2) for flood events of higher return periods.

When deriving flood peaks of 2, 5 and 10 year return period, only the unregulated part of the catchment was considered and for higher return periods, the total catchment was considered. Computed flood peaks are given in ***Table 3.8***

3.1.4.7 Bank Full Discharge at the Dam site

Figure 2.10 shows the cross section of the river at the proposed dam site. The part of river section which passes the normal river flows has a fairly regular section. The left

bank is nearly vertical and the point at which slope breaks is considered as the river bank for the purpose of defining bank full discharge.

Accordingly the bank top level is taken as 523.0 m asl. Bank full discharge was computed using a mean bed slope for the reach and a Manings n value of 0.05. River bed slope in the reach is 0.0062 and corresponding bank full discharge is 550 m^3/s. Using the analysis for flood frequencies as described above, return period of the bank full discharge is determined as close to 02 years.

Being a very large catchment subjected to many variations in levels of rainfall received by different parts of it throughout the year, the river flows would vary within a wide range depending on the levels of rainfall received in each year.

3.1.4.8 The minimum dry season flow, base flow

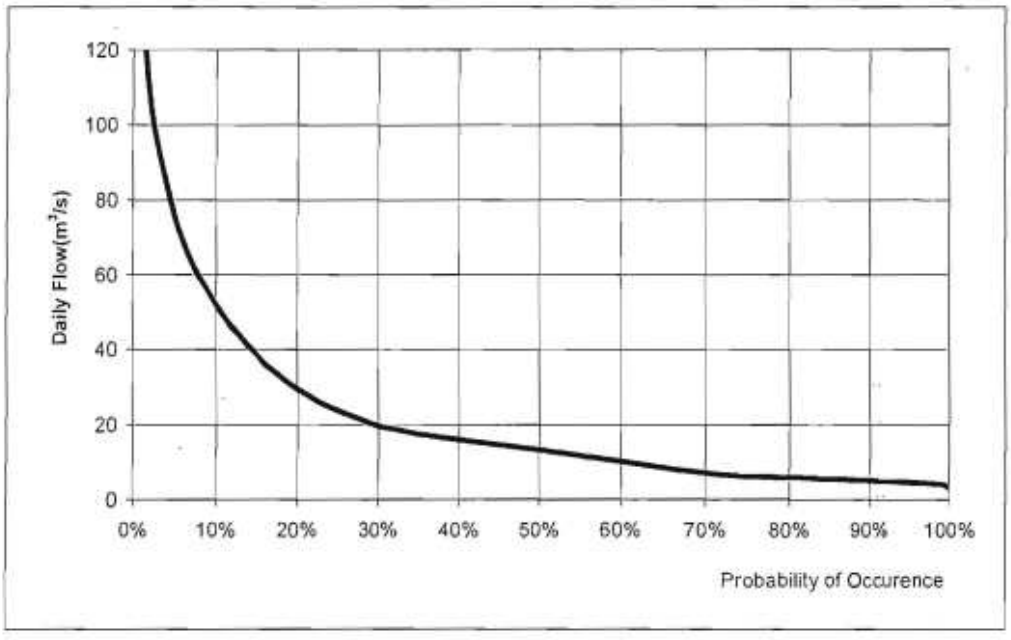

Figure 3.1 (c) Flow duration curve at the dam site

Dry season in the catchment of proposed Moragolla Hydropower Project lasts from mid December to mid April. Within this period February is generally the driest month. Minimum mean monthly dry season flow is 5.38m^3/s.

During dry years monthly mean flow has reduced to about 4.68m^3/s. On a daily basis, the lowest flows have been close to 3.20m^3/s. Base flow is taken as the flow which is continuously available in the river. Accordingly the base flow in the river is 3.0m^3/s.

The flow duration curve for the dam site is shown in ***Figure 3.1 (c)*** and the flow duration curves for wet and dry years are given in ***Figure 3.1 (d)***

3.1.4.9 Flow Details at the Proposed Moragolla Dam Site

Mean monthly flows at Moragolla dam site are given in ***Table 3.9*** in ***Annexure 3***. Mean annual natural flow of the river at dam site is 21.95 m^3/s. Variation of annual flow is shown in ***Figure 3.6*** using mean annual flows for a period of 40 years.

Accordingly mean annual flows ranged from a maximum of 34.6 m^3/s to a minimum of 13.8 m^3/s.

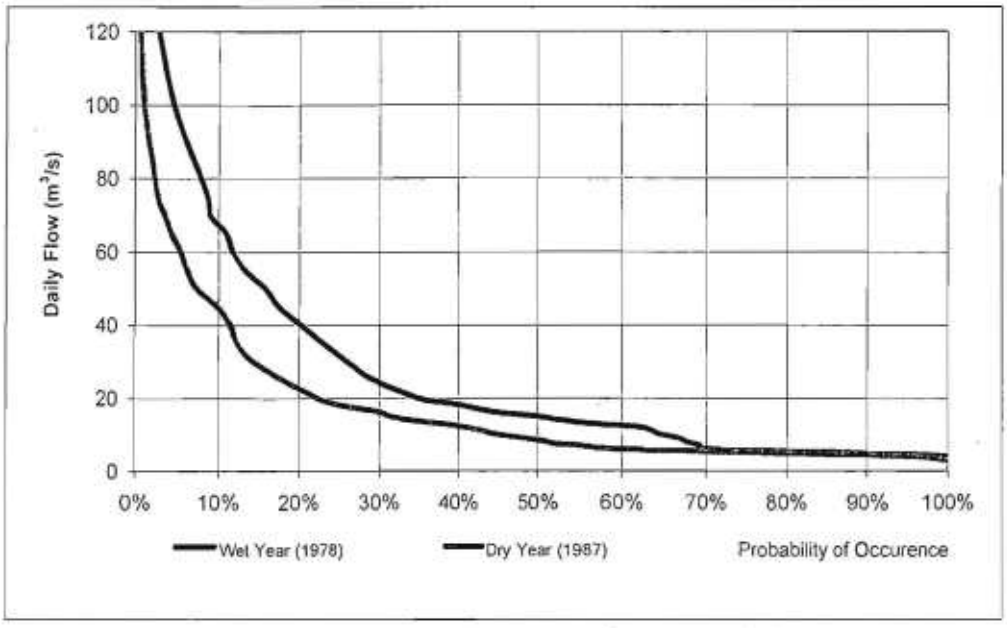

Figure 3.1 (d) Flow duration curves for wet and dry years

3.1.4.10Hazard Potential and Disaster Management Plan

The National Building Research Organization (NBRO) was requested to carry out a landslide hazard investigation (***Appendix D***) for the proposed Moragolla hydropower project. The evaluation of susceptibility to landslide aspect is the main objective of this investigation and included the following:

- Identifying the existing engineering geological conditions of the selected site for proposed project.
- Determining the vulnerability of future mass movements within the soil mass and the rock fall threats at the project area.
- Describing the subsurface geological conditions of the soil overburden and bed rock.
- Recommending to avoid or minimize the expected slope failure problems by applying most suitable remedial measures to overcome destructive situations to the project itself and to the surrounding environment.

According to final conclusions of the NBRO report there are no landslides or earth slips that have been reported within the proposed project area. No old landslides or potential landslides were observed during the field investigation except for several gully erosions and some bank failures, especially upstream of the dam location.

Rock falls may be possible on steep slopes along the surface areas of the rocky banks especially of the reservoir where rocks appeared to be segmented by joints. The steep slope on the tunnel portals, access path and penstock path may lead to unstable conditions during construction unless careful design and construction procedures are adopted. Considering the vegetation cover and predominant presence of residual soil,

no slope failures are to be expected if the construction works are carried out appropriately.

In the right bank of the reservoir planer failure or wedge failure of the rocky blocks can occur as the rock masses can slide on the foliation plane as the dip is more or less parallel to the slope. The dip direction of left bank is more favorable against sliding failure. However, toppling may be possible as the rock is dissected by above discontinuities and the steepness of the slope.

A part of the existing road in the right bank will be inundated. The water level will be increased about 25-30m in this area thus increasing the height of the saturated soil mass and reducing soil strength. The Ulapane Industrial Estate is at the left bank and the right bank accommodates the main road. Therefore, appropriate remedial measures should be taken to ensure the stability of both banks at locations with loose soil conditions or at locations closer to the rainwater gullies at the initial 500m upstream region of the reservoir from the dam.

The upstream of the Mahaweli Ganga will be inundated gradually decreasing the depth. Most of the banks are steep and rocky and usually subjected to inundation of lower slopes during floods. In addition to, there are no recorded observations of the toe failures surrounding lower slopes mainly due to sound rock conditions of the foothill. Therefore, such rock slopes inundation may not lead to unexpected failure.

According to landslide hazard zonation map in ***Figure 3.2*** the project features will be sited on "landslide not likely to occur" and "modest level of landslide hazard" zones. Therefore, according to the field observations and the information gathered, this project is feasible without provoking landslides. However, special attention is required while constructing on steep slopes and eroded gullies to avoid slope instabilities.

Only component of the proposed project that could have an impact due to potential landslide is the reservoir. However no potential locations for landslides could be seen around the periphery of the proposed reservoir.

Even in the unlikely event of a landslide, the impact will be minimal since the slopes adjoining the reservoir are not massive and slides into the reservoir would not be able to threaten the dam by overtopping.

Even in case of an unlikely event of overtopping of the dam due to a landslide into the reservoir there will be little hazard as flow volumes generated will not be large due to shallowness of reservoir.

Disaster management plan during a landslide will be similar to that during a flood, where an emergency situation has been faced and this has been dealt in section 2.2.13.

3.1.5 Ambient air quality in the project area

Air quality in the project area in four different sites (See ***Appendix C*** for full report on air quality measurements) were measured by National Building Research Organization

in March 2009. ***Table 3.10*** in ***Annexure 4*** indicates the air quality parameters measured at different places and the locations are given in ***Figure 3.5 (b)***.

Results manifested that all the air pollutant levels are well within the allowable ambient levels hence no indication of air pollution in the proposed project area.

3.1.6 Ambient noise levels in the project area

Noise levels in 10 different locations in the project area were measured by National Building Research Organization in March 2009 (See ***Appendix C*** for full report) and are given in ***Table 3.11*** in ***Annexure 4*** and the locations are given in ***Figure 3.5(c)***.

Results showed that the daytime and nighttime residual levels are not very high indicating that noisy activities in the area are very remote. However nighttime levels seem to be comparatively high mainly due to the screech of insects such as crickets.

3.1.7 Ambient vibration levels in the project areas

Ambient vibration levels in the proposed project area particularly in 9 different locations were measured by National Building Research Organization in March 2009 (See the full report in Appendix) and are given in ***Table 3.12*** in ***Annexure 4*** and the locations are given in ***Figure 3.5(d)***.

The present ambient vibration levels indicated very low values so that no human inconvenience or structural damage is likely to take place. Hence at present there are no high levels of vibrations in the proposed area.

3.2 Biological Environment

3.2.1 Existing vegetation / habitat types

Biogeographically, the proposed project area falls within the wet zone. The typical forest formation found in this area is classified as wet evergreen forest formation. The area that will be directly and indirectly impacted by proposed project can be classified as a high human use area. The area has been used mainly for cultivation of Tea and establishing human settlements. Some cleared lands have been abandoned later on and natural regeneration is taking place in these areas. Thin strips of degraded forest patches are present in some areas along the river banks that somewhat resembles typical forest formation in the area. Further, degraded grasslands are present on hill slopes and hill tops. Therefore, River and Riverside vegetation and abandoned land under different serial stages of regeneration are the main natural habitats present in the proposed project area. Home gardens and cultivated lands are the main human influenced habitats in an area. The main vegetation / habitat types observed during the field study are described below.

Riverside vegetation

In most places the river bank comprised of sloping land that is covered by a highly disturbed vegetation dominated by grasses and weeds such as *Panicum maximum* (Rata Tana), *Mimosa pigra* (Yodha Nidi kumba), *Eupatorium inulifolium, Eupatorium odoratum* and *Ludwigia peruviana*. Trees such as *Trema orientalis* (Gedumba), *Clusia rosea* (Gal Goraka), *Albizia falcataria*, *Macaranga peltata* (Kenda), *Macaranga indica* (Kenda), *Mallotus tetracoccus* (Bu Kenda), *Ficus* sp. (Nuga), *Ficus racemosa*

(Attikka) *Symplocos cochinchinensis* (Bombu), *Acacia mangium* and *Acacia melanoxylon* are found scattered around in this habitat.

Wet evergreen forest

This habitat contains weed and herb species such as *Panicum maximum* (Rata Tana), *Arundo donax*, *Mimosa pigra* (Yodha Nidikumba), *Ludwigia peruviana*, and tree species such as *Trema orientalis* (Gedumba), *Macaranga indica* (Kenda), *Macaranga peltata* (Kenda), *Syzygium jambos* (Seeni Jambu), *Madhuca neriifolia* (Gam Mi), *Albizia falcataria*, *Mallotus tetracoccus* (Bu Kenda), *Homonoia riparia*, *Aporusa lanceolata* (Heen Kebella), *Clusia rosea* (Gal Goraka), *Symplocos cochinchinensis* (Bombu), *Ficus* sp. (Nuga), *Artocarpus nobilis* (Wal Del), *Actinodaphne elegans*, *Eupatorium inulifolium*, *Nephrolepis* sp., and *Ficus racemosa* (Attikka).

River and Streams

The river is the main habitat that will be adversely affected by the proposed project. In most places it flows gently except at places where it forms shallow or deep cascades where the flow becomes rapid and turbulent. The river also has deep pools which are frequented by large cyprinid fish species *Tor khudree* (Marsheer; Lehella). The river has fairly high fish diversity including several species that are endemic to Sri Lanka such as *Belontia signata* (Comb tail; Pulutta), *Puntius nigrofasciatus* (Black Ruby Barb; Bulath Hapaya), *Puntius reval* (Red-fin two banded carplet; Rathu waral depulliya). Of these the two later species are possibly recorded for the first time in Mahaweli River as these two species to date were recorded only from the Southwestern region of Sri Lanka. There was a healthy population of *Puntius nigrofasciatus* which were observed along the river banks in slow flowing areas, especially around the dam site. Only a few aquatic plant species were recorded here. Several seasonal and perennial streams link up with the river.

Abandoned land

This is a grass dominated vegetation type with few scattered trees, weedy shrubs and herbs. *Panicum maximum* (Rata Tana) is the dominant grass species found in this region. In addition, weedy shrubs and herbs species such as *Cymbopogon nardus* (Pengiri Mana), *Lantana camara* (Gandapana) *Eupatorium inulifolium*, *Eupatorium odoratum*, *Dicranopteris linearis* (Kekilla), are also found here. Few tree species such as *Cipadessa baccifera* (Hal Bambiya). *Symplocos cochinchinensis* (Bombu), *Trema orientalis* (Gadumba), *Syzygium caryophyllatum* (Dan), *Acacia mangium*, *Macaranga peltata* (Kenda), *Alstonia macrophylla* (Hawari Nuga) were found scattered around in this habitat.

Tea Plantations

Number of tea plantations was observed in the project area. Apart from tea only a few shade trees were observed in the area. *Erythrina subumbrans* (Dadap), *Coffea arabica* (Kopi), *Cassia spectabilis* (Kaha Kona) were the common shade trees observed in the tea fields. *Ageratum conyzoides* (Hulan Tala), *Emilia exserta* and *Wedelia trilobata* were the dominant weedy herbs found here. Rest of the open channel will pass through this tea land.

Home Gardens

Home Gardens: Common home garden plant species such as *Mangifera indica* (Amba), *Cocos nucifera* (Pol), *Artocarpus heterophyllus* (Kos), *Swietenia macrophylla* (Mahogani), *Nephelium lappaceum* (Rambutan), *Michelia champaca* (Sapu), *Albizia falcataria*, *Areca catechu* (Puwak), *Alstonia macrophylla* (Hawari Nuga), *Macaranga peltata* (Kenda) were present in the home gardens located within the immediate impact zone of the project.

3.2.2 Description of vegetation characteristics in the areas identified for major project activities

Dam site and the surrounding area

Riverside vegetation found in the proposed dam site and its surroundings can be classified as highly disturbed vegetation due to human influence. Weedy plant species and pioneer plant species were commonly found in the proposed dam site. *Panicum maximum* (Rata Tana), *Mimosa pigra* (Yodha Nidikumba), *Ludwigia peruviana*, *Trema orientalis* (Gedumba), *Macaranga peltata* (Kenda), *Clusia rosea* (Gal Goraka), *Symplocos cochinchinensis* (Bombu), *Eupatorium inulifolium*, *Eupatorium odoratum*, *Acacia mangium* are the dominant plant species recorded at this site. A detailed list of the flora recorded during the field study at this site are listed in ***Table 3.13*** in ***Annexure 5***

Riverside vegetation in the area downstream of the dam

Both banks are covered by a thin strip of disturbed riverside vegetation. *Panicum maximum* (Rata Tana), *Arundo donax*, *Mimosa pigra* (Yodha Nidikumba), *Ludwigia peruviana*, *Trema orientalis* (Gedumba), *Macaranga indica* (Kenda), *Macaranga peltata* (Kenda), *Syzygium jambos* (Seeni Jambu), *Madhuca neriifolia* (Gam Mi), *Albizia falcataria*, *Mallotus tetracoccus* (Bu Kenda), *Homonoia riparia*, *Aporusa lanceolata* (Heen Kebella), *Clusia rosea* (Gal Goraka), *Symplocos cochinchinensis* (Bombu), *Ficus* sp. (Nuga), *Artocarpus nobilis* (Wal Del), *Actinodaphne elegans*, *Eupatorium inulifolium*, *Nephrolepis* sp., *Ficus racemosa* (Attikka) are the dominant plant species recorded in this vegetation type. A detailed list of the flora recorded during the field study at this site are listed in ***Table 3.13*** in ***Annexure 5***

Upstream Banks of the River

Both banks in the upstream area of the proposed weir are also covered by a thin strip of disturbed riverside vegetation. *Panicum maximum* (Rata Tana), *Arundo donax*, *Mimosa pigra* (Yodha Nidikumba), *Ludwigia peruviana*, *Trema orientalis* (Gedumba), *Syzygium jambos* (Seeni Jambu), *Macaranga peltata* (Kenda), *Albizia falcataria*, *Mallotus tetracoccus* (Bu Kenda), *Clusia rosea* (Gal Goraka), *Symplocos cochinchinensis* (Bombu), *Acacia mangium*, *Acacia melanoxylon*, *Saccharum spontaneum* (Wal Uk), *Caryota urens* (Kitul), *Homonoia riparia*, *Ficus* sp. (Nuga), *Artocarpus nobilis* (Wal Del), *Eupatorium inulifolium*, *Ficus racemosa* (Attikka), *Tripsacum laxum*, *Alstonia macrophylla* (Hawari Nuga) were the dominant plant species recorded in this habitat. A detailed list of the flora recorded during the field study at this site are listed in ***Table 3.13*** in ***Annexure 5***

Inundation Area

In addition to the above described vegetation found along the river banks, few home gardens and road side vegetation are the main vegetations types that were recorded in the area predicted to be innubdated due to proposed project. Home garden vegetation was dominated by cultivated plant species such as *Mangifera indica* (Amba), *Cocos nucifera* (Pol), *Artocarpus heterophyllus* (Kos), *Swietenia macrophylla* (Mahogani), *Nephelium lappaceum* (Rambutan), *Michelia champaca* (Sapu), *Albizia falcataria*, *Areca catechu* (Puwak), *Alstonia macrophylla* (Hawari Nuga), *Macaranga peltata* (Kenda) while the roadside vegetation comprised mainly of *Delonix regia* (May Mara), *Peltophorum pterocarpum* (Kaha Mara), *Panicum maximum* (Rata Tana), *Lantana camara* (Gandapana), *Eupatorium odoratum*, *Cymbopogon nardus* (Pengiri Mana), *Urena lobata* (Patta Epala), *Tithonia diversifolia* (Wal Suriyakantha), *Dicranopteris linearis* (Kekilla), *Melastoma malabathricum* (Maha Bovitiya). A detailed list of the flora recorded during the field study at this site are listed in ***Table 3.13*** in ***Annexure 5***

The underground tunnel / penstock trace

The tunnel trace will be passing beneath tea estates, home gardens and abandoned land. The home gardens comprise of mostly cultivated species such as *Mangifera indica* (Amba), *Cocos nucifera* (Pol), *Artocarpus heterophyllus* (Kos), *Swietenia macrophylla* (Mahogani), *Nephelium lappaceum* (Rambutan), *Michelia champaca* (Sapu), *Albizia falcataria*, *Areca catechu* (Puwak), *Alstonia macrophylla* (Hawari Nuga), *Macaranga peltata* (Kenda). The abandoned land is dominated by grasses with scattered trees, weedy shrubs and herbs. *Panicum maximum* (Rata Tana) is the dominant grass species found in this regionh. In addition, weedy shrubs and herbs species such as *Cymbopogon nardus* (Pengiri Mana), *Eupatorium inulifolium*, *Eupatorium odoratum*, *Dicranopteris linearis* (Kekilla), *Lantana camara* (Gandapana) were also recorded here. Few tree species such as *Cipadessa baccifera* (Hal Bambiya). *Symplocos cochinchinensis* (Bombu), *Trema orientalis* (Gadumba), *Syzygium caryophyllatum* (Dan), *Acacia mangium*, *Macaranga peltata* (Kenda), *Alstonia macrophylla* (Hawari Nuga) were found scattered around in this habitat.

Surge Shaft area

Surge Shaft will be located in open area. Except few weedy herbs and seedlings of trees the land is devoid of vegetation. Weedy herbs such as *Cymbopogon nardus* (Pengiri Mana), *Spermacoce verticillata* and *Alstonia macrophylla* (Hawari Nuga) seedlings were the dominant plant species recorded in the proposed Surge Shaft location.

Surface Penstock path

The penstock will pass through a grass dominated abandoned land. Other than grasses, scattered trees and weedy shrubs and herbs were also found in this habitat. *Panicum maximum* (Rata Tana) is the dominant grass species found here. The weedy shrubs and herbs found in this habitat included *Eupatorium inulifolium*, *Eupatorium odoratum*, *Dicranopteris linearis* (Kekilla), *Lantana camara* (Gandapana), *Clidemia hirta*, *Cipadessa baccifera* (Hal Bambiya). Tree species such as *Symplocos cochinchinensis* (Bombu), *Trema orientalis* (Gadumba), *Macaranga peltata* (Kenda), *Alstonia macrophylla* (Hawari Nuga), *Neolitsea cassia* (Dawul Kurundu) were found

scattered within the grassland. A detailed list of the flora recorded during the field study at this site are listed in ***Table 3.13*** in ***Annexure 5***

Power House and Tailrace Canal

The power house will be located in abandon land near the river. *Panicum maximum* (Rata Tana), *Lantana camara* (Gandapana), *Trema orientalis* (Gadumba), *Macaranga peltata* (Kenda), *Eupatorium inulifolium*, *Eupatorium odoratum*, *Gliricidia sepium* (Weta Mara) are common plant species in proposed power house location.

The tailrace canal will be going from power house to water releasing point of the river through above described abandon land and riverside vegetation. Riverside vegetation of the proposed water releasing point of the river is very disturbed and only a weedy plant species like *Mimosa pigra* (Yodha Nidikumba), *Ludwigia peruviana*, *Panicum maximum* (Rata Tana) are inhabited. A detailed list of the fauna and flora recorded during the field study at these sites are listed in ***Table 3.13*** in ***Annexure 5***

Transmission Line

About 80% of the length of the transmission line traverse above home gardens and the rest is passing over abandoned lands. The vegetation in the home gardens comprise of cultivated species such as *Mimosa invisia*. In addition to cultivated species, the plant species commonly encountered in the home gardens include species such as *Alstonia macrophylla* (Hawari Nuga), *Macaranga indica* (Kenda), *Macaranga* indica (Kenda), *Albizia* odoratissima (Huriya Mara). The abandoned lands are covered mostly by a secondary growth dominated by pioneering herbaceous and shrub species such as Ageratum conyzoides (Hulan Tala), Biden pilosa, Blechnum orientals (Pattara Werella), Crotalaria sp., *Panicum maximum* (Rata Tana), *Eupatorium odoratum (Podisinnamaran)*, *Lantana camara* (Gandapana) *and Dicranopteris linearis* (Kekilla) of which most species are listed as alien invasive species in Sri Lanka. A detailed list of plants recorded during the field study along the transmission line path are listed in ***Table 3.13*** in ***Annexure 5***

The river reservation to a distance of 60 m from the banks

Both banks of the river are covered by a thin strip of disturbed riverside vegetation. *Panicum maximum* (Rata Tana), *Arundo donax*, *Mimosa pigra* (Yodha Nidikumba), *Ludwigia peruviana*, *Trema orientalis* (Gedumba), *Syzygium jambos* (Seeni Jambu), *Macaranga peltata* (Kenda), *Albizia falcataria*, *Mallotus tetracoccus* (Bu Kenda), *Clusia rosea* (Gal Goraka), *Symplocos cochinchinensis* (Bombu), *Acacia mangium*, *Acacia melanoxylon*, *Saccharum spontaneum* (Wal Uk), *Caryota urens* (Kitul), *Homonoia riparia*, *Ficus* sp. (Nuga), *Artocarpus nobilis* (Wal Del), *Eupatorium inulifolium*, *Ficus racemosa* (Attikka), *Tripsacum laxum*, *Alstonia macrophylla* (Hawari Nuga) were the common plant species recorded in this area.

Other construction sites

Other construction activities (Office, Camps etc.) will take place on lands near the proposed new road. Home garden, tea and abandoned land are the main landuse types identified in the area demarcated for office and labor camps. *Cymbopogon nardus* (Pengiri Mana), *Eupatorium inulifolium*, *Symplocos cochinchinensis* (Bombu), *Lantana camara* (Gandapana), *Macaranga peltata* (Kenda), *Panicum maximum* (Rata Tana), *Eupatorium odoratum*, *Trema orientalis* (Gadumba), *Acacia mangium*, *Alstonia*

macrophylla (Hawari Nuga), *Dicranopteris linearis* (Kekilla), *Clidemia hirta*, *Erythroxylum obtusifolium*, *Careya arborea* (Kahata) are the dominant plant species found in this area. A detailed list of the flora recorded during the field study at this site are listed in ***Table 3.13*** in ***Annexure 5***

Road diversion near the dam site

Home gardens, tea lands and abandon lands are main landuse types affected by the proposed new road. *Cymbopogon nardus* (Pengiri Mana), *Eupatorium inulifolium*, *Lantana camara* (Gandapana), *Macaranga peltata* (Kenda), *Panicum maximum* (Rata Tana), *Eupatorium odoratum*, *Trema orientalis* (Gadumba), *Alstonia macrophylla* (Hawari Nuga), *Dicranopteris linearis* (Kekilla), *Clidemia hirta*, *Erythroxylum obtusifolium* are common plant species found in this area. *Alstonia macrophylla* (Hawari Nuga), *Macaranga peltata* (Kenda), *Mangifera indica* (Amba), *Artocarpus heterophyllus* (Kos), *Persea americana* (Ali Pera), *Michelia champaca* (Sapu), *Albizia falcataria* are the common plant species found in the home gardens. A detailed list of the flora recorded during the field study at this site are listed in ***Table 3.13*** in ***Annexure 5***

Road Improvements near the powerhouse

Home gardens and abandoned lands are the main landuse types present along the expansion road 1 while home garden is the landuse type found along the expansion road 2. *Alstonia macrophylla* (Hawari Nuga), *Macaranga peltata* (Kenda), *Mangifera indica* (Amba), *Artocarpus heterophyllus* (Kos), *Persea americana* (Ali Pera), *Michelia champaca* (Sapu), *Swietenia macrophylla* (Mahogani), *Cocos nucifera* (Pol), *Areca catechu* (Puwak), *Syzygium aromaticum* (Karabu) are the common home garden plant species present. *Cymbopogon nardus* (Pengiri Mana), *Eupatorium inulifolium*, *Lantana camara* (Gandapana), *Macaranga peltata* (Kenda), *Panicum maximum* (Rata Tana), *Eupatorium odoratum*, *Trema orientalis* (Gadumba), *Alstonia macrophylla* (Hawari Nuga), *Dicranopteris linearis* (Kekilla) are the common plant species found in the abandoned lands. A detailed list of the flora recorded during the field study at this site are listed in

Spoil Dump Sites

All five sites that are selected as dumping sites can be classified as disturbed lands covered with secondary vegetation. Weedy and pioneer plant species are the common inhabitants observed in all five sites. The fauna observed at these five sites are common species that can be seen in such secondary vegetation. A brief description of the species composition of the five sites is as follows.

Site 1

Albizia falcataria, *Alstonia macrophylla* (Havari Nuga), *Macaranga peltata* (Kenda), *Eupatorium inulifolium*, *Lantana camara* (Gandapana), *Panicum maximum* (Rata Tana) are the common plant species inhabit in the land. The fauna observed in this site included the butterflies [*Delias eucharis* (Jezebel), *Junonia lemonias* (Lemon pansy), *Junonia iphita* (Chocolate soldier) *Neptis hylas* (Common sailor), *Ypthima ceylonica* (White four-ring)], birds [*Megalaima zeylanica* (Brown-headed Barbet), *Centropus sinensis* (Greater Coucal), *Dicrurus caerulescens* (White-bellied Drongo), *Pycnonotus cafer* (Red-vented Bulbul), *Acridotheres tristis* (Common Myna), *Turdoides affinis* (Yellow-billed Babbler), *Dicaeum erythrorhynchos* (Pale-billed

Flowerpecker), *Nectarina zeylonica* (Purple-rumped Sunbird], and one species of mammal, *Funambulus palmarum* (Palm squirrel).

A single endemic plant *Artocarpus nobilis* (Wal Del) that is endemic to Sri Lanka was observed at the site. No nationally threatened plant species recorded during the study. No Nationally Threatened plant species were recorded at this site during the study. None of the fauna observed at this site is endemic to Sri Lanka or listed as Nationally Threatened.

Site 2

Macaranga peltata (Kenda), *Albizia falcataria*, *Mallotus tetracoccus* (Bu kenda), *Alstonia macrophylla* (Havari Nuga), *Artocarpus heterophyllus* (Kos), Coffea arabica (Kopi), *Lantana camara* (Gandapana), *Panicum maximum* (Rata Tana), *Eupatorium inulifolium* are the common plant species observed in this site. The fauna observed in this site included the butterflies [*Appias galane* (Lesser albatross), *Eurema hecabe* (Common grass yellow), *Junonia iphita* (Chocolate soldier) *Ypthima ceylonica* (White four-ring), *Papilio polytes* (Common mormon), (Mottled emigrant), *Parantica aglea* (Glassy tiger), *Danaus chrysippus* (Plain tiger)], birds [*Megalaima zeylanica* (Brown-headed Barbet), *Centropus sinensis* (Greater Coucal), *Streptopelia chinensis* (Spotted Dove), *Corvus levaillantii* (Large-billed Crow), *Aegithina tiphia* (Common lora), *Pycnonotus cafer* (Red-vented Bulbul), *Pycnonotus luteolus* (White-browed Bulbul), *Turdoides affinis* (Yellow-billed Babbler), *Dicaeum erythrorhynchos* (Pale-billed Flowerpecker), *Terpsiphone paradisi* (Asian Paradise- flycathcher), *Copsychus saularis* (Oriental Magpie Robin)] one species of reptile, *Ptyas mucosa* (Rat snake) and one species of mammal, *Pteropus giganteus* (Flying fox).

A single endemic plant *Actinodaphne elegans* that is endemic to Sri Lanka was observed at the site. No nationally threatened plant species recorded during the study. No Nationally Threatened plant species were recorded at this site during the study. None of the fauna observed at this site is endemic to Sri Lanka or listed as Nationally Threatened.

Site 3

Eupatorium inulifolium, *Lantana camara* (Gandapana), *Panicum maximum* (Rata Tana), *Albizia falcataria*, *Mallotus tetracoccus* (Bu kenda), *Acacia mangium*, *Ludwigia peruviana* are common plant species inhabit in the land. The fauna observed in this site included the butterflies (*Delias eucharis* (Jezebel), *Junonia lemonias* (Lemon pansy), *Neptis hylas* (Common sailor), *Ypthima ceylonica* (White four-ring), *Parantica aglea* (Glassy tiger)], birds *Streptopelia chinensis* (Spotted Dove), *Pycnonotus cafer* (Red-vented Bulbul), *Acridotheres tristis* (Common Myna), *Orthotomus sutorius* (Common Tailorbird), *Dicaeum erythrorhynchos* (Pale-billed Flowerpecker), *Nectarina zeylonica* (Purple-rumped Sunbird), *Prinia inornata* (Plain Prinia), *Copsychus saularis* (Oriental Magpie Robin)] and one species of mammal, *Funambulus palmarum* (Palm squirrel).

None of the plants or animal species observed at the site are endemic to Sri Lanka or listed as Nationally Threatened species.

Site 4

Lantana camara (Gandapana), *Eupatorium odoratum* (Podisinnamaran), *Panicum maximum* (Rata Tana), *Eupatorium inulifolium*, *Stachytarpheta dichotoma* are common plant species inhabit in the land. The fauna observed in this site included the butterflies [*Appias galane* (Lesser albatross), *Eurema hecabe* (Common grass yellow), *Neptis hylas* (Common sailor), *Ypthima ceylonica* (White four-ring), (Mottled emigrant)], birds *Corvus levaillantii* (Large-billed Crow), *Pycnonotus cafer* (Red-vented Bulbul), *Pycnonotus luteolus* (White-browed Bulbul), *Acridotheres tristis* (Common Myna), *Orthotomus sutorius* (Common Tailorbird), *Dicaeum erythrorhynchos* (Pale-billed Flowerpecker), *Prinia inornata* (Plain Prinia), *Lonchura punctulata* (Scaly-breasted Munia)] and one species of mammal, *Funambulus palmarum* (Palm squirrel).

None of the plants or animal species observed at the site are endemic to Sri Lanka or listed as Nationally Threatened species.

Site 5

This site can be described as a denuded grassland covered by few tree species and shrubs such as Albizia falcataria, Macaranga peltata (Kenda), Lantana camara (Gandapana), Panicum maximum (Rata Tana) and Cocos nucifera (Coconut), Eupatorium inulifolium. The fauna observed in this site included the butterflies [Delias eucharis (Jezebel), Appias galane (Lesser albatross), Eurema hecabe (Common grass yellow), Junonia lemonias (Lemon pansy)], birds [Megalaima zeylanica (Brown-headed Barbet), Streptopelia chinensis (Spotted Dove), Oriolus xanthornus (Black-hooded Oriole), Corvus levaillantii (Large-billed Crow), Pycnonotus cafer (Red-vented Bulbul), Pycnonotus luteolus (White-browed Bulbul), Orthotomus sutorius (Common Tailorbird), Turdoides affinis (Yellow-billed Babbler), Dicaeum erythrorhynchos (Pale-billed Flowerpecker), Copsychus saularis (Oriental Magpie Robin)] one species of reptile, Calotes versicolor (Common garden lizard) and one species of mammal, Funambulus palmarum (Palm squirrel).

No Endemic or Nationally Threatened plant species were recorded at this site during the study. None of the fauna observed at this site is endemic to Sri Lanka or listed as Nationally Threatened.

All five sites selected for disposing tunnel waste are disturbed habitats that comprised of common plant and animal species. All five sites contained mostly introduced plant species that are also designated as invasive alien species [Lantana camara (Gandapana), Eupatorium odoratum (Podisinnamaran), Panicum maximum (Rata Tana), Alstonia macrophylla (Havari Nuga), Clusia rosea (Gal Goraka)].

Two species of common endemic plants Actinodaphne elegans, Artocarpus nobilis (Wal Del) were recorded during the study in two of the five sites. None of the plant species observed is listed as Nationally Threatened Plants (MENR and IUCN 2007) or restricted to the sites selected.

The fauna observed are common species that can be seen in such disturbed habitats. None of the faunal species recorded are endemic to Sri Lanka or listed as Nationally Threatened species.

Flora of the Resettlement Sites

The locations and the facilities available at the resettlement sites and their suitability has been discussed in detail in section 4.6.9.4.

- ***Resettlement Site 1 Mahawilawatta –Thembiligala (10th plot of land in SAARC village)***

  Initially a land from Mahawilawatta – Kalugalhinna, was identified as one of probable sites for resettlement of those who will be evacuated due to the proposed project. However, it is now made to understand that this site is no longer available for the said purpose. Therefore another land from Mahawilawatta - Thembiligala, the 10th plot of land in SAARC village is now been considered for the said purpose.

  The Project Proponent, the CEB has made a request to the Hon. Minister of Sports, Mahindananda Aluthgamage (Member of Parliament) to allocate a suitable 5 Ac plot from this land. The Hon. Minister's consent has been given to release a 5 Ac plot for which a letter has been issued to the Land Reforms Commission (reference ***item no. 19*** in ***Appendix F***).

  This site comprises of an abandoned tea land and the detailed list of the flora recorded during the field study at this site is listed in ***Table 3.13*** in ***Annexure 5.***

- ***Resettlement Site 2 (Riverside)***

  This is an abandoned land dominated by grass species such as *Panicum maximum* (Rata Tana), *Cymbopogon nardus* (Pengiri Mana) and *Pennisetum polystachion*. The other species found here include *Ludwigia peruviana*, *Mimosa invisa*, *Eupatorium inulifolium*, *Eupatorium odoratum*, *Wedelia trilobata*, *Dicranopteris linearis* (Kekilla). Isolated *Albizia falcataria* and *Ficus arnottiana* (Patana Boo) tress were observed scattered in the land. A detailed list of the flora recorded during the field study at this site is listed in ***Table 3.13*** in ***Annexure 5***

- ***Resettlement Site 3 (Next to Land Sale Plot)***

  This is an abandoned land dominated by grass and weed species and a few scattered tree species. *Cymbopogon nardus* (Pengiri Mana), *Eupatorium inulifolium*, *Symplocos cochinchinensis* (Bombu), *Lantana camara* (Gandapana), *Macaranga peltata* (Kenda), *Panicum maximum* (Rata Tana), *Eupatorium odoratum*, *Trema orientalis* (Gadumba), *Acacia mangium*, *Alstonia macrophylla* (Hawari Nuga), *Dicranopteris linearis* (Kekilla), *Careya arborea* (Kahata), *Eucalyptus* sp., *Ziziphus oenoplia* (Heen Eraminiya), *Osbeckia octandra* (Heen Bowitiya) are the common species recorded at this site. A detailed list of the flora recorded during the field study at this site is listed in ***Table 3.13*** in ***Annexure 5***

- ***Resettlement Site 4 (Private Land)***

  This is an abandoned tea land. *Alstonia macrophylla* (Hawari Nuga), *Mangifera indica* (Amba), *Michelia champaca* (Sapu), *Albizia falcataria*, *Caryota urens* (Kitul), *Macaranga peltata* (Kenda), *Macaranga indica* (Kenda), *Carallia brachiata*

(Dawata) are common trees found in the land in addition to *Camellia sinensis* (Tea). *Symplocos cochinchinensis* (Bombu), *Lantana camara* (Gandapana), *Dicranopteris linearis* (Kekilla), *Gomphia serrata* (Bo Kera) are the other common plant species found here. A detailed list of the flora recorded during the field study at this site is listed in ***Table 3.13*** in ***Annexure 5***

3.2.3 The Fauna and Flora of the Area

Flora

A total of 225 plant species including 16 endemic and two nationally threatened species were recorded during the field survey within the study area and is given in ***Table 3.14***. 37% of the plant species recorded at the project area is exotic species which indicates that the area is highly disturbed due to human influence. Among the exotic species recorded several alien invasive species such as *Panicum maximum* (Rata Tana), *Lantana camara* (Gandapana), *Eupatorium odoratum*, *Mimosa pigra* (Yodha Nidi kumba) and *Alstonia macrophylla* (Hawari Nuga) were also observed. The detailed list of plant species recorded during the field study and their distribution in the major construction sites of the project is given in ***Table 3.13*** in ***Annexure 5***.

Table 3.14 Summary of the plant species recorded during the study

No of Species	Endemic Species	Nationally Threatened	Exotic Species
225	16 (7%)	VU - 2	84 (37%)

VU – Vulnerable

Fauna

A total of 158 faunal species were recorded during the survey, representing aquatic gastropods, butterflies, dragonflies, Inland fishes, amphibians, reptiles, birds and mammals. Among them 21 species are endemic to Sri Lanka while 9 species of birds are designated as winter visitors. The faunal assemblage also included 5 species that are listed as nationally threatened (IUCN SL & MENR, 2007).

Another interesting observation was the presence of healthy populations of *Puntius nigrofasciatus* (Bulath Hapaya) and *Puntius reval* (Rathu viral Depulliya). These two species along with two other species have been introduced to the upper reaches of the Mahaweli ganga in 1981 by Ranil Senanayake as a conservation measure. Wikramanayake, (1990) have reported that *Puntius nigrofasciatus* (Bulath Hapaya) has established very well in the upper reaches of the Mahaweli Ganga. Therefore this distribution indicates that both *Puntius nigrofasciatus* (Bulath Hapaya) and *Puntius reval* (Rathu viral Depulliya) have expanded their range to reach the middle reaches of the Mahaweli Ganga as well. However the limit of their distribution appears to be the site selected for the present dam as neither fish was observed below this point.

Majority of the faunal species observed in the project site are common species that are encountered in such man modified habitats. Number of endemic species was also observed in the area. 50% of the endemic species recorded are either aquatic or semi aquatic species. The detailed list of faunal species recorded during the field study and their distribution in the major construction sites of the project is given in ***Table 3.15*** in

Annexure 5. A summary of the faunal species observed in the project site is given in ***Table 3.16.***

Aquatic Gastropods

Two species of aquatic snails, *Pila* sp. and *Paludomes* sp. were observed in the river system in areas that has fast flow rates and rocky substrates. These species was abundant throughout the river habitat where the suitable habitat occurred. However, it was not possible to identify these two snails to the species level because of the lack of proper identification keys for Freshwater snails of Sri Lanka.

Butterflies

Total numbers of 32 species were observed within the project site. Sri Lankas largest butterfly species *Troides darsius* (Maha Kurulu piya papiliya) was also recorded. Of the butterfly species recorded at the project site two are listed as threatened and three are listed as Nationally Near threatened (IUCN SL & MENR 2007).

Dragonflies and Damselflies

A total of 05 dragonflies and damselflies were recorded within the site especially along the riverine habitats. Of these, Green's Gem (*Libellago greeni*) is endemic to the island and it was common along the habitats.

Inland Fishes

Total numbers of 10 freshwater fishes were observed along the Mahaweli river system. Of these, five are endemic to Sri Lanka. Presence of *Puntius nigrofasciatus* (Black Ruby Barb; Bulath Hapaya), *Puntius reval* (Red-fin two banded carplet; Rathu waral depulliya) is of interest.

As described above, these two species are not native to the Mahaweli ganga but have been introduced in 1981 as a conservation measure. This observation indicates that these two species have established well in the Mahweli ganga. The present population of both these species is in good condition. The population density of *P. revel* is somewhat lower compared to *P. nigrofaciatus*. Among them *Puntius nigrofasciatus* is listed as a nationally threatened (Vulnerable) while *Belontia signata* is listed as a Near threatened species (IUCN SL & MENR 2007).

Amphibians

07 species of Amphibians were recorded from both aquatic and terrestrial habitats. Of these 03 species are endemic to Sri Lanka and Common wood frog (*Hylarana temporalis*) is listed as a nationally Near Threatened species (IUCN SL & MENR 2007). Breeding population of *Ramenella verigata* was also recorded from the tree-holes along the road side trees.

Reptiles

A total number of 06 reptile species were observed within the project area and among them 02 species are endemic to Sri Lanka. *Otocryptis wiegmanni* is listed as a nationally Near Threatened species (IUCN SL & MENR 2007). *Xenochrophis cf. piscator* (Diya Bariya) is a water snake which was only observed in small agrarian

channel trace while *O. wiegmanni* (Gomu talikatussa) was also recorded near the Power house site where the canopy cover was present.

Birds

A total of 85 bird species were observed at the project site. Among them 70 are native to the island and 9 species are listed as winter visitors to Sri Lanka. 07 species recorded are endemic to Sri Lanka. Of the birds recorded at this site 11 species are listed as nationally Near Threatened species (IUCN SL & MENR, 2007).

Mammals

A total of 13 species of mammals were recorded in the project area. Of these two species are endemic to Sri Lanka. Two species, *Prionailurus viverrinus* (Handun Divia) and *Lutra lutra* (Diya balla) are listed as nationally Vulnerable (IUCN SL & MENR, 2007). Both these species are water loving and found along the riverine systems. *Bos indicus* is the only domestic mammal species recorded from the study site.

Table 3.16 Summary of Faunal species recorded at the Project site

Animal group	Sri Lanka				Project site			Threatened*			
	Total	Endemic	Exotic / Migrants	Threatened*	Total	Endemic	Exotic / Migrants	CR	EN	VU	NT
Butterflies	244	20	-	66	32	1	-	1	1	-	3
Dragonflies	118	49	-	2	5	1	-	-	-	-	-
Inland Fishes	118	46	24	28	10	5	1	-	-	1	1
Amphibians	108	93	1	52	7	3	-	-	-	-	1
Reptiles	207	114	-	56	6	2	-	-	-	-	1
Birds	492	28	-	46	85	7	9	-	-	-	11
Mammals	94	19	12	41	13	2	1	-	-	2	2
Total					158	21	11	1	1	3	19

Source: * IUCNSL & MENR 2007,

CR - Critically Endangered
EN - Endangered
VU - Vulnerable
NT - Near Threatened

Summary of Fauna and Flora by the major project activities

Table 3.17 gives the distribution of fauna and flora at the sites of major project interventions

Table 3.17 The distribution of fauna and flora at the sites of major project interventions

WE - Weir **DW** – Downstream **IN**- Inundation Area **PS**-Penstock Path **PH** - Power House **TL** - Transmission Line **CP** - Camp Site **NR** - New Road **R1** - Expansion Road 1 **R2** - Expansion Road 2 **DS** – Spoil Dumping Area **RS** -Resettlement Sites

Taxonomic Group	WE	DW	IN	PS	PH	TL	CP	NR	R1	R2	DS	RS
Butterflies	18	17	15	4	18	9	15	3	6	3	10	11
Dragonflies	5	5	3	0	0	0	2	1	0	0	0	0
Inland Fishes	8	6	8	0	3	0	0	0	0	0	0	0
Amphibians	2	4	5	0	2	0	1	1	0	0	0	0
Reptiles	2	2	1	0	5	1	1	0	0	0	2	0
Birds	62	66	52	5	49	17	44	25	19	8	19	28
Mammals	4	9	8	2	4	2	7	2	1	1	2	4
Total species of fauna	101	109	92	11	81	29	70	32	26	12	33	43
Flowering Plants	42	157	138	44	13	26	87	77	63	47	26	108

The highest faunal and floral diversity was observed in the area downstream of the proposed dam site. This is to be expected as this area contains the largest patch of natural evergreen forest. The diversity of species was found to be low at the site selected for the powerhouse and sites selected for dumping of tunnel waste and resettlement of people. This could be attributed to the fact that these sites are highly disturbed areas. The region that will be inundated also supports a rich species assemblage. The area where the weir will be located is also rich in fauna and flora and of particular interest is the inland fish which comprised of two endemic fish species *Puntius nigrofasciatus* (Black Ruby Barb; Bulath Hapaya), *Puntius reval* (Red-fin two banded carplet; Rathu waral depulliya).

3.2.4 Identification of Rare, Threatened and Endemic Species

Threatened and Endemic Fauna

Table 3.18 The Endemic and Threatened species and Near Threatened fauna recorded from the project site

Group	Species Name	Common Name	Endemic	Threatened
Mollusc	*Paludomes* sp	Freshwater snail	+	
Butterflies	*Troides darsius*	Common birdwing	+	NT
	Chilasa clytia	Mime		NT
	Cepora nadina	Lesser gull		CR
	Eurema andersoni	One-spot grass yellow		EN
	Pantoporia hordonia	Common lasker		NT

Group	Species Name	Common Name	Endemic	Threatened
Dragonflies	*Libellago greeni*	Green's Gem	+	
Fishes	*Devario cf. aequipinnatus*	Knuckles Danio	+	
	Puntius nigrofasciatus	Black ruby barb	+	VU
	Puntius reval	Redfin Two-banded carplet	+	
	Puntius singhala	Filamented Barb	+	
	Belontia signata	Combtail; Thalkossa	+	NT
Amphibians	*Hylarana gracilis*	Sri Lanka wood frog	+	
	Hylarana temporalis	Common wood frog	+	NT
	Lankanectes corrugatus	Corrugated water frog	+	
Reptiles	*Otocryptis wiegmanni*	Sri Lankan kangaroo lizard	+	NT
	Xenochrophis cf. piscator	Checkered Keelback; Diya bariya	+	
Birds	*Gallus lafayetii*	Sri Lanka Junglefowl	+	
	Dendrocopus nanus	Pygmy Woodpecker		NT
	Celeus brachyurus	Rufous Woodpecker		NT
	Picus chlorolophus	Yellow-naped Woodpecker		NT
	Megalaima flavifrons	Sri Lanka Yellow-fronted Barbet	+	
	Megalaima rubricapilla	Crimson-fronted Barbet	+	
	Loriculus beryllinus	Sri Lanka Hanging Parakeet	+	
	Psittacula calthropae	Sri Lanka Layard's Parakeet	+	NT
	Collocalia unicolor	Indian Swiftlet		NT
	Sitta frontalis	Velvet-fronted Nuthatch		NT
	Hirundo daurica	Red-rumped Swallow		NT
	Iole indica	Yellow-browed Bulbul		NT
	Pellorneum fuscocapillum	Sri Lanka Brown-capped Babbler	+	NT
	Pomatorhinus melanurus	Sri Lanka Scimitar Babbler	+	NT
	Dumetia hyperythra	Tawny-bellied Babbler		NT
Mammals	*Macaca sinica*	Sri Lanka toque monkey	+	NT
	Prionailurus viverrinus	Fishing cat		VU
	Lutra lutra	Otter		VU
	Moschiola kathygre	Sri Lanka pigmy mouse-deer	+	NT

CR - Critically Endangered EN - Endangered VU - Vulnerable NT - Near Threatened

Threatened and Endemic Flora

About 7 % (16 plant species) of the recorded floral species in the project are endemic to Sri Lanka and is given in ***Table 3.19***. None of these endemic floral species are unique or restricted to the project area. They are common to such habitats and not listed as threatened in national red book. Out of 225 recorded floral species recorded during the study, two species are listed as nationally threatened. These two species are also not unique or restricted to the project area. No endemic species were recorded at the dam site or power house area while all the endemic species were recorded in the riverside vegetation downstream of the dam site.

Table 3.19 The Endemic and Threatened species of flora recorded from the project site

Abbreviations - T: Tree; S; Shrub; H: Herbaceous

Family	Species	Local Name	HA	Endemic	Threatened
Acanthaceae	*Strobilanthes sp.*	Nelu	S	+	
Anacardiaceae	*Mangifera zeylanica*	Etamba	T	+	
Anacardiaceae	*Semecarpus nigro-viridis*	Badulla	T	+	
Araceae	*Lagenandra sp.*	Ketala	H	+	
Celastraceae	*Bhesa ceylanica*	Pelan	T	+	
Cyatheaceae	*Cyathea walkerae*	Ginihota	T	+	
Euphorbiaceae	*Aporusa lanceolata*	Heen Kebella	T	+	
Flacourtiaceae	*Hydnocarpus venenata*	Makulu	T	+	
Lauraceae	*Actinodaphne elegans*		T	+	
Lauraceae	*Litsea longifolia*	Rat Keliya	T	+	
Melastomataceae	*Osbeckia octandra*	Heen Bowitiya	S	+	
Moraceae	*Artocarpus nobilis*	Wal Del	T	+	
Myrtaceae	*Syzygium operculatum*	Bata Damba	T	+	
Pandanaceae	*Pandanus ceylanicus*		S	+	
Rubiaceae	*Wendlandia bicuspidata*	Wana Idala	T	+	
Rutaceae	*Micromelum minutum*	Wal Karapincha	T	+	
Euphorbiaceae	*Homonoia riparia*		T		VU
Euphorbiaceae	*Phyllanthus emblica*	Nelli	T		VU

VU - Vulnerable

3.2.5 Faunal Migration patterns

Birds' migration patterns

A total of 09 migrant bird species were recorded during the study. All of these can be classified as forest migrants that inhabit both natural habitats as well as human modified habitats such as home gardens and plantations. A single species of goby was recorded during the field investigation. It is possible that other migrant species such as eels are also present in this river system.

Recognized animal movement pathways and their significance

Literature search and the field investigation did not provide any evidence for the presence of major animal movement pathways such as flyways of migratory birds, a critical corridor between fragment habitats or traditional seasonal movement pathway of large mammals in the project site.

3.2.6 Existing Environmental considerations/ problems/ issues in the area

The project area can be classified as a high human use area with no protected areas or sensitive habitats. The only natural habitat present is the river itself, river side vegetation and abandoned land that are in early seral stages of succession. The area contains highly sloping lands and therefore subjected to erosion. Removal of natural vegetation in most places and unsuitable construction practices observed in many

places could further aggravate this problem. Further it was also noted that people depend on the remaining natural habitats for their fuel wood requirements. Also the presence of many invasive plant species was recorded in the project site.

3.2.7 Number of trees that will be felled due to the construction activities

This has been addressed in section 4.3.1 under Anticipated Environmental Impacts.

3.3 Social Environment

The social environment of each area proposed for development interventions is considered as different geographical units for descriptions. These different geographical units include areas of proposed reservoir, tunnel, powerhouse/switch yard, penstock and surge shaft, power transmission line, residential camp / office and stores, proposed road diversion, labor camp in left bank and access road to powerhouse and surge chamber.

The descriptions of the existing social environment are confined to following three geographical units:

- Project area (project area is defined as land required for proposed development interventions).
- Immediate environment of the project area (GN divisions located in the mmediate vicinity of the project area are considered). Immediate vicinity represents the geographical area located in about 1 KM radius from the project land.
- The Udapalatha and Ganga Ihala Korale Divisional Secretariat divisions have been considered as macro environment where project will be established. The information in the two DS divisions would help to understand the general socio-economic context in the project area.

3.3.1 Demographic and Socio Economic Status of the Communities

Population and Families at Proposed Locations for Project Components

The information on population and families of each different geographical units studied are summarized in ***Tables 3.20(a)-1*** and ***3.20(a)-2.***

Table 3.20 (a) – 1 Population and Families in the Project related DS divisions

Project component	DS divisions	
	Families	Population
Ganga –Ihala	12657	62429
Udapalatha	21912	94810

Source : Ganga Ihala and Udapalatha DS Offices -2008

The population in the project area can be considered as affected persons due to proposed project. Although the people living in the immediate vicinity of the project are not directly affected, they can be considered as indirectly affected and also the people having some stakes on the project. The data on population in DS divisions are shown mainly to describe the macro environment related to the proposed development project.

Table 3.20 (a) – 2 Population and Families in the Project Area and in the vicinity

Project component	Project area		Immediate vicinity of the project	
	Population	Families	Population	Families
Reservoir	97	20	6801	1619
Tunnel	0	0	4378	1063
Powerhouse / Switch yard, Penstock	11	2	1856	527
Transmission line	0	0	0	0
Residential camp / Office and stores	32	6	0	0
Proposed road diversion	0	0	0	0
Labor camp – left bank	17	4	0	0
Access road to Powerhouse and Surge Chamber	0	0	0	0
Total	**157**	**32**	**13116**	**3209**

Source : Social Assessment survey 2009 and project related DS offices 2008

Approximately 157 people reported from 32 families living in areas demarcated for constructing different project components are categorized as project affected communities. The people in the GN divisions located within 1 KM radius of the project boundary is considered as indirectly affected communities of the project. It is about 13116 living in 3209 families. The population in Ganga ihala and Udapalatha DS divisions are considered as people living in the macro level environment of the project (Ganga Ihala has 62429 people from 12657 families and Udapalatha has 94810 population reported from 21912 families).

Diversity of Population

Out of 32 families in the project area 3 are Muslims and 5 are Tamil and the balance is Sinhala. The Population belongs to all 3 ethnic groups and is residing in the immediate vicinity as well as in two DS divisions. Nearly 79% of population in the immediate vicinity of the project boundary are Sinhala, 8% Tamil and the balance 13% is Muslim. Ganga Ihala Korale DS division has 82% of Sinhala, 12% of Tamil and 6% of Muslim. This ethnic composition is little different in Udapalatha DS division. The Sinhala 59%,

Tamil 22% and 19% Muslim are reported from Udapalatha DS division. This situation is similar to the religious diversity.

The data related to ethnic diversity and the conditions of religious diversity are shown in ***Tables 3.20 (b)-1, 3.20 (b)-2, 3.20 (c)-1*** and ***3.20 (c)-2***

Table 3.20 (b)-1 Ethnic diversity in project related DS offices

DS office	Sinhalese	Tamils	Muslims	Others	Total
Ganga Ihala	51123	7468	3568	270	62429
Udapalatha	55639	21542	17474	155	94810
Total	106762	29010	21042	425	157239

Source : Project related DS offices 2008

Table 3.20 (b)-2 Ethnic Diversity in the Project Area and in the vicinity

Project component	Project area				Immediate vicinity			
	Sinhala	Tamil	Muslim	Other	Sinhala	Tamil	Muslim	Other
Reservoir	75	6	16	0	4883	736	1165	17
Tunnel	0	0	0	0	3879	245	247	16
Powerhouse / Switchyard, Penstock & Sure Shaft	11	0	0	0	1514	36	300	6
Transmission Line	0	0	0	0	-	-	-	-
Residential Camp / Office and Stores	32	0	0	0	-	-	-	-
Proposed Road Diversion	0	0	0	0	-	-	-	-
Labor Camp – left bank	0	17	0	0	-	-	-	-
Access road to Powerhouse & Surge Chamber	0	0	0	0	-	-	-	-
Total	**118**	**23**	**16**	**0**	**10276**	**1017**	**1712**	**39**

Source : Social Assessment survey 2009 and project related DS offices 2008

Sixty eight likelihood affected people living in 14 families belongs to a caste called "black smith". This group had been evacuated from their original village due to construction of Kothmale power project. In 1984 these people were resettled in an area in Kandy district but that area got threatened due to land slide, and therefore they were again resettled in this present location. Once again these people need to be evacuated due to vulnerable condition that might be created by the proposed Morogolla power project. The locations of these settlements are shown in the community map given in ***Figure 3.7***. The other families likely to be affected by the project belong to "Govigama" caste and also they are rural low income communities.

Table 3.20 (c)-1 Religious Diversity in project related DS areas

DS area	Buddhist	Hindu	Christian	Islamic	Total
Ganga Ihala Korale	50990	7116	557	3766	62429
Udapalatha	54977	17418	2145	20270	94810
Total	105967	24534	2702	24036	157239

Source : Project related DS offices 2008

Table 3.20 (c)-2 Religious Diversity in project area and in the vicinity

Project component	Project area				Immediate vicinity			
	Buddhist	Hindu	Christian	Islamic	Buddhist	Hindu	Christian	Islamic
Reservoir	75	6	-	16	4841	1718	149	93
Tunnel	-	-	-	-	3770	295	10	298
Powerhouse / Switchyard, Penstock and Surge Shaft	11	-	-	-	1514	30	12	300
Transmission line	-	-	-	-	-	-	-	-
Residential Camp / Office and Stores	32	-	-	-	-	-	-	-
Proposed Road Diversion	-	-	-	-	-	-	-	-
Labor Camp – left bank	-	17	-	-	-	-	-	-
Access road to Powerhouse & Surge Chamber	-	-	-	-	-	-	-	-
Total	118	23	-	16	10125	2043	171	691

Source : Social Assessment survey 2009 and project related DS offices 2008

3.3.2 River Users

Some sections of the river in the project area (especially in the area around the location of the proposed Dam) flow in a deeper terrain; therefore people in the area have no easy access to the river in those sections for various direct uses. However river water is used for some social and economic activities by the people in upstream and downstream of the proposed dam. The different users of the river are briefly discussed below.

Irrigation Purposes

About 54 ha of land in Gampolawela minor irrigation scheme located downstream of the proposed dam is cultivated with irrigation water fed from the Dunhinda canal. Dunhinda irrigation canal is the feeder canal which channels water from the Mahaweli river at a location downstream of the proposed dam. The water intake location for the Irrigation canal is shown in ***Figure 2.9***

As per the information provided by the Department of Irrigation, the water requirements of the irrigation scheme fed by the Dunhinda canal in terms of flow rate is 0.28 m^3/s (10 Cusecs - ***item no. 6*** *in* ***Appendix A***).

Paddy and vegetables are cultivated in both seasons in this irrigation scheme. Two Hundred and Ten families depend on Gampolawela irrigation scheme and the farmers can obtain about Rs 75,000/- gross income per cultivated season from 0.5 ha of land cultivated with high valued vegetables. About 80% of the land in command area of Dunhinda canal is cultivated by leased- in (tenant) farmers and this is mainly due to involvement of land owners in other non-agriculture income generation activities.

Two farmer awareness meetings were held by CEB on 08.05.2012 and 18.09.2012 and the minutes of the meetings together with the attendance at those meetings are attached as ***item nos. 13*** and ***14*** in ***Appendix F***. The concerns of the farmers on the implementation of the project have been discussed in detail in section 4.6.1.1.

Crysbro Broiler Processing Industry (downstream of the Dam)

The Board of Investment (BOI) approved Crysbro Broiler Processing Industry is located downstream of the proposed dam. The industry presently extracts water from the Mahaweli ganga at a location downstream of the proposed dam before the tailrace outfall.

Discussions were made with the BOI, Crybro and the MASL officials with regard to the Industry requirements. According to BOI, the initial water requirement of the industry has been 450000 litres per day and now approximately 600000 litres per day waste water is said to be discharged to the Mahaweli river after treatment to comply with the required standards for industrial wastewater discharged to inland surface waters (ref. ***Appendix A, item no. 17*** and ***19***). However, MASL has approved extraction of water only up to a maximum of 220000 litres per day (ref. ***Appendix A, item no. 4***) for which a royalty fee of Rs. 15,000/- is paid by the owners of the industry to MASL per month.

Discussions were made with the Crysbro Industry officials lately also and the minutes of the meetings are attached as ***item nos. 15*** and ***16*** in ***Appendix F***. Crysbro Industry

suggestion is to have the water intake to the industry relocated to a downstream point to ensure that water supply to the industry is available even during dry periods once the proposed project is implemented. This has been discussed in detail in section 5.6.1 under mitigation measures.

About 25000 nos. of birds are processed daily at the processing industry. The industry is said to be discharging treated effluents back to Mahaweli Ganga at a point downstream of the proposed dam and upstream of the intake of the Dunhinda canal. The existing location of effluent discharge pipe outlet from the Crysbro Broiler Processing Industry is shown in ***Figure 2.9***.

The processing industry is part of the Farm's Pride poultry farm, which is fairly a large scale project where about 700 permanent labourers are employed. In addition to these regular employees, the farm has got into forward contracts for poultry keeping with about 1200 persons living out side of the farm. In addition to these outside poultry suppliers, about 4000 farmers are growing maize under forward contract agreements with Crysbro. Only, processing activities in the Crysbro Industry requires water from the Mahaweli River.

Bathing and Washing

People in the area use possible locations of the river in both upstream and downstream of proposed dam for bathing and washing. These locations are situated within the sections that can be defined as project affected area and are shown in ***Figure 3.7.*** The details of the bathing and washing locations are given in ***Table 3.21***.

Group discussion (vi) given in ***Annexure I*** gives the views of the river users for bathing and washing.

Table 3.21 Details of bathing and washing locations

Location	No of spots	Users (approximate no. of families)
Upstream of the dam	01 near Ulapane bridge 01 at Weliganga GN division	15 families 50 families
Downstream of the Dam	01 at Singhapura GN division in Ganga Ihala Korale DS division	20 families

Two upstream and one downstream location of the proposed Dam respectively are being used by the local communities for bathing. About 85 families daily use these locations for bathing and washing.

Sand Mining

Some locations of the river upstream and down stream of the proposed dam are used for sand mining by people. More than 200 persons depend on sand mining activities in this area. Some of these locations have been given permits from GSMB.

During the initial study in the year 2009 of the preparation of the EIA report, data was collected on sand miners and the sand mining activities in the proposed project area and such data is given ***Appendix G***. These sand mining locations in the project area are shown in ***Figure 3.7.*** Notes on the discussions with these sand miners likely to be affected by the proposed project from the Community view point is given in (ii) under Group discussions in ***Annexure 1***.

However, it is to be noted that as the said data is variable due to the limited validity period (one year) of the permits issued to sand mining activities, the list of permit holders is always prone to change. Hence latest updated data as at 01st October 2012 was collected and is given in ***Table 3.22***.

Nineteen persons (known as parties in local term) are involved in sand mining in both upstream and downstream of the proposed dam. Two parties carry out mining activities at locations upstream of the dam with one near Ulapane bridge on left bank of the river and the other on the right bank. These two locations will get inundated and mining operations cannot be continued once the project is implemented. One of the two is a Muslim and the other is a Sinhalese. The rest of the seventeen sand mining parties are involved in the downstream areas of the dam and their mining activities lie in a stretch of about 2 km from an area about 2 km downstream of dam.

Sediment measurement data are not readily available for this area. There is one such gauging station once operated by the Forestry and Environment Division of MASL located about 1 km downstream of the confluence of Atabage Oya with Mahaweli Ganga which is at present is out of order. An attempt to resurrect the station during the feasibility study was unsuccessful. However, based on sediment yields of similar catchments, a moderate sediment yield of 240 m^3/km^2/year has been provisionally adopted in the feasibility study for the design of the dam.

The sand mine operators carry out their mining activities with certain number of labourers hired on daily payment basis. But theses labourers are not involved in mining on a regular basis as the mine owners hire labourers depending on the availability of labour in the local area. Therefore, it is not possible to list the names of the labourers who will have impact as the persons hired vary on different days. The number of labourers hired in each location range from from 2-3 except one party having 05 labourers.

According to the miners, the quantity of sand mined by each party ranges from 2-3 Cubes/day. However, when mining license is issued, several restrictions have been imposed by the DS offices with regard to sand mining activities limiting the number of days and the quantity of sand that could be mined by a mine owner per month. Accordingly, for the permit holders, the maximum quantity permitted to be mined ranges from 10-15 Cubes/month except for two miners who are permitted to mine 35 cubes/month.

The daily gross income of each party lies in the range Rs. 5,000 to Rs. 9,000. The net income for a labourer per day ranges from Rs. 800-2,000. The net income of the mine owner ranges from Rs. 2,000 to 3,000/day. The total income of a mine owner per mine is Rs. 21,000 to 45,000/month except two miners whose income will be Rs. 60,000 and Rs. 96,250/month.

3.3.3 Income generation sources and patterns

Table 3.23 (a) - 1 Income generation sources- Project related DS areas

DS area	Agriculture	Govt.	Private	Self	Foreign	Total
Ganga Ihala Korale	3330	4561	5625	6132	438	17086
Udapalatha	8573	4657	3418	2335	5837	24820
Total	8903	9218	9043	8467	6275	41906

Source : project related DS offices 2008

Table 3.23 (a) - 2 Income generation sources – Project area and vicinity

Project component	Project area (no. of families)					Immediate vicinity (no. of persons)				
	Agriculture	Govt.	Business	Labor	Private	Agriculture	Govt.	Private	Self	Foreign
Dam	3	2	2	4	9	285	430	666	904	95
Labour camp (LB)	-	-	-	2	2	210	315	490	655	50
Power house	2	-	-	-	-	105	141	162	268	21
Transmission line	-	-	-	-	-	-	-	-		-
Office camp/ road diversion	-	1	-	2	3	-	-	-		-
Total	5	3	2	8	14	600	886	1318	1827	166

Note:

(i) Project area refers to the land to be used for different components of the project. The immediate vicinity of the project area includes about 1 km radius from the project area. The data related to entire DS divisions has been shown under the column of the two DS divisions.

(ii) The income levels of the families

Though the income levels reported by the people and also data available in the formal sources on income do not reflect the accurate condition, the data in ***Table 3.23(b)*** helps to generate some understanding on the economic condition of the people in different geographical locations studied.

Most of the persons within the employable ages are involved in private sector income generation activities. The income generation activities of the people in the three geographical units (project area, immediate vicinity and the two DS divisions) studied includes:

- Agriculture
- Government sector employment
- Private sector employments
- Self employments
- Foreign employment

Table 3.23 (b) -1 Income levels of families – Project related DS areas

DS area	5000 <	5001-10,000	10001-15000	15000 >	Total
Ganga Ihala Korale	2024	2783	4682	3163	12652
Udapalatha	3725	4602	7669	5916	21912
Total	5749	7385	12351	9079	34564

Source : Project related DS offices 2008

Table 3.23 (b)-2 Income levels of families

Project component	Project area- Income (Rs.)				Immediate vicinity – Income (Rs.)			
	5000<	5001-10,000	10001-15000	15000>	5000<	5001-10,000	10001-15000	15000>
Reservoir	1	1	5	13	237	398	554	394
Tunnel	-	-	-	-	168	257	360	278
Powerhouse / switch yard & Surge Shaft	-	-	-	2	84	116	195	132
Transmission line	-	-	-	-	-	-	-	-
Residential camp / office & stores	-	-	2	4	-	-	-	-
Proposed road diversion	-	-	-	-	-	-	-	-
Labor camp – left bank	-	2	2	-	-	-	-	-
Access road to Powerhouse & Surge Shaft	-	-	-	-	-	-	-	-
Total	1	3	9	19	489	779	1109	804

Source : Social Assessment survey 2009 and project related DS offices 2008

The magnitude of the various income generation activities are indicated by the number of families / persons involved in each income generation sources and income levels are shown in ***Tables 3.23 (a)-1, 3.23 (a)-1, 3.23 (b)-1*** and ***3.23 (b)-2*** .

Table 3.23 (b)-3 Percentages of families belonging to different income categories

Income category (Rs/month)	Project area	Immediate vicinity of the project	Ganga Ihala Korale DS division	Udapalatha DS division
Less than 5000	4	16	16	17
5001-10,000	9	24	22	21
10,001-15,000	28	34	37	35
More than 15,000	59	26	25	27

The income levels of families in the project area shows that most of them belong to moderate income earning communities in the country (monthly income ranges from Rs 5,000 to little above Rs.15,000). The percentages of families belonging to each income category are shown in ***Table 3.23(b)-3***.

3.3.4 Existing environmental considerations, problems or issues prevailing in the area

The environmental issues and problems prevailing in the project areas studied as mentioned by most of the stakeholders consulted include:

- Discharge of waste from Crysbro broiler processing industry to the Mahaweli River at Singhapura GN division. This has led to the fecal pollution of the river in this area.
- Occasional fire on the reserved forest in the river reservations. This has led to create rapid erosion of the river banks. (The area affected with this problem has been marked in ***Figure 3.7***
- Illegal river sand mining (without permits from the DS offices) at Gampolawela GN division.
- The river reservation has been encroached and cultivated in many locations.
- Some of the river reservations encroached has been converted to the residential land plots. The people living in the river reservation discharge their solid and wastewater to the river.

The nature of problems mentioned above is related to management of river and its immediate environment.

3.3.5 Cultural and Archeological aspects/considerations

The land areas demarcated for different project components and also those in the immediate vicinity of each project component are not significant in terms of cultural or archeological sites. Most of the land areas are non-residential lands cultivated with tea. Any archeologically or culturally sensitive features are not observed in the land required for project implementation or in the immediate vicinity of project area.

3.3.6 Existing infrastructure facilities, transportation, communications, power supply etc.

The existing infrastructure facilities in and around different geographical locations demarcated for project interventions are described below:

Water supply

Pipe water supply is not available for the families living within the project implementing area. In all other locations pipe water facilities are available for considerable number of families. The project area has been provided with pipe borne drinking water supplies through a new water supply scheme which uses Ulapane oya in its source. The sources of domestic water facilities for the households in the three geographical areas studied are given in ***Table 3.24.***

Table 3.24 Sources of domestic water supply (% of households)

Source	Project area	Immediate vicinity of project	Ganga Ihala Korale DS	Udapalatha DS
Pipe water	0	48	35	12
Protected well	36	23	26	48
Common well	50	4	16	0
Unprotected well	14	8	14	16
Tube well	0	5	1	9
Stream	0	12	8	15
Total (%)	**100**	**100**	**100**	**100**

Majority of households in all geographical units studied use shallow wells for drinking purposes. About 48% of the households in the immediate vicinity and in the DS division have access to pipe water. Most of these pipe water systems are established based on small streams in the local areas. During dry periods these water supply schemes have difficulties. Since the river is flowing in deeper terrain in this area people have difficulties to access river water.

Transport, Communication and Power supply

The area is well connected to the main road and rail network of the country.

Route from Gampola to Nawalapitiya runs close to the project area, this road connects project area to major highways Colombo to Hatton and Colombo to Nuwara Eliya.

Broad gauge railway from Colombo to Badulla passes close to the project area. Ulapane is the closest railway station.

The entire project area has close access to electricity supplies from the national grid. All the communities in the area have been provided with electricity.

Land lines as well as mobile communication coverage is available in the area.

The information on basic infrastructure facilities available in the project area are summarized in ***Table 3.25*** in ***Annexure 1***.

3.3.7 Social / cultural and archaeological sensitive places

Social / cultural sensitive places

The socially, religiously and culturally sensitive locations and their distances from each project location are mentioned in ***Table 3.26*** in ***Annexure 1***. The locations of these features are given in the map in ***Figure 3.8***.

Cultural and archaeological aspects / considerations

Bureau of Earth Reconnaissance (BER) carried out and AIA for the proposed project and a summary of their findings are listed below.

There are no archeologically sensitive places located within 1 KM radius of any of the locations demarcated for project interventions. However, four locations of archaeological importance are in existence within the 5 km buffer zone and are as follows. These places of archaeological importance are shown in the Photographs.

Site 1. ***Niyamgampaya Raja Maha Viharaya***
(N 07^0 09' 00"; E 80^0 34' 01.9")

This is an ancient Buddhist monastery. The remaining architectural characteristics of this monastery comprise an old image house with its other related components. The sculptures and the paintings of the interior of the image house could be ascribed to the mid seventeenth century. However the historical chronicles have pushed back the historicity of this monastery to the mid fourteenth century. It is said that this vihara was founded by the King Vickramabahu III (1357-1374 CE) in the 17th year of his reign. Niyamgampaya Buddhist monastery has declared as a protected archaeological monument.

Site 2. ***Valvasagoda Raja Maha Viharaya***
(N07^0 08' 45.3"; E 80^0 33' 28.6")

This is an ancient Buddhist Vihara which was constructed by the King Buvanekabahu IV (1470-1478 CE). The only remaining features of the old monastery are the devala and the stupa. The doorframe and the interior of the devala have been colorfully painted. The stupa was housed in a building consists of four plastered pillars. It seems that the temple has been renovated several times in the past.

Site 3. ***Purana Gal Viharaya in Mawatura***
(N 07^0 05' 28.5"; E 80^0 34' 24.2")

This is an unfinished ancient stone building. The architectural style of this edifice shares a number of similarities with some of the buildings constructed in the Gampola period (1341-1415 CE). The ground plan of the building suggests that the intention of this construction was to erect an image house (35.6x 26.6 meters). The entrance of the building is facing south. No proper attention has been made to protect this monument.

Site 4. ***Ancient Pattini Devala in Savandarapitiya***
(N 07^0 05' 01.0"; E 80^0 32' 52.8")

This is an ancient Tampita Vihara style building. According to the architectural organization, it could assume that this shrine was constructed in the 18th century. Original structures and plan of the feature had been changed several times. Wooden beams of the original building have been removed and left at the premises of the shrine.

There are no above ground monuments of archaeological importance within a radius of 1 km area that is to be developed under the proposed hydro power generation plant in the village *Moragolla* and its suburbs. Careful observations of the field walking have shown a lack of artifact scatter on the ground as well. The area was re-examined as prehistoric implements has been recovered from the *Ethgala* hillock by the anthropologists in the early 20th century. However no such materials were observed and this lack of arte-facts is due to the high degree of landscape modifications that occurred in the recent time.

The analysis of the distance factor suggests that there is no direct impact that could be inferred from any activity involved with the construction of the power plant. The propagation of the vibration during the tunneling will not be a key factor in the present case as the lack of any above ground monument of archaeological importance situated within the underground vibration penetrates distance.

The areas to be submerged after the filling of the reservoir have been thoroughly observed for surface finding but the observed surface is sterile for any archeological material.

3.3.8 Brief descriptions of the socio-economic environment in the 1 KM radius of each location

Dam, reservoir, road diversion and residential camp / office and stores area

The above mentioned project features will be established in the Weliganga GN division. This is a remote rural area. The communities living in the interior areas of this GN division have access difficulties. A secondary road starting closer to the Ulapane Bridge and connecting to the Nuwaraeliya-Gampola main road at the other end traverse along the river reservation of the Mahaweli river in the project area passes the Weliganga area. Community members in the area can not use river water for bathing or any other purpose near the dam site due to access difficulties to reach the river as the river valley is very steep in this area.

About 20 years ago 14 families living in this area had been evacuated from their previous residences due to Kotmale power project and relocated in an area of Weliganga GN division. This resettled location became vulnerable as the area was prone to land slides and they had been resettled again in their present location (The present location is marked in the community map).

Most of the families in this village belong to blacksmith caste but the traditional livelihood activities they had performed have now disappeared. The employable

persons are involved in diverse income generation activities. The area is poor in socio-economic infrastructure facilities such as schools, economic centers etc.

Tunnel, powerhouse, switch yard and surge shaft area

This area is surrounded by Ulapane North, Udagama, Singhapura and Gampolawela GN divisions. Settlements called Denmark Watta, Ethgala Watta village, Madoldeniya colony and Ulapane village are the specific places located on the ground surface on the corridor of the tunnel trace. Powerhouse, switchyard and surge shaft will be located in Gampolawela GN area and the lands in this area are sloping lands and are in general very poor in access facilities. The drinking water is a serious problem in the area. Scattered houses located can be observed in the area.

Ulapane industrial estate is located close to this area and therefore, significant number of persons from the area is involved in various income generation activities. The socio-economic environment or any other features in this area will not be negatively affected by the proposed Moragolla power generation project.

Proposed power transmission line

The corridor of the power transmission line falls in Gampolawela GN division. About 80% of the length of the transmission line traverse above home gardens and the rest is above abandoned lands. Some of the home gardens traversed by the line route would anyway be acquired for the components of the proposed project. In the balance home gardens, trees would be either cut / pruned for the safety clearance of the line.

3.4 Details of existing and planned projects in the area

Existing Projects in the area

(i) Ulapane industrial estate is located on the left bank of Mahaweli Ganga close to the proposed dam site. There are several industries located in the Estate and the details are given in ***Table 3.27*** in ***Annexure 6***.

The Ulapane Industrial Estate is shown in ***Figure 2.9***. About 25 acres of land belonging to "JANAWASAMA" has been allocated to this Industrial Estate. Approval has been granted by the Ministry of Industrial Development for 11 investors to set up various industries. 08 different industries have been so far established out of which 05 are in operation. Four more other industries are also to be established in addition to the above 11.

Presently these industries use water tapped from the aquifers from the land and also additional water is brought from outside. However the industrial estate is to be supplied with water from the Kandy-South water supply scheme of the National Water Supply & Drainage Board (NWS & DB) which is under construction and was scheduled to be completed by Dec. 2009.

(ii) Kothmale dam on Kothmala Oya is located upstream of the proposed dam and it's underground power house is located on the right bank of Mahaweli Ganga close to the tailrace area of the proposed power house.

(iii) An Irrigation Scheme known as Raja Ela (13 km long) draws water from a point well upstream on Ulapane Oya and takes water to Maligapurana, Gampolawela and Jayamalapura. Raja Ela which belongs to ID.

(iv) An irrigation scheme known as Dunhinda Ela draws water from a location in the river between the points of diversion and the location of proposed tailrace outfall.

(v) Towns South of Kandy Water supply scheme is a new project under NWS&DB. The scheme has one of it's intakes located well upstream on Ulapane Oya and the treatment plant at Ulapane has a capacity of 8000 m3. Presentiy the project is under construction.

(vi) Ulapane bridge on Mahaweli Ganga is being constructed by the RDA.

Planned projects in the area

(i) Ethgala New Town Development

Ethgala-East development is being implemented by the UDA with Ganga Ihala Korale Pradheshiya Sabha funds.

(ii) Ulapane Industrial Estate

Various Industries are being built in the Estate and construction works of 02 water tanks at a cost of Rs. 8 M is being built. The details of the Industries at the Estate is given in ***Table 3.27*** in ***Annexure 6***.

Discussions were made on 26th May 2009 by CEB and EIA Consultant with the relevant investors of the Ulapane Industrial Estate, DS (Ganga Ihala Korale) and the Divisional Director, Regional Industry Service Centre (Central Province). At the meeting, concerns were raised by the industrialists with regard to tunnel been aligned underneath the industrial estate and on the effects of water level fluctuations of the proposed reservoir on the nearby Industrial Estate Land.

Except for certain perceived fears, the investors are not against the proposed power generation project. They have doubts about some potential land slides due to reservoir and also other adverse implications due to underground tunneling works.

Considering the Industrialists concerns and the geological investigations carried out in the area it was decided to align the tunnel as much a possible away from the Industrial Estate and therefore the intake was located very close to the dam to avoid any influence of blasting on the buildings in the Industrial Estate.

With regard to the effects of water level fluctuations of the proposed reservoir on the Industrial Estate lying close to the reservoir, suggestion of the possibility of giving another land within the Industrial Estate to the investor concerned whose land will be vulnerable was also discussed.

However, it is recommended that further investigations are carried out during the detailed design stage to ascertain the stability around the specific area of the reservoir lying close to the Industrial Estate.

(iii) Towns South of Kandy Water Supply Project

A water supply scheme of the NWS & DB is being constructed with a capacity of 53000m^3/day from 04 treatment plants including that of Ulapane. The construction works was scheduled to be completed in Dec. 2009.

(iv) Raja-Ela Development Project

Rehabilitation works are to be done.

(v) Ulapane Mahawilawatte Land and Housing Project

Lands have been distributed to the people and 100 houses have been built.

CHAPTER 4

Chapter 4

Anticipated Environmental Impacts of the Project

This chapter discusses the overall effects of the proposed project on the Environmental components. Impacts are given as both either direct or indirect impacts and short or long term positive or negative impacts.

4.1 Soil Erosion and Siltation

Soil erosion and Siltation is an important social and economic problem and an essential factor in assessing health and function of an ecosystem. Estimates of erosion are essential to address issues of land and water management which include sediment transport and storage in lowlands, reservoirs, and hydropower systems.

The Natural Resource Management Centre at the Department of Agriculture, Peradeniya prepared a Soil Conservation Plan (***Appendix D***) for the Moragolla hydropower project during June to August 2009 (some of the important findings in the report have been included in sections discussed below).

The immediate catchment is defined as the area important as far as the soil conservation is concerned and therefore needs to be given priority during conservation. The extent of the immediate catchment is approximately 257 ha and is shown in ***Figure 4.1***

The immediate catchment lies in Mahaweli catchment and belongs to the mid country and the elevation ranges from 520-675m asl and the land use is dominated by tea (including degraded tea lands). Other than tea, degraded tea lands which are being converted to homesteads, well developed homesteads, paddy, surface water bodies are the remaining land-use types.

4.1.1 Soil erosion and siltation hazards during constructions / establishment of dam, penstock, powerhouse and tunnel

During construction, existing trees will be uprooted and the soil will be excavated for the construction of access roads, canals, tunnels inlet /outlet portals, drains and power house buildings etc. These activities will make the ground prone to soil erosion and such erosion impacts may be pronounced along the existing natural drainage systems and also if the disturbed surfaces are exposed to heavy rains. Steep slope cuttings for construction works may initiate earth slips. However, the likelihood of significant erosion impacts during construction is high due to sloping terrain but at the operational stage considered to be marginal.

Table 4.1 gives the slope class and slope area within the immediate catchment. ***Figure 4.2*** shows the slope map for the immediate catchment.

The area drains to Kothmala oya and subsequently to Mahaweli River. There are few perennial streams running across the catchment and most of those are with stable banks and thus stream bank erosion is not significant. Apart from those streams and nick points along the streams, there are no significant surface water collecting structures within the immediate catchment. Surface water available is in good quality and some dwellers are using well water or spring water for drinking purpose.

Table 4.1 Slope Class and % Slope area within the immediate catchment

Slope class (%)	Extent (ha)	Percentage of the catchment
0 - 15	57.4	22
16 – 30	102.0	39
31 - 45	65.3	25
46 – 60	18.2	7
› 60	13.8	7

Types of soil at project sites and its susceptibility to erosion

The predominant Great Soil Group in the site is Reddish Brown Latasolic (RBL) soils in association with Red Yellow Podzolic (RYP) soils in limited locations. Both the RBL and RYP soils are considered to be less vulnerable for soil erosion under moderate topographies such as the project site. However in situations where slope is high and canopy cover is not dense, possibilities of soil erosion is high. In general the catchment is moderately vulnerable to soil erosion.

Dam Site

The proposed construction involves heavy earth moving work including rock and earth excavation and filling. The amount of earthwork is bound to affect the drainage of surface water during construction.

Penstock Area

During construction, existing trees will be uprooted and the soil will be excavated for the construction of anchor blocks. The total excavation area involved is very small in extent and will hardly affect the flows in the streams.

Power House Site

About 15500m^3 of surface earth material will be removed by soft excavation at the power house site. If soil is allowed to wash off, the stream water will be contaminated. Therefore a proper dumping plan has to be maintained.

A deep earth excavation will be made at the powerhouse site. A safe slope angle has to be maintained to prevent damages to humans and property due to slope and rock failure.

4.1.2 River bank erosion during construction and operation of the project

During construction, the total excavation area involved closer to the river bank is very limited in extent and will hardly affect the flows in the streams. However, blasting and deep excavations will take place for dam foundation construction. Therefore, soil erosion activation cannot be avoided during this time. Compared to the other activities, foundation construction will be only during a limited period of time and therefore the effects will not be significant. A small amount of soil in the surface soil cover removed during construction of the dam can be disposed off at a proper dumping site before the stream gets contaminated.

The river banks consist of clayey soil. Therefore during the operation of the project the quantity of silts added to reservoir due to erosion is negligible. But, the amount of silts being presently removed due to sand mining will be reduced due to cessation of such activities being taken place in the islands that lie within the valley as the access is blocked to these areas due to reservoir impounding. This increases the silts accumulated specially in the area of confluence of Mahaweli Ganga and Kotmale Oya.

Once the reservoir is impounded, inundation of the upstream of the dam may cause submergence of slope banks. Frequent fluctuation of water level may lead to bank failures, erosion and undercuts. These processes may cause land degradation. Taking appropriate mitigation measures will minimize such impacts on bank failures. In the proposed project, the optimum drawdown of the reservoir is only 2m and therefore such impacts due to fluctuation of water levels is reduced. Nevertheless appropriate mitigation measures to minimize such impacts on bank failures have been discussed in sections 5.4.1 and 5.4.15.

4.1.3 Impacts during construction of access road / rehabilitation of access road to the dam, power house, switchyard, surge shaft, tunnel portals etc.

In general, increased soil erosion is observed during construction activities. This is due to uprooting of existing trees and excavation of soil for construction of access roads or the improvements to the existing access roads. In addition, road construction activity is incorporated with compaction, refilling and re-compaction sequences. Therefore movement of heavy construction equipment further increases the removal of soil particles from the surface leading to washing away of the soil with runoff. Also, tendency of movement of fractured bedrock wedges during blasting activities may be significant adjoining the excavated mass.

An excess of soil material can be generated during earth works for road works. The volume of cut material can be utilized for areas to be filled and thereby material to be disposed during construction can be minimized. Also the failure of newly formed banks of cuts and fills can be minimized by maintaining a safe angle for side slopes.

4.2 Water quality impact

4.2.1 Impacts on water quality during construction of weir and power house.

During the construction phase there will be various activities such as land clearing, demolition works, excavation works, blasting and drilling works, cut and fill operations, spoil disposal, soil stabilization works and landscaping, etc. which could result in surface water quality deterioration mainly in terms of high turbidity and color. Exposure of bare soil to heavy rains and subsequent generation of runoff containing substantial soil quantities could lead to water quality enrichment with any biocides and associated heavy metals that may be adsorbed in the soil material and even with nutrients noting that soil contains adsorbed phosphorous and NH_4^+ ions in significant amounts. In the proposed project area, surface water quality deterioration due to surface and subsurface runoff enrichment will be significant during the heavy rainy periods of the south-west monsoon (May-September) mainly due to the fact that steep slopes are available in many areas.

Surface run-off from the cut and fill areas, borrow areas, spoil disposal sites, etc. contains substantial dust and earth quantities which will cause significant color and turbidity problems, though these impacts could be temporary.

Also fairly large quantities of concrete are required for the construction of weir and power house. Therefore, wash water arising during the cleaning of the machinery involved in concrete plant operations or batching plants could cause colour and turbidity problems in water bodies as well as contamination with oils or hydrocarbons (HCs) and heavy metals such as Pb and Fe. Although these impacts are temporary considering the small duration of the construction phase the effects can be significant when several machinery and equipment are washed at a given time. The impacts such as smothering effects on benthic biota due to settling of suspended, flocculated material in large quantities under clam and quiescent conditions, thick oil spills restricting atmospheric O_2 diffusion at the air-water interface and bioaccumulation of heavy metals will be significant in slow moving streams or stagnant water bodies such as ponds. Although ordinary cement material is not toxic to biota, the cement rich wastewater is alkaline due to the presence of lime (calcium oxide) which could therefore, kill aquatic biota.

Cement grouting used as an underground treatment in tunneling to prevent the possible water seepage can flow along rock fractures to long distances through the ground and cause spreading of alkaline compound in cement. Thus alkalinity and pH of the groundwater around the grouting areas during the construction period will be increased. An impact to ground water can be expected in the vicinity of such areas. But the impact is not long-term.

Geotechnical studies of the project area indicate that cracks of the rock below the dam and power house areas are not critical. Therefore required quantity of cement for grouting may not be much higher. Also housing areas are located about more than 1km away and about more than 30m above the grouting area of the dam site. Groundwater usage in this area is insignificant.

Types of the bed rock at the dam, tunnel and power house areas are Garnetiferrous and Charnockittic gneisses. Content of water soluble minerals of those rocks are negligible.

In addition to colour and turbidity problems, contamination scenarios with oil and heavy metals such as Pb and Fe could occur during the clearing of the soil and from vehicles transporting construction material too. Further significant lubricating and fuel oil spills from machinery and other equipment used for construction works would cause contamination of the nearby soil, eventually leading to contamination of the water bodies particularly during heavy rainy periods. Waste oil is anticipated to be produced at the time of commissioning and inspection of equipment, and in most of cases the waste cloth are also produced. Risks also will occur during handling of drummed and waste oils.

Moreover bridge and culvert construction activities and even dredging works affects surface water quality deterioration mainly with reference to color and turbidity. Further, improper storage of construction materials such as cement and excavated material including spoil, results in such material being washed into nearby water bodies during periods of heavy rains hence leading to higher turbidity problems.

Scrap material such as cables, metal structures, steel wires and insulators involved in power line construction works would have deleterious effects on aquatic fauna if these left over material is open dumped or gets washed to the nearby waterways in significant amounts. This is because heavy metals under acidic pH conditions could become readily bio-available due to dissolution, hence resulting in bioaccumulation on aquatic fauna.

Open dumping of wood and timber used as packaging material of equipment and tools and cardboard packages to the water bodies may not have adverse effects on biota. However, such disposal could deteriorate the aesthetic beauty of the area and further contribute to blocking and making the water bodies shallow.

Construction generated wastes including any debris left after construction works may be carried away by runoff during rainy periods, resulting in blocking of river. Large sized material such as stones used for concrete manufacturing when washed during the heavy rainy periods could get settled and make the river and other open water bodies shallow when deposited.

Further, construction wastes getting deposited in the waterways during the rainy periods could contribute to significant turbidity and even colour problems depending on what type of material gets washed away. For example, excess cement material left contributes to significant visual pollution (though ordinary cement is not toxic to biota) and also the cement particles are being or known to form flocculated particles, which could produce a smothering effect on benthic fauna such as snails and other freshwater mollusks when the such particles settles slowly. This effect will be significant if a large quantity of such material is washed off. Moreover open dumping or improper storage of the excavated soil material (spoil) near the river would lead to further turbidity and colour problems during the rainy periods.

Table 4.2 presents a summary of the anticipated construction impacts for some of the activities.

Table 4.2 Anticipated construction impacts on water quality

Activity	Factors affecting impacts	Remarks
Construction material, exploitation, handling and storage	Improper handling and storage of construction material; e.g. cement	Turbidity and colour problems are significant during periods of heavy rains, but effects are temporary
Site clearing	Run-off during rains will deliver debris and sediments, etc.	Turbidity and colour problems are significant during periods of heavy rains, but effects temporary
Cut and fill operations	Run-off during rains will deliver debris and sediments, etc.	Turbidity and colour problems are significant during periods of heavy rains
Borrow areas	Run-off during rains will deliver debris and sediments, etc.	Turbidity and colour problems are significant during periods of heavy rains
Spoil disposal	Run-off during rains will deliver debris and sediments, etc.	Turbidity and colour problems are significant during periods of heavy rains
Construction of bridges and culverts	Run-off during rainy days Spillage of construction material	Turbidity and colour problems are significant, but effects temporary
Concrete plants	Oil spills and contamination during rains (as run-off) Wash waters from cleaning of machines	Effects are significant (unless measures taken), though temporary
Application of weedicides for soft landscaping	Frequency and dosage of application Run-off and leaching of pollutants	Application of pesticides rich in OCPs, OPPs and even heavy metals could be a serious concern if large scale application of such chemicals is carried out for the project
Unplanned activities	Increased number of persons employed in the project Inadequacy of facilities or infrastructure for appropriate sanitation and solid waste disposal	Effects on water quality will be significant if the duration of the construction phase becomes long due to unforeseen circumstances

4.2.2 Waste generation and pollution from temporary workers camps

Disposal of grey water and black water from the workers quarters or from temporary toilets within the project site to the river could cause contamination with high levels of BOD, nutrients, pathogens such fecal coliforms (*Escherichia coli*), *Enterobacter* spp. and fecal streptococci (e.g. *Streptococcus fecalis* and *Streptococcus durans*), and even with Cl^- ions (noting that human excreta in general has a chloride content of 6 g per person per day). Although these effects are temporary, the effects will be significant if the construction period is long and considering the fact that a large number of workers are involved.

However, it should be noted that the effects of BOD enrichment varies diurnally depending on the oxygen solubility. The presence of high BOD levels due to

enrichment with untreated sewage may result in substantial DO depletions with acidity generation during night time due to microbial degradation of the biodegradable organic matter with adverse effects on fish when DO levels drops below 4 mg/l. Nevertheless, higher enrichment with nutrients may also favor algal growth under sunny conditions and subsequently oxygenation of the water bodies with increases in pH to values exceeding 8.3. Nevertheless, death of algal blooms too would contribute to sediment oxygen demand and subsequently DO depletions.

This project would involve a large number of workforces for the construction works. Therefore careless disposal of large amounts of municipal solid waste to the water

bodies or leaving the wastes and subsequent washing by runoff could lead to further pollution of the river and even have deleterious impacts on the biota in the river, unless appropriate solid waste disposal facilities are available. It should be noted that during the acidogenic and acetogenic biodegradation phase, the leachate is characterized by a high electrical conductivity, COD, BOD and Na^+, Cl^- and NH_4^+. Acidogenic and acetogenic leachate is extremely toxic and will have serious consequences to the biota. Further this leachate is also highly toxic to bacterial biofilms present in the roots of aquatic plants and sediments.

4.2.3 Impacts on water quality of the proposed pond from existing and planned projects

The ponding caused by impounding with the construction of dam may lower the flow velocities and the retention time of water becomes high. This phenomenon leads the accumulation of nitrogenous and phosphorus compounds in the water. With the availability of sun light there exists a high potential for eutrophication in the pond resulting in the formation of algae. If this scenario occurs particularly during dry season, neighboring community will have to suffer inconveniences such as poor water quality for drinking, bad smell, poor aesthetic appearance etc.

In addition, agro chemicals being used by the people in the upstream of the dam could get collected in the pond creating toxic effects to aquatic fauna.

The Ulapane Industrial Estate is constructed on a land very close to the project site and the land slopes down towards the reservoir. Soil erosion and earth failure can take place due to the non engineered constructions that is carried out in the Industrial Estate. If this happens, the eroded soil will directly flow down and get mixed with reservoir which will result in surface water quality deterioration mainly in terms of high turbidity and color. Exposure of bare soil to heavy rains and subsequent generation of runoff containing substantial soil quantities could lead to water quality enrichment with any biocides and associated heavy metals that may be adsorbed in the soil material and even with nutrients noting that soil contains adsorbed phosphorous and NH_4^+ ions in significant amounts.

The Ulapane Industrial Estate claims that no industrial wastewater will be discharged into the Mahaweli river and hence there is no impact after impoundment of the reservoir. With the reduction in flows in the river Crysbro Broiler Processing Industry

has been found to be greatly affected and as a result fecal pollution downstream of this industry may be high causing health impacts to those who utilize the water up to power house.

Further the grey and black water emission from SAARC Village, Denmark colony and Madoldeniya colony are too critical when the flow of water in the river decreases drastically.

4.3 Ecological impacts

There will be long term land use changes due to the establishment of the permanent structures such as the dam, formation of reservoir, tunnel, surge shaft, power house and switch yard and the transmission line, new roads and widening of roads. Further, there will be short term land use changes due to structures which are temporary such as establishment of labour camps, quarry sites, waste disposal sites and vehicle service areas.

The major ecological impacts that can be caused by these activities are as follows.

The flora and fauna in the immediate impact zone where various project interventions will be are given in ***Tables 3.13*** and ***3.15*** in ***Annexure 5***. The summary of fauna and flora by site of major project interventions are given in ***Table 3.17*** in Chapter 3.

4.3.1 Impacts on terrestrial fauna and flora

Removal of Trees due to various project interventions

Table 4.3 in ***Annexure 7*** lists the trees that are likely to be removed or affected due to the project interventions. The number of trees that will be affected due to inundation was estimated based on sample plot analysis method.

A total of 489 trees with a DBH of more than 20 cm will be removed / impacted due to various activities planned under the project. Construction of new roads and road widening will account for more than 48% of the trees that will have to be removed due to the project. An estimated 231 trees that have DBH over 20 cm belonging to 28 species will be affected by this activity. The species that will be most affected by road construction are *Artocarpus heterophyllus* (58 trees) and *Swietenia macrophylla* (53 trees). The landscapes affected by the road construction are mostly abandoned lands and home gardens located near the dam site and the powerhouse. Further, the affected area is spread over a large area. Therefore the magnitude of the impact on the area due to removal of trees due to road construction is minimal.

An estimated 179 trees that have DBH over 20 cm belonging to 26 species will be affected by the establishment of the reservoir which is the activity that will have the second highest impact on trees as nearly 38% of the trees that will be lost due to this project will result from this activity. The species most affected will be *Albizia falcataria* (34 trees) and *Peltophorum pterocarpum* (23 trees). The river banks in the region that will be inundated are generally steep and covered by a thin strip of riverside vegetation that is highly disturbed due to high human influence. The riverside vegetation

comprises mostly of grass and herbs with few scattered trees. Furthermore, as in the case of road widening the impact is spread over a large area and therefore the magnitude of the impact is minimal.

A total number of 28 individual trees over 20 cm DBH belonging to 9 plant species will be affected (some either pruned / removed) due to the construction of the transmission line (see ***Table 4.3*** of the ***Annexure 7***). Among the 9 affected plant species, four are exotic or introduced plant species and others are native plant species to the country. No endemic and nationally threatened plant species will be removed for the construction of the transmission line. All affected native plant species are common constituent plant species of dry zone forest, open forest and secondary forest vegetations.

Removal of trees due to other construction activities can be considered insignificant as most of these activities are carried out at abandoned lands or private land that has no natural habitats and only a few trees will be lost due to rest of the activities.

Impacts due to recruitment of labour force for construction activities

This will lead to establishment of campsites, generation of sewage, waste water and solid waste, spread of diseases due to poor sanitation practices, creation of possible breeding places for insect vectors, dust and noise generation due to site preparation and construction of temporary structures. Further, they may engage in activities that are detrimental to the social or environmental settings in the area such as unsustainable extraction of fuel wood and illegal tree felling, poaching, illicit brewing etc.

Loss of habitat for species due to removal of vegetation and inundation of river banks

During construction stage removal of vegetation cover and existing buildings may result in loss of habitats (feeding, roosting and breeding sites) of animals. During operational stage inundation of the river banks due to establishment of the dam will result in further loss of habitat which is irreversible.

None of the plant species observed at the proposed dumping sites are listed as Nationally Threatened Plants (MENR and IUCN 2007) or restricted to the sites selected. The fauna observed are common species that can be seen in such disturbed habitats. None of the faunal species recorded are endemic to Sri Lanka or listed as Nationally Threatened species. Therefore dumping of spoil at the five sites will not result in a significant impact on the fauna, flora or their habitats. Furthermore, the entire area impacted by this sites is around seven hectares in extent. Thus disposal of tunnel waste will not have a significant impact on the environment.

Detailed list of fauna observed in the immediate impact zone is given in ***Table 3.15*** in ***Annexure 5***.

Establishment of invasive species

During the construction phase, soil will be brought into the construction zone from outside. This soil may contain seeds of alien invasive species. Further, in many other instances it has been shown that heavy machinery used for construction can introduce seeds of invasive plant species if used without proper cleaning. Further, if temporary facilities such as camp sites, soil storage and rubble storage areas are not decommissioned properly invasive plant species can easily establish in such areas. As alien invasive plant species can spread rapidly once established it will threaten the natural and man made habitats in the area.

Disturbance to wildlife and human beings by noise and vibrations

During the construction phase, noise and vibrations will arise due to activities such as excavation, cutting, filling and compaction work as well as operation of construction related vehicles. This could cause disturbance to both humans as well as the wild animals that inhabit the area. Further these activities will also result in emission of dust and other pollutants that will decrease the quality of air in the project area that will have an impact on humans and wildlife that inhabit the area.

Detailed list of fauna observed in the immediate impact zone is given in ***Table 3.15*** in ***Annexure 5***.

Changes in the topography of the area

The implementation of this project will result in irreversible changes of the topography and landscape in the area due to the new reservoir that will result and associated structures such as the dam and powerhouse. Changes in the topography generally affect migratory species such as birds and reptiles that depend on landmarks to complete their migration. However, in the project area, the change is very small as the reservoir will be contained within the river valley and very few migratory species of birds frequent this area and their migratory pattern will not be affected by such a minor change in topography.

4.3.2 Impacts on aquatic fauna and flora with special reference to migration of fish species and environment flow downstream of the Dam

Drying of the river downstream of the dam site

The river downstream of the dam site will receive less amount of water due to blockage of the river by the dam and reservoir impoundment. The stretch of the river affected by this activity is estimated to be approximately 3 km at which point a major tributary of the river Atabage Oya links up with it. This downstream area contains deep pools that can retain water for prolonged periods when the water flow is cut off by the dam. It has been observed in other similar projects that, when the flow is restricted due to diversion of water, the water retained in such deep pools tend to get stagnated and the quality of water deteriorates rapidly making them unsuitable for most aquatic fish.

The reduced flows in the river downstream will impact number of aquatic species such as inland fishes and dragonflies. Three species of endemic freshwater fish was observed in the area that will become dry due to diversion. These are *Puntius*

nigrofasciatus (Black Ruby Barb; Bulath Hapaya), *Puntius reval* (Red-fin two banded carplet; Rathu waral depulliya) and *Belontia signatai* (Comb tail). All three species show a distribution starting from about 400 m downstream of the dam site and extending upstream into the inundation area and to the upper reaches of the Mahaweli ganga.

However, between the dam site and the Atabage Oya outfall, one perennial stream and several seasonal streams join the river. The perennial stream releases flows into the river at a point about 400 m downstream from the dam site (these streams have been discussed in section 5.6.1). Therefore flows from these streams combined with the balance flows (after release for other users) from the environmental flow of 1.5 m^3/s released downstream, it can be seen that a substantial flow is available from locations beyond 400m downstream from the dam.

Therefore only a small part of their present range (approximately 400m) of the aquatic species will be impacted due to the project. However, this will not have a significant impact on the population of this fish as their main habitat is located in the upper reaches of the Mahaweli ganga which will not be impacted by the project. Further, these three species of fish are found in many river basins in Sri Lanka including Kelani, Kalu up to Nilawala Basins and therefore the impact on these fish can be considered insignificant.

Waste generation and pollution of water courses

Ponding in reservoir due to the dam could make the water rich with nitrogen and phosphorus compounds which in turn lead to algal blooming. If the algal blooms are severe, algal toxins that have impacts on health could be possible. In shallow areas vegetation growth may be possible. Excessive growth may cause oxygen depletion causing stresses to aquatic biota.

Disposal of grey water and black water from the workers quarters or from temporary toilets within the project site to the river could cause contamination with high levels of BOD, nutrients, pathogens such fecal coliforms (*Escherichia coli*), *Enterobacter* spp. and fecal streptococci (e.g. *Streptococcus fecalis* and *Streptococcus durans*), and even with Cl^- ions (noting that human excreta in general has a chloride content of 6 g per person per day). Although these effects are temporary, the effects will be significant if the construction period is long and considering the fact that a large number of workers are involved.

However, it should be noted that the effects of BOD enrichment varies diurnally depending on the oxygen solubility. The presence of high BOD levels due to enrichment with untreated sewage may result in substantial DO depletions with acidity generation during night time due to microbial degradation of the biodegradable organic matter with adverse effects on fish when DO levels drops below 4 mg/l. Nevertheless, higher enrichment with nutrients may also favor algal growth under sunny conditions and subsequently oxygenation of the water bodies with increases in pH to values exceeding 8.3. Nevertheless, death of algal blooms too would contribute to sediment oxygen demand and subsequently DO depletions.

some sections of hilly areas in the form of a small waterfall during wet seasons. During dry seasons the drop becomes small and it becomes rather a rapid than a waterfall.

Since Moragolla is a small run–of–the river type of dam, the water is regulated on a daily basis. Due to smaller reservoir capacity, it is certain that reservoir will be spilling in most instances during wet seasons thus minimizing the effect on this Dunhinda water drop. During dry seasons a reduction in the water passing through the water drop is anticipated, but the reduction will be compensated to a certain extent by the environmental flow released from the dam.

The area does not have any unique vegetation as can be seen in the spray zones of larger waterfalls and hence no impacts will arise on flora.

4.4 Impacts on the discharge capacity of the river.

4.4.1 Backwater curves of the river reaches upstream of the proposed Moragolla dam

Backwater curves of the river reaches upstream of the proposed Moragolla dam were computed using a hydraulic model.

Hydraulic modeling software HEC-RAS was used for backwater computations. The basic computational procedure is based on the solution of the one dimensional energy equation. Energy losses were evaluated by friction (Mannings Equation) and Contraction/Expansion (coefficient multiplied by velocity head). The momentum equation is utilized in situations where the water surface levels are rapidly varied. These situations include mixed flow regime calculation (i.e. hydraulic jumps), hydraulics of bridges and evaluating profiles at river confluences.

The effects of various obstructions such as bridges, culverts, weirs, and structures in the flood plain are considered in the computations. Impact on the proposed construction on river water level profiles was investigated for the cases stipulated in the ToR items 4.4.1 to 4.4.3 using this model.

One of the main observations on the impacts on river water levels due to proposed construction is that present normal water levels in the river within the area demarcated as the reservoir will be significantly altered due to the proposed project on a permanent basis.

This is an inherent feature of any reservoir construction and referred to as permanent inundation. Impacts associated with inundation such as re-settlement, altering of habitats etc. will be dealt separately under environmental impacts.

Therefore any backwater study on the impacts of a proposed reservoir is concerned about any impacts due to the proposed reservoir beyond the bounds of the river reaches identified as the reservoir.

For the present backwater study, river reaches under Mahaweli Ganga, Kothmale Oya and Ulapone Oya were investigated. Following river reach lengths were investigated during this study.

Mahaweli Ganga	-	6000 m u/s of proposed Moragolla dam
Kothmale Oya	-	3911 m u/s of confluence with Mahaweli Ganga
Ulapone Oya	-	1966 m u/s of confluence with Mahaweli Ganga

Total of 36 river cross sections were identified at critical and important locations in Mahaweli Ganga and cross sectional details of these locations were surveyed.

Similarly 16 cross sections along Ulapane oya were identified and surveyed. Total number of cross sections identified in Kothmale Oya was 06 although the reach length is around 3911 m. This was due to the reason that river bed slope of Kothmale Oya in this reach is very steep and there are only few locations in the tributary which would have significant influence on the river hydraulics. The bed level difference of Kothmale Oya downstream of Kothmale dam and the confluence of Kothmale Oya with Mahaweli Ganga is about 80 m.

As discussed above, parts of the river reaches investigated will be submerged by the proposed reservoir. Therefore there will be significant changes in river water levels in these reaches before and after the project as they will be submerged in the proposed reservoir. The lengths of river reaches submerged are;

Mahaweli Ganga	Ch 300 - 3146 m
Ulapane Oya	Ch 0 - 409 m
Kothmale Oya	None

Therefore for the comparison of the impacts before and after the project, following river reaches are relevant.

Mahaweli Ganga	Ch 3146- 6300 m
Ulapane Oya	Ch 409 - 1966 m
Kothmale Oya	Ch 0 - 3911 m

Results of backwater computations for the case of flood events of 2 year, 5 year and 10 year return periods with all the gates closed are given in ***Table 4.4 (Annexure 7)*** alongside with the water levels corresponding to the "without structure" situation. River water levels for same events with gates partially opened to maintain the full supply level of 548m asl are also given in the same table.

The results show that there will be no impact on the above river reaches due to proposed dam and reservoir when the reservoir is operated as planned (with required number of gates operated to pass the incoming floods).

It was also noted that even with "all gates fully closed", there will be no impact on the reaches of Mahaweli or Kothmale upstream of the reservoir. However there will be

some impacts on Ulapane Oya in the case if "all five gates are kept closed" of the proposed Moragolla reservoir. A summary of these effects are described in ***Table 4.5***.

Table 4.5 Summary of Impacts due to floods (with all gates closed)

Flood Event	Mahaweli Ganga	Ulapane Oya	Kothmale Oya	Dam
2 yr	No significant impact beyond the reservoir boundary.	Levels of river for about 1 km length between Ch 409 m to Ch 1398m will rise by about depths ranging up to 0-3.3m. No impact upstream of Ch. 1398 m.	No impact at all	Overtopped Level = +2.16m bund top level of 550m asl
5 yr.	No significant impact beyond the reservoir boundary	Impact propagates up to about Ch 1398 About 1.0km beyond the limit of the reservoir. Depths will range 0-3m.	No impact at all	Overtopped Level = +2.58m above bund top level
10 yr.	No significant impact beyond the reservoir boundary	Impact propagates up to about Ch 1398 about 1km beyond the limit of the reservoir. Depths will range from 0- 3.3m above normal for the same event in this reach. Some buildings at Ulapane junction between Ulapane Oya and Mawathura road will be partially submerged Some buildings of the Raja Ela school will be partially inundated Nearly 125m length of Gampola-Nawalapitiya road will be inundated. All buildings between this part of road and Ulapane Oya will be inundated.	No impact at all	Overtopped Level= + 2.83m above bund top level

However it can be seen that this is highly an improbable situation. For that matter this will happen in any reservoir if all gates are kept continuously closed during a large flood event. The effect is further exaggerated since the free board for the gates is 1.0 m. In the event of all gates are kept fully closed; flood levels will first have to rise by additional 1.0m before flowing over the closed gates and eventually over the dam top.

In fact in the present case it was found that even the dam will be overtopped if gates are kept closed in all three flood events of 2 year, 5 year and 10 year.

This fact can be clearly seen by comparing the "all gates fully closed condition" with that of "at least one gate out of 05 is in operational condition". There will be no impact at all due to flood inflows for 02, 05 and 10 year return period in the latter case. In fact

it was found that in case of flood of 10 year return period if at least one gate is opened by 25% none of the impacts mentioned in ***Table 4.5*** would occur.

The proposed Moragolla reservoir is provided with five gates which are capable of passing 6500 m^3/s in a flood 10,000 year return period even with one gate non operational. Further the reservoir and the dam will be operated by an owner who has sufficient skills and experience in operating large number of similar installations throughout the country. Round the clock supervision will be provided at the dam and management of reservoir levels will be a routine operation of the project.

Flood peaks for each river reach were estimated by proportioning the peak flow at the dam site for an event of particular return period according to area ratios of the respective sub-catchments at their confluences.

It is highly unlikely that all such peaks would occur simultaneously as assumed in the computation of back water profiles. For example, in the case of Kothmale Oya it has been assumed that Kothmale reservoir would be at high flood level at the time of incoming flood and inflow would be released downstream without any routing effect. Therefore what is analyzed here will be events which would have much higher return probabilities than stated.

In conclusion it can be stated that, there will be no impact on the upstream reaches due to the proposed reservoir for the above flood events.

4.4.2 The flood surcharge owing to the Dam at the Dam site for the bank full discharge

Bank full discharge was established on the flooding having a return period of approximately 02 years. For the bank full discharge, cases for;

(a) All the gates open and
(b) 10% of the gates failing to open

Since the number of gates is 05, 10% of gates was taken as 01. Total no. of gates open will therefore be 04 Nos.

The same flood hydraulics model used for computations in section 4.4.1 is used here, but this time with the gates as appropriate have been taken as opened.

The summary results are tabulated in ***Table 4.6*** (***Annexure 7***). The results show that;

(i) There will be no impact compared to pre-project situation for bank full discharge if all gates are opened.

(ii) In the case of 10% of the gates failing to open too, there will be no impact during bank full discharge compared to pre-project condition with the same discharge.

4.4.3 The flood surcharge owing to the Dam at the Dam site for 50 and 100 year return period floods, with all the gates open.

Flood surcharge at the dam and upstream river channels were computed for the peak discharges of 50 and 100 year return periods. Some flood hydraulic model as described in section 4.4.1 was used for computations.

The results are tabulated in ***Table 4.7*** (***Annexure 7***) The computations show that there will be no impact on the river reaches which are upstream of the limits of reservoir full supply level, compared to the water levels in these river reaches for the same floods before the construction of the project.

Figure 4.3 shows the inundation area for the 100 year flood.

4.4.4 Impacts on existing Polgolla and Kotmale water management area

Proposed project envisages the construction of a very small reservoir which would have a capacity of 4.2 MCM which is capable of holding only a single day's storage at the design plant capacity.

Major contribution of water in Mahaweli Ganga at the final point of discharge which is close to the confluence with Atabage Oya comes from the Kothmale Oya basin. These flows will not be altered by any means due to the proposed project since they will not be utilized in the proposed project.

The balance part comes from unregulated part of Mahaweli Ganga upstream of confluence with Atabage Oya which will be regulated by the proposed reservoir. As stated earlier, this part will not be heavily regulated as the proposed reservoir is not capable of storing more than a single day's storage in the proposed reservoir. However, in order to facilitate the smooth functioning of Polgolla and Kothmale water management area, operation of Moragolla reservoir will be coordinated with Kothmale and Polgolla via a 24 hr. hot line linked to the two operation centres.

Hence it can be concluded that proposed project will not have any impact on water management operations of either Polgolla or Kothmale Water Management areas.

4.4.5 Temporary diversion works, surveillance included in operation and management plan to face emergency situations and communication facilities in case of an emergency and possible health hazards due to ponding

4.4.5.1 Method of diversion of the existing water during construction stage.

Diversion of river for construction of dam will be done in several stages using a combination of cellular sheet pile coffer dam with rock and earth-fill coffer dams. Proposed diversion methodology relies on "in river" diversion in place of diversion tunnel since the proposed dam is small and project economics does not allow construction of diversion tunnels.

According to the proposed method, part of the river will be isolated by a coffer dam placed along the direction of flow over a certain river length connected to a bank at upstream and downstream ends as shown in the method of river diversion in ***Figure 4.4***. The isolated part will be dewatered and dam foundations will be constructed inside this part. Diversion conduits (04 nos. of 4m x 4m) will also be installed in this part. Each diversion outlet will be able to discharge 200m^3/s.

After completion of dam in this part, coffer dams will be moved and connected to the other bank in a similar manner. Then the river will be channeled through the diversion conduits and the construction in the newly isolated part will be completed.

Except for one, all other diversion outlets will be plugged by concrete. The remaining diversion outlet will serve as the bottom outlet to allow the emptying of the reservoir in case of an emergency situation due to endangered safety of the dam, maintenance purposes or for flushing out of sediments from the reservoir during operation. The bottom outlet will be provided with 02 gates; 01 no. service gate (radial) and 01 no. revision gate.

According to this method of diversion there will be no pondage and river flow will be maintained as usual. Hence no alteration of flow takes place and there will not be an additional hazard due to ponding.

4.4.5.2 Proper surveillances to be included in the operation and maintenance plan for possible hazards that may arise due to breaching of coffer dam / dams in the event of an emergency flood and water release in case of emergency operations in the Kotmale reservoir

The height of coffer dams provided will be designed to cater for flow depths corresponding a fairly reasonable river flow level such as 100-200m^3/s. If river flows increase above these levels, there is a possibility of breach of coffer dams.

However, since coffer dams in this instance are only guide bunds rather than dams in that sense and no storage of water is present behind them there is no threat to the downstream areas including people and property due to breach of these coffer dams. On the other hand such breach would most likely to occur during a flood event in the river exceeding flows of over 100m^3/s. Therefore there is no possibility of river users such as people bathing in the river be present in the river at the time of such a large flood event.

Although there is no threat to the downstream users or property due to a breach in the cofferdams of the proposed project, there is a hazard posed to the workers inside the dewatered side of the river channel in the event of a breach in the coffer dam.

Therefore coffer dams will be monitored round the clock by persons designated especially for the purpose and any weakening in the coffer dams will be promptly remedied and strengthened. Standing orders will be established on the methodologies

in carrying out such strengthening and repairs to the coffer dams while workmen are in side the dry areas.

Water levels in the formed river channel will be constantly monitored and all work will be ceased and personnel working within the areas protected by the coffer dams will be promptly evacuated when the channel water level reaches a predetermined level. When deciding this level, consideration will be given for the time required for satisfactory evacuation and a suitably low water level will be assigned as the threshold level for evacuation. These will be strictly enforced as standing orders by especially appointed safety officials at the work site.

While there can be a rise in water levels due to floods originated from the unregulated parts of Mahaweli Ganga catchment upstream of the dam site, water levels could also rise due to emergency or scheduled releases of water from Kothmale dam in the form of spill or bottom outlet flows. In this case hazard levels are the same as described earlier. However in this event this is an advantage as prior warning could be obtained from the operations of Kothmale dam.

4.4.5.3Possible hazards that may arise due to disease outbreaks as a result of ponding

The increase of water fringe areas provide suitable habitat for the growth of vectors of various diseases and increase the possibility of communication of water related diseases.

Ponding in reservoir, even though is a breeding ground for mosquitoes, there will not be any threat from any vector borne diseases due to the availability of predators of mosquito larvae, the fish. However, the 3Km stretch of the river between the dam site and the tail race contains deep pools that can retain water for prolonged periods when the water flow is cut off by the dam. It has been observed in other similar projects that, when the flow is restricted due to diversion of water, the water retained in such deep pools tend to get stagnated. The quality of water in these pools deteriorates rapidly making them unsuitable for most aquatic fish. Therefore, these stagnant pools will result in increase in mosquito breeding as one of the major predators of mosquito larvae, the fish is removed due to poor water quality. This in turn can lead to vector borne diseases such as dengue mosquito menace in the area.

Therefore it is necessary to maintain a steady environmental flow downstream of the dam to prevent formation of such stagnant pools leading to health hazards. In addition, flows from perennial and seasonal streams which contribute to the river downstream starting from locations about 400 m downstream of the dam will also prevent formation of such stagnant water pockets.

Also, creation of water holes in and around worker camps and offices may bring about dengue mosquito menace with even severe health impacts.

4.4.5.4 Communication facilities or arrangement between Kotmale Dam in case of an emergency.

A 24 hour hotline communication will be maintained between the operators of Kothmale dam and the staff on duty at the dam site during construction. System Control Centre of the CEB will be kept in constant contact during such event. Through this channels of communication, information on impending releases from Kotmale reservoir is obtained and responsive measures similar to those adopted for natural floods would be implemented.

At present there is an arrangement to issue warnings of impending releases (either during floods or normal operation) for Kothmale reservoir. This mechanism will be continued as it has been successfully implemented for over 25 years by now.

There will be certain hazard level for the downstream users in case of release from Kothmale reservoir through spill or bottom outlet gates. Over the last 25 years of operation MASL has managed the hazard by issuing warnings in advance. The proposed project would neither increase nor decrease the hazard levels on downstream users than originally posed since no additional storage is created which could breach.

However, as described earlier even these release operations could pose a hazard to the workers who are working in areas adjacent to river or in special dry areas within the river under the proposed project. Such hazards can be mitigated by adopting measures already described above.

4.4.6 Construction hazards that have been taken into account in project construction planning, especially those relating to silt runoff, health and safety of workers

Construction hazards are of different nature. It is therefore essential to implement the occupational health guidelines given by Labour Department of Sri Lanka. This guideline elaborates the typical hazards possible and also the measures taken to avoid them.

Construction works involves heavy machinery like earth moving vehicles carrying out earth excavation and filling. Since the work is carried out in steep areas, possibilities of accidents due to slope failure can occurr. In deep excavations, the sides of excavated areas can also collapse resulting in accidents.

Tunneling involves both general construction risk and risk which is specific to the tunneling environment such as collapsing of rock and sudden inflow of water. Also accidents can occur due to toxic gases, dust, fire and smoke.

The creation of water holes in and around worker camps and offices may bring about dengue mosquito menace with even severe health threats.

Recreational activities such as bathing, washing etc. could be adversely affected particularly during both construction and operational phases due to the sediment laden

water being generated. During operation, the water flow between dam site and power house becomes extremely low due to the minimal release. In this stretch there have been number of people using the river water for domestic purposes such as washing bathing etc. However, due to the high fecal pollution reported even at present, it may get enhanced during operation phase due to less dilution causing severe health impacts to those who utilize the water in this stretch of river. The silt laden water though causes visual clarity problems does not result in significant health impacts.

Construction hazards due to oil spills and contamination with hazardous materials

During construction

During construction there exist a great potential for oil spills or hazardous material spills to take place if not properly managed in stores.

Different material handling techniques are necessary to avoid such spills and if occurs immediate response to clean them will be taken.

During operation

During the operational phase possibilities exists that there would be oil spills from bowzers bringing in fuel to the in-house tanks during events such as accidents. Although risks from accidental spillage and subsequent negative effects due to improper storage and transport would be low, it is still imperative to implement the necessary measures to minimize or prevent significant spills. However, at present there is no proper legislation in Sri Lanka pertaining to the safe storage and transport of such hazardous material. Nevertheless, the following basic measures need to be implemented to prevent possible spills from hazardous materials transporting vehicles.

- Pressure-relieving equipment and other safety devices fitted to tanks to be in good condition.
- Enforcement of stringent speed limits is crucial with implementation of heavy fines for any violations
- Bowzers transporting fuel oil have to be ensured that such vehicles are well sealed to prevent spillage or loss of contents; for example discharge outlets should be checked whether they are properly sealed with a blank flange or cap on the outside of the discharge valve.
- Ensure that hoses are stored in such a way that no liquid is discharged while transporting.

In addition, the power plant authorities will take necessary measures to safely store any hazardous materials that may be brought to the site. For this purpose, it is of paramount importance that the power plant authorities employ persons having qualifications and extensive experience in handling or managing dangerous goods with reference to the safe storage and transport of such material. Alternately expert advise or assistance should be obtained from persons or reputed organizations having sound knowledge and experience in managing dangerous goods and hazardous material.

It is of paramount importance that the power plant is heavily equipped with necessary effective fire fighting equipment. It is also of importance that competent personnel are employed to combat emergency situations, hazardous material contamination scenarios and fire fighting events.

Emergency Centres equipped with medical care facilities and fire fighting equipment to be established at the dam site and at the powerhouse site for all the emergencies such as medical emergency, accidents, fire and others. Safety Inspectors to be made responsible for due maintenance of the Emergency Centres. Qualified medical officers and nurses will be made available at these Emergency Centres.

The closest hospital is at Ulapane. Suitable vehicles with drivers will be stationed at all times at the site to transport injured personnel or sick persons to hospital whenever required. In addition, first-aid kits will be placed at important locations in the sites for treating injuries and personnel are to be trained in emergency treatment.

4.4.7 Effect of project activities including tunneling on waterways and groundwater table, possible health hazards and effects on the vegetative cover

During the past, many tunnels have been constructed in Sri Lanka for hydropower projects as well as for other projects over similar terrain. The only impact known to have occurred in the tunnels constructed thus far is the temporary lowering of the ground water levels due to free drainage into the excavated tunnel during construction. This has caused difficulties to the communities who are relying on the ground water sources for their day to day activities.

Although in the proposed project, no geological conditions has been revealed along the investigations conducted on the proposed tunnel to conclude that such occurrences will definitely take place in the proposed tunnel, possibility of such cannot be discounted. Therefore it is prudent to anticipate at least few such occurrences and be prepared to cater for such situations. In the past the remedial measure adopted was to bring water from other sources and provide all affected parties with their requirements of water for the period affected during the period of construction of the tunnel. In all the cases of such lowering of ground water levels, the phenomenon was only temporary. Ground water levels were restored soon after concrete lining of specific high leakage zones and filling of the tunnel.

People in the settlement called "SAARC" are provided with water from a community water supply system established on a well in this area. The people in the settlement called "Denmark Watta" depend on 7 shallow wells for drinking purposes. Similarly another settlement known as "Mariyawatta" in the area is dependent on 20 shallow wells for domestic uses. There can be disturbances temporarily during tunneling to the drinking water wells located on the surface area of the land corridor demarcated for constructing the proposed tunnel. Therefore similar conditions experienced in other sites can be expected in this case too and period of such impact is expected to be manageable by supply of water. On the other hand in all previous instances the ground water users did not have an alternative source of water; however in this project most of the users will have access to pipe borne water from the Towns South of Kandy Water

Supply Project of the Water Supply & Drainage Board. Therefore it can be expected that only few will have to be actually provided with water brought in bowsers.

Also, a small extent of paddy land present in Madoldeniya area which lies above the tunnel path obtain water required for cultivation of these lands from natural stream flows. If these natural streams are affected by lowering of ground water levels during tunneling. It could make cultivation of these paddy lands difficult during the period of tunnel construction.

Compensation has to be paid for the paddy lands for the seasons that are made unable to cultivate due to lowering of ground water levels during the period of construction of the tunnel.

Ground water level will rise depending on the subsurface characteristics and mainly on the distance from the perimeter of the impounded reservoir. The increased moisture content will not be suitable for cultivation in the riparian region. As only few houses are located close to the reservoir, impact to soakage pits and foundation structures will be minimum.

In the case of tunneling, if maintained under wet and dark conditions there could be growth of insects or any other fauna that could inhabit such areas. If this happens in large scale, it could lead to health risk for operators of the power plant perhaps due to outbreak of disease causing microorganisms etc.

4.4.8 Effect of project activities on the normal water management operations of the Kotmale reservoir and the Polgolla diversion.

Project activities will not have any effect on normal water management operations of the Kothmale reservoir and Polgolla diversion as explained under section 4.4.4.

4.4.9 Dam design in respect of environmental flow downstream, facilitation of the drinking water requirement of Gampola and Peradeniya water supply intake and irrigation water requirement in case of severe drought

It is essential to provide the necessary environmental flow that is required for aquatic flora and fauna respectively. Non-provision of this flow could cause decline in biodiversity in the river perhaps enhancing the eutrophication potential.

The requirement of the irrigation scheme feeding Gampolawela area from Dunhinda Ela Irrigation canal should also be fed with the required amount of water (reference section 0.28m^3/s) so that the existing irrigation activities could go ahead without being adversely affected. The existing irrigation intake / canal will be improved / rehabilitated and designed to have an effective system to supply the same irrigation water requirements as at present.

The water requirements of Crysbro broiler processing industry also to be met without depriving the livelihood of the number of families benefitted from the industry and without affecting the production of the industry.

The requirements of people bathing in the river are also expected to be met by these releases. Failing such a provision deprives the water rights of those who live in the neighborhood causing severe social issue.

Taken into consideration all the above requirements, the Dam will be designed to facilitate an environmental flow of 1.5m^3/s.

The drinking water requirement of Gampola and Peradeniya water supply schemes are extracted at locations downstream of the proposed tailrace outfall of the Moragolla power house and the existing Kothmale outfall. Therefore, the inflows at existing water intakes of Gampola and Peradeniya includes the flows released from existing Kothmale reservoir and proposed Moragolla reservoir in addition to flows along the main river as a present. Therefore the proposed project will have no interference on the quantity of water taken for the water supply schemes. The water intake for the Gampola area is at Ethgala as at present but with the new South of Kandy Water Supply Project, the intakes for the Gampola area will be located in areas upstream as shown in ***Figure 4.7*** and there will be no interference with the Moragolla project. However as the NWS & DB has plans to rehabilitate the water intake at Ethgala to cater to the increasing demand, CEB will abide by the conditions stipulated in the MOU dated 24.02.2010 given in ***Appendix A*** in ***item no. 3*** in this regard.

A pipe outlet at elevation 534.5m asl located in the spillway bay in the dam structure will facilitate this release. On a rare occasion of Moragolla power plant is not operational, provisions are made at the Moragolla dam to release the necessary flows direct to the river via bottom outlet gate mentioned in section 4.4.5.1.

4.4.10 Impacts of the dumping of the tunnel muck (including the location of the dumping site of the tunnel muck).

Project is located in a mountainous area, which is fast becoming urbanized. Therefore, there are very few areas of choice for dumping of tunnel muck. Considerable portion of tunnel muck is expected to be re-used in construction work for the production of aggregates and still there will be a significant quantity of tunnel muck to be disposed. Part of the rock materials excavated during tunneling will be used to produce coarse aggregates for subsequent use in the project. Also, part of the overburden soil from the tunnel outfall area and the soil material from common excavations will be used for backfilling and landscaping works. Therefore only the excess material, both rock and soil material is planned to be disposed off in these areas.

The locations of spoil dumping sites are given below and the areas are shown in ***Figure 2.15.*** Google Images of these dumping sites are given in ***Annexure 8*** and the descriptions at these locations are given in section 3.1.2.2.

Dumping Site	*Latitude (N)*	*Longitude (E)*	*Ownership of land*	*Landmark*
1	513700	478483	CEB	Near the existing road
2	513553	478741	CEB	Close to Kothmale Power House and Switch Yard
3	513372	478952	CEB	Near the existing road
4	513037	478980	CEB	An old dumping site of Kothmale Project
5	514721	478579	MASL	Near the Army Camp

According to the Landslide Hazard Zonation map prepared by NBRO, location of dump site 1 is in an area where 'landslides are to be expected' and the dump sites 2, 3, 4 and 5 are in safe areas. Filling of the dump site 1 will stabilize the toe and reduce the risk of land slide.

River flows about 700 meters away from the proposed land for dump site 2. Therefore siltation will not be a significant problem. Access to the lower parts of the dumping area will be difficult for the dumping trucks due to the steep sloping terrain. Therefore access roads should be prepared before dumping is carried out.

Destabilization of the slopes of the dumps or failure of retaining structures and sudden collapse creating threat for lives of people living and working in the vicinity of the sites (applicable to site 1and 2) and blockage of paths of natural streams creating flooding conditions (specially applicable to site 2) are some of the impacts.

The proposed dump site 3 is on a nearly flat terrain with a gentle slope. Some springs initiate from this area and flow to the river. Nearest distance to the river is around 650 m from the location and siltation will not be a problem.

The proposed dump site 4 is located about 1 km away from the river and therefore siltation will not be a problem.

Mahaweli River is flowing as one of the boundaries of the proposed dump site 5 and two small streams flow through the land to Mahaweli River. Therefore, special attention will be made to mitigate the problems due to siltation. Part of the area is cultivated and the other part is used as a playground by the Army. The proposed site is almost on a flat terrain with a gentle slope close to the existing road.

None of the plant species observed at the proposed dump sites are listed as Nationally Threatened Plants (MENR and IUCN 2007) or restricted to the sites selected. The fauna observed are common species that can be seen in such disturbed habitats. None of the faunal species recorded are endemic to Sri Lanka or listed as Nationally Threatened species. Therefore dumping of spoil at the five sites will not result in a significant impact on the fauna, flora or their habitats. Furthermore, the entire area impacted by these sites is around seven hectares in extent. Thus disposal of spoil will not have a significant impact on the environment.

The tunnel muck may consist of a wide variety of particles in size including silt, sand and gavel. Dumping of this tunnel muck in the runoff paths and on land that slopes down to the streams will cause addition of aggregate partials to the stream bed. However, none of the sites contained any perennial streams within the area identified for disposal of spoil. However, streams were observed in the vicinity of the site and some streams are located at elevations below the site selected for disposal sites. These streams are narrow and fast flowing streams that do not support many species of fish other than species such as Puntius bimaculatus (Redside barb), Rasbora carverii (Carverii Rasbora) and Lepidocephalichthys thermalis (Common Spiny Loach). During rainy season sediments can get washed into the streams from the disposal site that can have an adverse impact on the ecology of the stream.

The spoil disposal areas will be managed during construction such that no fine material will be washed down to the river and proper mitigation measures as described in section 5 will be used to handle muck disposal sites in an environmentally friendly manner. Properly designed sedimentation pits are a major feature in prevention of waste water and solid particles.

Dumping during wet season may cause erosion leaving the river and streams rich in sediments and silts. Careless dumping may create holes or uneven surfaces in which water could get stagnated. These water holes may be good breeding grounds for dengue mosquitoes leading to severe health impacts. Dumping during dry season may cause dust particles to emanate in the vicinity of such dump yards. This phenomenon could bring inconvenience to the neighborhood.

The perishable material such as tree debris or any other vegetation may cause leachate rich in tannin being generated and finally it could be mixed with the river water with run off.

Destabilization of the slopes of the dumps or failure of retaining structures and sudden collapse creating threat for lives of people working in the vicinity of the sites (applicable to site 1 and 2), blockage of path of natural steams and thus creating flooding conditions (specially applicable to site 2) are also some of the impacts of dumping.

The final use of such dump places is of utmost importance which may otherwise be attracted by those who are involved in collection of such material.

After completion of the construction work, measures will be taken to restore the vegetative cover in the spoil dump areas such as grass and small shrubs etc.

A Memorandum of Understanding between the Ceylon Electricity Board and the Mahaweli Authority of Sri Lanka will be signed at the time of construction of the project in relation to provision of necessary general specifications for the relevant contractors for management of spoil disposal in Mahaweli river reservation areas within 60m including regulation of impacts to the Mahaweli river. A sample MOU in this regard in accordance to the conditions stipulated by the MASL is given as ***item no. 1*** *in* ***Appendix F***.

4.5 Impacts on bedrock stability

4.5.1 Construction of dam

Blasting may be required in certain locations which can be controlled so that damages to the bedrock could be minimized. There will be no adverse impacts on bedrock stability due to construction of dam.

The earth and rock in the slopes can be destabilized due to excavation which can be minimized by maintaining a safe slope angle.

The grout curtain will block the underground seepage paths in the vicinity of the dam and thus will cutoff the under ground water flow across and along the dam axis. This will improve the long term stability in addition to seepage cut off.

Dam construction will be carried out adhering to the applicable standards and specified limits. Considering the present geological and geotechnical conditions at site, bedrock stability will improve immediately after the construction.

4.5.2 Penstock installation

A moderate excavation works on slope is required at site. If penstock anchors are not seated at a suitable level in the bed rock, the stability of the rock will be disturbed. The amount of earthwork is bound to affect the drainage of surface water during construction. Existing trees will be uprooted and the soil will be excavated for the construction of anchor blocks. Therefore, all excavated pits to be filled back as early as possible to avoid any ponding during any rain storm.

In practice, excess earth material due to excavation pits will be placed nearby the penstock line. Therefore, tendency of destabilizing and erosion due to lose soil is relatively significant immediate after excavation.

4.5.3 Power house construction

A deep excavation will be done at this site. If stabilization methods are not adopted rock and soil mass failure can occur and cause damage to workers and property.

4.5.4 Tunnel construction

The length of the tunnel is 2.96km and rock within more than 2.5km will be blasted. Uncontrolled blasting methods can damage the bed rock. Roof failure in weak zones can cause damages to workers.

4.5.5 Transmission Line trace

If the foundations are not constructed at a suitable level in the bed rock or anchored to the same, depending on the subsurface conditions so that they withstand the forces, the bed rock can be destabilized.

During the stringing works, best engineering practices will be adopted to avoid / minimize disturbances to the river banks. Care will be taken not to obstruct any natural processes such as surface water runoff and river water flow during construction works.

Retaining structures will be built with necessary drainage facilities around the existing towers located in sloping areas or any locations disturbed by the project implementation.

4.6 Sociological impacts

4.6.1 Impacts on existing water users

4.6.1.1 Impacts on water users downstream of the dam

There are several important water users in the river reach downstream of the proposed Moragolla dam and upstream of the tailrace outlet of the proposed powerhouse who will find reduced inflows due to proposed project. They are;

(i) Irrigation feeder canal (known as Dunhinda Ela) taking water to Gampolawela area.

(ii) Farm's Pride Poultry Industry / Crysbro broiler processing industry

(iii) People using the river for bathing purposes.

(iv) Sand Miners

The impacts are analyzed in terms of their nature, period of implications (short or long) and also on their positive / negative effect.

Irrigation water users

Table 4.8 Impact on farming community in Gampolawela

Short term negative impacts	Long term negative impacts	Potential positive impacts
If adequate quantity of water is not released to the downstream, the farmers in Gampolawela will find difficulties to cultivate their land	If the command area of Dunhinda canal does not get adequate supply of water in the long run the livelihood system of about 210 farmer families will be disturbed significantly and they will have to look for alternative livelihood activities. There will also be conflicts among power generators and the farmers. Such conflicts can even lead to political issues.	There will be water released downstream from the proposed reservoir, to cater to the irrigation requirements for the Gampolawela irrigation scheme. As experienced by the community, in some years during dry periods there has not been adequate supply of water to irrigate the command area. When the proposed project is implemented there will be a reliable supply of water for irrigation which will be beneficial from the point of view of the farming community.

Once the proposed dam is built across the Mahaweli river and water is diverted from the tunnel for power generation, there will not be adequate flow for feeding Dunhinda irrigation canal. Further, as the powerhouse is at a lower elevation than that of the irrigation canal, the water released from the powerhouse after power generation also cannot be captured by the canal.

If the water requirements of the farmers who depend on irrigation waters from the Dunhinda canal is not met, impacts on farmers due to disturbances to the water flow to the irrigation feeder canal are summarized in ***Table 4.8***

Two farmer awareness meetings were held by CEB on 08.05.2012 and 18.09.2012 with the participation of members from farmer organizations, officials from the Irrigation Dept., DS office and GNN and the minutes of the meetings together with the attendance at those meetings are attached as ***items 13*** and ***14*** in ***Appendix F***.

The concerns of the farmers / farmer organizations and those present at the above meetings in relation to the irrigation water users are summarized as follows.

(i) These pady lands have been originally belonging to Sri Dalanda Maligawa and have been distributed among the people and these are therefore have become inherited property down the family lines.

Irrespective of having been able to cultivate or not, it has become mandatory for these farmers to pay taxes to Dalanda Maligawa at the end of all seasons. Due to the project if these farmers find it difficult to cultivate these paddy lands they will face hardships in paying taxes. Therefore it is a request of these farmers that CEB make aware of this situation to the Dalanda Maligawa Management Committee and to have discussions with the tax collectors together with these farmer organizations, Divisional Secretary, Grama Niladaris and the Irrigation Dept. officials.

(ii) Farmers who depend on irrigation waters from the Raja Ela presently experience great difficulties with their water requirements as a proper MOU has not been signed between the Water Supply and Drainage Board and the Irrigation Dept. CEB should ensure that no such problems are created with the water requirements of Dunhinda Irrigation Canal.

In addition, whether there is the possibility of getting the water requirement of NWS&DB from the proposed Moragolla Reservoir so that the hardships faced by those farmers due to cut-off of water along Raja Ela could be arrested.

(iii) Presently there is wastage of irrigation water along the Dunhinda canal and the farmers requested that CEB repair this whole length of canal at CEB cost. Also, priority to be given to the repair and rehabilitation works of the canal and intake during construction of the project.

Also the farmers were concerned whether the water supply to the Dunhinda Irrigation Canal will be cut-off during construction of the project.

(iv) In addition, farmers requested that some employment opportunities during construction of the project be given to these farmer families who will be possibly affected due to the project.

(v) Farmers claim that if adequate water is not provided to these farming lands, they will not be able to cultivate these lands and the farmers were concerned that the water levels in the nearby wells will reduce and finally dry up.

(vi) To ensure that people building new houses do not face difficulties, they will need to be made aware of possible road widening well in advance and these road limits to be marked.

(vii) After implementation of the project as there is the possibility of inundation of cultivable lands in the Ulapane Area, the reservoir FSL was queried.

(viii) As there is no proper management of the water that is discharged from the Crysbro Industry to the Mahaweli ganga, the water in the dunhinda irrigation canal also gets polluted.

The impact on Crysbro Broiler Processing Industry / Farm's Pride Poultry Industry

If the water requirement of the Crysbro Broiler Processing Industry is not released, the industry will face difficulties and the likelihood impacts are summarized in ***Table 4.9***.

Table 4.9 Impacts on Crysbro Broiler Processing Industry (Farm's Pride Poultry Industry)

Short term negative impacts	Long term negative impact	Potential positive impacts
If adequate water is not released for the requirements of the industry, activities of the industry will have to be temporary stopped.	There may be a tendency for loosing employment of 700 employees fully depending on the poultry farm / processing industry. If such an impact is created about 2800 (average family size is 4) persons who depend on the 700 employees will have long term negative impact on their livelihood activities. The owner of the Company may be compelled to relocate the company to another place where he can find land and water. Also, about 1200 meat producers and 4000 maize farmers on forward contract agreement will be affected.	(i) If the power generators make arrangements to release some water from the reservoir to the downstream of the dam, the poultry processing industry will benefit by having reliable and adequate supply of water for the activities of the industry. (ii) Poultry farm will benefit by having improved access facilities in the area that will be developed as a result of the proposed power project.

Discussions took place with Farm's Pride (Pvt.) Ltd. lately on 21.08.12 and 21.09.12 and the minutes of such meetings are given as ***item 15*** and ***16*** in ***Appendix F***.

In these discussions, Crysbro Industry Management has suggested of the possibility to relocate their water intake to a suitable location further downstream of the tailrace of the proposed Moragolla Hydropower plant to ensure the availability of sufficient water even in extreme drought conditions. In this regard, CEB has consulted the Mahaweli

Authority of Sri Lanka and according to them they have no objection for the intake relocation as proposed by the Crysbro Industry Management, provided that the Crysbro Industry utilizes only one intake location (i.e. either existing location or the new location downstream of the proposed power house).

Impact on Sand mining

Recent updates as at 01.10.12 on sand mining activities and sand mine operators is given in ***Table 3.22*** in ***Annexure 1*** and has been described in section 3.3.2

There are about 19 teams involved in sand mining on a small scale in the river downstream of the proposed dam. The mining locations in Navadewita GN division, Amunupura GN division and Galpaya GN division are located within a stretch of about 2km. More than 200 persons depend on sand mining activities in this area.

Mine operators whose mining activities are carried out downstream of the proposed dam between the dam and the confluence of Atabage Oya with Mahaweli Ganga may face difficulties in sand mining once the project is implemented as the dam will trap most of the sediment yield. However those whose mining activities are carried out downstream of the confluence of Atabage Oya with Mahaweli Ganga may not face much difficulties in sand mining due to the sediments flowing with the water flow from Atabage Oya and from it's catchment.

However, as discussed in section 3.3.2 since there are no sediment measurement data readily available for this area, the exact impact on these sand miners cannot be quantified at this stage. However, during the impacts monitoring, the impact on these sand miners will be monitored and the necessary compensation will be made based on the extent of impacts.

The mine operators who will be affected by the proposed development will be compelled to relocate their mining activities to other feasible areas of the river. Until they obtain new license for mining in new locations they will have to forego current operations for a certain period (approximately about 02 months). CEB will coordinate with the Geological Survey and Mines Bureau and will facilitate to expedite the process of issuance of new licenses for the affected persons who will be eligible for sand mining operations (although following normal procedures, it will take about 06 months, considering the importance of the project, it is presumed that support of Geological Survey and Mines Bureau and other relevant institutions is received to expedite the process of issuance of licenses for the new locations).

Impact on Bathing and Washing

The terrain in the area downstream of the dam is very steep and therefore there aren't any bathing locations up to a point closer to the confluence of Mahaweli Ganga / Atabage Oya. Once the project is constructed there will not be sufficient quantity of water in the river stretch downstream of the dam between the dam and the powerhouse. People who use this river stretch for bathing and washing purposes will have difficulties. They will be compelled to travel far distances to other locations such as those located downstream of the powerhouse for bathing and washing.

There may be positive impacts for the people using river for bathing if some water from the dam is released. Since this quantity is to be released from the reservoir, it can be a reliable supply that will become beneficial to the river users for bathing purposes.

Impacts on water users in terms of water quality

The water quality in the river stretch between the proposed dam and the tail race will be adversely affected once the project is constructed. However, it has to be noted that even at present, the fecal pollution levels in the river is high as discussed in water quality in section 3.1.4.4.

This was also one of the concerns of those who participated at the two farmer awareness meetings held on 08.05.2012 and 18.09.2012 with the participation of officials from the Irrigation Dept., DS office and GN (minutes of the meetings together with the attendance at those meetings are attached as ***items 13*** and ***14*** in ***Appendix F)***. It was raised by them that presently, discharge of waste water from the Crysbro Industry is poorly managed and therefore pollutes the river waters and necessary action in this regard needs to be taken.

This issue may be even more severe in terms of fecal pollution and suspended matters which in turn affect water uses such as drinking, bathing, washing etc. Hence it is imperative to monitor the water quality within this stretch so that adverse impacts could be mitigated effectively.

4.6.1.2 Impacts on existing water users upstream of the dam

Bathing and washing

There are 02 nos. of bathing locations upstream of the dam used by about 65 people. When these bathing locations gets inundated due to proposed reservoir the users of these bathing locations will need to change their present places of bathing. This was also one of the concerns of those present at the farmer awareness meetings held on 08.05.2012 and 18.10.2012 (***item nos. 13*** and ***14*** in ***Appendix F***), also with the participation of representatives from the stakeholder Government Institutions. It was also mentioned that during periods of less rain, this need is very much felt.

Locations used for bathing are shown in ***Figure 3.7.*** Group discussion (vi) given in ***Annexure I*** gives the views of the river users for bathing and washing.

Sand mining

Discussions took place initially during 2009 with sand miners and the notes on these discussions with sand miners likely to be affected by the proposed project from the Community view point is given in (ii) under Group discussions in ***Annexure 1***. Such locations of sand mining are shown in ***Figure 3.7***.

However, as mentioned in section 3.3.2, the details of sand mining activities was updated as at 01.10.12. Accordingly, The two sand mining locations in Ulapane and Weliganga GN divisions are located upstream of the proposed dam and therefore,

these locations will get inundated once the reservoir is filled. The users of these sand mining locations will be compelled to change their locations of mining.

4.6.2 Impacts on land use pattern

It has to be noted that this project is at its feasibility stage and funding will be available / identified for implementation in near future. As accepted and long term practiced norm in project planning and implementation cycle in Sri Lanka, during the detailed design phase, comprehensive Resettlement Action Plan will be prepared by CEB to work out comprehensive plans of action to pay compensation for the affected persons. Therefore during the detail designs stage detail surveys which includes the extents of all affected lands and property will be carried out. The following impacts have been identified.

4.6.2.1 Impacts on land use pattern due to different project interventions

Impacts on the land use in proposed dam site area including the reservoir and in new road diversion area

The proposed dam will be established in a place where both river banks are bare land with some scattered bushes and therefore, the existing land use may not be significant to create impact.

The proposed reservoir will lead to inundate a stretch of existing Mawathura-Atabage road and therefore, the land use in the inundated area will get changed. The proposed alternative road also will create some impact on the corridor of land cultivated with tea, coconut, arecanut and banana. Altogether about 1ha of land will have this impact.

A staged drop of about 7m in the river bed is located about 500m downstream of the proposed dam. It may appear as a waterfall during wet seasons. Due to smaller reservoir capacity, it is certain that reservoir will be spilling in most instances during wet seasons thus minimizing the effect on the Dunhinda water drop. During dry seasons the drop becomes small and it becomes rather a rapid than a waterfall. During dry seasons a reduction in the water passing through the waterfall is anticipated but the reduction will be compensated to a certain extent by the environmental flow released downstream.

Also due to it's location in the high security zone and access difficulties due to the steep slopes that are in this area, accessibility to the area is limited. Due to this, the place is not generally frequented by visitors. However a single opinion has been received from one who has a land close to the dam site of the proposed project to the effect that there will be a deterioration of the natural beauty of river flowing in the vicinity of his land due to decrease in the water flow between the dam site and the powerhouse site as a result of diversion for power generation. However, as long as there will not be any landslide occurring in the area due to the proposed project, he has no objection on this project.

Impacts on the land use due to the propose tunnel

Since the proposed tunnel is designed underground there will not be a direct impact on the land use on the surface area due to the structure. However, as discussed under

section 4.4.7, lowering of the ground water levels can be anticipated during construction of the tunnel.

A small extent of paddy lands present in Madoldeniya area which lies above the tunnel path obtain water required for cultivation of these lands from Natural stream flows. If these natural streams are affected by lowering of ground water levels during tunnelling, it could make cultivation of these paddy lands difficult during the period of tunnel construction. Therefore it is prudent to anticipate at least few such occurrences and be prepared to cater for such situations.

Impacts on the land use in the proposed powerhouse, switchyard, penstock area

The proposed powerhouse and switchyard will be established in an extent of land of about 1 acre and the land is bare land with some bushes. This existing land use will get changed once the powerhouse is established.

There are two home gardens in extent of 2.25 acres of land with housing structures located in the vicinity of powerhouse, switchyard and penstock. One of these will have to be acquired and thus the land use in this home garden will change. In the other since only the access to the house is affected, it will be needed to provide alternative access to this house. However for the long-term security of the project if CEB acquires this home garden, then the land use in this home garden will also get changed as a result of acquisition to the project.

Impacts on the land use in the proposed transmission line trace

It is to be noted that only 1 suspension tower and 2 Terminal towers are to be erected for the proposed transmission line. About 80% of the length of the transmission line traverse above home gardens and the rest will pass over abandoned lands. There will be no removal/cutting of riverine vegetation. Some change to the land use will occur as the trees above 3 m height along the 30m wide line corridor in the home gardens would be pruned / removed for the safety clearance of Transmission line. Altogether 28 trees will be affected due to the establishment of the transmission line.

Some of the home gardens traversed by the transmission line route would anyway be acquired for other components of the proposed project for which the owners would be fully compensated. For the balance home gardens, the land owners would be compensated as per the assessment by the relevant Divisional Secretary for the trees that have to be pruned / removed if necessary to ensure that the transmission line does not come in to contact with any vegetation. Where the trees are cut, the owners would be fully compensated depending on the market value of the species affected.

Table 4.3 (***Annexure 7***) lists the trees that are likely to be removed or affected due to the project. Accordingly, 28 trees above 20 cm DBH will be affected (either pruned / cut) due to the proposed transmission line trace.

During the stringing work, best engineering practices will be adopted to avoid/minimize disturbances to the river banks. Care will be taken not to obstruct any natural processes such as surface water runoff and river water flow during construction works. Earth retaining structures will be built with necessary drainage facilities around the

towers located in sloping areas or any locations disturbed by the project implementation.

MASL will be informed in advance of any activities in this area associated with the project and CEB will comply with requirements and conditions imposed by the MASL.

Impacts on the land use in the proposed residential camp / office, stores and the new road diversion

The existing land use (tea and mixed crops) of the portions of land belonging to 11 owners will change due to proposed residential camp / office and stores and also road diversion proposed.

The total land area belonging to these 11 land owners is about 33 acres but only a portion of land from each owner will be required for project intervention.

Impacts on the land use due to construction of access to project components

Creation of access facilities that are required for different project interventions at different locations will also lead to change the existing land use patterns.

The existing roads from Ethgala junction is required to be widened and extended up to powerhouse/switchyard, outfall structure and also to the surge shaft to create the required access to these facilities. The lands in the immediate vicinity of the road which are mainly cultivated with crops such as pepper, jack, breadfruit various other mixed crops will get changed due to project intervention.

Impacts on land use due to construction of access facilities to the proposed labour camp

Access facilities to the proposed labor camp in the left bank also need to be created and the land use in the area will get changed as a result. The land belt that will be acquired is not cultivated with significant crops except scattered tea bushes located in the land. The land proposed to establish labour camp in the LB is a part of Ulapane Industrial Estate.

The land plots demarcated to establish a labor camp has few jack trees, and some other fruit trees and scattered tea bushes (neglected tea plantation). The land use in this portion will get changed due to proposal to establish labour camp. This will be a temporary negative impact because once the construction phase of the project is over the labour camps will be demolished and the land can be used for some other purpose.

Impacts on land use in areas of spoil / tunnel muck dumping

Five locations in the project area will be used to dump tunnel muck and spoil and therefore, the existing land use of these land plots will get changed in the short run during the period until such deposited tunnel muck is used for other purposes and the remainder is disposed off properly.

4.6.2.2 Specific likelihood Impacts on land use pattern in areas providing access to project components

Six different access roads have been suggested to provide transport facilities to the different project locations. The nature of improvements/construction suggested for establishing these 06 nos. of access roads are summarized in ***Table 4.10*** in ***Annexure 7.***

The improvements to the 06 nos. of access roads mainly due to expansion of width and the length will create some negative impacts on the land and other properties of the communities living in each access road area. The summary of the likelihood impacts due to access roads are shown in ***Table 4.11*** in ***Annexure 7.***

Specific information of impacts due to access road improvements (out of the improvements to the 06 nos. of access roads, only 04 nos. of these access road improvements will have impacts on private property) and are given in ***Tables 4.12, 4.13, 4.14(a), 4.14(b)*** and ***4.15(a), 4.15(b)*** in ***Annexure 7***.

Two business establishments in road improvement activities from Ethgala to Power house will have partial impact. Only the extended sections to the buildings of these two will need to be removed. This will not create negative impacts on the existing business buildings. The business activities carried out in these affected sections will need to be stopped temporary.

One business place (small hut in 3 perch land) will be fully affected in the proposed road diversion in right Bank.

4.6.3 Impact on commercial activities

The likelihood positive and negative impacts due to proposed development interventions are described below:

The project involves clearing of productive home gardens in the area. Although some of these outputs of these home gardens do not directly enter into the market, they do provide significant benefits to the respective households.

It has to be noted that this project is at its feasibility stage and funding will be available /identified for implementation in near future. As accepted and long term practiced norm in project planning and implementation cycle in Sri Lanka, during the detailed design phase, comprehensive Resettlement Action Plan will be prepared by CEB to work out comprehensive plans of action to pay compensation for the affected persons. Therefore during the detail designs stage detail surveys which includes the information as to the extent to which each party is affected will be carried out.

4.6.3.1 Impacts due to proposed dam

There may be opportunities for local labourers to find some temporary work in the dam site during its construction phase which will be a positive impact of the project.

Disturbances to the water flow in the river due to dam will create significant negative impact to the irrigation water users in the downstream if alternative arrangements are not made to release water to the downstream users. There are about 210 farmers depending on irrigation water from Dunhinda irrigation canal.

Similar impact will be created for the Farm's Pride poultry farm / Crysbro broiler processing industry, if water is not released to the downstream. If the Crysbo broiler processing industry is shifted to another place, about 700 regular employees and also 1200 contract poultry farmers and about 4000 maize growers on forward contracts will have significant negative impacts.

4.6.3.2 Reservoir

About 265 persons are dependent on sand mining in upstream and downstream of the dam. The mine operators who will be affected by the proposed reservoir will be compelled to relocate their mining activities to other feasible areas of the river.

There may not be adequate sediment transported to the downstream of the dam for sand formation due to reservoir and therefore availability of sand in the downstream of the dam will get reduced. However, as discussed in section 3.3.2 since there are no sediment measurement data readily available for this area, the exact impact on these sand miners cannot be quantified at this stage. However, during the impacts monitoring, the impact on these sand miners will be monitored and the necessary compensation will be made based on the extent of impacts.

The details of sand miners with the mining locations are given in ***Table 3.22*** in ***Annexure 1***

4.6.3.3 Tunnel

There will not be significant negative impact on the economic activities of the people living on the surface of the land area demarcated for the underground tunnel.

Some of the people in the area may have opportunities to find temporary employment and also some others will benefit by providing accommodation and meals for the workers in the construction project.

As discussed under 4.4.7, lowering of the ground water levels can be anticipated and these communities who depend on ground water sources for their day to day activities will face difficulties.

There can be disturbances to the drinking water wells located on the surface area of the land corridor demarcated for constructing the proposed tunnel. The people in the settlement called "SAARC" are provided with water from a community water supply system established on a well in this area. The people in the settlement called "Denmark Watta" depend on 7 shallow wells for drinking purposes. Similarly another settlement known as "Mariyawatta" in the area is dependent on 20 shallow wells for domestic uses.

Also the small extent of paddy lands present in Madoldeniya area which lies above the tunnel path obtain water required for cultivation of these lands from Natural stream flows. If these natural streams are affected by lowering of ground water levels during tunnelling, it could make cultivation of these paddy lands difficult during the period of tunnel construction. Therefore it is prudent to anticipate at least few such occurrences and be prepared to cater for such situations.

4.6.3.4 Power house / Switchyard, Surge Shaft, Surface Penstock

A land plot identified for establishing powerhouse, switchyard and other required elements need to be acquired. The person who owns this land is not living in the area. Also, this land is not being used for any agricultural activities and therefore, there will not be any significant negative impact on economic activities. Two residential land plots in extent of 2.25 acres will have impacts due to proposed development activities around powerhouse / switchyard, penstock. ***Table 4.16*** lists the details of the families affected.

Table 4.16 Details of families affected due to powerhouse / switch yard and penstock

Name of land owner	Total Extent (Acres)	Title	Land use
H M Francis	1.0	freehold	House and land with fruit and mixed crops
Nalin Liyanarachchi	1.25	freehold	Land with house
Thilak Abesingha	1.0	-	Bare-land

Source: Social Assessment survey- 2009

The homestead of Mr. H. M. Francis will have to be acquired for the project. The access to Mr. Nalin Liyanarachchi's house is affected due to project interventions and evacuation will not be necessary if alternate access road is provided to him under the project.

At least few persons in the local area may get a chance to find some paid work in the powerhouse during its construction phase.

4.6.3.5 Proposed road diversion (right bank)

Eleven land plots will get affected due to proposed road diversion. Certain portions of these land plots will be required for construction of this road. 06 nos. of these land plots are residential lands and other 05 nos. are bare-lands not used for establishing houses. The details of these 11 land plots including the details of the 5 families in the affected residential lands due to proposed road diversion are summarized in ***Tables 4.14(a)***, ***4.14(b)***, ***4.15(a)*** and ***4.15(b)*** in ***Annexure 7***.

One business place (small hut in 3 perch land) will be fully affected in the proposed road diversion in right Bank.

4.6.3.6 Power transmission line

Some change to the land use will occur as the trees above 3 m height along the 30m wide line corridor in the home gardens would be pruned / removed for the safety clearance of Transmission line. Since the length of the transmission line is only 500m and as the line will traverse well above the top of the trees for a considerable length, there will be no requirement for removal of trees in order to establish the transmission line.

Some of the home gardens traversed by the line route would anyway be acquired for the components of the proposed project for which the owners would be fully compensated. For the balance home gardens, the land owners would be compensated for the trees which would be removed for the safety clearance of the line, as per the assessment by the relevant Divisional Secretary based on the market value of the species.

4.6.3.7 Proposed residential camp, office and stores

These components of the proposed project will be established in the same area where proposed road diversion will also be constructed. Therefore, the land plots affected are included in ***Tables 4.15(a)*** to ***4.15(b)*** *in* ***Annexure 7***. There are no houses or people affected due to access road to camp area. Only land will be required.

4.6.3.8Proposed Access Road Improvements

Two business establishments in road improvement activities from Ethgala to Power house will have partial impact. Only the extended sections to the 2 business buildings will need to be removed. This will not create negative impacts on the existing business buildings. The business activities carried out in these affected sections will need to be stopped temporary. However, the The core business activities of these 2 places will not be negatively affected.

4.6.4 Impacts due to material transportation

Most of the existing access roads to the powerhouse are narrow and dilapidated. Therefore, there will be some difficulties to the present users of these roads during construction phase. The existing roads in the right bank are in good condition and they are not congested due to heavy traffic. There will not be problems to transport material to the dam site in this existing access roads (the main access road in RB will get inundated due to the proposed reservoir but it can be used during construction phase to transport materials to the dam site).

Impacts on Roads

The construction of the proposed project will involve the transportation of plant, machinery and equipment. Most of the machinery and equipment would be imported and transported from the Colombo Harbour to the site in heavy vehicles and container carriers. However, a project of this nature invariably involves more heavy vehicles visiting the site. Therefore this project will have a significant impact on the roads due to the use of several heavy machinery and vehicles used for transportation of construction material.

The main impacts would include increased traffic flow causing inconvenience to road users and even wear and tear (damage) to road surfaces. It should be noted that with regard to the streets surrounding the project area, there are many roads which are found to be very narrow. In general, these roads could not handle two way traffic; hence delays could be very likely.

Noise Pollution

High noise from engines and irritating noise emanated from beeping horns and vibration effects will cause inconvenience to neighbors living in the road traces used. It should be noted that the noise levels in terms of L_{eq} dB(A) or L_{10} dB(A) should be maintained below 67 dB(A) or 70 dB(A), respectively in accordance to Federal Highway Association of USA (FHWA). Therefore in view of these facts the impacts will be high since the heavy vehicles emit noise levels exceeding 67 dB (A).

Air Pollution

Movement of heavy vehicles such as lorries, trucks and container carriers on bare soil could result in significant dust generation and these effects are anticipated to be high during dry weather and gusty wind conditions (though such impacts may be temporary). Generally meteorological conditions and fineness of the material are some of the triggering factors for increased dust pollution scenarios. The more fine materials before being deposited either on nearby structures or vegetation or in residence in the form of a thin film may be carried away to considerable distances depending on the weather conditions or wind patterns.

Blowing of dust is anticipated when transporting construction material and taking away excavated soil material unless the vehicles are well covered to prevent dust emissions and spillage.

Also improper handling and unloading of construction material such as cement from vehicles could lead to some significant dust emissions when the weather is windy. The presence of ready made concrete plants too could contribute to dust. The presence of fine cement dust particles along with other suspended particulate matter in significant quantities could lead to asthmatic problems to the work force.

In addition to dust problems, air pollution in terms of smoke and gaseous pollutants could also arise from the diesel-powered vehicles transporting construction material to the project site. These impacts will be high since it is anticipated that the traffic for a project of this nature is high.

4.6.5 Noise, Vibration and Air pollution due to dust

Noise

During the construction period, apart from increased traffic there could be several high noise levels generated with noise levels far exceeding 75 dB(A) (which is the maximum permissible level stipulated in the Sri Lankan legislation for daytime activities defined as 6.00 am to 7.00 pm), though these effects are sporadic and temporary in nature. Some of the high noise generating activities includes concrete mixing activities,

cut and fill operations, use of backhoes for excavation works, drilling and blasting and buildozers for filling works.

Most of the machinery and equipment used during construction works (i.e., road connections, access roads and infrastructure facilities or buildings) are known to produce high noise levels. For example, cranes (movable and derrick), excavators, pile drivers (drop hammer type) and pneumatic drills are known to produce noise levels of around 85 dB(A), 112 dB(A), 110 dB(A) and 85 dB(A), respectively at a distance of 7 m. Further, trucks, scrapers or grader without silencers, loaders, electric drills, jack hammers without silencers and generators with silencers are known to produce noise levels of around 94, 112, 75, 80 and 82 dB(A), respectively.

Equipment involved in cut and fill operations or soil boring from hammering are also known to generate high noise. Similarly, equipment used in clearing the site and asphalt and concrete plants are also known to generate significant noise levels.

The higher noise levels generated from the machinery and equipment would have a disturbing effect on the fauna living in the nearby areas. The disturbing effects will be even more higher as the anticipated noise levels are higher than the stipulated limit of 50 dB(A) for in case of night time construction activities defined from 7.00 pm – 6.00 am on the following day.

Further the construction works for the power (transmission) lines consisting of the foundation works, tower erection works and the wire-stringing works and hammering activities involved in laying penstock, etc. would contribute to noise. This could interrupt nesting, breeding and feeding habits of the avi-fauna if emitted in high levels, through the effects may be restricted to shorter time period.

The exploitation of rock which involves blasting operations is likely to produce very high noise levels which could result in having adverse impacts on nearby communities, though the effects may be sporadic and temporary in nature.

Constant exposure to very high noise levels often causes hearing deficiencies. Workers who are old will be at a risk as hearing impairment is known to occur with advancement of age. Also machine operators who are directly involved in such activities will be at high risk. ***Table 4.17*** shows the exposure levels and time limits adopted in the United Kingdom and they can be used as guides in Sri Lanka as such a guideline is not yet available in Sri Lanka.

Pneumatic construction equipment used for internal road maintenance works and the parking area may produce some higher noise levels though these effects are temporary. However, frequency of road and parking area maintenance works generally depends on the extent of damage or wear and tear of the roads, which in turn depends on the vehicular traffic flow. Since traffic flow within the project area is expected to increase with time, the frequency of road and parking area maintenance works would also increase with the time period. However, drastic effects of vibration from vehicular traffic and pneumatic construction equipment used for maintenance works are very low or insignificant.

Table 4.17 Exposure levels and time limit in the UK

Levels (dB)	Dose time limits
90	8 hr
93	4 hr
100	48 min
110	4.8 min
120	28.8 min
130	2.88 min

Vibration

There are significant amount of rock boulders to be blasted at the site. Therefore ground induced vibrations with subsequent substantial damage to nearby building structures could be anticipated during the construction phase. Piling for foundations could be expected in the site, which may create moderately high vibration in the area as well.

Potential vibrations and shocks arising from blasting activities could result in severe damages to nearby properties. In this respect houses and buildings having weak structures would be at risk from substantial damage or even from total collapse (especially any structure which may have an archeological significance).

Moreover the vibration from the heavy traffic flows in the quarry sites and the proposed project site could damage properties (for example, shattering of glass windows) and even cause discomfort to persons living in the immediate vicinity.

During the operational phase, there will be significant noise sources. This includes traffic noise from related vehicles and noise from power plant facilities such as turbines, main transformers etc.

The high noise level generated from the main power generator rooms and other areas will have some disturbing effects on nearby residential areas and wildlife in the nearby areas. Moreover the vibration caused by these operating generators and other equipment would affect the nearby building structures in the long-run and even cause inconvenience to occupants and persons working in the relevant facilities. Therefore it is imperative that such facilities are well isolated from the relevant facilities.

It is also anticipated that openings (exhaust chimneys) from which hot air is released would result in undue noise due to local turbulence, if such openings are too narrow and proper insulation is not given. Also there will be vibration effects if no proper dampers are installed.

Air Pollution

There will be no major odour problems during the operational phase. However, there will be some odours from the fuel oil tanks unless the tanks are fully sealed and frequent checks are carried out by well trained competent personnel for possible

corrosions and leaks, hence to take appropriate containment action. Fuel to be used up on burning does not generate any odour problems as it has low vapour pressures.

Incidences of air pollution in terms of suspended particulate matter ($PM_{2.5}$ or PM_{10}) notably dust (which will include dry spoil material) and even cement particles would occur during activities such as the construction of the relevant road connections including access roads (which may include clearing of vegetation), excavation works and cut and fill operations. Movement of heavy vehicles such as lorries, trucks and container carriers on bare soil in the construction site could result in significant dust generation.

The presence of significant fine dust particles, cement particles along with other suspended particulate matter could affect nearby sensitive recipients such as residential areas. In these respect elderly persons and small children would be at risk from asthmatic and other respiratory problems. Furthermore, significant dust would lead to asthmatic and other respiratory problems to the work force too. It is anticipated that dust from exposed earthwork will be high in areas having laterite soil and even in areas having sandy clay or clay soil (in the dried form) when vehicles are travelling at high speeds and also when the weather is too windy.

Dust emission scenarios would be high during dry weather and gusty wind conditions, though such impacts may be temporary. Generally meteorological conditions and fineness of the material are some of the triggering factors for increased dust pollution scenarios. The more fine materials before being deposited either on nearby structures or vegetation or in residence in the form of a thin film may be carried away to considerable distances depending on the weather conditions or wind patterns.

Dust emission scenarios could also occur during transport of quarry material (rock/metal aggregates) and in producing concrete in batching plants. Also improper handling and transferring of excavated soil material (i.e. spoil especially when dry and other debris rising due to demolition of houses and other infrastructure) in large amounts into vehicles for external or internal transport, unloading of construction material such as cement from construction vehicles (such as tractors and trucks/tippers) and improper storage or cover of construction material could lead to significant dust emissions. Blowing of dust is anticipated when transporting construction material and taking away excavated soil material and building debris to disposal locations unless the vehicles are well covered to prevent dust emissions and spillage.

Furthermore, improper storage or cover of spoil material, building debris (demolition wastes) and construction material could lead to significant dust emissions. It should be noted dust emissions could occur from the large piles of spoil material (especially from material such as laterite soil and clay soil when in the dried forms) if such material is improperly stored in open areas, which are often subject or exposed to winds.

In addition to dust problems, air pollution in terms of unpleasant diesel smoke (rich in partly burnt or unburnt hydrocarbons) and gaseous pollutants such as NO_x, SO_2 and

CO could also arise from the larger number of excavators / backhoes and diesel powered construction vehicles (transporting construction material to the project site) having faulty or poorly functioning exhaust silencers. Though the impacts are temporary, these impacts will be high since it is anticipated that the traffic for a project of this nature is high. Moreover production of concrete/batching plants may cause fairly high emissions of various materials such as cement particles, gaseous pollutants and un burnt or partially burnt petroleum products (hydrocarbons)

Effect of quarry sites and tunneling

Construction material exploration and exploitation seems to be a major activity of a project of this nature. For the proposed project it is anticipated that a substantial amount of the construction material is to be found from the tunneling activities. However if the rock material is to be harnessed from a quarry site it could result in significant air pollution scenarios in terms of fine dust particles along with high noise and vibration levels. Also significant dust emissions could result in from drilling works when compressed air operated hand drills are used.

The crushing plants too could cause significant dust if not properly located and inadequately covered with wet gunny bags. Due to intense dust problems respiratory problems such as silicosis and even cardio thoracic problems could occur to persons in the vicinity of the quarry sites. In this respect children and elderly persons would get affected. Furthermore, dust could cause significant sociological issues / problems such as maintenance of houses and drying of washed clothes becoming difficult.

It should be noted that ammonium nitrate fuel oil (ANFO) and dynamite containing nitroglycerin (which are essentially Class A or detonating explosives) are used for blasting. ANFO under higher temperatures (actually less than 175°C) during blasting decomposes to produces NH_3, which is toxic at high levels. Further there are several ways that ANFO containing NH_4NO_3 can decompose at very high temperatures and therefore, when detonation conditions are optimal, blasts produce moderate amounts of toxic gases such as CO, H_2S and NO_x such as N_2O_3 and NO_2. Also nitroglycerin degrades with time to unstable forms. Infrequent exposure to high doses of nitroglycerin can cause severe headaches which may be adequate to incapacitate some people.

In addition to opening quarries, works may include the construction of access roads and the establishment of a platform for sieving and loading operations. Therefore vehicles involved in transporting the quarry material could lead to dust generation when traveling on unpaved roads. The effects would become more significant when operating at high speeds under dry weather and gusty wind conditions. Further, dust emissions scenarios would occur from the quarry material transporting vehicles unless the material is well covered with dust covers.

Furthermore, flying debris could contribute to significant damage to the houses and even physical injury to persons living in the vicinity of quarry sites and areas nearby tunneling.

4.6.6 Impacts on existing water extraction for drinking purposes by the National Water Supply & Drainage Board at downstream of the river

The water requirements of Gampola and Peradeniya water supply schemes of the National Water Supply and Drainage Board are extracted at locations downstream of the proposed tailrace outfall (514438N, 478257E) of the Moragolla power house and the existing Kothmale outfall. Therefore, the inflows at existing water intakes of Gampola and Peradeniya includes the flows released from existing Kothmale reservoir and proposed Moragolla reservoir in addition to flows along the main river as at present. Therefore the proposed project will have no interference on the quantity of water taken for the water supply schemes and therefore impact on the water quality seems to be very low. High suspended matters could be expected particularly during construction period but other issues are very unlikely to be significant.

Towns South of Kandy Water Supply project of the NWS&DB is scheduled to be commissioned in December 2009. Once this water supply project is commissioned, water to the Gampola area will be catered from Ulapane, Gampolawatta, Paradeka, Nayapana, Dartry, 3rd Mile post intakes and whereas the water demand in Peradeniya area will be catered by Meewathura intake. The Meewathura intake is located further downstream of the Moragolla tailrace outfall and therefore the proposed project will have no effect on Peradeniya water supply scheme. The locations of the water intake points of the Towns South of Kandy Water Supply Project are given in ***Figure 4.5***.

One of the present intakes of Gampola water supply scheme is located at Ethgala (515114N, 478667E) and lies about 700m downstream of the tailrace outfall of the proposed Moragolla project. However, this Ethgala intake will be replaced by the Paradeka (512650N, 482500) and Nayapana (511199N, 482192E) intakes located at further upstream points on Pussella Oya and therefore there will not be any effect from the proposed Moragolla project to the Gampola water supply scheme as well. Even though Ethgala intake will go out of operation with the commissioning of the Towns South of Kandy Water Supply Project, NWS&DB has long-term plans of rehabilitation of this intake at Ethgala. Therefore CEB will abide by the conditions stipulated in the MOU dated 24.02.2010 as given in ***Appendix A*** in ***item no. 3*** in this regard.

4.6.7 Impacts on irrigation and flood protection work.

There are no flood protection works in the area of the river that will be related to the proposed project. Therefore the proposed scheme will not have any impact on the flood control schemes in Mahaweli Ganga either upstream or downstream.

The existing irrigation scheme described under Section 4.6.1 depends on the river flows in the river reach downstream of the proposed dam. If adequate water is not released to the downstream from the proposed reservoir, Gampolawela, Maligapurana land area will have negative impacts. About 54 ha cultivated by 210 farmers will have negative impacts. The details of this impact have been discussed in Section 4.6.1 above.

4.6.8 Uncontrolled migration of people into the area and if so, regulatory measures proposed and the basis.

There are no neglected lands belonging to the Government for migratory people to encroach and create human settlements. Therefore, this is not a significant issue in the proposed Morogolla power generation project.

During the studies it was noted that certain ponding takes place for floods of higher return periods in the Ulapane Oya valley even without the project. This has been discussed in detail in section 5.4.11. Present land use of the area subjected to flooding comprises of paddy lands, some Jasmine plantations and reed beds on stream banks. However, it can be seen that this flood plain being gradually encroached and some buildings are coming up. As a mitigatory measure it is proposed to mark the area of Ulapane Oya below contour of 550 m asl, as an area not permitted for construction. Further, it is also seen that there exists some buildings and houses within the 100m reservoir reservation of the proposed project. Any future constructions in this reservoir reservation area can be prevented by declaring the 100m strip of land around the perimeter of the reservoir FSL as a restricted zone that will be managed by CEB.

The property rights of the existing habitat will remain with the owners of the properties. CEB will maintain the reservation area as a green belt (wherever feasible), and appropriate action will be taken to prevent earth slips, erosion etc.

Prior approval of the General Manager, CEB will have to be obtained for excavation / removal / filling of soil, dumping of material and developments which may impact the stability of the reservoir banks. Security huts will be setup where necessary for proper management of the reservation. The water rights of the reservoir including reservoir operation and maintenance (such as desilting etc.), navigation etc. will be controlled by CEB.

CEB will work out a suitable mechanism to exercise restrictions within the reservoir reservation area. This mechanism will be tied up to the current practice followed for obtaining required approvals from the local authority and / or any other authority. Further, a legal framework to enforce above restrictions will be prepared, with the assistance of the Attorney Generals Department.

4.6.9 Will the project activities create relocation of families?

Different development interventions proposed under the project will create certain relocation impacts including evacuation of families and acquisitions of lands. Detailed resettlement action plans need to be prepared following necessary policies and other legal requirements. It will be done during detailed design phase of the project. The information provided in this section will indicate the magnitude of the resettlement issues of proposed Morogolla power generation project.

4.6.9.1 Number of potential families affected

The number of potential families affected by the different project interventions are given by DS division wise in ***Table 4.18***

Impact on houses and lands due to the formation of the reservoir

Twenty residential lands and two line houses need to be acquired with the houses constructed in those lands due to likelihood vulnerability created by the proposed reservoir. These families will need to be resettled. The details of these 20 families are given in ***Table 4.19(a)*** to ***4.19(b)*** in ***Annexure 7.***

Table 4.18 Potential no. of families affected by DS division wise

Development Intervention	Bank	DS	Homesteads	Land only
Reservoir	RB	Udapalatha	14	11
Reservoir	LB	Ganga Ihala Korale	06	03
Reservoir / Labour Camp	LB	Ganga Ihala Korale	02 (but 04 families)	-
Road diversion/office camp, stores etc	RB	Udapaltha	06	05
Power house/switch yard/surge shaft / surface penstock	LB	Ganga Ihala Korale	02	01
Total	-	-	30 (but 32 families)	20 Plots

Note : Families affected due to road widening / improvements have not been included in the above list. Also, in some of the affected homesteads only part of the homestead is affected and therefore such households will not be evacuated .

The 02 line houses (04 families) are located on the left bank of the reservoir near the Ulapane Industrial Estate premises. These two line houses have been in existence in the Industrial Estate premises land even long before the land has been leased out to the Industrial Estate. However, now these line houses are considered as property located outside the boundary of the Industrial Estate. With the impoundment of the reservoir, there can be possible adverse impacts on the existing river bank slopes below these 02 line houses due to the inundation of the toe of the bank. Moreover, these 04 families will also be confined between the reservoir FSL and the Ulapane Industrial Estate boundary. It is also to be noted that this group is an isolated group and therefore is a socially vulnerable group. Hence this group of people have to be given due consideration and carefully resettled during resettlement. Therefore this land can be used to establish the labour camp. The details of these 02 line houses are given in ***Table 4.19(b)*** in ***Annexure 7.***

These 02 line houses have been included under the number of homesteads to be evacuated due to the impact on houses and lands due to the formation of the reservoir as mentioned in ***Table 4.18*** above.

In addition to 20 households and 02 line houses another 14 non-residential land plots will have negative impacts due to proposed reservoir. The details of 14 land plots those will be vulnerable due to proposed reservoir are shown in ***Table 4.19(c)*** in ***Annexure 7.***

Impact on houses and lands due to road diversion residential camp / office and stores

06 nos. of residential land plots and 05 nos. of non-residential land plots will have adverse impact due to the development intervention mentioned above. Certain

portions of these residential and non-residential land plots will be required to establish the project components mentioned. The details of impacted residential lands and non-residential lands are given in ***Tables 4.14(a)***, ***4.14(b)***, ***4.15(a)*** and ***4.15(b)*** in ***Annexure 7***.

Impact on houses and lands due to powerhouse, switch yard, surge shaft and penstock

03 nos. of properties in the immediate vicinity of powerhouse, switch yard and penstock and surge shaft areas are impacted by the project. 02 of these properties are homesteads and will have to be evacuated. The details of these properties are given in ***Tables 4.16*** in section 4.6.3.4. The other, a private land plot located in the close proximity of the river has also been identified as required to establish powerhouse and switch yard. Three grown jack trees are located in this one acre extent of land that will be completely required for the project activities.

The homestead of Mr. H. M. Francis will have to be acquired for the project. The access to Mr. Nalin Liyanarachchi's house is affected due to project interventions and evacuation will not be necessary if alternate access road is provided to him under the project.

The overall list of likelihood affected persons due to various project interventions are listed in ***Table 4.20*** in ***Annexure 7*** with additional remarks.

4.6.9.2The Resettlement Plan

The proposed Morogolla power project will create some adverse impacts on houses and other properties specially lands and therefore during the detailed design preparation and project implementation stages, resettlement will be an important component requiring due consideration.

A separate study has to be carried out to prepare a comprehensive resettlement plan according to the procedures and other principles of the Involuntary Resettlement Policy of the Government (NIRP- approved in 2001) in the detailed design study which is to be started in the near future. This plan (RAP) will be implemented during the project implementation phase. Although the present report includes substantial information on resettlement issues, an RAP is not appropriate as detailed surveys on the information related to the individual plots of homesteads and properties affected are liable to be changed between the timeframe now and the detailed design stage. Once the RAP is prepared and all the parameters are fixed under the detailed design stage, CEB will be able to implement the RAP during the project implementation stage.

The information related to resettlement policy frame work and resettlement actions required for the likelihood affected persons / properties have been discussed in Chapter 5.

4.6.9.3 Compensation package and their acceptability by the affected and the local authorities.

The affected land owners need to be paid compensation. Option need to be given to the affected persons to chose their preferred method of compensation, alternative land or the monitory compensation.

The persons losing houses should be given opportunities under resettlement policies. Some of them may prefer to receive monitory compensation and make their own arrangements to find alternative residences and some others may like to have alternative land to construct their houses. In such cases land may be provided with money to construct the houses in the land given. However, all these options need to be discussed with the APs.

The consultations of affected persons generally indicate the following preferences. However, it is required to do intensive questionnaire survey with all affected persons and decide their individual / personal preferences. Depending on the individual preferences implementation strategies of resettlement program need to be worked out.

- The APs with affected homesteads need land for re-establishing their affected homesteads. They prefer to have money for constructing the houses in the land given to them as alternative to their land lost due to the proposed project.

- The persons who lose only land need alternative land. If the portions of land in their existing homesteads (home gardens) are affected they need money as compensation for the land extent acquired for the project.

4.6.9.4 Location of Resettlement

Preferred Location of the people impacted

The likelihood affected persons indicated that they prefer to get resettled in the following areas.

Mahawila watta (23 families of 32 affected),

Somewhere near Ulapane GN division (7 out of 32) and

Ethgala area (2 families of 32)

Total area required for resettlement

Land allocation for each affected individual need to be attended case by case considering particular individual's affected portion of land. However, we need to propose some options to be considered and use as tools for negotiation at the time of resettlement project implementation.

The following options may be suggested.

Option 1 ***Resettled in uniform size land plots***

Category I : say 40 perch for each family

Allocation of 40 perches of land for the affected families who lose 40 Perches or more. If the acquired land is more than 40 perch in extent such persons' excess land should be given compensation. Sometimes some individuals may opt for less than 40 perches and if it is the case, they may be paid for their extra land allowed for acquisition for the project.

Category II : say 20-30 perch for each family.

Persons who had less than 40 perches affected land may be given 20 - 30 perches depending on the land extent they had (equivalent plot to each affected land extent may be given to them as compensation).

Category III : say < 20 perch for each family.

The affected persons who had less than 20 perches may also be given equivalent extent they had. Under this category their may be persons who have less than 10 perches but they need to be given a minimum of 10 perch plot for resettlement.

Option 2 ***Affected parties to be paid compensation while they find their own location of resettlement***

The APs may be willing to get paid for their affected properties and find their own locations for resettlement. Even if all the people do not chose this option there maybe some. APs may be consulted with this option at the time of preparation of the resettlement plan. In such case, land required for compensation is the extent of land in their present plots.

Project Proponent, CEB decided lately to consider the above ***Option 2*** and the following, in place of ***Categories I*** to ***III*** in ***Option 1***

Option 1 ***Resettled in uniform size land plots***

Allocation of 15 perches land from the SAARC Village for each family to be resettled. Although this allocation is smaller than the present land areas belonging to some of the potentially affected persons the level of living standards are up in the SAARC Village. If the acquired land is more than 15 perches in extent, the excess land will be given compensation.

Potential sites for resettlement

04 potential resettlement sites were identified at the initial stages of preparation of the EIA report in 2009/2010. A discussion was held with the DS Uda Palatha, DS Ganga Ihala Korale and the respective GNs in identifying 02 of the potential sites.

However one of these sites identified at Mahawilawatta – Kalugalhinna as one of probable sites for resettlement is no longer available for the said purpose as mentioned in section 3.2.2. Therefore another land from Mahawilawatta -Thembiligala, the 10th plot of land in SAARC village is now been considered for the said purpose.

The Project Proponent, the CEB has made a request to the Hon. Minister of Sports, Mahindananda Aluthgamage (Member of Parliament) to allocate a suitable 5 Ac plot from this land. The Hon. Minister's consent has been given to release a 5 Ac plot for which a letter has been issued to the Land Reforms Commission as of October 2012. (reference ***item no. 18*** in ***Appendix F***).

Whether a Resettlement site has been identified was one of the concerns that was raised at the farmer awareness meetings held by CEB on 08.05.2012 and 18.09.2012 with the participation of officials from the Irrigation Dept., DS office and GN (reference ***items 13*** and ***14*** in ***Appendix F)***.

Some information on the existing envir onment in the potential resettlement land sites and their surroundings are given below. These sites are potential sites for exploring possibilities for creating resettlement facilities. This information is to be given careful consideration in resettlement action preparation phase.

1. Mahawilawatta –Thembiligala (10th plot of land in SAARC village)

- DS division land located : Ganga Ihala Korale
- GN division Land located : Thembiligala
- The land owned by : Land Reforms Commission (LRC)
- Existing crop : Abandoned Tea Estate (almost bare land covered with Iluk/Mana
- Extent : 05 Acres
- No. of families living in adjoining divisions in SAARC village : 270
- Infrastructure facilities

Drinking water	:	Presently water is supplied every other day for the houses in the SAARC Village
Electricity	:	Available
Access roads	:	Located near Gampola-Nawalapitiya AB013 main road. Internal roads inside the village, culverts and drains are already established.
Education	:	Two schools are located nearby and all national schools at Gampola is 7.0 – 8.0 km distance
Health	:	Ulapane rural hospital (a Government dispensary) and a maternity home available at a distance of 1.1 km from SAARC village)
		Gampola Teaching Hospital (nearly 8.0 km distance)

- Nearest urban Centre : Ethgala (near 0.6 km distance)
  Ulapane (near 1.1 km distance)
  Gampola (near 7.3 km distance)
- Distance from the affected project area
  (affected communities) : About 2.8 km along the road

Observations

Since the SAARC village had been developed with the intention of allocation of lands for lower middle income category in year 2008 under the guidance of the Hon. Minister Mahindananda Aluthgamage, Member of Parliament, following activities had been completed at that time.

- Development clearance from the NBRO for the whole land belonging to SAARC village.
- Preparation of the layout plan of housing plots for the whole village (including the 5 Acre area earmarked for the resettlement of APs) by the Department of Surveys, Kandy according to the NBRO guidelines.
- Establishment of a community center and a playground.
- Establishment of basic amenities like roads and electricity

Suitable site for resettlement as infrastructure is developed.

2. ***Land located near water treatment plant of Kotmale Mahaweli residences***

- DS division land located : Udapalatha
- GN division Land located : Mawathura
- The land owned by : MASL
- Existing crop : Bare Land (Mudu Idama in local term)
- Extent : 10 Hectares
- The families living in the land : none
- Nearest Urban centre - Ulapane - about 3 km from the project site
- The environment in the vicinity of the land

A tea Land belong to JEDB (known as Kana bandi watta) is located in East and north of this land. Mahaweli residences are located in West side of the land. River side Colony (settlement) is located in the south.

Observations

The facilities in the affected project area are far better than the area in this potential land.

3. The land near Prime Land Sale

- DS division land located : Udapalatha
- GN division Land located : Kakulanda
- The land owned by : B.K.D. Enterprises, No 23, Kanda veediya, Gampola
  - Telephone No. 081-2352342
- Existing crop : Neglected Tea land
- Extent : 140 Acres
- Families living in the land : None
- Infrastructure facilities
  - Drinking water - Easily available
  - Electricity - Available near the land
  - Access roads - Located near Atabage-Mawathura road (no public transportation available)
- The urban centre located near the land - Ulapane - about 4 km from the project site and about 2 km from the locations of affected community due to the project.

Observations

A suitable land for a resettlement site. There are villages around the land.

4. Private land located near 2 km post on Mawathura- Kotmale Road. This land is called "Maugahahena Watta".

- DS division land located : Udapalatha
- GN division Land located : Weliganga
- The land owned by : D.W. Wanigasekara (Kahatapitiya), A.W. Wanigasekara(Singhapitiya), A.A. Wanigasekara (Watapuluwe)
- Existing crop : Scattered Cardamom trees
- Extent : 22.5 Acres
- Families living in the land : 2 families (for about 40 years)
- Infrastructure facilities
  - Drinking water - Easily available through aquifers
  - Electricity - Available near the land
  - Educational infrastructure facilities -
    - Ulapane Central School - 2 km distance
    - Mawathura Junior School - 2 km distance
    - Nayapana Maha Vidyalaya - 4 km distance
  - Health infrastructure facilities -
    - Ulapana Rural Hospital - 2 km distance
    - Mawathura Rural hospital - 2.5 km distance

Access roads	- Located near (about 0.25 km) Ulapane-Mawathura road

- Nearest urban centre - Ulapane -about 2 km to the affected project site

Observations

Suitable location for a human settlement. There are human settlements located in the vicinity (17 Colony and Kalugalheena Colony)

Out of all the above four sites, Mahawilawatte- ***Thembiligala (10th plot of land in SAARC village)*** is considered as the most suitable site to be used for resettlement due to the following reasons.

- The location of SAARC village is closer to the main city of the area (Gampola), compared to all other three alternative sites
- Said site is located very close to the main road (Gampola – Nawalapitiya)
- The accessibility to Gampola (main city in the project area), and to the other common amenities including hospital, leading schools, and Government offices etc., is much higher compared to other sites.
- If the affected families are re-settled in said site, access to public transport is much better compared to the present locations of all of them, except two families located in Power house/tailrace area in Gampola etc.

The only drawback in utilizing this site is that the area which could be allocated for each family is limited to 15 perches even though the lands occupied them are . It is not possible to allocate higher area per family due to following.

- Majority of the land belonging to SAARC village is already allocated and occupied, all of which are 15 perches (equally sized) plots.
- The total area of land available for thgis purpose from SAARC village is 5 acres.

However, it is worthy to mention that although the allocation of land of 15 Perches in extent per each family is smaller than the present land extents occupied by some of the affected families needing re-settlement, the benefits that these families could enjoy as mentioned above outweighs this only drawback. Arrangements have been made by Hon. Minister of Sports, Mahindananda Aluthgamage (Member of Parliament from Kandy District) to release of 5 Acres from 10th plot in the SAARC village to Ceylon Electricity Board for this purpose (reference ***item no. 18*** in ***Appendix F***)

Considering above, it is decided that Mahawila Watta - Thembiligala Division (10th plot in the SAARC Village) is the site which is best suited for the relocation of the project affected families who prefer ***Option 1,*** where 15 Perches is given to them while paying compensations for any areas acquired in excess of 15 perches.'

Compensation would be paid for the total extent of acquired lands (including houses) for the affected families who would prefer ***Option 2***.

4.7 Impacts of the existing and planned project activities in relation to the components of the project proposal

The Ulapane Industrial Estate is constructed on a land very close to the project site and the land slopes down towards the reservoir. Soil erosion and earth failure can take place due to the non engineered constructions that is carried out in the Industrial Estate. If this happens, the eroded soil will directly flow down and get mixed with reservoir which will result in surface water quality deterioration mainly in terms of high turbidity and color. Resulting effects will be the same as discussed in section 4.2.3. There will be no significant impacts from the Ulapane industrial state if its excavations, earth cuts and drainage system are well planned.

After completion of the reservoir, a section of the land of the industrial estate will lie next to the reservoir. As such, at the request of DS (Ganga Ihala Korale) discussions were made on 26th May 2009 by CEB and EIA Consultant with the relevant investors of the Ulapane Industrial Estate, DS (Ganga Ihala Korale) and the Divisional Director, Regional Industry Service Centre (Central Province). At the meeting, concerns were raised by the industrialists with regard to tunnel been aligned below the industrial estate and on the effects of water level fluctuations of the proposed reservoir on the nearby Industrial Estate Land.

Considering the Investors' concerns of the tunnel being aligned beneath the Industrial Estate, It was decided to have the tunnel aligned as much as possible, away from the Industrial Estate area based on the geotechnical investigations. As such, the intake was located very close to dam to avoid having any adverse impacts due to blasting on the industrial buildings as conceived by the Industrialists.

As discussed in section 3.4, with regard to possible impacts of the water level fluctuations in this area of the Estate, the reservoir operating range is only 2m as the optimum draw down level of the reservoir has been taken as 546m asl. Therefore fluctuation of reservoir levels is limited and therefore the possibility of bank failures is further reduced. However, if a significant fluctuation of water level is expected appropriate remedial measure will be taken to ensure the stability of the river banks to prevent failure of the soil slopes. Nevertheless, mitigation measures to stabilize the embankments of the Ulapane Industrial Estate and the main road which may become vulnerable due to water level fluctuations in the reservoir has been elaborately discussed in section 5.4.15. However, it is recommended that further investigations be carried out during the detailed design stage to ascertain the stability around the specific area.

The industrial estate claims that no industrial wastewater will be discharged into the Mahaweli river and hence there is no impact after impoundment of the reservoir (reference ***Item no.18*** in ***Appendix A***)

The proposed reservoir will extend beyond the Ulapane bridge over Mahaweli Ganga that is presently being constructed by RDA. The water level in the river at this location will increase due to reservoir FSL and the foundations of the abutments and piers of this Ulapane bridge will be submerged. According to RDA, even though the footings of

these bridge piers and abutments are founded on sound rock, at some locations as sound rock was not encountered, RDA has been compelled to stop these foundations on weathered rock. Therefore, soil overburden in these areas could get eroded with the increase in water level.

With the reduction in flows in the river, Crysbro Broiler Processing Industry has been found to be greatly affected in relation to waste water discharges from the industry as the fecal pollution level in river water is already high even at present. And as a result fecal pollution downstream of this industry may be high causing health impacts to those who utilize the water up to power house.

Further the grey and black water emission from SAARC Village, Denmark Colony and Madoldeniya colony are too critical when the flow of water in the river decreases drastically.

As discussed in section 4.4.7, there is a possibility of temporary lowering of water table in areas associated with tunneling. In other projects where such lowering has taken place, the project developer had to provide requirements of water of the communities by water bowzers. Towns South of Kandy Water Supply Project will cover some of the areas nearby the project area and thus the water supply project will have a positive impact on the proposed project. Availability of the water supply scheme for the communities nearby will reduce the need for the provision of water requirements by bowzers to at least a certain extent.

CHAPTER 5

Chapter 5

Proposed Mitigatory Measures

5.1 General

Chapter 4 of this report has identified the potential environmental impacts associated with the construction and operation of the Moragolla Hydropower Project. This Chapter of the report identifies mitigation and best practice measures that should be developed in order to avoid or minimize any such adverse impacts.

The Project Proponent is to ensure that the mitigatory measures to be implemented during the construction phase with reference to physical environmental deterioration including air pollution and noise pollution should be included in the contract documents. Similarly required waste management practices too need to be included in the contract documents. Therefore the contractor is held responsible for carrying them out during construction and on completion of the work.

Attention has also been focused on the mechanism required to ensure the implementation of the mitigatory measures. This forms part of the Environmental Management Plan, which is elaborated in detail in the following chapter.

5.2 Mitigation by Planning and Design and its Continuation in the Detailed Design

The approach to the EIA and engineering studies has been 'Mitigation by Planning and Design'. Therefore potential environmental impacts have been reduced to a great extent and thus has reduced the need to apply mitigation measures.

In this approach of "Mitigation by Planning and Design" site selection and selection of the project layout have been carried out to minimize the impact on environment. In the selection of the best alternative, possible loss of cultivated lands, inundation of populated areas and infrastructure, possible health hazards and environmental management aspects have been given consideration in addition to the costs of dam and waterways.

This approach of 'Mitigation by Planning and Design' can be further extended in the detailed designs of the project to minimize environmental impacts and the need to carry out mitigation measures and resulting costs.

5.3 Mechanism for Implementation of the Mitigatory Measures

The implementation of the mitigatory measures and the management of potential environmental impacts during the construction phase is largely the responsibility of the contractor under the supervision of the responsible bodies. The recommendations on

Mitigatory Measures set out in this chapter and those of Monitoring given in Chapter 6 will be incorporated to form an Environmental Management Plan (EMP). This document is an important document covering a wider area and will be referred to in the following chapter.

The primary reason for adopting the EMP approach is to make the Contractor aware of his environmental responsibilities and to be proactive in his commitment to achieve the standards specified.

The EMP provides details of means by which the Contractor (and any Sub Contractor) will implement the recommended mitigation measures and achieve the environmental performance standards defined and recommended in Sri Lankan environmental legislation, in the EIA and in the Contract.

5.4 Mitigation measures to address Impacts on the Physical Environment

5.4.1 Soil conservation management plan including soil erosion / siltation control and land stabilization measures

Soil Conservation Plan for the Moragolla Hydropower Project described herein includes some of the recommendations made by the Natural Resource Management Centre of the Dept. of Agriculture, Peradeniya. For mitigation of soil erosion threats, the immediate catchment is defined as the area important as far as the soil conservation is concerned and is approximately 257 ha and is shown in ***Figure 4.1.*** However, the extended catchment spreads into a larger extent but priority is given to the immediate catchment assuming that due attention to the periphery will be given by the project management after the said immediate catchment has been conserved.

Soil conservation measures within the catchment will be planned based on slope, land use, soil characteristics and rainfall characteristics. However, the catchment is comparatively small and therefore rainfall characteristics can be considered almost same for the entire catchment. Moreover, dominant soil is RBL which is widely distributed. Thus, these two factors can be considered constant over the catchment. Therefore conservation measures can be decided based on most important two factors, that is slope and present land use. Appropriate agricultural practices are to be adopted to avoid impacts such as loading of agro chemicals resulting in reduction of the water quality of the reservoir.

River bank erosion during construction will be mitigated by constructing drains to take the water away from the slope and to ensure that surface runoff is kept at a minimum, incorporation of silt traps and silt barriers, application of perimeter control methods and implementation of a suitable vegetation program.

River bank erosion during operation will be mitigated by having all surfaces that will be kept exposed be either lined or paved with rock, maintaining safe slopes, designing the drainage system considering the drainage patterns, susceptibility for erosion and topography and by provision of adequate drainage facilities incorporated with silt traps and silt barriers, vegetation of open land with suitable plants.

The report on Landslide Hazard Investigation Report prepared for the proposed project by NBRO (***Appendix D***) gives recommendations which also have already been incorporated herein will be followed during construction and operation of the project.

5.4.1.1 Mitigatory measures for major construction sites

All cut slopes, fillings, and other erosion-prone working areas will be stabilized to an extent feasible for work to be carried out. There will be a number of areas that are subjective to transporting excavated materials off the site in order to avoid unnecessary accumulations. That is, a considerable amount of excavations and earth moving will take place.

The potential impacts during construction will be mitigated by the implementation of erosion and sedimentation control measures such as silt barriers and sedimentation ponds. Open cut areas will be promptly seeded or vegetated with appropriate grass and plants.

Extensive excavations and soil mobilization activities during periods of heavy rain will be avoided. Accordingly, construction schedules will be prepared and work implemented accordingly. Surfaces vulnerable to erosion from heavy rain will be covered with suitable material to avoid flash erosion.

Slopes of the area

The immediate catchment area as defined above is dominantly under tea. Other than tea, marginal tea lands which are gradually being converted to homesteads, well developed homesteads, paddy, surface water bodies, are occurring as other land uses.

The land-use, area wise in the immediate catchment is given in ***Table 5.1***

Soil erosion within the catchment is moderate under the present situation. However, some land uses with less amount of canopy cover such as degraded tea is prone to soil erosion and therefore mitigatory measures are needed.

Table 5.1 Land-use for immediate catchment (for soil conservation concerns)

Land use	Extent (ha)
Tea	63.6
Home garden/ degraded tea	142.4
Paddy	32.1
Water bodies	17.4

Dam Site

The proposed construction involves heavy earth moving work including rock and earth excavation and filling. Surfaces that need to be kept exposed during project operation will be either lined with stones or paved. The open land will be covered with a suitable variety of grass, which will reduce erosion by surface runoff and wind. However,

paving will reduce the extent of infiltration and the runoff will be increased. The impact due to this will be mitigated by means of properly designed drainage systems.

Penstock Area

All excavated pits will be filled back as early as possible to avoid any ponding during a rain storm. De-stabilisation of slopes will be prevented by maintaining a safe slope angle and using preventive measures such as soil nailing, vegetative cover and rock bolting if necessary.

Power House Site

About 15,500m^3 of surface earth material will be removed by soft excavation at the power house site. Construction of powerhouse will involve deep earth excavations. Precautions will be taken when handling excavated loose material, especially when they are kept in relatively flat ground before being handled for either compaction or disposal. A safe slope angle will be maintained to prevent damages to humans and property due to slope and rock failure during and immediately after excavations. Strict specifications and guidelines for material handling will be written into the contract documentation, especially for earthworks. Similarly, all other parties involved in construction work will be mandated contractually to comply with procedures to avoid any contamination with construction materials and measures for dealing with an emergency situation will be clearly laid out.

Construction of access road / rehabilitation of access roas to the Dam, power house/switchyard, construction of transmission line etc.

Disturbed areas will be stabilized immediately after final grade has been attained. Any exposed soil is subject to erosion from rainfall, wind and vehicles. Localized stabilization methods will be applied as quickly as possible after the land is disturbed. Temporary stabilization practices include seeding, mulching and erosion control blankets or mats.

Excessive on-site damage will be avoided by best practices. Runoff velocities will be kept low and runoff will be retained at the site. The erosive power of runoff increases dramatically as distance and slope increases.

Perimeter control practices will be applied to protect the disturbed area from offsite runoff and to prevent sedimentation damage to areas below the construction site. A sediment and runoff barrier surrounding the disturbed area prevents construction site runoff from moving offsite and meeting surface water downstream.

During the stringing works for the transmission lines, best engineering practices will be adopted to avoid/minimize disturbances to the river banks. Care will be taken not to obstruct any natural processes such as surface water runoff and river water flow during construction works. Retaining structures will be built with necessary drainage facilities around the existing towers located in sloping areas or any locations disturbed by the project implementation.

Tunnel Construction

Tunneling involves both general construction risk and risk which is specific to the tunneling environment such as collapsing of rock and sudden inflow of water. They will be mitigated by adopting control blasting methods and proper supporting and dewatering system which is designed and supervised by a qualified engineer. Also, accidents can occur due to noise, toxic gases, dust, fire and smoke. Therefore before tunneling starts, an occupational health and safety plan will be drawn up.

Table 5.2 gives the soil management plan to address the impacts due to various project activities.

Table 5.2 Soil management plan to address impacts due to various project activities.

Project Activity	Impacts	Mitigatory measures
Excavation	Slope failure,	Proceed from top of the slope and maintain a safe slope angle
	Erosion Siltation	Construct drainage paths that will drain the water away from the slopes, construct silt traps where silts are accumulated, apply perimeter control methods to protect the disturbed area from offsite runoff and to prevent sedimentation damage to areas below the construction sites, construction of sediment and runoff barrier surrounding the disturbed area to prevent construction site runoff from moving offsite and meeting surface water downstream, preparation of construction schedules to avoid heavy excavation during rainy periods, covering of open cuts with suitable material during rains, vegetation of open cut areas
	Generation of Dust	Watering the soil masses that can generate dust during excavation
Soil piling	Erosion	Maintaining a suitable slope and watering
	Generation of Dust	Watering at required frequency
Soil transportation off the site	Erosion	Preparation of construction schedules to avoid heavy earth moving during rainy periods.
	Generation of Dust	Watering
Soil Dumping	Erosion	Selection of dumping sites so that erosion is minimum, designing of the bund incorporating stone terraces, bunds or any stabilization structure to prevent erosion
During operation	Erosion due to rain and wind	Surfaces that will be kept exposed to be lining or paved with rock, provision of adequate drainage facilities, vegetation of open land

5.4.1.2 Mitigatory measures for immediate catchment

Soil erosion within the catchment is moderate under the present situation. However, some land uses with less amount of canopy cover such as degraded tea is prone to soil erosion and therefore mitigatory measures are needed.

Soil conservation measures within the catchment will be planned based on slope and present land use as mentioned in section 5.4.1. Conservation can be economically achieved by adopting a proper drainage plan and also with the use of proper vegetation.

(a) Storm water drainage plan

With the construction of residential / office buildings, enhanced runoff can be expected from the site as a result of rainfall. A suitable storm water drainage plan capable of handling this expected enhanced flow will be prepared and implemented within the site in order to ensure safe disposal of runoff water without enhancing soil erosion or causing any damage to infrastructure within the site or surrounding areas. Following general guidelines will be adopted.

- Provision of effective drainage-ways for each landscape unit
- Avoidance of blocking of natural drainage ways but will be protected and conserved to ensure efficient and safe disposal.
- In a drain, if the slope is exceeding 5%, drops will be used to reduce slope.
- Drainage ways will be paved with concrete. Measurements of those will be based on its feeding area.
- All artificial drainage lines will be connected to the nearest natural drainage through protective measures such as manhole, silt traps etc.
- Culverts at suitable locations will be established.

In view of the cost and maintenance considerations, the number and length of surface channels will be kept to a minimum for the design of new slopes mainly closer to the dam site and up slope area of the power house. The requirement for surface drainage is heavily dependent on slope geometry. Wherever platforms or berms are incorporated in the design, surface drainage will be allowed to ensure prevention of ponding and infiltration or localized erosion at low points.

Layout of slope drainage

Runoff will be conveyed by the most direct route away from vulnerable areas of the slope, particularly from behind the top of slope. Runoff will be led down the large slopes in several stepped channels and it will be ensured that it is not concentrated into only one or two. Streams intercepted by a slope will be conveyed directly down the slope. Any change in direction needed to rejoin the stream course will be made to occur at the toe of the slope.

Type of Channel

Channels for slope drainage will be open concrete-lined U-channels or half- round channels. Pipes will not be incorporated in slope drainage systems. Cut-off drains may be used at the top of a slope to intercept some of the water flowing into the slope from infiltration further up the hill side. These drains are most effective where there is a shallow impermeable layer. The drain will be excavated upslope of possible failure surface to avoid acting as tension cracks.

(b) Vegetative protection measures

Vegetation on man-made slopes aids erosion control and serves important landscape functions. Slope-forming materials may also have a direct effect on establishing slope vegetation, as the fertility, moisture availability and resistance to root penetration are all determined by the composition of the materials. As a general rule, routine planting techniques will be used for all types of vegetation in soil and completely decomposed rock.

In these weathered material, establishment becomes increasingly difficult, especially for shrubs and trees, and consideration will be given to the use of special techniques such as planting in formed pockets or benches on the slope backfilled with soil.

Trees will generally not be planted on steep rock slopes where root-wedging along joints could cause instability.

Vegetation Species

Planting on newly-formed slopes will be commenced with grass, and selection of species will be made to achieve a vigorous covering capable of controlling surface erosion. Low maintenance requirements, low fire hazard in the dry season and compatibility with other slope plantings are other desirable factors that will be considered in species selection.

Shrub and tree planting will be commenced after the grass has been established, so that a stable vegetative cover can be attained.

Slope plantings will generally consist of both shrub and trees, and include a mixture of species. Typically, a planting programme might consist of 75% trees and 25% shrubs, with particular species limited to not more than 30% of mix.

Recommended soil conservation plan based on slope angle

- ***Lands exceeding 60% slope***

This slope class covers only 13 ha within the immediate catchment. The lands with moderately deep to deep slopes will be converted into forest. Native tree species existing under natural setting would be more environmentally friendly but Gravilia, Albesia, Ginisapu, Havarinuga, Toona etc will be the options that can have an economical benefit after maturity.

However, these lands will not be disturbed by any means, and even the tree planting program also will be carried out with minimum soil disturbances. The rainfall distribution characteristics, given in section 5.4.1 will be utilized to decide suitable time periods for initiation of a planting program. However, where the lands are with extreme slopes (within the class) planting trees would not be practically feasible. Such lands are found just near the stream banks and at present most of these lands are under grass. Therefore, protection of grass from fire is vital and if so, such lands will be left for the natural succession.

- ***Lands within 46 – 60% slope***

This slope class is dominantly under tea but most of the tea is degraded at present. The extent is 18 ha approximately. Therefore intensive rehabilitation program is essential. Construction of stone bunds, terraces, lock and spill drains, construction of leader drains are essential items. However, specifications and horizontal intervals between two measures etc. will be decided based on each and every field inspection. The technical assistance for this may be provided by the Department of Agriculture, through training and pilot scale implementation. However, this will be done in consultation with Tea Small Holders Authority.

However, if the dwellers are insisting on a land-use change from tea to another, they will not be allowed to cultivate annuals. Instead, fruit tree cultivation or floriculture will be promoted. Following are the options.

* Doorian, Avocado
* Roses, Gerbera spp, Limonium species(spp), Anthuriums,
* Cyprus spp, Agloanema spp, Ceylodendran spp

- ***Lands with 31 – 45 % slope***

These lands are approximately 65 ha. in extent and mostly under degraded tea, but milder landscapes are gradually transforming into Homestead/Tea land. If the dwellers are insisting to wean out from tea, cultivation of export crops, fruit trees, floriculture (same spp mentioned above) will be considered as alternatives.

- ***Lands with 16 – 30 % slope***

This is the highest category in extent-wise and is 102 ha. Dominant land-use within this category is home gardens. It is vital to improve the canopy cover of home gardens with perennial systems but at the same time milder slopes can be utilized for annual crops as required. However, conservation measures will be essential if annual crops are to be established. Terracing is the most appropriate, but stone bunds, vegetative hedgerows are important and can be established according to the field situations. Training on soil conservation of lands which are under annual cropping will be arranged through Department of Agriculture, on request.

- ***Lands with 0 – 15 % slope***

Most of the lands occurring within this category are paddy lands and adjacent valleys where no severe threats of soil erosion can be expected.

- ***Off-farm soil conservation***

Careful observation within the immediate catchment indicated that there are no considerable lengths / extents of soil erosion particularly in stream banks, except in few locations. If, such locations can be protected with boulders (Resulting from tunneling) it would be beneficial.

In places where road banks are unstable, mechanical protection through masonry or Gabion walls are musts. If the road banks are exceeding the height of 1.5 meters such mechanical measures are required. If roads banks are less than 1.5 and stable, those will be protected with vegetative measures such as turfing, cover crop establishment etc. However, if road banks are unstable those will be protected with mechanical means irrespective of the height.

5.4.1.3 Excavation and dumping of soil

Earth excavation of this project seems to be extensive and if not properly handled it can create heavy soil loss and downstream effects. Selection of dumping sites and its protective measures are vital. The selection of dumping sites will be done with a joint inspection with the officers representing the Project, Pradeshiya Sabha, Department of Agriculture, National Building Research Organization and Divisional Secretary. However, dumping sites should be selected in such a way that the dumping process is not blocking any natural stream or drainage paths.

Design of dump sites will be carried out according to the geomorphologic features and the properties of the material to be dumped. Dumping areas will be demarcated ensuring dumping will not be obstructing the natural drainage paths and providing adequate drainage paths where required. Dumping of soil will be done according to stages and a stone terrace / bund constructed along a contour. Boulders resulting from tunneling can be used in the periphery of these bunds to protect or to prevent soil erosion.

The disposal areas will be managed during construction such that no fine material will be washed down to the river and proper mitigation measures as described herein and elsewhere in this chapter will be used to handle muck disposal sites in an environmentally friendly manner. Properly designed sedimentation pits are a major feature in prevention of waste water and solid particles entering into water courses.

Soil and other loose material will be dumped in layers inside the perimeter wall and will be compacted to achieve a desired density (if soil field density> 95% proctor). Steps at the hill side on existing ground will be provided so that proper connectivity with the existing ground is achieved when dumping.

Once this height is filled, then the next stage of filing can be performed by constructing another bund on top of the first. Dump site will be maintained to a slope so that a FOS>1.3 is achieved or < 25^0 and berms will be provided if fill height increases to avoid sudden earth mass failure. Most importantly, at any stage of dumping, the bund for the protection which is located at the boundary of each stage should be constructed prior to dumping. Proper drainage system and berms will be provided when fill height

increases to prevent any instability of soil dumps. Covering of the surface with a suitable soil that promote plant growth and vegetation of the slopes with suitable plants will be carried out to reduce the erosion.

Also, it will be ensured that the material dumped is not contaminated with harmful matter.

Locations for dumping of soil is given in ***Figures 2.15*** and reference ***Appendix F*** for the letters received from the respective state institutions with regard to dumping of soil in the lands owned by these institutions. Excavated soil also can be disposed off with the concurrence of the respective Pradeshiya Sabhas in areas that are being developed by these local bodies such as in playgrounds, roads and other such development works.

A Memorandum of Understanding between the Ceylon Electricity Board and the Mahaweli Authority of Sri Lanka will be made in relation to provision of necessary general specifications for the relevant contractors for management of soil dumps in the Mahaweli river reservation areas within 60m.

5.4.1.4 Other Supportive Recommendations

- Implement soil conservation activities within the immediate catchment without delay and proceed to periphery if the situation demands.
- Initiate conservation measures from the crest of the immediate catchment and move downward.
- Take steps to create awareness among dwellers in soil conservation and implement conservation programs through forming community groups.
- The cost of conservation should be born by the project and if dwellers are implementing those measures, they should be able to reimburse their cost through the project.
- It is recommended to allocate a reasonable share from the earnings of the project for catchment management in the long run.

5.4.2 Mitigatory measures to avoid water quality deterioration

5.4.2.1 Mitigatory measures to avoid surface water quality deterioration

During construction

All in-situ construction activities such as vegetation clearing cut and fill operations involved in all types of construction works and excavation works for foundations etc. will not be carried out during the rainy periods to avoid the generation of surface run-off and subsequent colour and turbidity problems. Construction activities may be carried out during the north-east monsoon (December-February) period as practical as possible, during which relatively little rain is received. However, if the time schedules of the construction activities cannot be effectively coincided with the desired weather patterns in the area, then silt traps and interceptor drains will be incorporated in the construction sites to prevent erosion and siltation. Also maintaining suitable surface covers is recommended to reduce the effects of rainfall impact.

Any vegetation clearing activities will be carried out using manual labour to the extent possible to avoid severe erosion problems and even undue noise. The use of weedicides and pesticides especially biocides containing heavy metals such as As and Cu or organo-chloride rich compounds (which are non-biodegradable and soluble in fat tissue) in significant amounts will be strictly prohibited. Nevertheless, clearing of vegetation cover needs to be minimized in order to avoid possible erosion during periods of light rain.

In order to prevent erosion of sites due to excavation, it is recommended that these exposed surfaces are covered with suitable covering material or with coir mats, grass, etc. Thatching of exposed soil areas with dead or live vegetation or replantation of such areas with any stripped vegetation is also recommended to reduce the generation of surface run-off during rainy periods, and also to reduce dust emission scenarios. Similarly, any cut slopes, etc. will not be exposed to erosive forces and should be graded and then covered by coir mats, grass or any other suitable material to prevent excessive erosion.

Impacts on water quality can be mitigated through proper storage of construction material, reuse of waste water, treatment of contaminated water before it is released into the environment.

It is imperative to refrain from the practice of stockpiling of construction material near the water bodies to prevent such material from entering through erosion by rains or by any other means. Similarly, excavated soil known as spoil too will not be stockpiled near the water bodies without proper covering or protective measures. Any excavated spoil will be stored in temporary storage areas until they are taken away or is used as a re-filling material within the site itself.

Wastewater from asphalt plants should not be directed to soil or to the nearby water bodies unless treated using pH correction and physicochemical treatment such that the treated wastewater quality conforms to the CEA stipulated wastewater standards for the discharge to inland surface waters. Provision of oil and grease traps is crucial to curtail run-off carrying them to water bodies (if such plants are to be located in the vicinity of water bodies).

Heavy restrictions have to be implemented on washing of construction material and building material transporting vehicles and other machinery involved in the construction works. Washing of vehicles and construction associated machinery has to be undertaken only at designated areas (i.e. off-site the project area preferably in vehicular washing service stations having wastewater treatment plants that are effectively functioning). Similarly, vehicle and machinery servicing and maintenance should be carried out only at designated areas. Oil catchers have to be placed at workshop to avoid any spills/leakage at the time of preventive maintenance of vehicles as per maintenance schedule. The waste oil and water coming out from maintenance of the vehicles are collected in Pits. The layer of oils collected from pits is to be collected and disposed off in an authorized manner.

Also to minimize oil spills during the construction period, all machinery and transporting vehicles should be properly and regularly maintained. The machinery and vehicles used during the construction period should be checked daily or as practical as possible for oil, fuel and lubricant leaks and any leaks should be immediately repaired. Records of such checks and repairs should be maintained.

In addition, there need to be heavy restrictions on fuel storage for any machinery such as concrete mixers that may be required for *in-situ* construction works in the vicinity of the water bodies in order to prevent contamination of soil, groundwater and surface water bodies. Any storage of oil or oil rich products should be stored only in cans that are not corroded and have well closing lids or in self-contained enclosures. These cans, etc. should be stored in temporary sheds that are well protected against heavy rain and wind and are not close to the water bodies. Used or waste oil and lubricants should not be disposed or burnt and should be stored securely in full compliance with the national and local regulations.

During operation

Specific measures are not necessary with reference to wastewater disposal issues particularly for the treatment of gray and black waters from quarters and power house apart from proper maintenance and operation and frequent inspection of the wastewater treatment plant. Any malfunctioning scenarios or other trouble shooting have to be immediately attended. In this respect only well trained, competent personnel shall be deployed to operate and manage the wastewater treatment plant.

With the reduction in flows in the river due to diversion for power generation, fecal pollution levels downstream of the Crysbro Broiler Processing Industry may become high as the outlet pipe from the industry discharges directly to the Mahaweli Ganga. Therefore the outlet pipe from the industry will be extended and taken to a location immediately downstream of the power house (line diagram showing the proposed extension for the waste discharge pipe is shown in ***Figure 2.9***). All costs related to these improvements will be borne by CEB (Minutes of the meeting held with the Farms Pride (Pvt.) Ltd. is attached as ***item 15*** and ***16*** in ***Appendix F***).

With regard to ensuring quality of water at the water extraction point of the NWS& DB, CEB will abide by the conditions stipulated in the MOU between the NWS& DB and the CEB.

The minimum environmental flow of 1.5m^3/s will be released downstream and part of this flow will contribute to reduce the higher pollution potential within the river stretch between dam site and power house.

With the analysis done by both University of Moratuwa and ITI (***Appendix C***) has envisaged that the effluent being disposed to the River by Crysbro Industry has very high fecal coliform levels (Average value would be around 1x10^6 MPN/100ml). As per the regulation on effluent discharge to inland waters stipulated by CEA, it has to be 40 MPN/100ml. Unless the Industry reduces this value up to accepted levels, dilution will not be maintained.

The pollution of the river waters by the Crysbro Industry finally affecting the water quality of the Dunhinda irrigation feeder canal is also one of the concerns of the participants present at the farmer awareness meetings conducted by CEB (***item nos. 13 and 14 in Appendix F***).

Hence reduction of this high level is highly recommended to the acceptable levels so that the proper dilution could be maintained so as not to have any impacts on the downstream users of the river. The proposed environmental flow (1.5 m^3/s) is more than enough to maintain the dilution at Crysbro industry provided that the Industry maintains their fecal coliform level at the acceptable limit.

Water quality deterioration in the reservoir due to increased nutrient levels can be arrested by periodic flushing of the reservoir which will be done during flood events. The bottom outlet provided in the dam will be used to flush off the sediments from the reservoir bed.

5.4.2.2 Mitigatory measures to avoid ground water quality deterioration

During construction

Deep excavations for foundations should be avoided to avoid any alterations in water table. Water needed for construction works and even for dust suppression works (if any) needs to be provided to the sites in tankers or bowzers.

The provision of temporary toilets (which mainly includes squatting pans or pit latrines) is not recommended as the area is already fecally polluted. Therefore the work force involved in the construction activities has to be provided with proper sewage facilities at least with septic tanks associated with soakage pits. Further the workforce should be provided with good sanitary and solid waste disposal facilities and with adequate clean drinking water systems.

During operation

The environmental flow must be released so as to avoid higher pollution potential within the river stretch between dam site and power house. Few small streams including one perennial stream drain to the main river within this reach. This flow coupled with the local inflows and the minimum flow of 1.5 m^3/s that will be released downstream from the reservoir is expected to provide the environmental flow requirements of the river reach.

No leakages should be allowed to ground water and the hazardous material must be kept under close supervision particularly for pilferages.

5.4.3 Mitigation measures to address air quality deterioration

During construction

It is anticipated that during the construction works, dust emission scenarios would be significant. Therefore dust emission scenarios need to be minimized through measures

such as frequent wetting or wet spraying of dusty surfaces and any exposed earthwork surface. In this respect it is recommended to use sprinklers and the contractor should

Employ tanks or bowzers. It should be noted that wastewater or waste oil for dust suppression is prohibited. In addition, it is imperative to carry out regular cleaning of the construction sites and remove excessive or unnecessary construction related material, some of which could be reused and recycled for other construction works.

The vehicles transporting construction material should adequately cover the material to avoid wind induced dust and spillage. Further all construction material such as cement brought to the site needs to be carefully stockpiled to avoid unnecessary dust emissions. Hence such material needs to be adequately covered and stored in temporary sheds that are well protected again rain and wind.

All highways and roads used by vehicles of the contractor, or any of the sub-contractor or supplies of materials shall be kept clean and clear of all dust/mud or other extraneous material dropped by the vehicles or their tyres.

During the construction phase it is also imperative that the vehicles and the machinery to be used are regularly and well maintained in order to avoid smoke emissions. They shall be fitted in full compliance with the national and local regulations (National Environmental Air Emissions Fuel and Vehicle Standards E.O. Gazette 1137/35 of June 2000, updates by air emissions fuel and vehicle standards (importation standards) 1268/18 December 2002 and 1295/11 June 2003). Further stringent requirements should be implemented to all vehicles involved in transporting construction material and soil, and also to properly store and cover such material with dust covers in to avoid spillage and dust emissions. Further enforcing speed limitations to the vehicles carrying such material are also crucial in reducing dust emissions.

Aggregate piles from asphalt plant must be kept in places where dust and impurities are minimal. Any ready-made concrete plants should be located sufficiently away from the sensitive areas and sprinklers should be used to curtail excessive dust emissions. Watering of stock piles of sand and coarse aggregates too should be carried out to avoid dust emissions. Use of cement silos in high elevations and the use of dust collectors especially fabric bag filters wherever possible need to be practiced. Burning of tires for the preparation of bitumen (for road construction works) should not be carried out.

If excessive dust generation results at the spoil disposal sites watering should be done to prevent such dust generation. All vehicles transporting spoil to the disposal sites should have coverings to prevent dust generation.

During Operation

No significant air pollution potential is to be found during operation phase.

5.4.4 *Mitigation measures to address impacts due to noise and vibration*

During construction

Construction activities including heavy vehicle movements should be restricted during night to avoid disturbances to neighborhood community. The vehicles to be used for the construction phase need to be regularly and well maintained in order to avoid generation of significant noise levels, hence less disturbing effects on avifauna. The vehicles should have good quality mufflers or silencers to reduce exhaust noise. Alternately low noise generating or well designed vehicles should be used wherever possible. Similarly, low noise generating machinery such as concrete/cement mixers for *in-situ* construction activities should be used to the extent possible. However, all machinery which is to be used during the construction works needs proper and regular maintenance in order to minimize smoke emissions and any potential noise generation which may include irritating hums. For example, proper lubrication of the moving parts of the machinery in contact will reduce noise due to friction.

Proper traffic management practices too have to be implemented along with maintenance of access roads during transport of materials in order to reduce traffic noise. Noise levels should be well monitored during the construction phase. If ambient levels are far higher than the stipulated limit of 75 dB(A) for daytime construction works, then measures such as limiting the number of vehicles per given period of time is recommended to reduce noise and even air quality deterioration due to exhaust emissions.

It should be noted that archeological structures are sensitive to vibration and the ground induced vibrations due to operation of machinery, construction activities and vehicle movement traffic and as a result shocks can have severe damages to nearby properties when ground vibrations are exceeding well over 0.5 mm/sec. However, the vibration standards for Type 3 structures (ie single and two storey domestic houses and buildings made of lighter construction material such as bricks and cement blocks, not designed to resist seismic activities) will be a maximum value of 2.0 mm/sec. vibration standards for Type 2 structures – Single and two storey houses and buildings made of reinforced block work, pre-cast units and with reinforced floor and roof construction, or wholly of reinforced concepts, not designed to resist seismic activities should have a maximum value of 4.0 mm/sec. The multi story buildings could have a maximum vibration level of 10.0 mm/sec without any adverse impact from vibration.

Underground tunneling requires drilling and blasting while people live on the ground level. This operation needs to be carried out very carefully so as to not to make any inconvenience or structural damage to the existing dwelling units.

It has been determined that for satisfactory tunneling operations, the explosive charge required would not generate maximum velocity of 3.6 mm/sec. at a place about 300m distance from the point of blasting. This was found to be the closest distance to the surface from the tunnel face being excavated and this is in the SAARC village area. During construction it has to be assured that maximum velocities of vibration will not exceed this level.

In addition to this, trials have to be carried out prior to commencement of tunneling work in proper, to determine the minimum explosive charge levels required to obtain the rate of advance required. This is part of the tunneling methodology investigations to be carried out.

Prior to tunneling it is necessary to carry out a survey on existing cracks on the existing housing units and while or after tunneling the same needs to be monitored. If the cracks or any other structural failure is reported, immediate assessment has to be done by a competent authority. Based on the damage, compensation package must be worked out or else the repair work has to be conducted as appropriate as possible.

Proper planning is necessary to reduce noise levels within and outside the site. Enclosures with double leaf walls (with an air gap inside and the interior of the walls lined with 2 inch glass wool layer having a density of 64 kg/m^3) are necessary for all areas where high or disturbing noise levels are likely to be generated. Further it is crucial that the masonry walls in such facilities are finished with a render or cement based paint in order to avoid possible cracks and gaps. Also the roof needs to be lined with suitable sound absorbing material such as acoustical tiles, cork and felt, etc. and the doors should be properly sealed with rubber beadings.

Facilities where noise levels are likely to exceed 80-85 dB(A) should be well enclosed and such areas should be marked with special warning systems with access being restricted or being limited to certain time periods and only with ear plugs/muffs.

The generator rooms and other areas where machinery and equipment (that are likely to produce structure-borne and ground-borne vibrations) are placed need be located away from other facilities to avoid potential vibration effects on any nearby structures and inconvenience to workers. Otherwise all these machinery and equipment should be effectively isolated with well designed dampers fixed on to them and even rubber, cork or felt pads should be used as resilient mats or pads under these machinery and equipment.

In addition, it is important that all machinery and equipment used in the power plant for electricity generation works are properly and regularly maintained to cut down high noise levels.

Exhaust lines connected to building walls too should have properly designed damping material to prevent structure-borne vibrations. Further the exhaust lines should be fairly wide, equipped with spoilers and well insulated with suitable noise absorbing material throughout the height of the lines.

Proper landscaping of the outside area of facilities and the parking area where high or disturbing noise levels are likely to occur has to be carried out with planting of thick and tall native vegetation. In other words it is recommended to have a greenways concept to further reduce air-borne noise transmission and even arrest wind induced dust, intercept rain, decelerate run-off and to minimize visual intrusion impacts. However, planting should be preferably carried out in a zigzag manner, hence to effectively intercept the escaping sound waves and attenuate it.

During operation

During the operational phase it is anticipated that road and parking area maintenance activities would required to be carried out. Although high noise generation scenarios are temporary the relevant mitigatory measures with reference to minimization of high noise generation should be practiced. For example, the use of high noise generating pneumatic construction equipment should be restricted to the extent possible and any repairing or maintenance works too should be carried out only during day time. However, when night maintenance is required sometimes to cater to the system requirements, all precautions will be taken to comply with the standards.

All these relevant mitigatory measures should be implemented by the Power plant authorities and the contractor involved in undertaking the repairing/maintenance works. It is also imperative that during such maintenance construction works noise monitoring is carried out by Power plant authorities and contractor in order to minimize or avoid generation of high disturbing noise levels. This task should be carried out throughout the period of the maintenance works and it should be ensured that the noise levels are not exceeding the day time stipulated limit of 50 dB(A) for silent zones.

Traffic management practices

Table 5.3 Necessary actions to control possible high noise levels In certain areas of the road traces

Category	Description	Maximum Permissible L_{eq}*	Remedial Measure
Undeveloped lands	Paddy, rubber, tea, coconut, water shrubs and marshy areas	-	No action necessary
Sensitive areas	Schools, religious places, libraries, public meeting, rooms, courts, residences, hospitals, etc.	52 (Interior) 67 (Exterior)	Sound barriers and sound insulation techniques
Developed lands	Home gardens and other areas not included in the above categories	72 (Exterior)	Buffer zone with luxuriant vegetation and tree canopy layers and sound insulation of affected buildings (Any existing thick and tall vegetation notably shrubs and trees such as weeping willows could be used for this purpose)

* Maximum permissible limits stipulated by the Federal Highway Association of USA (FHWA)

It is recommended to limit the number of vehicles particularly heavy vehicles and bowzers entering the site during the night time. Further it is important to emphasize that all vehicles are regularly and well maintained to reduce air pollution as well as undue noise.

Also necessary actions may be exercised in certain areas (especially in urbanized areas having noise sensitive places such as residences and schools) of the road traces to be used in order to cut down any high or irritating vehicular noise levels that

may arise during periods of heavy traffic congestions. ***Table 5.3*** above illustrates the necessary actions to be exercised in certain areas of the road traces to be used.

5.4.5 Mitigation of Impacts on Bed rock stability

5.4.5.1 Construction of dam

Damages to the bedrock during blasting will be minimized by adopting control blasting. There will be no adverse impacts on bedrock stability due to construction of dam.

The earth and rock in the slopes that could be destabilized due to excavation will be minimized by maintaining a safe slope angle.

The grout curtain will block the underground seepage paths in the vicinity of the dam and thus will cutoff the under ground water flow across and along the dam axis. This will improve the long term stability in addition to seepage cut off.

Dam construction will be carried out adhering to the applicable standards and specified limits. Considering the present geological and geotechnical conditions at site, bedrock stability will improve immediately after the construction.

5.4.5.2 Penstock installation

Penstock anchors will be seated at a suitable level in the bed rock so that the stability of the rock is not disturbed. Construction of anchor blocks will involve uprooting of trees and moderate excavation of soil on slopes. De-stabilization of slopes will be prevented by maintaining a safe slope angle and using preventive measures such as soil nailing, vegetative cover and rock bolting if necessary.

The amount of earthwork is bound to affect the drainage of surface water during construction. Therefore, all excavated pits will be filled back as early as possible to avoid any ponding during any rain storm. In practice, excess earth material due to excavation pits will be placed nearby the penstock line. Therefore, tendency of de-stabilizing and erosion due to lose soil is relatively significant immediately after excavation.

5.4.5.3 Power house construction

A deep excavation will be done at this site. If stabilization methods are not adopted rock and soil mass failure can occur and cause damage to workers and property.

Application of control blasting will minimize the impact to the bed rock stability. De-stabilization of slopes can be prevented by maintaining a safe slope angle and using preventive measures such as temporary support systems, soil nailing and rock bolting.

5.4.5.4 Tunnel construction

The length of the tunnel is 2.96 km and rock within more than 2.5 km will be blasted. Uncontrolled blasting methods can damage the bed rock. Roof failure in weak zones can cause damages to workers due to rock mass failure.

Application of controlled blasting methods will minimize the damages to bed rock and cause no significant impact to bed rock. Temporary support system will be used in weak zones to prevent damages to workers.

5.4.5.5 Transmission Line

Tower foundations will be constructed at a suitable level in the bed rock or anchored to the same to avoid destabilization of bedrock.

During the stringing works, best engineering practices will be adopted to avoid / minimize disturbances to the river banks. Care will be taken not to obstruct any natural processes such as surface water runoff and river water flow during construction works.

Retaining structures will be built with necessary drainage facilities around the existing towers located in sloping areas or any locations disturbed by the project implementation.

5.4.6 Debris/waste/tunnel muck/disposal facilities method and location

During Construction

- ***Solid waste management***

Contractor will be required to remove the construction debris, arising out of the construction operations such as used formwork, pieces of metal, lubricants etc. to be disposed safely elsewhere. Solid wastes including any debris will not be left after construction works is complete since it may be carried away by water.

Locations of sites for disposal of spoil will be carefully selected. In the carefully selected locations the debris and spoil shall be disposed in such a manner that waterways and drainage paths are not blocked, the disposed material are not washed away by floods and will not be a nuisance to the public. Recycling potential of some of the construction generated wastes such as excess concrete and soil will be looked for. Therefore attempts will be made to trade off or sell such wastes to relevant stakeholders (if not the excess material may be used for other or future construction works). For example, concrete and bricks could be crushed up to make aggregates required in road repairs. The excavated material will not be left in the construction area or disposed to water bodies or left near water bodies in order to avoid degradation of the water bodies but will be dumped in lands with similar soil layers with the provision of adequate drainage facilities.

All scrap materials such as cables, metal structures, steel wires, insulators involved in power line construction works for the site need removal after construction works are complete and wherever possible attempts will be made to evaluate their recycling potential.

Left-overs including wastewater treatment plant sludges from asphalt plants will be dumped only in pre-determined places which do not disturb public, aquatic and terrestrial biodiversity. Nevertheless, these left over material needs to be safely

disposed in accordance to guidelines on disposal of contaminated material and it is recommended to carry out the US Environmental Protection Agency (USEPA) prescribed toxicity characteristics leaching protocol (TCLP) test prior to disposal. Wherever possible, options should be evaluated in trading off the left over material for the construction industry.

It is also necessary to provide the work force with appropriate municipal solid waste facilities in terms of collection, transport and final disposal. For this purpose sufficient number of separate bins having well closing lids with clear instructions and figures will be provided in the project area in order to segregate the perishable or biodegradable wastes from recyclable material such as cardboard and paper products. In this respect green coloured bins, blue coloured bins, red coloured bins, brown coloured bins and orange coloured bins should be provided for the purpose of collecting biodegradable wastes, paper, glass, metal and plastic and polythene, respectively in accordance to the technical guidelines on solid waste management developed by the CEA in 2005. Attempts have to be made to exclude flies, birds, rats and even domestic animals such as cats and dogs to avoid garbage disposal and spreading. The collected biodegradable or perishable solid wastes containing essentially leftover food such vegetable matter may be composted or arrangements should be made with the relevant local authorities to regularly dispose of the collected wastes provided it is well segregated. The recyclable waste material such as paper, metal and plastics may be handed over to stakeholders involved in recycling or handed over to recycling centres established.

- ***Tunnel muck / Spoil disposal***

The re-use of spoil material will be explored and whenever possible they will be used. Part of the tunnel muck is used as aggregates for concrete works. The disposal of tunnel muck will be done only at the designated places. The proposed alignment of head race tunnel, surge shaft, powerhouse and tunnel outfall area are along the left bank. The tunnel will be excavated from the two ends and there will not be any adits. Spoil will be dumped at the locations identified as shown in ***Figure 2.15*** (reference ***item nos. 1, 6 , 7, 8*** and ***9*** in ***Appendix F***).

The dumping sites should not harm the aesthetics of the environment and the tunnel muck dumps should be made stable. Therefore tunnel muck will be deposited behind rock bunds that are suitably built with safe slope angles and berms to ensure stability of the slope. Provide toe filters in the bund to prevent loss of fines.

Dump sites will be designed according to the geo-morphological features and the properties of the material to be dumped.

(i) Demarcate dumping areas not obstructing the natural drainage paths or provide adequate drainage paths if required.

(ii) Providing steps at the hill side so that proper connectivity with the existing ground is achieved.

(iii) Construction of a retaining wall around the perimeter with the large rock particles or rubble or gabion boxes. This can be constructed stepwise. After the inner area is filled as described in (ii), next step of perimeter wall can be constructed.

(iv) Dumping soil and other loose material in layers inside the perimeter wall and compacting to achieve a desired density (if soil field density>95% proctor).

(v) Maintaining a slope so that a FOS>1.3 is achieved or $<25^0$

(vi) Provide berms if fill height increases to avoid sudden earth mass failure.

It is also needed to ensure that the material dumped is not contaminated with harmful matter.

Cover the surface with a suitable soil that promote plant growth and vegetate the slopes with suitable plants that reduce erosion.

Out of the five dump sites, four sites (excluding MASL site) are located on hilly lands. Even though there are no streams located inside the sites selected for dumping tunnel waste, there are seasonal streams present at the bottom of the hill and therefore sediments can get washed into these streams. Therefore permanent erosion and sediment control measures such as silt traps should be installed around the dump sites to prevent such sedimentation events.

When dumping, care will be taken not to create water holes so that with rainfall the threat of mosquito breeding is minimal. The disposal areas will be managed during construction such that no fine material will be washed down to the river. Therefore tunnel muck disposal sites will have sediment traps such that any fines and solid particles will be settled before runoff from the dumping areas enters the waterways. Properly designed sedimentation pits are a major feature in prevention of waste water and solid particles.

After completion of construction work, dumping sites will be covered with top soil such that grass cover and small shrubs can grow over them.

A Memorandum of Understanding between the Ceylon Electricity Board and the Mahaweli Authority of Sri Lanka will be made in relation to provision of necessary general specifications for the relevant contractors for management of tunnel muck dumping sites in the Mahaweli river reservation areas within 60m. A sample MOU in this regard in accordance to the conditions stipulated by the MASL is given as ***item no. 1*** *in* ***Appendix F.***

During Operation

- ***Disposal of solid wastes***

The power plant authorities have plans of making necessary arrangements with the local authorities to collect and dispose Municipal Solid Waste (MSW) on a daily basis. However, proper large bins or containers must be provided in all infrastructure facilities and the bins should be of different colours with clear

instructions and figures in brief, thereby explaining as to what type of wastes are to be disposed. In other words green coloured bins, blue coloured bins, red coloured bins, brown coloured bins and orange coloured bins will be provided for the purpose of collecting perishable wastes, paper, glass, metal and plastic and polythene respectively in accordance with the technical guidelines on solid waste management developed by the CEA in 2005. This is important for the purpose of segregating the perishable wastes from recyclables such as glass and plastics.

The garbage bins provided for the collection of perishable wastes should be lined with biodegradable bags. It is also imperative that all the bins have well closing lids and are closed at all times to avoid rummaging by stray dogs or other animals such as birds and even to prevent access to flies and other insects.

In addition to placing garbage bins in the civil infrastructure facilities where the project activities would occur, garbage bins will also be provided in the vehicle parking area. Collection of garbage and cleaning of these areas too will be done on a regular basis by the local authorities particularly during periods of low traffic (e.g. during late night and early morning hours).

Regular sweeping of roads using manual labour or mechanical litter collection systems (for example devices having a series of rotating plastic teeth that fling the litter into a collection basket or devices equipped with vacuum arms on a truck to suck up the roadside litter while cruising at highway speed) is recommended rather than flushing with water to effectively remove litter as well as nutrient rich dirt, organic matter and other contaminants. Further regular sweeping tends to improve the aesthetics of the landscape and prevents blocking of drains.

It is also recommended that the power plant authorities carry out regular surveys pertaining to the adequacy of bins and other facilities for garbage collection. Also the efficiency of the relevant local authorities has to be assessed with reference to the daily collection frequency, thereby to avoid unnecessary, nuisance collection of garbage heaps and subsequent vermin problems and odor due to anaerobic decomposition.

In the case of disposing recyclable waste material it is recommended to set up networks with relevant stakeholders involved in recycling or purchasing such wastes to be used as resource for other purposes and to the extent possible options of recycling and reusing recyclable waste material have to be looked into within the power plant site.

5.4.7 Restructuring of the surrounding environment including landscaping of the construction areas.

In this regard a Memorandum of Understanding between the Ceylon Electricity Board and the Mahaweli Authority of Sri Lanka will be made in relation to provision of necessary general specifications for the relevant contractors for environmental protection and soil conservation measures, clearing of work sites and landscaping of

the areas affected by construction activities (of both permanent and temporary facilities) etc. in the MASL reservation areas.

Restoration Plan for Quarry Areas

It is suggested that the voids generated of quarrying of rocks may be refilled with muck which would be generated as disposable wastes not suitable for construction. This may be stabilized after refilling and planting grass, shrubs and trees along slopes. This area affected will be reclaimed and restored by engineering and biological measures and providing suitable landscaping to improve the aesthetics of the area.

Landscaping of construction areas

As a part of various project related activities it is also proposed to develop nature parks, children's parks, gardens, and other recreation facilities near the project area once the construction activities of the project are over. During the construction of main features like Dam, Tunnels, Power House and other building structures of the project including residential camp and project roads, various slopes may be disturbed which shall be stabilized using measures like benching and plantation as proposed above in the soil conservation plan based on slope section 5.4.1.2

Proper landscaping of the outside area of facilities and the parking area where high or disturbing noise levels are likely to occur has to be carried out with planting of thick and tall native vegetation. In other words it is recommended to have a greenways concept to further reduce air-borne noise transmission and even arrest wind induced dust, intercept rain, decelerate run-off and to minimize visual intrusion impacts. However, planting should be preferably carried out in a zig-zag manner, hence to effectively intercept the escaping sound waves and attenuate it.

5.4.8 Public health measures to control vector and water born diseases

Steps should be taken as appropriate as possible to prevent mosquito breeding in the working areas of the project. The breading sites such as ponds, depressions or areas of shallow water logging should be refilled with excess of excavated material. Ponding of the low lying area near the confluence of Ulapane Oya with the Reservoir may be tackled by filling the maximum extent of such area with loose sand generated during excavation works in project area.

There are one perennial and several other seasonal streams located downstream of the proposed dam site (Sooriyagoda Ela, Imbulu Ela, Galkotuwa Ela and Umagiri Uyana Dolapara etc.). Therefore from the dam, downstream up to the proposed powerhouse the river flow consists of drainage from an incremental catchment of 4.87 Km^2 and the mean monthly flows of the downstream in this stretch is as follows.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
Flow (m3/s)	0.18	0.13	0.12	0.19	0.24	0.28	0.27	0.26	0.25	0.43	0.53

After release for irrigation and other industry, the balance flow from the environmental flow of 1.5 m^3/s combined with the flows contributing from other small streams downstream of the dam will have a sufficient flow to prevent formation of stagnant water pockets in the river stretch between the dam site and the tail race thus preventing the spread of vector borne diseases such as dengue in the area.

Examination of the construction site with the Public Health Inspector will be recommended so that the possible sources for health hazards could be avoided.

During the construction period of the project the project staff and workers and migrant labourers along with their family members needs to get vaccinated / inoculated against infectious diseases. Regular health check-up and programmes are to be set up to check endemic diseases.

5.4.9 Disaster Management Plan

Dam failure is a hazard which has a potential of becoming a disaster, if proper disaster management and mitigation measures are not ensured. For the proposed project, Emergency Action and Preparedness Plan (EAPP) has to be prepared, to identify potential emergency conditions at the dam and to specify preplanned actions to be followed to minimize property damage and loss of life.

The Emergency Action and Preparedness Plan has to specify the actions CEB should take to moderate or alleviate the problems at the dam. EAPP should have the following.

- procedures and information to assist the authorities in issuing early warning and notification messages to responsible downstream emergency management authorities.
- inundation maps to show the emergency management authorities of the critical areas for action in case of an emergency

A disaster preparedness plan essentially contains measures to be taken before, during and after disaster strikes. It contains an inventory of what materials are available, where and with whom, and the delegation of responsibilities among various officials and other government departments.

Disaster Management activity can be divided basically into the following three stages:

(i) Pre-disaster stage which involves disaster preparedness and framing up of emergency action and preparedness plan;

(ii) Emergency stage which involves implementation of contingency rescue and relief operations, and,

(iii) Long term post disaster stage which involves rehabilitation of affected persons, strengthening/ re-strengthening of existing health facilities and infrastructure, rehabilitation of educational activities within the disaster affected region and rehabilitation of women and children affected by the disaster.

Moragolla dam failure due to overtopping is highly unlikely situation as the spillway has been designed with five gates which are capable of passing 6500 m^3/s in a flood 10,000 year return period even with one gate non operational as have been discussed under section 4.4.1. However in the improbable situation of all gates non-operational, the dam will overtop even for floods of 2 year return period as have been discussed in section 4.4.1. In this context, the Disaster Management Plan for dam failure due overtopping has been discussed.

Disaster Management Plan has to be prepared on the basis of Dam Break Modeling which can be undertaken during the detailed designs of the Moragolla Hydropower Project. The dam break modeling predicts the movement of the flood wave downstream of the proposed dam to determine travel time, maximum water level reached, identification of inundated areas etc.

If there is a danger of over topping of the dam, the Engineer in charge of the dam will immediately report to the superior officer for further action. For that purpose they are supplied with communication facility in their residence and there should be standing orders to cover such situation. Engineers responsible for preventive action for unforeseen events should identify sources of repair equipments, materials, labour and expertise for use in case an emergency. It is desirable to store sufficient quantities of construction materials and keep equipments at safe place from the dam site or wherever it can be readily available. The construction materials include stone, rip-rap, sand bags, cement, plastic sheeting, etc; equipments such as cranes, shovels, bulldozers, etc. should are readily available when required.

The level at which the situation reaches an emergency status will be pre-determined and shall include the stage at which the surveillance requirement should be increased both in time and level. Whenever there is a possibility that flood water could raise the reservoir level beyond expected, the Engineer in charge should notify to higher official of the CEB and Chief Engineer in charge of Dam safety, District level officers of the Kandy District Disaster Management Coordinating Unit, various other officers such as the Superintendent of Police, the officials or Transport, Railway, Health Department, major industries / installations downstream, publicity officer the following information :

- Existing reservoir elevation
- Observed rate of rise of water level per day
- Danger level

If the communication with the dam site is lost, the site engineer should take the following actions:

Discharges from the bottom outlet should be increased if the reservoir is above the specified level. When increased release is necessary, this should be done in stages so as to allow the river in the downstream portion to rise gradually. However, if in the judgment of the Engineer-in-charge, this would be inadequate for the safety of the dam, larger releases should be made.

Toe and abutment should be checked for any new seepage or abnormal increase in quantity of seepages or any indication of muddy or silt flow in the discharge from the embankment.

Efforts must be made to contact key personnel, through special messenger to carry request for assistance to the nearest place where communication is available.

Proposals for Emergency Action Plan along with arrangements for early warning systems and details required to ensure the dam safety aspects have been discussed in detail in section 2.2.13.

5.4.10 Re-establishment / restoration of infra structure

It is proposed to develop greenbelts in the excavated quarry site and muck dump sites after land filling and landscaping (terracing and construction of retaining walls) apart from the designated greenbelt area, in conformity with the engineering and aesthetic needs of the area.

The greenbelts have to be developed in a phased manner. In the first phase, the activity can be initiated in the open spaces in the side of the inundation area on either bank. In the second phase, the muck dump yard, the excavated quarry site and the temporary labour camp areas can be included.

Greenbelt development should be worked out in consultation with the forest department/ agricultural department. Such scientifically designed/ planned greenbelts will improve the aesthetics and environmental quality of the area apart from providing a field model for conservation education.

5.4.11 Mitigations measures for impacts on discharge capacity of the river

Backwater studies carried out for the project indicate that there will be no impact on the river reaches of Mahaweli Ganga, Kothmale Oya and Ulapane Oya in the case of floods and normal reservoir operational conditions due to construction of the proposed project.

However, during the studies it was noted that even without the proposed project there could be certain ponding in Ulapane Oya during floods of higher return period in some areas upstream of the bridge over Ulapane Oya on the road from Gampola to Nawalapitiya. This was confirmed by the people in the area including the Grama Niladhari.

Effect of the bridge opening on these upstream flood levels was also investigated and it was found that ponding was not due to any downstream control imposed by the bridge opening but due to mild slopes of the reach upstream of the bridge.

Though this inundation and flooding is no way due to the construction of the proposed project as they are present occasionally even now, in the future, once the project is in place, such flooding can be conceived to be due to the project by the communities who will not remember it as old feature.

Present land use of the area subjected to flooding comprises of paddy lands, some Jasmine plantations and reed beds on stream banks. However, it can be seen that this flood plain being gradually encroached and some buildings are coming up. As a mitigatory measure it is proposed to mark the area of Ulapane Oya below contour of 550 m asl, as an area not permitted for construction. Further, it is also seen that there exists some buildings and houses within the 100m reservoir reservation of the proposed project. Any future constructions in this reservoir reservation area can be prevented by declaring the 100m strip of land around the perimeter of the reservoir FSL as a restricted zone that will be managed by CEB.

The property rights of the existing habitat will remain with the owners of the properties. CEB will maintain the reservation area as a green belt (wherever feasible), and appropriate action will be taken to prevent earth slips, erosion etc.

Prior approval of the General Manager, CEB will have to be obtained for excavation / removal / filling of soil, dumping of material and developments which may impact the stability of the reservoir banks. Security huts will be setup where necessary for proper management of the reservation. The water rights of the reservoir including reservoir operation and maintenance (such as desilting etc.), navigation etc. will be controlled by CEB.

CEB will work out a suitable mechanism to exercise restrictions within the reservoir reservation area. This mechanism will be tied up to the current practice followed for obtaining required approvals from the local authority and / or any other authority. Further, a legal framework to enforce above restrictions will be prepared, with the assistance of the Attorney Generals Department.

5.4.12 Mitigation measures to address possible Impacts due to breaching of coffer dam / dams and possible hazards that may arise due to disease outbreaks due to ponding

Although there is no threat to the downstream users or property due to a breach in the cofferdams of the proposed project, there is a hazard posed to the workers inside the dewatered side of the river channel in the event of a breach in the coffer dam.

Therefore coffer dams will be monitored round the clock by persons designated especially for the purpose and any weakening in the coffer dams will be promptly remedied and strengthened. Standing orders will be established on the methodologies

in carrying out such strengthening and repairs to the coffer dams while workmen are in side the dry areas.

Water levels in the formed river channel will be constantly monitored and all work will be ceased and personnel working within the areas protected by the coffer dams will be promptly evacuated when the channel water level reaches a predetermined level. When deciding this level consideration will be given in time required for satisfactory

evacuation and a suitably low water level will be assigned as the threshold level for evacuation. These will be strictly enforced as standing orders by especially appointed safety officials at the work site.

Control of water –related diseases

The dengue mosquito menace can be prevented by preventing the formation of any mosquito breeding sites. Areas such as ponds, depressions or areas of shallow water logging will be refilled with excess of excavated material. The ponding of the low lying area near the confluence of Ulapane Oya with the Reservoir may be tackled by filling the maximum extent of such area with loose sand generated during excavation works in project area.

5.4.13 Facilitation of the environmental flow requirement down stream of the Dam

The river reach between the point of diversion dam and the tailrace of the proposed powerhouse is about 3 km. There is one perennial stream and several seasonal streams draining into Mahaweli Ganga within this river reach. As described under the existing environment under several headings, there are several users who are currently utilizing the river flows in the reach that will experience reduced flows.

Table 5.4 Effect on power generation for various environmental flows

Environmental flow (m^3/s)	0.5	1.0	1.5	2.0	2.5	3.0	3.5
Long term mean annual energy (GWh)	81.65	79.48	77.29	75.10	72.92	70.73	68.53
EIRR (%)	12.33	12.07	11.81	11.54	11.28	11.00	10.73
EIRR for 01 year delay of project implementation (%) (worst case scenario as per sensitivity analysis in the feasibility study)	11.19	10.99	10.76	10.53	10.3	10.07	9.83

To meet these requirements as well as of the eco system, 1.5 m^3/s will be released from the reservoir as the environmental flow. A separate pipe outlet will be provided in the spillway bay of the dam structure at 534m asl to release the environmental flow downstream.

From this environmental flow, the estimated requirements of irrigation scheme fed by Dunhinda irrigation canal (0.28m^3/s) and the Crysbro Broiler Processing Industry (0.01 m^3/s) will be supplied on a continuous basis. The balance flow coupled with the local inflows from the above mentioned streams in the river reach downstream is expected to provide the flow requirements of the river reach downstream.

To ensure that these water users get their flow requirements, the Dunhinda irrigation canal intake, 200m initial section of this irrigation canal and the water intake of the Crysbro Industry will be rehabilitated at CEB cost (reference ***item nos. 2, 15*** and ***16*** in ***Appendix F***).

Also, necessary measures will be taken by CEB as follows to address the concerns of those participated at the awareness meetings organized by CEB, the Project Proponent as discussed in section 4.6.1.

(i) Action has already been taken to inform the relevant tax officer concerned of the Sri Dalanda Maligawa and the company collecting taxes about the project. The Diyawadana Nilame and the Sri Dalanda Maligawa Management will also be informed of the project.

(ii) Action has already been initiated to sign a MOU between the CEB and the Irrigation Department (the tentative MOU subjected to the concurrence of the Irrigation Dept. is given as ***item 18*** in ***Appendix F***).

Also, action will be taken to discuss with relevant parties with regard to the possibility of getting water requirement of NWS&DB from the proposed reservoir of the Moragolla Project without blocking the Raja Ela.

(iii) The canal length within the Proposed Moragolla Project premises will be repaired and maintained CEB by at CEB cost. However for the canal length beyond the project premises up to Raja-Ela section, required corporation will be given by CEB after discussing with the Irrigation Department. During the initial stages of project construction, infrastructure development will be undertaken and therefore the repair and rehabilitation works of the Dunhinda canal also will be done concurrently.

It was assured by CEB that during project construction, water to the Dunhinda canal will be continuously supplied.

(iv) Providing employment opportunities to the members of the affected farmer communities will be given.

(v) As the water requirement of the Dunhinda canal is definitely met by CEB, there will be no problems such as not been able to cultivate and drying up of wells.

(vi) It is possible to make the people aware of road widening and this will be discussed with the Divisional Secretary and required action will be taken.

(vii) During project planning stage itself, action has been taken to minimize the possible impacts on cultivable lands by fixing the reservoir FSL at 548 msl

(viii) Pollution of river waters (and hence the water in the irrigation canal) from the discharges of the Crysbro Industry will not arise as the outlet of the discharge pipe from the Crysbro Industry will be taken to a downstream location (reference

Figure 3.7) and arrangements will be made for hassle free monitoring of the quality of water discharged at these locations.

It is to be noted that with the increase of the environmental flow released downstream, the energy generated will be reduced and will be as given in ***Table 5.4.*** However, resulting energy deficit due to increased environmental flow has to be met by an alternative source to meet the electricity demand. This can only be achieved by using other available energy sources which means further generation of fossil fuelled energy. Gaseous emissions from fossil fuelled energy generation plants results in climatic changes and other negative impacts as discussed in section 1.2.

The water requirements of the 3km stretch downstream of the dam up to the tailrace outfall is not critical from the ecological point of view as this stretch is not inhabited by rare or endangered species and the prescribed environmental flow is sufficient to meet the ecological demands of the existing species. Further the water requirements of other users are met by the project while all measures are taken to reduce the negative impacts of the proposed project and therefore a release of environmental flow in excess of $1.5m^3/s$ is not warranted.

5.4.14 Mitigation measures to address construction hazards

Construction hazards are of different nature. It is therefore essential to implement the occupational health guidelines given by Labour Department of Sri Lanka. This guideline elaborates the typical hazards possible and also the measures taken to avoid them.

All skilled operators to be engaged in operating heavy machinery like excavators and earth moving vehicles. All cut slopes, fillings, and other erosion-prone working areas should be stabilized to an extent feasible for work to be carried out. All excavated soils to be removed to the soil dumping sites as early as possible without letting it to pile up near the working areas. Precautions are to be taken when handling excavated loose material, especially when they are kept in relatively flat ground before being handled for either compaction or disposal. A safe slope angle has to be maintained to prevent damages to humans and property due to slope and rock failure during and immediate after excavations. Strict specifications and guidelines for materials handling should be written into the contract documentation, especially for earthworks.

During tunnelling adopt controlled blasting methods and proper supporting and dewatering systems which are designed and supervised by a qualified engineer. To prevent any accidents from noise, toxic gases, dust, fire and smoke an occupational health and safety plan needs to be drawn up before tunnlling starts.
The mosquito breeding sites such as ponds, depressions or areas of shallow water logging should be refilled with excess of excavated material.

Construction hazards due to oil spills and contamination with hazardous materials

During construction

During construction there exist a great potential for oil spills or hazardous material spills to take place if not properly managed in stores. Different material handling

techniques are necessary to avoid such spills and if occurs immediate response to clean them will be taken.

During operation

During the operational phase possibilities exists that there would be oil spills from bowzers bringing in fuel to the in-house tanks during events such as accidents. Although risks from accidental spillage and subsequent negative effects due to improper storage and transport would be low, it is still imperative to implement the necessary measures to minimize or prevent significant spills. However, at present there is no proper legislation in Sri Lanka pertaining to the safe storage and transport of such hazardous material. Nevertheless, the following basic measures need to be implemented to prevent possible spills from hazardous materials transporting vehicles.

- Pressure-relieving equipment and other safety devices fitted to tanks to be in good condition.
- Enforcement of stringent speed limits is crucial with implementation of heavy fines for any violations
- Bowzers transporting fuel oil have to be ensured that such vehicles are well sealed to prevent spillage or loss of contents; for example discharge outlets should be checked whether they are properly sealed with a blank flange or cap on the outside of the discharge valve.
- Ensure that hoses are stored in such a way that no liquid is discharged while transporting.

In addition, the power plant authorities will take necessary measures to safely store any hazardous materials that may be brought to the site. For this purpose, it is of paramount importance that the power plant authorities employ persons having qualifications and extensive experience in handling or managing dangerous goods with reference to the safe storage and transport of such material. Alternately expert advise or assistance should be obtained from persons or reputed organizations having sound knowledge and experience in managing dangerous goods and hazardous material.

It is of paramount importance that the power plant is heavily equipped with necessary effective fire fighting equipment. It is also of importance that competent personnel are employed to combat emergency situations, hazardous material contamination scenarios and fire fighting events.

Emergency Centres equipped with medical care facilities and fire fighting equipment to be established at the dam site and at the powerhouse site for all the emergencies such as medical emergency, accidents, fire and others. Safety Inspectors to be made responsible for due maintenance of the Emergency Centres. Qualified medical officers and nurses will be made available at these Emergency Centres.

The closest hospital is at Ulapane. Suitable vehicles with drivers to be stationed at all times at the site to transport injured personnel or sick persons to hospital whenever required. In addition, first-aid kits will be placed at important locations in the sites for treating injuries and personnel are to be trained in emergency treatment.

5.4.15 Mitigation measures for stabilization of river banks close to Ulapane Industrial Estate and main road

In addition to following the recommendations made by NBRO in their report on Landslide Hazard Investigation for the proposed project (***Appendix D***) which have already been incorporated hereinto the EIA report, the following measures will be adopted.

Reducing the slopes to a safe angle

This can be applied to steep and unstable cuts. The safe slope angle depends on the type of soil and the loads applied to the slope.

Cut slopes will be designed to the minimum factor of safety of 1.3. A slope may be cut at one angle for its full height, or alternatively, at angles that vary according to the materials through which the slope is cut. In the case of soil overlying rock, the slope can be steeper through the rock than through the soil. Berms may be formed at regular intervals up the slope. If berms are provided, the stability of both the overall slope and the slopes between berms should be checked.

If slopes are to be formed in fresh or weathered rock so that joints that dip in to the excavation are exposed, it may be safer and more economic to form these slopes on a continuous profile parallel to the joints, rather than providing berms on a slopes that has intermediate steeper slopes. Consideration should be given to the method of forming the final face in rock excavations. Controlled blasting techniques will be used to acceptable standard of finish.

Berms, where used, must be at least 1.5m wide and should generally be spaced at not more than 1.5m vertical intervals. One of the main advantages of providing intermediate berms with drainage channels is the reduction in volume and velocity of runoff on the slope surface and the consequent reduction of erosion and infiltration. Wide berms can also catch debris from slips occurring higher up the slope, reducing the damage to structures at the slope. They also improve access for maintenance. Benches can also reduce stability in adversely jointed soils and rocks.

Horizontal drains or drainage are effective only where the original groundwater level is high, relative to possible failure surfaces. Any such installation on which the safety of a slope depends will require monitoring throughout the life of the slope .

Vegetation of the slopes

With the use of the vegetation cover the soil erosion can be reduced. The newly formed slopes have to be vegetated using the suitable plants.

Vegetation on man-made slopes aids erosion control and serves important landscape functions. The Effects of vegetation on slope stability is a complex interaction of mechanical and hydrological factors that are difficult to quantify. As yet, there are on firm design rules, but in recent years there has been rapid growth in local experience with a variety of vegetation types, and this knowledge can be of valuable assistance to

the designer. Planting on newly-formed slopes will commence with grass, and a particular selection of species should be made to achieve a vigorous covering capable of controlling surface erosion. Low maintenance requirements, low fire hazard in the dry season and compatibility with other slope plantings are other desirable factors that will also be considered in species selection.

Slope planting should generally consist of both shrubs and trees, and include a mixture of species. Typically, a planting programme might consist of 75% trees and 25% shrubs, with particular species limited to not more then 30% of the mix. Trees are usually planted as seedlings or whips. Shrubs should generally be planted in a grouped pattern rather then randomly dispersed among the trees.

Surface Drainage Measures

The factor of safety against failure on any potential slip surface which passes below the water table can be improved by subsurface drainage, thus reducing groundwater levels. In any subsurface drainage system, monitoring is important.

In rock masses, the groundwater flow will generally be confined to joints, and therefore any drainage system must intersect these. Where the drain is above the water table, consideration should be given to providing an impermeable lining so that the drains do not recharge the soil or rock. Where an unlined drain passes through partly saturated zones, seepage from the drain can decrease the pore suction in the vicinity, there by decreasing stability. In all gravity drains, the outlet to the collecting chambers should be lower than the drain to prevent water backing-up the drain.

Strengthening appropriate locations with gabions.

Some locations very close to the river bank can be susceptible to erosion and slope failure. Where adequate space is not available for stabilizing using the above methods, gabion structures will be used.

Construction of retaining structures.

Retaining walls will be constructed if required to stabilize the earth masse.

Recommended approach for any exposed rock slopes

Most rock slopes, after bulk excavation, need some form of treatment to ensure continued stability.

1. **Scaling.** Immediately after excavation, loose blocks or boulders will be removed from exposed rock faces. Potentially unstable blocks will be removed carefully, without blasting, to prevent further loosening of the face.

2. **Buttresses.** Buttresses to support unstable rock masses may be concrete or masonry gravity structures, which can be anchored to improve stability. Drainage will be provided behind buttresses to prevent water pressure building up in covered fissures.

3. **Dentition**. Bands of soft materials that are exposed in a rock face will be trimmed back from the face. The resulting slots will then be filled with a suitable filter

   material protected by masonry or reinforced concrete to prevent erosion of the soft materials.

4. **Weep-holes** will be provided in the facing to ensure that the soft seam is adequately drained and that high water pressures do not develop. If required, concrete or masonry facing will be dowelled into the harder rock in which the soft seams occurs.

5. **Sprayed concrete**. Sprayed concrete can be used to provide surface protection for zones of weak or highly fractured rock. Concrete is required to span between rock bolts or other supports, it will be suitably reinforced with steel fabric that can be attached to the rock surface with dowels and bolts. Before spraying sufficient weep holes will be provided where necessary to prevent a build up of water pressure behind the surface.

6. **Dowels.** Dowels are un tensioned steel bars, usually 25mm to 32mm diameter and 1m to 3m long, grouted over their full length into holes drilled in the rock. They are used for reinforcing closely-jointed rock and for anchoring reinforcement, concrete or masonry and small blocks of rock.

7. **Rock bolts**. Rock bolts are suitable for stabilizing localized area but will not be used as a major slope support system. They are generally tensioned steel bars that comprise a short anchorage zone in sound rock and an un bonded zone in which tension is developed. The head of the bolt is treaded and fitted with a nut. Tension will normally be applied by a jacking system. The load developed is applied to the face by means of a steel plate bearing into the rock surface, although for weak or badly-fractured rocks, a concrete pad may also be required. Typical rock bolts are 25mm to 40mm in diameter, 3m to 6m long, and have a tensile working load of up to 100kN.

5.4.16 Mitigation measures for the impacts of the existing and planned project activities in relation to the components of the project proposal

New bridge under construction at Ulapane

Erosion of the soil overburden near footings of the piers and abutments of the Ulapane bridge will be mitigated by providing protection measures as suggested by the RDA up to a level of 1m above the reservoir FSL (reference ***item no. 5*** in ***Appendix A***). During the designs stage of the project, the approval of the RDA will be obtained for the designs related to these protection measures. All costs related to such improvements will be borne by CEB.

Existing Water Intake of NWS & DB at Ethgala

The drinking water requirement of Gampola and Peradeniya water supply schemes are extracted at locations downstream of the proposed tailrace outfall of the Moragolla power house and the existing Kothmale outfall. Therefore, the inflows at existing water intakes of Gampola and Peradeniya includes the flows released from existing Kothmale reservoir and proposed Moragolla reservoir in addition to flows along the main river as a present. Therefore the proposed project will have no interference on the quantity of water taken for the water supply schemes.

The water intake for the Gampola area is at Ethgala as at present but with the new South of Kandy Water Supply Project, the intakes for the Gampola area will be located in areas upstream as shown in ***Figure 4.7*** and there will be no interference with the Moragolla project. However as the NWS & DB has plans to rehabilitate the water intake at Ethgala to cater to the increasing demand, CEB will abide by the conditions stipulated in the MOU between the CEB and the NWS & DB dated 24.02.2010 given in ***Appendix A*** in ***item no. 3*** in this regard to ensure quantity and quality of water at the water extraction point.

Impacts on Ulapane Industrial Estate

At the detail design stage, further geotechnical investigations are recommended to be carried out to determine the stability of the embankment in this area. Nevertheless, mitigation measures to stabilize the embankments of the Ulapane Industrial Estate and the main road which may become vulnerable due to water level fluctuations in the reservoir has been elaborately discussed in section 5.4.15.

Kandy South Water Supply Scheme

Kandy South Water Supply Scheme once completed would be of benefit to those people living in the nearby areas of the project. Possible impacts during tunneling in the proposed project with regard to possible ground water level fluctuations will not be significant if water supply is made available to the would be affected communities. Road widening and improvements under the Moragolla project will result in better access facilities to the road users in the relevant project areas.

5.5 Mitigation measures to address Impacts on the Biological Environment

5.5.1 Impacts on terrestrial fauna and flora

Mitigation measures for removal of trees and loss of vegetation / loss of habitat for species due to various project interventions

As described in Chapters 3 and 4 considerable numbers of trees over 20 cm DBH will have to be removed due to various construction activities. The loss of vegetation cover can be compensated by establishment of a buffer zone around the reservoir that will also act as an effective mechanism to prevent erosion and sedimentation of the reservoir while acting as a habitat for wildlife. It is recommended at least 100 m buffer zone be established around the reservoir and the area can be planted by species that

are indigenous to the area. The types of indigenous tree species present in the area to be inundated are listed in the detailed plant list and is given in ***Table 3.13*** in ***Annexure 5*** and trees affected are given in ***Tables 4.3*** in ***Annexure 7.***

Therefore, it is recommended that compensatory tree plantation is undertaken along the buffer zone reservation of the reservoir. The following native trees that are already present in the area that will be inundated are suitable for such a tree plantation programme. They are, *Anacardium occidentale* (Cadju), *Lannea coromandelica* (Hik), *Mangifera indica* (Amba), *Mangifera zeylanica* (Atamba), *Semecarpus nigro-viridis* (Badulla), *Alstonia scholaris* (Ruk Attana), *Stereospermum colais* (Dunumadala), *Dillenia indica* (Hinda para), *Macaranga indica* (Kenda), *Macaranga peltata* (Kenda), *Mallotus tetracoccus* (Bu kenda), *Phyllanthus emblica* (Nelli), *Albizia odoratissima* (Huriya mara), *Pongamia pinnata* (magul karanda), *Pterocarpus marsupium* (Gammalu), *Hydnocarpus venenata* (Mkulu), *Litsea longifolia* (Rath keliya), *Careya arborea* (Kahata), *Leea indica* (Gurulla), *Michelia champaca* (Sapu), *Cipadessa baccifera* (Hal bembia), *Melia azedarach* (Lunu midella), *Ficus amplissima*, *Ficus exasperate* (Bu deliya), *Ficus hispida* (Kota dimbula), *Ficus racemosa* (Attikka), *Syzygium cumini* (Madan), *Bambusa vulgaris* (Kaha una), *Carallia brachiata* (Dawata), *Wendlandia bicuspidate* (Wna idala), *Acronychia pedunculata* (Ankenda), *Madhuca neriifolia* (Gn mi), *Pterospermum suberifolium* (Welan), *Symplocos cochinchinensis* (Bobu), *Trema orientalis* (Gedumba), *Debregeasia longifolia* (Gas dul) and *Vitex altissima* (Mila).

The cost of planting a hectare of land based on current rates is about SLR 40,000 per ha (approximately 1600 seedlings per ha assuming a 3m x 3m spacing) that will include obtaining seedlings, ground preparation and planting. Once planted, the cost of maintaining a ha of planted tress is around SLR 160,000 for a period of three years. Thus total cost of planting and maintaining 1ha of land will be approximately SLR 200,000. It is recommended at least 100 ha of forest cover being established along the periphery of the reservoir which will cost approximately SLR 20 million.

With regard to the spoil dumping sites, removal of trees is to be avoided on the site unless it is necessary. If trees are to be removed, necessary permits should be obtained from local authorities.

The disposal sites should be rehabilitated once the tunnel waste disposal is completed. It is recommended that a vegetation cover is established using native plant species such as Macaranga peltata (Kenda), Albizia falcataria, Mallotus tetracoccus (Bu kenda), Artocarpus heterophyllus (Kos) and Artocarpus nobilis (Wal Del) that will increase the habitat value of these sites after disposal is completed.

Mitigation measures for impacts due to recruitment of labour force for construction activities

Impact on the communities can be mitigated through proper compensation schemes, following the mitigatory measures that are described to minimize the effect of pollutants and off site investments aimed at improving the living conditions of the local communities.

Work force involved in the construction activities has to be provided with proper sewage facilities at least with septic tanks associated with soakage pits. Further the workforce should be provided with good sanitary and solid waste disposal facilities and with adequate clean drinking water systems.

Establishment of invasive species

Impacts due to introduction of invasive alien plant species can be avoided by ensuring that the heavy machines that are used at the construction site are properly washed down before transporting them to the site. Also, rehabilitate temporary soil storage sites and sites cleared for construction activities after the construction phase is terminated.

Disturbance to wildlife and human beings by noise and vibrations

Impacts on biodiversity can be mitigated through measures aimed at reducing air and noise pollution. Noise and vibrations can be mitigated by reduction of operations at night time, and proper maintenance of heavy equipment that generates noise.

Impacts on air quality can be mitigated through an efficient traffic management system. Further dust pollution due to construction activities can be prevented by observing practices such as wet drilling, avoidance of conducting dust generation activities during high wind, regularly spraying of water on hauling roads and other roads, covering of dumpers carrying muck.

Changes in the topography of the area

Impacts on the topography and landscape can be mitigated by choosing designs that blend with the surrounding environment and following proper post construction rehabilitation practices.

5.5.2 Impacts on aquatic fauna and flora with special reference to migration of fish species and environment flow downstream of the Dam

Miigation measures for drying of the river downstream of the dam site

The low flows that will be experienced in the stretch of the river downstream of the proposed dam site will result in partial loss of habitat to the species that inhabit this portion of the river. The stretch of the river affected by this carries fewer species of fish compared to the stretch of the river upstream of the dam site. The three endemic species of fish *Puntius nigrofasciatus* (Black Ruby Barb; Bulath Hapaya), *Puntius reval* (Red-fin two banded carplet; Rathu waral depulliya) and *Belontia signatai* (Comb tail)

observed in this stretch show a distribution starting from about 400 m downstream of the dam site and extending upstream into the inundation area and to the upper reaches of the Mahaweli ganga. Therefore, a small part of their present range (approximately 400m) will be impacted due to the project. However, this will not have a significant impact on the population of this fish as their main habitat is located in the upper reaches of the Mahaweli ganga which will not be impacted by the project.

Further, these three species of fish are found in many river basins in Sri Lanka including Kelani, Kalu up to Nilawala Basins and therefore the impact on these fish can be considered insignificant. Therefore the environmental flow of 1.5 m^3/s released from the reservoir coupled with the inflows from the seasonal and perennial streams in this stretch of the river will be sufficient to meet the ecological demands of the stretch of the river that will experience low flows due to implementation of the project.

Waste generation and pollution of water courses

Water quality deterioration in the reservoir due to increased nutrient levels can be arrested by periodic flushing of the reservoir which will be done during flood events. The bottom outlet provided in the dam will be used to flush off the sediments from the reservoir bed.

All mitigation measures listed in section 5.4.2 is to be followed to avoid water quality deterioration due to waste generation and pollution of water courses.

Blockage of movement patterns of the riverine fish due to construction of the dam

During this study only a single migratory fish species, *Awaous melanocephalus* (Scribbled goby) was recorded. That does not preclude the presence of other migratory fish species such as eels. The impact arising due to the blockage of the river can only be mitigated with the construction of a fish ladder. However, this is not recommended as the river is subjected to blockage at many places downstream of the proposed dam and and none of these dams contains measures to facilitate free movement of fish across the dam. Therefore the possibility of such migratory fish reaching the dam is very low. Therefore, incorporation of measures to facilitate free movement in this particular instance will not be an affective measure. Therefore, it can be concluded that the dam will not pose a significant impact on migratory fish species.

Increased soil erosion in the area

This is an impact which cannot be avoided but can be minimized by limiting land preparation stage to the dry period, construction of temporary bunds, placing storage site away from water bodies.

Burrowing sites, construction material storage yards and solid waste disposal sites should be located away from the aquatic habitats to minimize run off. The contractor should draw up and implement plans for decommissioning and rehabilitating any temporary structures or sites such as labour camps, burrowing sites, construction material storage yards, solid waste dispersal sites, latrines etc.

Out of the five dump sites four sites (Except MASL site) are located on hilly lands. Even though there are no streams located inside the sites selected for dumping tunnel waste, there are seasonal streams present at the bottom of the hill and therefore sediments can get washed into these streams. Therefore permanent erosion and sediment control measures such as silt traps should be installed around the dump sites to prevent such sedimentation events

Alteration of surface flow patterns

Since the major alteration in surface flow pattern is due to the impoundment of the reservoir, mitigation of impacts due to this is the same as discussed in section 5.5.1

5.6 Mitigation measures to address Impacts on the Social Environment

The Moragolla project is at its feasibility stage and funding will be available / identified for implementation in near future. The proposed project involves some resettlement issues and impacts on livelihood and other properties. As accepted and long term practiced norm in project planning and implementation cycle in Sri Lanka, during the detailed design phase, comprehensive Resettlement Action Plan will be prepared by CEB to work out comprehensive plans of action to pay compensation for the homesteads / lands, other property as well as livelihood support measures for affected persons.

CEB will prepare a comprehensive Resettlement Action plan (RAP) including all the details following the policies of National Involuntary Resettlement Policy document at the detailed design preparation stage. This plan (RAP) will be implemented during the project implementation phase.

Although the present report includes substantial information on resettlement issues, an RAP is not appropriate as detailed surveys on the information related to the individual plots of homesteads and properties affected are liable to be changed between the timeframe now and the detailed design stage. Once the RAP is prepared and all the parameters are fixed under the detailed design stage, CEB will be able to implement the RAP during the project implementation stage.

CEB will carry out detailed measurement survey of all these affected properties at the detailed design phase and declare cut-off date for the communities. Declaring cut-off date will help to decide the number of affected persons and the magnitude of properties. CEB will also inform the communities living in the area about the project and especially on the cut-off date and therefore, other community members will not encroach /intervene in the demarcated right of way of the access roads. CEB will mark the required right of way and inform the communities in each road including the other relevant stakeholders such as GNs and DS in the area.

5.6.1 Mitigation of Impacts on existing water users upstream and downstream - *Irrigation water users and Crysbro Broiler Processing Industry (Farm's Pride (Pvt.) Ltd.)*

1.5m^3/s of water will be released from the Moragolla reservoir as the environmental flow. Out of this flow, 0.29m^3/s will be continuously released to cater to the existing water requirements of 0.28 m^3/s of the Dunhinda canal and 0.01 m^3/s of the Crysbro Broiler Processing Industry respectively (reference ***item nos. 4, 6, 17*** and **19** in ***Appendix A***).

Irrigation water users

In this connection, two farmer awareness meetings were held by CEB on 08.05.2012 and 18.09.2012 with the participation of the members of the farmer organizations, officials from the Irrigation Dept., DS office and GNN of the area (minutes of the meetings and the attendance at these meetings are given as ***items 13*** and ***14*** in ***Appendix F***). All measures that will be taken to address the concerns of all stakeholders have been discussed in detail in section 5.4.13.

In order to have an efficient system of diversion of water to the Irrigation canal providing water to Gampolawela Irrigable area, the present diversion facilities will be re-designed during the detailed design stage in close collaboration with the Irrigation Department. A sum of Rs. 10.7 Million is the estimated cost for rehabilitation works of irrigation intake and a 200m length of the Dunhinda canal. Rehabilitation works will be carried out with the approval of the Irrigation Dept. and all costs related to these rehabilitation works will be born by CEB. Consensus has been sought from the Dept. of Irrigation in this regard and such letter of request made by CEB to Dept. of Irrigation is given as ***item 2*** in ***Appendix F***. The MOU between the CEB and the Irrigation Dept. is given as ***item 18*** in ***Appendix F***).

CEB will develop an operating mechanism in the operation phase with the Dept. of Irrigation and will closely coordinate also with the Dept. of Agrarian Development with regard to the release of water and to its adequacy, timeliness and reliability. CEB will attend the project coordination committee meetings where agriculture seasonal plans are prepared and provide guidance for implementation and monitor the seasonal agriculture plan. If there will be any issues related to the water issues due to the power project operations CEB will take the responsibility to attend to such issues.

Crysbro Broiler Processing Industry

CEB will carry out all necessary modifications to the water intake at it's present location so that the required quantity of water is diverted through the intake throughout the year. All costs associated with such improvements will be borne by CEB.

With regard to release of water to cater to the requirements of the Crysbro industry, mechanism is to be developed by CEB to release the required quantity and establish norms to operate the system developed for water releases to avoid conflicting situations with the owners of the Crysbro industry.

Meetings were held by CEB with the Crysbro Industry officials and its' management in this connection and the minutes of such meetings is attached as ***item 15*** and ***16*** in ***Appendix F***.

The suggestion of Crysbro Industry Management is to have their existing water intake relocated at a suitable location further downstream and below the tailrace outlet of the proposed Moragolla Hydropower Plant. As explained by them, the purpose of such relocation is to ensure the availability of sufficient water even in extreme drought conditions. In this regard, CEB consulted the MASL and they have no objection for the proposed intake relocation subjected to the provision of only one intake is used from

this area. However, if such relocation of the intake is required, Crysbro Management will require to obtain the official consent of the MASL.

The cost of re-designing and construction of the Crysbro Industry's new intake and the cost of maintenance of the intake and associated tubing system will be borne by the Crysbro Industry. In addition, expenditure for pumping water would also be borne by

the Crysbro Industry. Crysbro Industry Management requested CEB to transfer the cost of modification of the existing water intake at its present location (which CEB would otherwise have incurred) towards the construction cost of the intake at the new location downstream so that the Crysbro Management will have to bear only the balance cost.

Provided that this proposal is to be implemented instead of modifying the existing water intake, during the detail design of the project, CEB will quantify the cost of modification of the intake at its' present location and a suitable mechanism of transferring such costs to the Crysbro Industry will be worked out through the relevant DS of the area (Ganga Ihala Korale).

If this intake relocation is to be materialized, it will be advantageous for both the affected party (Crysbro) and the Project Proponent (CEB).

Also, as mentioned in section 3.1.4.4, fecal pollution levels of water in the river section downstream between the dam and the powerhouse is already high. In order to prevent further aggravation of the situation, the effluent pipe outlet of the Crysbro Industry which is presently located within this river stretch will be re-located to a point immediately downstream of the tailrace outlet (***Figure 2.9*** shows the arrangement of re-location of the discharge pipe outlet). All costs associated with such improvements will be borne by CEB while the discharge pipe will be maintained by the Crysbro Industry.

As discussed in section 5.4.8, there is one perennial and several other seasonal streams located downstream of the proposed dam site (Sooriyagoda Ela, Imbulu Ela, Galkotuwa Ela and Umagiri Uyana Dolapara etc.). Therefore from the dam, downstream up to the proposed powerhouse, the river flow consists of drainage from incremental catchment as discussed.

Therefore the balance flow from the environmental flow (after release for the irrigation canal and for Crysbro industry) coupled with the inflows from this increment catchment is expected to provide the requirements of the eco system, bathing and washing needs of the people who use the river downstream.

Sand miners

CEB will coordinate with the Geological Survey and Mines Bureau and facilitate to expedite the process of issuance of new licenses for new mining locations for the affected persons who are eligible for sand mining operations and who will have to forego mining operations due to the proposed project.

As livelihood support measure, each affected party will be compensated for the period they are compelled to forego sand mining activities. CEB will observe and study the sediment flow data to monitor the effects on these sand miners and will pay compensation to these mine operators for the affected period (until they obtain new sand mining license). Compensation will be paid amounting to the net income they have been receiving from sand mining subjected to the conditions imposed at the issuance of license by the government (updated details as at 01.10.2012 of sand mining activities, sand miners and the net income received according to mine operators are listed in ***Table 3.22***).

CEB will also explore the possibility of providing employment at the construction sites and also during the operation phase of the project to those who loose their opportunity of sand mining.

CEB will also make arrangements to provide labour work during construction for the labourers who will loose their work at the present sand mines due to the proposed project.

These needs are to be negotiated with the contractors during construction. Most of the sand miners carry out sand mining without the necessary permits and therefore this alternative could be convinced to these sand miners.

During the detailed design stage, CEB will prepare the comprehensive RAP to work out comprehensive plans of action required to pay compensation to the affected sand miners

Bathing and washing

Due to the impoundment of the reservoir area, the local people who used to take bath in the river will be deprived of their bathing sites at the river stretch. A safe pool will be built with steps leading to it near the new Ulapane bridge to meet for bathing purposes. This will provide safer facility for about 100-110 families who use the rive both at upstream and downstream locations of the proposed dam site. They will also have their own choices to reach other bathing locations of the river in the down stream areas.

There may be positive impacts for the people using river for bathing as the environmental flow is released downstream of the dam and it can be a reliable supply that will become beneficial to the river users for bathing purposes.

Group discussion (vi) in ***Annexure I*** gives the outcomes of the discussions with the river users for bathing and washing purposes.

5.6.2 Mitigation of Impacts due to the Access Roads

The business activities carried out in these affected sections of the two buildings will need to be stopped temporary. The daily income of these business activities need to be calculated and pay compensation until the road improvements are over. After that

the affected persons can restart their activities in the same business building. The core business activities of these two places will not be negatively affected.

The person whose business place (small hut in 3 perch land) which will be fully affected in the proposed road diversion in right bank will be compensated for his business structure and land. He will be able to start same business activities in a new place. Until such time (until he is resettled or get resettled himself with the money paid as compensation by the project) his income from the business center need to be compensated.

The design engineers will explore all the possibilities to avoid negative impacts on properties such as houses and lands located in the right of way of the roads. All the properties that cannot be avoided will be properly compensated and the legal procedures and other measures have been highlighted in the section on Resettlement plan in sub section 5.6.5. However, comprehensive action plan for mitigating the resettlement impacts will be developed by CEB during the detailed design phase of the project.

All existing access paths that are being hindered by the proposed project will be given alternative access routes. Such access routes will be provided with the consent of the affected communities, relevant Pradheshiya Sabhas and the Grama Niladaris of the areas.

RDA approval will be obtained for all designs and improvements for the roads and all costs associated with these new constructions and/or improvements will be borne by CEB.

5.6.3 Mitigation of Impacts due to various project interventions

Reference is made to ***Table 4.21*** in ***Annexure 7*** with regard to the overall list of likelihood affected families due to various project interventions. The likelihood affected homesteads/lands have been marked in ***Figure 3.7***

Most of the affected persons (APs) are not required to be evacuated from the present locations and these have ben discussed below. According to the overall list of APs there are 52 families who will have negative impacts due to different project interventions.

The social impact assessment team together with the engineers of the EIA team made attempts to explore the possibilities (engineering) to reduce the number of APs.

The information on the feasibility to reduce the number of affected homesteads and land plots have been listed below.

Likelihood affected by the Reservoir

The 14 homesteads listed from nos. 1 – 14 in ***Table 4.21*** cannot be prevented from the need to evacuate through any measure. They will become significantly vulnerable

homesteads (properties) and therefore, such high risk should not be taken by any body.

The 06 homesteads listed from 15-20 in ***Table 4.21*** will also need to be evacuated due to the nearness of the FSL and effects on these steep slopes due to water level fluctuations.

In addition there are four families (ID numbers 49, 50, 51 and 52 in ***Table 4.21*** living in two line houses where the labour camp is to be established. Being located in the upstream area of the proposed dam on the left bank and with the reservoir inundating the toe of this bank, possible effects on the existing slopes could result. In addition, this group is an isolated group and therefore is a socially vulnerable group. Hence this group of people have to be given due consideration and carefully resettled during resettlement.

100m reservation of the proposed Moragolla reservoir will be marked on the ground and necessary action will be taken by the CEB to gazette it for further management.

In areas where the ground water level has risen due to the establishment of the reservoir, the foundation of the houses can be strengthened to compensate for the reduced bearing capacity. Also soakage pits that are suitable for the raised ground water table will be constructed to replace the existing ones.

Likelihood affected by the alternative road, residential camp/office and stores

Possibility of likelihood damage and hence evacuation of 04 homesteads listed as nos. 40, 41, 44 and 45 in ***Table 4.21*** is to be investigated during the detailed design stage. Even though the houses can be prevented from any damage, there will be the need to acquire some extent of land from each plot for the project and therefore, land should be compensated.

The homesteads listed as nos. 42 and 43 in ***Table 4.21*** will not be fully affected. Only part of the houses needs to be demolished for the project purposes. Therefore, damaged parts of the houses need to be compensated. The balance part can be protected by constructing strong retaining walls. These affected extent of land plots also need to be compensated

Likelihood affected by the Powerhouse/Switchyard, Penstock, Outlet Portal and access roads to these sites

The homestead listed as no. 46 is one of the affected property due to the disturbances to the access road to his premises. But this impact also can be mitigated by creating alternative access to his house.

Homestead listed as no. 47 will need to be acquired due to its vulnerability and also due to security reasons for the project.

5.6.4 Mitigation of impacts on commercial activities

Livelihood restoring plans will be prepared based on case by case depending on the nature of livelihood affected, its impact and the feasibility of the alternative plans etc. This will be done during the resettlement implementation plan preparation stage of the project.

The CEB will follow the NIRP policy on potential impact of the project on livelihoods of the people and make all the required methods to restore their project induced impact on livelihoods.

However, the mitigation measures proposed for the impacts on commercial activities due to proposed project components are as follows.

5.6.4.1 Impacts due to proposed dam and reservoir

Irrigation water users

Irrigation water requirements of the farmers who depend on water from the Duninda canal will be released from the proposed hydropower reservoir. From the minimum water release of 1.5 m^3/s from the proposed reservoir, the water requirement of 0.28m^3/s of water will be diverted along the dunhinda canal. A Memorandum of Understanding between the Ceylon Electricity Board and the Irrigation Dept. will be drawn up in this regard and a letter to this effect from the Irrigation Dept. is given in ***Appendix A*** (reference ***item no. 6***).

Crysbro Broiler Processing Industry (Farm's Pride (Pvt.) Ltd.)

The water requirements of 0.01m^3/s of the Crysbro broiler processing industry also will be met by the downstream releases from the reservoir.

Sand miners

Each sand mine operator who will be affected by the proposed development will be compensated for the period (until they obtain new sand mining license) they are compelled to forego sand mining activities. As livelihood support measure, compensation will be made amounting to the net income they have been receiving from sand mining (ref. ***Table 3.22*** in ***Annexure 1*** for net income received according to the mine operators) subjected to the conditions imposed at the issuance of license by the GSMB.

According to the miners, the quantity of sand mined by each party ranges from 2-3 Cubes/day. The daily gross income of each party lies in the range Rs. 5,000/- to Rs. 9,000/-. The cost of labour ranges from Rs. 800/- to Rs. 2,000/- Therefore the net income of the mine owner per location ranges from Rs 2,000/- to 3,000/day. . The total income of a mine owner per mine is Rs. 21,000 to 45,000/month except two miners whose income will be Rs. 60,000 and Rs. 96,250/month.

However, when mining license is issued, several restrictions have been imposed by the DS offices with regard to sand mining activities limiting the number of days and the quantity of sand that could be mined by a mine owner per month.

CEB will also explore the possibility of providing employment at the construction sites and also during the operation phase of the project to those who loose their opportunity of sand mining.

CEB will make arrangements to provide labour work for the labourers during construction of the project for those who are working in these sand mines.

5.6.4.2 Impacts due to proposed Tunnel

Grouting will be done to seal any leakages during tunneling depending on the geological conditions while tunneling is being carried out.

However, during construction of the tunnel depending on the geological conditions if lowering of ground water levels occur and drinking water wells get affected, people affected will be supplied with their water requirements for the total period affected by the proposed project.

In all previous hydropower projects, the ground water users did not have an alternative source of water. However in this project most of the users specifically in areas of Ulapane, Thembiligala, Mariyawatte, Ethgala etc. will have access to pipe borne water from the Towns South of Kandy Water Supply Project of the Water Supply & Drainage Board. Therefore it can be expected that only few will have to be actually provided with water brought in bowsers.

Table 5.5 Method of compensation for paddy lands affected

Area cultivated	Average yield (Kg) per season/ acre	Selling price (Rs. / Kg	Gross income/ acre (Rs.)	Cost of production (Rs.)	Net income (amount to be paid as compensation per season / acre foregone cultivation)
1 acre	2000	Rs.30/-	60,000/-	25,000/-	Rs. 35,000

Note: If the affected extent is more or the number of seasons that are to be foregone cultivation are also more, this formula can be applied to work out compensation.

Also, if natural streams get affected by lowering of ground water levels, the farmers who depend on these streams for paddy cultivation will be paid compensation for the seasons that they are made unable to cultivate during the period of construction of the tunnel.

The practical method of compensation is making payment for potential net income that can be drawn from 1 acre of paddy land in a given season that the owner of the paddy land has to forego cultivation.

The calculation given in ***Table 5.5*** can be used as the method of compensation.

5.6.4.3 Power house / Switchyard, Surge Shaft, Penstock

The house where the access to house is affected due to project interventions will be provided with an alternate access road or the homestead will be acquired for the project. For the homesteads to be acquired for the project, the affected parties will be resettled and will be paid compensation.

5.6.4.4 Proposed road diversion (right bank) and access road improvements

This has been discussed in section 5.6.2

5.6.5 Resettlement Plan

CEB will develop a comprehensive Resettlement Action Plan (RAP) at the detailed design preparation stage of the proposed project. The details of the specific project interventions will be known at that time and hence the specific number of APs and the properties will be identified at that time. Once the detailed engineering designs are available the CEB will carry out detailed measurement surveys on affected properties to document the magnitude of the impacts and declare cut-off date for the communities. Declaring a cut-off date will help to decide the number of affected persons and the magnitude of properties. CEB will also inform the communities living in the area about the project and especially on the cut-off date and therefore, other community members will not encroach /intervene in the demarcated right of way of the access roads. CEB will mark the required right of way and inforrn the comrnunities in each road including the other relevant stakeholders such as GNs and DS in the area. CEB will then determine the required funds to provide compensation for affected properties. The plan for resettlement of affected families who need to be evacuated will also be prepared with specific details for action.

The information included in this EIA report prepared at this feasibility stage will reveal only the magnitude of the impacts and likelihood number of APs and approximate funds needed for the implementation of the RP. Although the present report includes substantial information on resettlement issues, an RAP is considered as not appropriate as detailed surveys on the information related to the individual plots of homesteads and properties affected are liable to be changed between the timeframe now and the detailed design stage. Once the RAP is prepared and all the parameters are fixed under the detailed design stage, CEB will be able to implement the RAP during the project implementation stage.

The basic policies to be followed in preparation and implementation of RP are also included in this report.

5.6.5.1 National Involuntary Resettlement Policy (NIRP)

The proposed Morogolla power project will create some adverse impacts on houses and other properties specially land and therefore, resettlement will be an important component of the project during its detailed design preparation and project implementation stages.

A comprehensive resettlement plan needs to be developed according to the procedures and other principles of National Involuntary Resettlement Policy of the Government (NIRP- approved in 2001). This is mainly because the affected number of persons due to the proposed project is more than 20. Only the information related to resettlement policy frame work and also likelihood affected persons/properties are discussed in this section. The Policy will apply to all development induced land acquisition or recovery of possession by state.

Following the statutes of Involuntary Resettlement Policy, the goal of the resettlement plan of this project would be:

- To avoid or reduce the impacts of land acquisition and structure (residential / commercial) demolition all possible measures including engineering, technical and economic measures have to be adopted. When it is not avoidable, measures should be taken to reduce the impact on livelihoods of APs as much as possible.
- The Resettlement Plan will be framed according to the magnitude of possible adverse social impacts due to implementation of Morogolla Power Project, and the goal will be to enhance the living standard of the Affected Persons (APs) or at least rehabilitate the living standard to the pre-project scenario.
- APs will be encouraged to participate in the resettlement plan preparation.

The objective of the resettlement policy framework is to highlight the important components/ elements of the policy of Sri Lanka to be followed to address the resettlement impacts on project affected communities during implementation of each component of proposed project. The resettlement policy framework's final objective is to facilitate the project executing agency to implement the project without conflicts with the potential affected parties, and also to help safeguard the affected parties during project implementation phase.

5.6.5.2 Resettlement Policy and Framework

The policy framework and entitlements specific to the Project will be prepared based on the requirements of the Government of Sri Lanka, principally the Land Acquisition Act (1950 and revised in 1979) with basic principles as follows:

(i) Acquisition of land and other assets, and resettlement of people will be minimized by identifying possible alternative project designs and improvement standards, and appropriate social, economic, operational and engineering solutions that have the minimal impact on populations in the project area.

(ii) The affected persons (APs) are defined as those who may stand to lose, as a consequence of the project, all or part of physical and nonphysical assets, including homes, homesteads, productive lands, commercial properties, tenancy, income- earning opportunities, social and cultural activities and relationships, and other losses that may be identified during the process of resettlement planning.

(iii) All project APs who will be identified in the project impacted areas before the cut-off-date will be entitled to be compensated for their lost assets, incomes and businesses at full replacement cost and provided with rehabilitation measures

sufficient to assist them to improve or at least maintain their pre-project living standards, income earning capacity and production levels. The cut off date should be decided at the detailed Measurement survey (DMS) of the affected properties at the time of resettlement planning/ detailed design preparation phase of the project.

(iv) All APs will be equally eligible for compensation and rehabilitation assistance, irrespective of tenure status, social or economic standing, and any such factors that may discriminate against achieving the objectives outlined above.

(v) Non-titleholders (i.e. squatters/ encroachers), if vulnerable, will be eligible for assistance for the loss of structures/assets at full replacement costs, and entitled to transfer/shifting allowance/s, but are not eligible for compensation for loss of land.

(vi) The rehabilitation measures to be provided are:

(a) cash compensation at replacement cost without deduction for depreciation or salvageable materials for houses and other structures;

(b) full title to replacement agricultural land-for-land of equal or higher productive capacity acceptable to the AP as a priority, or cash in lieu of land at replacement cost at current market value (acceptable to the developer);

(c) full title to replacement of residential and commercial land of equal size acceptable to the AP;

(d) cash compensation for crops and trees at current market value; and

(e) livelihood restoration measures, relocation allowances and rehabilitation assistance.

(vii) Replacement of residential and agricultural land will be as close as possible to the land that was lost, and acceptable to the AP. Where there is not sufficient agricultural land available in villages, the project will assist in the development of new agricultural land wherever this is possible (i.e. conversion of unused land or other non-agricultural land). The project will also assist villagers to prepare residential land (as well as sites for livestock, if required).

(viii) Temporarily affected land and community infrastructure and property will be restored to pre-project conditions.

(ix) The compensation and resettlement activities will be satisfactorily completed and rehabilitation measures in place before the Government will approve the start of civil works. However, people who are not being disturbed by the civil works will be evacuated in due course.

(x) The CEB will see that institutional arrangements are in place to ensure effective and timely design, planning, consultation and implementation of the land acquisition, compensation, and resettlement and rehabilitation program.

(xi) Existing cultural and religious practices shall be respected and, to the maximum extent practical, preserved.

(xii) Adequate budgetary support will be fully committed and be made available to cover the costs of land acquisition and resettlement and rehabilitation and topsoil restoration of borrow areas or pits / temporarily acquired land for mixing plants/ labor camps and depositing of Tunnel muck etc within the agreed implementation period.

(xiii) Special measures shall be incorporated in the resettlement plan prepared under the project and complementary mitigation and enhancement activities to protect, and help improve the livelihoods of, socially and economically vulnerable groups such as ethnic minority peoples, female-headed households, children, elderly or disabled people without support structures and people living in extreme poverty.

(xiv) There shall be effective mechanisms for hearing and resolving grievances during the implementation of the resettlement plan.

(xv) Details of resettlement plans (RPs) shall be available in a form and language that can be understood by APs and relevant resettlement information shall be distributed to APs and placed in project and village offices for the reference of affected people as well any interested groups.

Appropriate reporting, monitoring and evaluation mechanisms will be identified and set in place as part of the resettlement management system.

5.6.5.3 Eligibility and Entitlement

For title holders the cut-off date for eligibility for entitlement will be the date of notice under the Land Acquisition Act. For non-title holders the cut off date for eligibility is the date when the socio-economic survey (to develop resettlement plan) will be completed. Persons who, for residential / commercial / livelihoods purposes encroach on the area after the cut-off-date are not entitled to compensation or any other form of resettlement assistance. To avoid the likelihood of conflicts on persons eligible for compensation, a list of affected persons (APs) has been prepared with details to identify the genuinely affected persons (address, location) and provided in ***Table 4.21*** in ***Annexure 7***.

5.6.5.4 Relocation Strategy

The relocation strategy will be based on a participatory approach. Consultation will be carried out with APs in terms of the choice of their relocation options. For the affected households (AHs) who would have to relocate their residential and commercial structures, the project would assist in identifying sites that minimize the social disruption and have access to services and facilities similar to those available in the lands affected. AHs can also opt for resettlement sites (subject to availability of land) and the project would carry out necessary consultation with AHs in site selection, consultation with host population, necessary environmental assessment and provide sufficient civic infrastructure prior to relocation.

The relocation strategy will also take care of social issues concerning the host populations where relocation of APs / AHs is expected. The host communities who will accommodate the project APs will also be eligible for compensation and rehabilitation assistances for losses incurred upon them.

The likelihood affected persons indicated that they prefer to get resettled in the following areas.

Mahawila watta (23 families of 32 affected),
Somewhere near Ulapane GN division (7 families of 32 affected) and
Ethgala area (2 families of 32 affected)

Table 5.6 Affected Properties needing mitigation during the implementation of the Resettlement Action Plan

Property	Nature of adverse impact	Resettlement actions proposed
Residential land	30 different homesteads will be affected due to various project interventions. - 22 homesteads due to reservoir - 06 homesteads due to road diversion, residential camp, Office and stores. - 02 homesteads located around powerhouse / switch yard area	Affected persons (APs) need to be relocated in new land with monitory compensation to rebuild their demolished houses and help to develop their new lands given to re-establish affected livelihoods. There may be possibilities to reduce the number of houses to be demolished through engineering designs prepared during detailed design stage. A playground also will be provided.
Non-residential land	20 different plots of lands will be affected due to various project interventions. - 14 plots due to proposed reservoir. - 05 plots due to road diversion residential camp, office and stores. - 01 plot due to establishment of powerhouse / switchyard.	The land plots those having freehold titles need to be compensated according to the existing market value of land in the particular area. The government land encroached by people for various purposes need not to be compensated, but if there are structures established in encroach land those structures should be compensated if the encroach land plots are acquired for the project.
Standing crops in the affected land	In some of the land plots affected there are standing crops.	All the affected crops should be compensated if the crop lands are acquired. The procedures prescribed in involuntary resettlement policy should be followed in deciding the compensation for affected crops.

Source: Social Assessment Survey 2009

The resettlement project developed based on the policy mentioned above need to identify exact number of properties affected and the action to be taken to mitigate the adverse impacts. Thirty residential lands and 20 non-residential lands which will have adverse impacts will have to be mitigated during the implementation of the resettlement action plan.

The list of affected persons (APs) due to various project interventions is given in Table 4.21 in Annexure 7. The summary of affected properties needing mitigation during the implementation of the resettlement action plan are listed in Table 5.6 above.

The Project Proponent, the CEB has made a request to the Hon. Minister of Sports, Mahindananda Aluthgamage (Member of Parliament) to allocate a suitable 5 Ac plot from Mahawilawatte-Thembiligala, the10th Plot of SAARC village. The Hon. Minister's consent has been given to release a 5 Ac plot for which a letter has been issued to the Land Reforms Commission as of October 2012 (reference ***item no. 18*** in ***Appendix F***).

5.6.5.5 The magnitude of properties affected

The details of the impacts and the magnitude of the impacts are given in ***Table 5.7*** and the details on specific items are given in ***Annexure 7***.

Table 5.7 Summary of the major impacts and their magnitudes

Impact / resettlement plan item	Magnitude
Impacts due to proposed access roads and right bank road diversion and access to residential camp area	82 perches of land, sections of 03 business structures, sections of 02 houses, 01 gate and 21 meter length of boundary walls. Total estimate of impact is Rs. 6.0
Residential lands impacted due to residential camp / office and stores (including access to residential camp area)	Sections of 06 nos. of homesteads where only sections will have impacts and the total value of the these houses is Rs. 9.4 M
Non-residential lands impacted due to residential camp / office and stores(including access to residential camp)	Sections of 7.25 Acres of land
Residential lands with homesteads vulnerable due to Proposed Reservoir	13 Acres
Two line houses vulnerable due to reservoir	04 families in 02 line houses with a total value of the houses Rs. 1.0 M
Non-residential land plots impacted due to Proposed Reservoir	5.25 Acres
Proposed reservoir and powerhouse/switchyard / surge shaft / penstock area	26 families to be evacuated

5.6.5.6 Compensation package and their acceptability by the affected and the local authorities.

The affected land owners need to be paid compensation. Option need to be given to the affected persons to chose their preferred method of compensation, alternative land or the monitory compensation.

The persons losing houses should be given opportunities under resettlement policies. Some of them may prefer to receive monitory compensation and make their own arrangements to find alternative residences and some others may like to have alternative land to construct their houses. In such cases land may be provided with money to construct the houses in the land given. However, all these options need to be discussed with the APs.

The consultations of affected persons generally indicate the following preferences. However, it is required to do intensive questionnaire survey with all affected persons and decide their individual / personal preferences. Depending on the individual preferences implementation strategies of resettlement program need to be worked out.

- The APs with affected homesteads need land for re-establishing their affected homesteads. They prefer to have money for constructing the houses in the land given to them as alternative to their land lost due to the proposed project.

- The persons who lose only land need alternative land. If the portions of land in their existing homesteads (home gardens) are affected they need money as compensation for the land extent acquired for the project.

Land allocation for each affected individual need to be attended case by case considering particular individual's affected portion of land. However, we need to propose some options to be considered and use as tools for negotiation at the time of resettlement project implementation.

The following options may be suggested.

Option 1 Resettled in uniform size land plots

Category I : say 40 perch for each family.

Allocation of 40 perches of land for the affected families who lose 40 Perches or more. If the acquired land is more than 40 perch in extent such persons' excess land should be given compensation. Sometimes some individuals may opt for less than 40 perches and if it is the case, they may be paid for their extra land allowed for acquisition for the project.

Category II : say 20-30 perch for each family.

Persons who had less than 40 perches affected land may be given 20 - 30 perches depending on the land extent they had (equivalent plot to each affected land extent may be given to them as compensation).

Category III : say < 20 perch for each family.

The affected persons who had less than 20 perches may also be given equivalent extent they had. Under this category their may be persons who have less than 10 perches but they need to be given a minimum of 10 perch plot for resettlement.

Option 2 ***Affected parties to be paid compensation while they find their own location of resettlement***

In cases where the APs cannot be offered land with at least equal facilities that they presently enjoy, they may be willing to get paid for their affected properties and find their own locations for resettlement. Even if all the people do not chose this option there maybe some. APs may be consulted with this option at the time of preparation of the resettlement plan. In such case, land required for compensation is the extent of land in their present plots.

However, the Project Proponent, CEB decided lately to adopt both, ***Option 1*** as follows and ***Option 2*** remaining as above.

Option 1 ***Resettled in uniform size land plots***

Allocation of 15 perches land from the SAARC Village for each family to be resettled. Although this allocation is smaller than the present land areas belonging to some of the potentially affected persons the level of living standards are up in the SAARC Village. If the acquired land is more than 15 perches in extent, the excess land will be given compensation.

5.6.5.6Process for Acquisition of Land

Land acquisition is not a significant issue of this project. Only small plots of land with 1 to 3 perch in extent will be required to acquire along the roads. Acquisition should follow the process mentioned below.

- Consultation with the owners of the affected land
- Proper assessment of the extent and the value of the land
- Negotiation with the land owners on the compensation
- Preparation of a written agreement according to the negotiated conditions.
- Payment of compensation

Institutional procedures to be adopted in carrying out the aforesaid process have been stated hereunder and are given in ***Table 5.8***.

- All the affected persons and also affected physical structures should be marked on the ground. This should be done at least three months ahead of project implementation.
- The community leaders as well as Grama Niladharis (GN) and other grassroots level officers such as Samurdhi Niyamakas and agriculture production and research assistants should be used to identify the ownership of the affected properties.
- A committee comprising government valuers, GNs and land officers with the involvement of PMU staff should be established to assess the monitory value of the affected properties.
- All the APs should be informed in writing the value of the properties affected and also the procedure of the compensation.
- Cut-off date/s should be decided depending on the plans for project implementation and inform (notify) all the APs and other communities in the project area. (This will help to firmly decide the exact number of APs and also avoid new people attempt at encroaching the Right of way expecting compensation

Table 5.8 Process to be followed as per Sri Lanka Land Acquisition Act (LAA) during Resettlement Action Plan –Moragolla Power project

Stage and Activity/Role	LAA Section	Responsible Unit/ Institution	Role of CEB	[1] Current Status
Stage I: Preparation of Acquisition Proposal				
1. Identification of a suitable land after preliminary investigation. 2. Preparation of rough sketch of land. 3. Arrangement of funds by obtaining approval from the Treasury under F.R.53. This fund should be 25% of the rough estimate of the budget or Rs. 50,000.00 which ever is higher. This amount should be deposited by the Project Executing Agency in each Divisional Secretariat Divisions for their official expenses	248	CEB	CEB to ensure that budget for the land acquisition for the project/subproject is included in the CEB annual plan and funds are available from the relevant Ministry and from the Donor Agency to implement these activities.	
4. Preparation of application for acquisition (to be submitted to the Land Acquisition Division of the Ministry of Lands) • Application • Detailed Statement • Tenement list and rough sketch or survey plan • Approved RAP	2 (1)	CEB	CEB to prepare the application and follow-up with various agencies involved in the land acquisition process. CEB to maintain its own file copy of the application and supporting documents (including RAP)	
Stage II: Publication of 1st notice and Preparation of Advanced Tracing				
1. Registration of acquisition proposal and obtaining approval from the Hon. Minister of Lands	248	Director of the Land Acquisition Division, Ministry of Lands	CEB to follow up and report on action taken by the Ministry of Lands.	

[1] This column on the Current Status will have to be filled during the Implementation of the RAP

Stage and Activity/Role	LAA Section	Responsible Unit/ Institution	Role of CEB	[1] Current Status
2. Issuing of Section 2 order to Divisional Secretary by the Ministry of Lands	2	Director of Lands, Ministry of Land	CEB to ensure that funds are deposited in the account of each Divisional Secretariat Office to cover their expenses in land acquisition activities. (The amount should be 25% of the rough estimate of the budget or Rs. 50,000.00 which ever is higher. This amount should be deposited by the Project Executing Agency in each Divisional Secretariat Divisions for their official expenses. This can be replenished based on actual requirements and submission of documents)	
3. Exhibition of Section 2 notice in three languages in the relevant land and in some conspicuous places in that area, handing over to relevant persons including claimants (Divisional Secretary to appoint a Land Officer to undertake the relevant activities with the support from the Grama Niladhari of the respective Grama Niladhari Divisions)	249	Divisional Secretary	CEB to assist the Land Officers of the Divisional Secretariat Offices in the translation of the notices in three languages and in the dissemination of information to APs. CEB to assist in orienting the Land Officers and appointed staff from the Grama Niladhari Divisions on the project and land acquisition/resettlement issues	
4. Sending of Survey requisition to the Survey Superintendent to survey and prepare the advanced Tracing		Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries	
5. Preparation of Advanced Tracing and sending it to Ministry of Lands and Divisional Secretary		Survey Superintendent	CEB to follow up and report on action taken by the Survey Department	
6. Confirmation of receipt of Advanced Tracing by the Ministry of Lands		Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretary and ensure that Advanced Tracing is properly received by the Ministry of Lands	
Stage III: Investigation and calling for objections [2]				

[2] Stage III applies to the normal land acquisition process. However, Section 38 (a) of the Land Acquisition Act allows for skipping this step. Under such section, publication of Section 38 (a) provision in the Gazette can be done immediately after the receipt of the advanced tracing from the Survey Department.

Stage and Activity/Role	LAA Section	Responsible Unit/ Institution	Role of CEB	Current Status
1. Issuing of Section 4 Order to Divisional Secretary	4, 250, 4.3	Director of Lands Division, Ministry of Lands	CEB to follow up and report on action taken by the Director of Lands Division, Ministry of Lands	
2. Preparation of Section 4 notice in three Languages (Sinhala, Tamil, and English) and exhibition		Land Officer and Grama Niladhari of relevant Grama Niladhari Divisions	CEB to assist the Land Officers of the Divisional Secretariat Offices in the translation of the notices in three languages and in the dissemination of information to APs. CEB to keep a copy of the notices in its files.	
3. Reporting to the Ministry of Lands as above		Divisional Secretary	CEB to coordinate with the Divisional Secretaries on complaints or objections received from the public.	
4. Investigation of objections received according to the Section 4 notice and sending recommendations to the Ministry of Lands (Ministry of Power and Energy shall form a Grievance Committee to investigate the complaints)	251,252, 4.4	CEB	CEB to report to Ministry of Land the status and resolution of cases/complaints received (whether to proceed or not in the land acquisition).	
Stage IV: Deciding to acquire the land				
1. Refer to the Divisional Secretary regarding the declaration by the Hon. Minister of Lands under Section 5	5, 253	Director of Lands Division, Ministry of Lands Assisted by the Land Officer from the Divisional Secretariat Office	CEB to follow up and report on action taken by the Director of Land.	
2. Publication of Section 5 declaration in the Government Gazette in three languages	254	Divisional Secretary / Government Press	CEB to follow up and report on action taken by the Divisional Secretaries and the Government Press CEB to keep a copy of the publication in its files.	
3. Exhibition of the Gazette among the conspicuous places and interested persons		Divisional Secretary (through the Grama Niladaries)	CEB follow up and report on action taken by the Divisional Secretaries and assists in the dissemination of information to APs.	
4. Sending a copy of the Gazette to Survey Department, Ministry of Lands		Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries	

Stage and Activity/Role	LAA Section	Responsible Unit/ Institution	Role of CEB	[1] Current Status
5. Issuing of Survey requisition to Survey Superintendent to prepare a final plan	6	Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries and ensure that the request is properly received by the Survey Superintendent.	
6. Surveying the land, preparation of Preliminary Plan, laying of boundary stones by the Survey Superintendent and forwarding of plan to Divisional Secretary and Ministry of Lands	255	Survey Superintendent of Survey Department	CEB to follow up and report on action taken by the Survey Superintendent and ensure that the plans are properly received by the Divisional Secretaries.	
7. Sending a copy of Preliminary Plan to the Ministry of Lands		Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries and ensure that the plans are properly received by the Ministry of Lands.	
Stage V: Inquiry into claims and payment of compensation				
1. Preparation of Sec.7 notice in three languages and publication in the Gazette. • Call for claims for compensation (both for title holders and non-title holders) • Deciding of dates and places for inquiries	7 255 7.2	Divisional Secretary / Government Press	CEB to follow up and report on action taken by the Divisional Secretaries and the Government Press and assists in the translation and dissemination of information to APs. CEB to keep a copy of the publication in its files	
2. Sending a copy of the Gazette to Chief Valuer, Ministry of Land and Ministry of Power and Energy	9	Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries and	
3. Holding of inquiries into claims and compensation	256, 10 (1) (a)	Divisional Secretary	CEB to recruit and orient additional staff to support the activities, if necessary. CEB to assist the APs in the completion of necessary documentation to expedite payment of compensation.	
4. Issuing of decision under 10 (1) decision	257	Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries	
5. Refer to Valuation Department for valuation		Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries	

Stage and Activity/Role	LAA Section	Responsible Unit/ Institution	Role of CEB	Current Status
6. Issuing of valuation report to Divisional Secretary		Valuation Department	CEB to follow up and report on action taken by the Valuation Department	
7. Declaration of the award	17	Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries	
8. Issuing of award under Sec. 17 award	259	Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries	
9. If the owner agrees to obtain the compensation, payment of the compensation from the funds obtained through the treasury • Divisional Secretary sends the request to Ministry of Power and Energy through CEB • CEB to issue the cheque in favor of the Divisional Secretary • Divisional Secretary to pay compensation	261	Divisional Secretary, CEB	CEB to follow up and report on action taken by the Divisional Secretaries and the processing of payments. CEB to track and report on status of compensation payments and livelihood restoration assistance.	
10. Payment of interest (For the period from the date of publication of 38 (a) to the date of compensation payment (@ 7% per annum)		Divisional Secretary, CEB	CEB to follow up and report on action taken by the Divisional Secretaries and the processing of payments. CEB to rack and report on the status of compensation payments and livelihood restoration assistance to Ministry of Power and Energy and Donor Agency.	
Stage VI: Taking over of possession after the acquisition				
1. Apply for 38 (a) after the completion of payment of compensation	262	Divisional Secretary, CEB	CEB to follow up and report on action taken by the Divisional Secretaries	
2. Publication of Sec. 38 (a) order in the Gazette and giving instructions to Divisional Secretary to take over the possession	38	Director of Lands, Ministry of Lands / Government Press	CEB to follow up and report on action taken by the Ministry of Land and the Government Press. CEB to keep a copy of the publication in its files.	

Stage and Activity/Role	LAA Section	Responsible Unit/ Institution	Role of CEB	[1] Current Status
3. Handing over the possession to CEB and reporting to the Ministry of Lands		Divisional Secretary	CEB to follow up and report on action taken by the Divisional Secretaries	
Stage VII: Vesting of Certificates				
Vesting of land through the vesting certificate in the Local authority after taking over the possession under Sec. 38 (a) or Sec. 38 (a) proviso for CEB : • Obtaining the required full amount of funds from the relevant organization, obtaining approval from the Ministry of Land for vesting • Mentioning of imposing of conditions and units in the Vesting Certificate • Registration of Vesting Certificate in the District Land Registry • Sending of copy of Vesting Certificate to Ministry of Lands	44 (1), 267	Divisional Secretary (assisted by its Lands Officer) Director of Lands, Ministry of Lands Divisional Secretary Divisional Secretary Divisional Secretary	Divisional Secretary and Land Officer.	

5.6.5.7 Resettlement budget

Comprehensive plan with realistic cost for mitigating the resettlement impacts will be prepared by the CEB during detailed design and project implementation phase. The detailed designs of the project components will facilitate to carry out resettlement survey. This EIA report includes only the principles to be followed in deciding monitory compensations and other mitigatory measures in addressing resettlement issues. The principles to be followed are mentioned below:

Monitory compensations

The land and other properties such as houses, fences, gates and boundary walls of some homesteads will be compensated after preparation of detailed cost plans. The affected lands will be surveyed and decided the compensation at the market price existing at the time of acquiring lands for the project. The other properties will be paid compensation at amounts that is adequate to replace the demolished properties. The amounts will be decided after carrying out of detailed measurement surveys. Without detailed measurement surveys carried out compensation for houses or land cannot be decided. The purpose of the budget mentioned below is therefore only for the CEB to have an idea to allocate financial resources for implementing resettlement plan at the time it is required.

Table 5.9 Resettlement Budget and Monitory Compensation Costs

Impact / Resettlement Plan Item	Magnitude	Approximate Budget (Rs.)
Proposed reservoir , powerhouse/switchyard / surge shaft / penstock area, labor camp	26 families to be evacuated (20 due to reservoir, 4 due to labor camp and 2 in the vicinity of powerhouse / switch yard area)	52 M (average Rs. 2 M per house)
Impacts due to proposed access roads and right bank road diversion and access to residential camp area	82 perches of land, small front sections of 03 business structures and 02 houses, 01 gate and 21 meter length of boundary walls.	6.0 M (approximate figure came up with the discussions of stakeholders in the area)
Residential lands with homesteads vulnerable due to Proposed Reservoir	13 Acres	20.8 M (10,000/perch)
Non-residential land plots impacted due to Proposed Reservoir	5.25 Acres	8.4 (10,000/perch)
Non-residential lands impacted due to residential camp / office and stores(including access to residential camp)	7.25 Acres	11.6 M (10,000/perch)
Total	24 houses where 26 families are living and 26 acres Land extent	98.8 M

Notes to Table 5.9 :

1. Rs 2.0 M is proposed as average value of a house. This will get significantly varied during resettlement plan preparation in detail design phase. The real value of the houses can be decided only after detailed measurement surveys. This figure has been suggested to have some idea about resettlement cost to be allocated.

2. The likelihood compensation payments for negative impacts due to proposed access roads were proposed by stakeholders together with the social assessment survey team. It should be noted that these figures are also approximately proposed numbers without any detailed measurements on the affected properties on each access road. This will be done by CEB during detailed design phase of the project.

3. The land value has been taken as Rs 10,000/perch. This will also get significantly changed and such changes will be considered at the detailed measurement surveys on affected land that need to be acquired for the project.

4. In general value appreciation and depreciation of affected properties (land and other buildings) will be considered and incorporated to the compensation package when the compensations are paid to the affected persons.

CHAPTER 6

Chapter 6

Environmental Monitoring Programme

6.1 General

An Environmental Monitoring Programme has to be conducted in the proposed project with the participation of reputed and independent R & D organizations. Environmental Monitoring Programme is crucial in order to assess the performance or the success of the implementation of mitigatory measures.

This chapter outlines the environmental monitoring to be carried out in the pre construction stage, during construction and operation of the Project. A Monitoring Plan shall be developed on the basis of these recommendations.

It should be noted that during the construction phase the contractor should accept a major responsibility in undertaking the monitoring aspects with assistance from reputed organizations. In Addition it is also recommended that an environmental officer is permanently employed at the construction site to carry out day to day monitoring and to provide necessary technical inputs regarding environmental related issues on a regular basis. A person with a postgraduate level qualification in Environmental Science or Environment Management and with project related experience should be employed.

6.2 Types of Monitoring

There are three types of monitoring, namely:

- Pre-construction monitoring
- Construction compliance monitoring
- Post construction monitoring or Impact Confirmation Monitoring

Pre-construction monitoring

This is required to determine the baseline conditions in detail to identify noise, air quality, water quality, vibrations levels and hydrology and mitigation measures and costs to respond to CEA conditions of approval.

Construction compliance monitoring

This is required to confirm the effective implementation of mitigation measures. The MASL will develop the Compliance Monitoring Plan in consultation with the CEB and relevant institutions.

During construction, the implementation of the mitigation measures will be the responsibility of the relevant Contractor who will be overseen by the project proponent

or a representative (section 5.3). During the works, Compliance Monitoring should be facilitated by routine site inspections as part of the Contract to ensure mitigation measures are implemented correctly and efficiently.

The process of Compliance Monitoring essentially includes third party verification. Therefore, Compliance Monitoring facilitates the audit of the Environmental Management Plan (EMP) prepared by the Project Proponent / Contractor. The EMP will form part of the relevant contract.

Impact Confirmation Monitoring

The purpose of Impact Confirmation Monitoring is twofold;

- To ascertain the effectiveness of the mitigation measures proposed for construction and operation and
- To validate and confirm the assumptions made in the EIA process.

Impact confirmation monitoring should be carried out by a party independent of the Contractor(s), taking into account all concurrent works contracts. Impact Monitoring primarily includes measurements of environmental media to determine the influence, if any, of the works.

6.3 Institutional Framework for mitigation of impacts

CEB, as the project proponent is responsible for the Implementation of the mitigatory measures. MASL as the Project Approving Agency is responsible for monitoring of proper implementation of the mitigation measures.

The appointment of an Environment Monitoring Committee (EMC) is recommended to oversee the implementation of the Monitoring Plan. A well-structured programme will ensure both Compliance and Impact Confirmation Monitoring to high degree of efficiency. The proposed monitoring committee should be chaired by the MASL and members should be representatives from key stakeholder organizations. All appointees to the committee should be approved by the MASL.

The membership as given in ***Table 6.1*** is recommended for the EMC.

The EMC will work in close consultation with the MASL, Contractor, EIA Team and the Design Consultants on all matters relating to monitoring. The EMC will have regular meetings in order to review the monitoring. CEB will act as the facilitator of the theses meetings. In areas of potential conflict, the EMC will have responsibility to resolve such issues.

Arising from such activity, the EMC in consultation with the Contractor(s) should develop a mechanism to manage, investigate, respond and act upon, any issues raised by the public during construction.

The EIA team is of the view that wider participation of all stakeholders is important in achieving the objectives of Environmental Monitoring.

The EMC in consultation with the Contractor (/s) should develop a mechanism to manage, investigate, respond and act upon any issue raised by the public during construction.

Table 6.1 Members of the proposed Monitoring Committee

Organization	Nominee
Mahaweli Authority of Sri LankaLanka (MASL) - Project Approving Agency (Monitoring Agency of proper implementation of Mitigatory measures)	Representative from the MASL
Central Environmental Authority (CEA)	Environmental Officer
Department of Irrigation (ID)	Environment Officer Irrigation Engineer
Divisional Secretariat Office (Relevant DS Offices)	Divisional Secraties of Uda Palatha and Ganga Ihala Grama Nildaris of the respective GN Divisions in the project area Samurdhi Niyamaka – project area Environment officer
Respective Pradeshiya Sabhas	Chairman Environmental Officers / Public Health
National Resource Management Centre / Department of Agriculture (NRMC)	Agriculture Officer
National Building Research Organization (NBRO)	Officer from the Landslides Services Division
Geological Survey and Mines Bureau (GSMB)	Geologist
Road Development Authority (RDA)	Civil Engineer
National Water Supply & Drainage Board (NWS & DB)	Environmental Engineer
Dept. of Wild Life Conservation	Representative Officer
Community representatives	Clergy of the nearest religious organization Representative(s) from Community Based
Non Government Organizations (NGO's) (if any)	Representatives from local NGO's

6.4 Environmental Management Plan (EMP)

The EIA report provides a detailed description of the Monitoring Method to be adopted via the appointment of an EMC. The Monitoring Plan has to be developed along with the detailed designs. It will also be a part of the EMP which has to be prepared by the EMC and the Engineering Designers and EIA Consultants and then finalized in consultation with the Contractor because it will be a part of the Contractual Agreement.

The EMP specifies the mechanisms for the implementation of the mitigation measures and for monitoring and will set out the relevant mechanisms and institutional arrangements to achieve the objectives of Compliance and Impact Confirmation Monitoring.

Before construction, the EMP has to be updated in full consultation with the Environmental Monitoring Committee (EMC) and the Contractor. Discussions with the Contractor are critical because the EMP is part of the relevant contract. Therefore the EMP will be used as means by which the Contractor (and any Sub Contractors) will implement the recommended mitigation measures and achieve the environmental performance standards defined and recommended in Sri Lankan environmental legislation, in the EIA and in the Contract.

As the EMP will form part of the contract there will be provisions to ensure that the Contractor fulfils his obligations regarding the implementation of mitigation measures. It is recommended that the MASL appoints from the EMC to independently verify that the measures are implemented correctly and efficiently as part of third party verification. This arrangement will fully satisfy the requirement of Compliance Monitoring.

6.5 Monitoring of mitigation of impacts on the Physical environment

Table *6.2* includes the Environmental Monitoring Framework for the mitigation of impacts identified.

6.5.1 *Monitoring of soil erosion and sedimentation*

A comprehensive erosion and sediment control plan prior to earth-moving activities should be developed. Requirements should be written into plans, specifications, and cost estimates for the project. Four key factors affect the potential for soil erosion from a site: soil characteristics, vegetative cover, topography, and climate. All of these factors should be taken into consideration to develop an erosion control plan that will minimize soil loss, limit the area exposed to construction and maximize the vegetative cover, use natural topographic features to the best advantage.

Develop a schedule and implement a comprehensive inspection and maintenance program (which should be regular inspection and maintenance) to ensure that they are operating effectively and optimally, both during and after construction.

Monitoring during the construction phase of the Project should focus primarily on sedimentation and the control of erosion and runoff. Periodic observations of the water flow in the surface water channels will be made after heavy rainfalls to determine the effectiveness of the erosion and runoff controls that have been put in place as part of the construction process.

Supervision of maintenance of constructed siltation barriers and erosion controls should be done on a daily basis as part of the ongoing supervision and inspection of construction.

Benches cut in hard rock may be an exception to this rule, but problems of concentrated flow at low points causing damage further down slope should be carefully assessed before deciding to omit surface channels. When new channels are designed to discharge through existing outfalls, the capacity of the outfalls and the risk of erosion damage beyond the site limits should be checked as part of the design.

Trash grills and sand traps should not be provided above or on slopes susceptible to surface erosion, it is prudent to construct a sand trap at the slope toe or other locations convenient for inspection and maintenance. Runoff in the channel should then pass over the sand trap and through a trash grill to prevent material from entering and blocking any storm drains into which channel discharge.

In steep terrain and where there are erodible materials, the land areas may restrict the construction of sand traps with required capacities. In such case, the need for regular maintenance of the sand traps should be stressed. If space is so severely restricted that provision of a sand trap is impossible, an alterative is to construct a catch pit at the toe of the slope channel, which should be accessible for manual or mechanical de-silting.

Appropriate construction practices for the dumping sites to be adopted and surface soil erosion towards the stream to be monitored. Also, streams can carry large rocks or boulders during heavy rain, which may block or damage the slope drainage system. If the stream course is strewn with rocks and boulders, a rock trap should be provided, together with suitable access for maintenance.

To control pollution resulting from runoff from construction sites of roads, access roads, and dam, an erosion and sediment control plan that incorporates the most appropriate and cost-effective best management practices is essential. Inspection and enforcement authority are necessary to ensure awareness of and compliance with the adopted practices. Regular maintenance is required to ensure that they perform optimally. The following principles apply to an effective erosion and runoff control program during construction.

Catchment Management

Launching a long-term catchment management activity is beneficial for long term sustainability of the project. Thus, it is recommended to allocate a reasonable share from the project earnings for catchment management per year basis.

6.5.2 Monitoring of impacts on Water Quality, Ground water, Air Quality, Noise levels, vibration levels, crack monitoring plan, solid waste disposal practices and wastewater quality

Table 6.2 includes the Environmental Monitoring Framework for these elements.

Table 6.2 Proposed Environmental Monitoring Framework

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
Pre-Construction Phase				
Monitoring Soil Erosion and Siltation				
Prevention of erosion of the fill material, excess erosion of slopes and flow channels and corresponding siltation of the Mahaweli river	Upstream and downstream of the project area preferably at datum points	Mass of silt accumulated in silt traps / sedimentation ponds during a given period of time, suspended particulates in surface water streams	Monthly (during rainy period - 03 readings, dry period - 03 readings)	Monitoring Committee
Water Quality				
(i) Surface Water				
Determination of baseline (existing) conditions of surface water quality in Mahaweli river	Locations already selected for water quality monitoring	pH, turbidity, electrical conductivity, total and fecal coliform levels, DO, TN, TP Grab samples in triplicate to be collected for analysis and the results may be assessed with reference to the CEA standards.	Twice a year (dry and wet seasons)	Monitoring Committee
(ii) Ground Water				
Determination of baseline (existing) conditions on groundwater level	Upstream and downstream wells (at least one well)	Depth of groundwater	Twice a year (dry and wet seasons)	Monitoring Committee
Air quality				
Determine baseline (existing) conditions on air quality	NBRO Selected locations	NO_x, CO, SO_2, ground level O_3, PM_{10} and PM $_{2.5}$ to be assessed with reference to the CEA or National Standards for Ambient Air Quality	Twice a year (North-east and south-west monsoon seasons)	Monitoring Committee

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
Noise levels				
To get an insight into existing background levels	Noise locations identified by NBRO (15 locations)	Equivalent sound levels (L_{eq} A). It is important to measure residual noise levels and ambient noise levels.	At least once each (day and night)	Monitoring Committee
Vibration levels				
To get an insight into existing background levels	Locations identified by NBRO for vibration measurements	Vibration in mm/s.	At least once	Monitoring Committee
Crack Monitoring Plan				
To get an insight into existing crack levels	Locations to be identified	Length and patterns of cracks in dwelling units	At least once	Monitoring Committee
Construction Phase				
Monitoring Soil Erosion and Siltation				
Prevention of erosion of the fill material and excess erosion of slopes and flow channels and corresponding siltation of the Mahaweli river	Selected locations in the project area, upstream and downstream areas as well	Water levels in streams / channels	At least twice each during wet and dry seasons	Monitoring Committee
	Selected locations in the project area, upstream and downstream areas and minimum at five locations	Mass of silt accumulated in silt traps / sedimentation ponds during a given period of time, suspended particulates in surface water streams	Monthly and in high rainfall events	

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
Erosion Management	Entire construction site and associated work areas specifically including areas of excavations, earth cuts, deep excavations and spoil dump areas	No evidence of uncontrolled erosion following high rainfall, No evidence of sedimentation in watercourses, Review of land reinstatement of Erosion controls, Erosion controlled and limited to that consistent with "natural processes". After construction, measures adopted in restoring greenery in the sites where spoil was deposited has to be monitored.	Regular inspection to assess the effectiveness of erosion protection measures. Ongoing monitoring to be undertaken to assess the success and integrity of permanent erosion control practices	Monitoring Committee
Watercourse Management	Project site premises	Watercourse banks effectively reinstated to prevent scouring, Erosion and sediment control techniques implemented on-site where necessary and any failure of water quality control. Ensured that all discharge is in accordance with conditions stipulated (e.g. visual observation, turbidity, dissolved oxygen, pH and suspended solids)	Regular inspection to assess the effectiveness of protection measures, with particular attention to management of watercourse environments. A post-construction audit to be conducted annually for two years following construction. This audit should evaluate erosion control, prevention of water course alteration and success of bed and bank re-profiling	Monitoring Committee
Water Quality				
(i) Surface Water				
Avoid contamination of Mahaweli river by the construction activities and to ensure surface water quality conforms to the environmental standards stipulated	Locations already selected for water quality monitoring.	pH, turbidity, electrical conductivity, total and faecal coliform levels, DO, TN, TP Grab samples in triplicate to be collected for analysis. The results may be assessed with reference to the CEA proposed standards	Once in 3 months and should cover both dry and wet seasons.	Monitoring Committee

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
Minimization of water pollution	Project site premises and immediate vicinity	Observation for evidence that unplanned release of water into waterways does not take place. Observation for evidence that the contractor has taken adequate steps to prevent run off of sediments	Once a month to ensure that water quality monitoring stations are established both within and outside the project site, Surface water quality are monitored once a month before and after construction for possible contamination by oil, lead (Pb), detergents, chemicals used for construction, sediment and sewage	Monitoring Committee
(ii) Ground Water				
(i) To determine any deviation of ground water level due to construction activities	Upstream and downstream wells (at least one well)	Depth of groundwater	Once in 3 months and should include the dry season and wet season.	Monitoring Committee
(ii) Minimization of ground water pollution	Project site premises and immediate vicinity	Ground water quality for possible contamination by oil, lead (Pb), detergents, chemicals used for construction, sediment and sewage. Ensure it conforms to the environmental standards stipulated	Once a month to ensure that water quality monitoring stations are established both within and outside the project site, ground water quality are monitored once a month before and after construction	Monitoring Committee
Air quality				
(i) To minimize the air pollution to ensure maintaining of ambient air quality standards.	NBRO Selected locations	NOx, CO, SO_2, ground level O_3, PM_{10} and $PM_{2.5}$ should be assessed with reference to the CEA or National Standards for Ambient Air Quality	Once in 6 months and should cover both the south-west and north-east monsoon seasons.	Monitoring Committee

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
(ii) minimization of Air Pollution	Construction site and immediate vicinity and monitoring stations should be established both within and outside the project site.	Visual observation of defective exhausts, dust emissions during windy/dry periods, receipt of air quality related complaints from neighboring residential areas, excessive visual dust cloud during construction activities, watering of construction sites and access roads to be carried out regularly. Awareness of the workforce regarding dust mitigation measures	Regular inspection to assess the effectiveness of Air Quality protection measures. Regular dust monitoring to determine the impact of dust on the community and project site activities. It should also be monitored once a month for contamination by NO_x, CO, SO_2, volatile organic compounds, CO_2, SO_2 and particulate matter	Monitoring Committee
Noise levels				
To ensure that noise emissions arising during construction are minimal	All noise sensitive locations identified during preliminary investigations, and any new sensitive areas identified.	Equivalent sound levels (Leq A). Measure residual and ambient noise levels and assess with reference to the maximum permissible construction noise levels	At least once in 6 months during day and night times and also depending on complaints from local people at relevant premises.	Monitoring committee
	Project site premises and immediate vicinity	Number of noise related complaints received from residents and landholders during construction Evidence that faulty equipment is repaired or replaced as soon as possible. Evidence of consultation and planning for typical noise events	Once a month. Liaise with community to advise on likely timing and duration of noisy activities, schedule noise events for appropriate times	Monitoring committee
Vibration levels				
To ensure that vibration emissions arising during construction are minimal	Locations identified by NBRO for vibration measurements	It is required to make sure that the vibration levels in the residences or archaeologically important places be less than 0.5 mm/s.	At least once in 6 months. Also depending on complaints from local people at relevant premises.	Monitoring committee

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
Crack Monitoring Plan				
To get an insight into newly developed crack levels	Locations to be identified	Length and patterns of cracks in dwelling units	At least once in six months and also on complains from local people at relevant premises	Monitoring Committee
Solid waste disposal practices, wastewater treatment plants and wastewater quality				
To ensure that both MSW produced by the work force and construction generated wastes are properly managed and that a proper plan to collect and safely dispose the wastes is available.	Locations within the site where the construction activities are carried out	Adequacy of facilities for waste collection and disposal.	Regular surveys should be done.	Monitoring committee
Ensure proper disposal of solid waste, waste water and sewage, control of vector breeding and spread of diseases	Labour Camps, site offices and site management	Demonstration of minimization of impacts by having a system to dispose solid waste, having adequate sanitary facilities, use of alternate energy for cooking, absence of open objects that can collect water within the site	Once a month to assess the effectiveness of protection measures with particular attention to waste management, pest and disease vector breeding and general housekeeping	Monitoring committee
Waste Management	Project site premises	Cleanliness and waste efficiency of the construction site, amount of litter detected on-site after construction / maintenance, records of regulated waste disposal, onsite sewage system operating efficiency	Regular inspection	Monitoring committee
Flora and Fauna Protection				
Weed Management	Project site premises	Weed data on on-site species and distribution properly documented. Whether appropriate steps have been taken to manage any alien invasive weed species	Regular inspection. Monitoring should be continued for a period of up to 2 years after construction is completed to assess the success of weed control activities	Monitoring committee

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
Minimal disturbance to terrestrial flora and fauna	1 km radius around the project site	Observation of minimal disturbance to terrestrial flora and fauna by above ground structures, tracks, services and campsites during construction of the project site. Restoration of disturbed areas after construction, measures adopted in restoring greenery in the sites where muck was deposited has to be monitored.. No exotic plant species are introduced to the area No damage to, or removal of, protected species unless permitted by relevant authority.	Once in three months to assess the effectiveness of protection and management of fauna and flora. Throughout construction, open pits should be inspected by approved faunal handlers regularly. Success and integrity of rehabilitation measures should be assessed a year after commissioning the project site	Monitoring committee with DWLC officials
Clean Up and Rehabilitation	Project site premises	No new weed species introduced and weed management is effectively implemented, no impediments to re-vegetation from compacted ground, re-vegetation occurring naturally and in line with surrounding vegetation, no unplanned change in drainage pattern leading to soil erosion	Once a month inspection until re-growth is established; seeded areas should be monitored regularly to ensure growth. If necessary, appropriate re-application of seed should be carried out. The success of restoration should be assessed against the goals set forth for post construction restoration	Monitoring committee
Handling and Disposal of Dangerous Goods				
No contamination of the environment by hazardous goods	Project site premises	Reviews and corrections to storage and handling procedures as appropriate. Review of records showing that any spill has been affectively addressed.	Weekly inspections should be conducted to ensure that chemical and other storage facilities continue to meet national standards	Monitoring Committee
Operation Phase				
Monitoring Soil Erosion and Siltation				
(i) Prevent erosion of the fill material and excess erosion of slopes and flow channels and corresponding siltation of the Mahaweli river	Existing water retention areas and river profiles	Records of flood levels, water table, water levels	Monthly. Particularly during rainy season,	Monitoring Committee

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
(ii) Verify that erosion is controlled and slope stability is achieved and recommend repair works accordingly.	Spoil Dump sites	No evidence of uncontrolled erosion following high rainfall, No evidence of sedimentation in watercourses, Review of land reinstatement of Erosion controls, Erosion controlled and limited to that consistent with "natural processes". After construction, measures adopted in restoring greenery in the sites where muck was deposited has to be monitored.	Monthly inspection	Monitoring Committee
(iii) Watercourse Management	Project site premises	Watercourse banks effectively reinstated to prevent scouring, erosion and sediment control techniques implemented on-site where necessary and any failure of water quality control.	A post-construction audit should be conducted annually for two years following construction. This audit should evaluate erosion control, prevention of water course alteration and success of bed and bank re-profiling.	Monitoring Committee
Water Quality: *Surface Water*				
Ensure existing water quality of the Mahaweli river will not be spoilt during the operational phase	Locations already selected for water quality monitoring	pH, turbidity, electrical conductivity, total and faecal coliform levels, DO, TN, TP. Grab samples in triplicate to be collected for analysis and the results may be assessed with reference to the CEA proposed standards stipulated	Once in 3 months. Both dry and wet season period should be covered	Monitoring Committee
Air quality				
To minimize the air pollution in operation phase, hence to ensure maintaining of ambient air quality standards.	NBRO Selected locations	NO_x, CO, SO_2, ground level O_3, PM_{10} and PM $_{2.5}$ to be assessed with reference to the CEA or National Standards for Ambient Air Quality	Once in 6 months; should cover both the south-west and north-east monsoon seasons.	Monitoring Committee

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
Noise levels				
To ensure that noise emission arising during operational activities is minimal	All noise sensitive locations identified during preliminary investigations and during construction phase, and any new nearby sensitive areas identified.	Equivalent sound levels (Leq A). Measure residual noise levels and ambient noise levels and be assssesed with reference to stipulated standards.	At least once in 6 months during day and night times. Also depending on complaints from local people, at relevant premises.	Monitoring Committee
Vibration levels				
To ensure that vibration emission arising during operational activities is minimal	locations identified by NBRO for vibration measurements	It is required to make sure that the vibration levels in the residences or archaeologically important places be less than 0.5 mm/s.	At least once in 6 months. Also depending on complaints from local people, at relevant premises.	Monitoring Committee
Solid waste disposal practices, wastewater treatment plants and wastewater quality				
To ensure that adequate facilities are available for wastewater treatment systems	Wastewater treatment plant for sewage disposal	Adequacy of infrastructure facilities for wastewater treatment. Chemical and microbial analysis of the treated wastewaters. The measured parameters needs to be assessed with reference to the CEA stipulated Tolerance Limits. Adequacy of infrastructure facilities for solid waste collection and disposal to be ensured.	Regular surveys should be done.	Monitoring Committee
Flora and Fauna Protection				
Minimal disturbance to terrestrial flora and fauna	1 km radius around the project site	Restoration of disturbed areas after construction, no exotic plant species are introduced to the area, no damage to or removal of protected species unless permitted by relevant authority	Success and integrity of rehabilitation measures should be assessed a year after commissioning the project site	Monitoring committee with DWLC officials

Monitoring Objective	Location	Monitoring Parameters	Frequency of Monitoring	Responsible Agency
Weed Management	Project site premises	Weed data on on-site species and distribution properly documented. Whether appropriate steps have been taken to manage any alien invasive weed species	Monitoring should be continued for a period of up to 2 years after construction is completed to assess the success of weed control activities	Monitoring Committee
Clean up and Rehabilitation	Project site premises	No new weed species introduced and weed management is effectively implemented, no impediments to re-vegetation from compacted ground, re-vegetation occurring naturally and in line with surrounding vegetation, no unplanned change in drainage pattern leading to soil erosion	Once a month inspection until re-growth is established; seeded areas should be monitored regularly to ensure growth. If necessary, appropriate re-application of seed should be carried out. The success of restoration should be assessed against the goals set forth for post construction restoration	Monitoring Committee
Handling and Disposal of Dangerous Goods				
No contamination of the environment by hazardous goods	Project site premises	Reviews and corrections to storage and handling procedures as appropriate, Review of records showing that any spill has been effectively addressed	Weekly inspections to be conducted to ensure that chemical and other storage facilities continue to meet national standards	Monitoring Committee

6.6 Monitoring of the Biological Environment

Table 6.2 for Environmental Monitoring Framework includes the monitoring of the Biological environment. Most of the impacts arising due to this project can be mitigated with proper design and following environmental best practices. The specific mitigation measures to be observed are described in Chapter 5.

6.7 Monitoring and Evaluation of the Social Impact Mitigation Process

6.7.1 General

The monitoring and evaluation of the social impact mitigation process will be managed by the project developer, CEB in this case. CEB will establish a committee comprising relevant stakeholders to provide guidance and over see the monitoring process. This committee can be managed / lead by CEB with the assistance of following stakeholder agencies:

- Divisional Secretaries of Ganga Ihala and Udapaltha
- Representative of Irrigation Department
- Representative of Agrarian Services Department
- Representative of Agriculture Department
- Representative of Crysbro Broiler Processing Industry
- Representative of affected communities
- Grama Niladharies representing project affected areas
- Representatives from relevant Pradeshiya Sabhas

External monitoring and evaluation mechanisms may be suggested to monitor the effectiveness of the Resettlement plan (RP) implementation. A consultant may be engaged on an intermittent basis to carry out external monitoring and evaluation activities.

6.7.2 Monitoring and Evaluation (M & E) of the Resettlement Action Plan.

The resettlement process will be monitored by CEB through an independent party (an individual consultant or consultancy firm). A comprehensive M&E plan will be developed during the detail design stage of the project as a component of the RAP. This report includes only the parameters to be used and the frequency of monitoring required during resettlement plan implementation process.

Table 6.3 gives the Social Impact Monitoring Programme.

Table 6.3 Social Impact Monitoring program

Aspect	Indicator	Frequency	Methods
Affected persons and families	No. of APs and AP families	One time in the resettlement period	Household survey with AP families
Properties affected	Type of properties and magnitude from each type	One time in the resettlement period	same household survey-
Funds	Amount paid for affected properties and land	Continuous in the resettlement action phase	Data from CEB
Grievances	Complains made by the APs	Continuous in the resettlement action phase	Filed observations, interviews and Focus group discussions
Conflicts	Number of conflicts taken place between APs and the project implementers	Continuous in the resettlement action phase	Filed observations, interviews and Focus group discussions

6.7.3 External Monitoring of Physical and Financial Progress of RP

The External monitoring and Evaluation Consultant (EMEC) may closely monitor RP implementation to provide CEB officials with an effective basis for assessing the resettlement progress and to identify potential difficulties and problem areas. Monitoring will be carried out by the EMEC and reported regularly to the relevant CEB officers of the project on a quarterly basis. The monitoring activities will involve the following tasks:

- Administrative monitoring to ensure that implementation is on schedule and problems are dealt with on a timely basis;
- Socio-economic monitoring during and after the relocation process, (utilizing the baseline information established by the socio-economic survey of APs undertaken during project preparation), to ensure that people are settled and are recovering;
- Overall monitoring whether recovery has indeed taken place successfully and on time.

To assess the progress and success of the RP implementation, the data from the baseline socio-economic surveys undertaken during the project preparation stage will provide the benchmark for monitoring. However, the monitoring process will also include the following:

- Communication with and noted reactions from APs;
- Information from APs on entitlements, options, alternative developments, etc.;
- Valuation of properties;
- Usage of the grievance redressing mechanism; and
- Disbursement of compensation amounts and all assistances

Table 6.4 Indicators for physical progress of RP

No.	Monitoring Indicators for Physical Progress	Implementation Target (No.)	Revised Implementation Target	Progress this Quarter	Cumulative Progress	% against Revised Implementation Target
1.	Permanent land acquired (sq m)					
2.	Temporary land acquired (sq m)					
3.	No. of Owners paid compensation for land acquisition					
4.	No. of APs paid compensation for felling of trees					
5.	No. of APs paid compensation for felling of standing non-perennial crops					
6.	Area (ha) of temporarily occupied land restored with topsoil after constructional use					
7.	No. of APs getting back temporarily occupied land with topsoil restored					
8.	No. of APs provided with livelihood restoration / household maintenance grants etc.					
9.	No. of Cultural properties acquired.					
10.	No. of Cultural properties re-established.					

Monitoring will also cover the physical progress of RP implementation. This will include relocation of the APs and project affected community properties. The EMEC will prepare quarterly reports on the progress of the RP provisions.

Tables 6.4 to ***Table 6.6*** give sample indicators that can be used for monitoring of RP implementation process.

Table 6.5 Monitoring indicators for financial progress of RP

No.	Monitoring Indicators for Financial Progress	Implementation Target (Rest.)	Revised Implementation Target	Progress this Quarter	Cumulative Progress	% against Revised Implementation Target
1.	Compensation paid for land acquisition to Owners					
2.	Compensation paid for loss of trees					
3.	Compensation paid for loss of standing non-perennial crops					
4.	Expenditure on re-establishing community properties / cultural properties					
5.	Expenditure on staffing and providing training to Social Management staff					
6.	Expenditure on engaging External Monitoring and Evaluation Consultant.					
7.	Expenditure on outsourcing Impact Evaluation Agency					
8.	Expenditure on non-quantified impacts (10% of total RP cost)					

Table 6.6 External Impact Indicators for evaluation of RP (beyond the project)

Items	Impact Indicators	Frequency
Better Economic Conditions	Income: Project related and independent means but assisted by the project. Housing: Changes in quality over a period of time. Food Security. Changes in occupation. Skill portfolio. Migration profile.	Implementation Stage : Quarterly monitoring. Implementation and Post implementation Stages : mid-term and end-term impact evaluation study
Better Social Conditions	Representation in Community Based Institutions: Indicators of participation. Empowerment. School enrolment. Health and morbidity. Better available infrastructure: potable water, living space, sanitation, proper road and drainage facilities, etc.	Implementation Stage : Monitoring. Implementation and Post Implementation Stage : impact evaluation study

External Monitoring Indicators

The two kinds of indicators for assessing achievement of the objectives under the RP implementation are:

- Process Indicators – indicating project inputs, expenditure, staff deployment, etc.
- Output Indicators – indicating results in terms of numbers of affected people compensated, area of temporarily occupied lands restored with topsoil, number of APs provided with livelihood assistance grants, etc.

6.7.4 Tentative budget for monitoring of the social impacts mitigation process during project implementation phase.

The major task of monitoring will be to study and help in addressing the negative implications due to resettlement. Though the number of affected persons (households) to be resettled is small, the resettlement process described under the Sri Lankan laws need to be followed.

Different tasks with different intensities are involved in resettlement. Each task requires different time periods for mitigation depending on its intensity. The resettlement process will require about 1.5 years completing the entire program.

A monitoring and evaluation (M & E) specialist need to be employed part time for this activity. He will be involved in the resettlement programme from its planning stage up to the stage of completion. Even some aspects of post re-settlement phase also need to be monitored to ensure the fairness and justice for the people being resettled.

Tentative budget of Rs. 1.0 M is allowed for monitoring and evaluation task of resettlement. This includes remuneration for the M & E specialist, cost of surveys with

affected families to be conducted before and after (01 each) the resettlement and for transport costs.

Terms of reference for the M & E expert

The overall task of M & E expert is to provide professional inputs to the Project Developer to plan and implement the resettlement programme. In this context, his/her main tasks involved will be as follows.

During planning stage of the resettlement

- Conduct a survey to gather information on individual preferences of the affected communities on the resettlement sites and other conditions/ issues etc.
- Develop a plan for each individual family to consider for implementation (if feasible) during resettlement process.
- Work out strategies for getting the affected persons involved in the resettlement process.

During resettlement programme implementation

- Carry out consultations with affected families and document their experience and perceptions on the on-going resettlement programme implementation.
- Provide written feed back to the project developer on the resettlement process and propose strategies to re-direct the process if such needs arise.

Post re-settlement phase

- Carry out the perception and experience survey on the satisfaction of the re-settled families.
- Prepare a written report on the satisfaction survey.
- Highlight the problems those need to be immediately addressed to rectify any serious draw backs of the re-settlement.

6.8 Monitoring costs

Monitoring costs are given in ***Table 6.7***

Except otherwise mentioned in Table 6.2, Monitoring costs covers a further period of 06 months after completion of the construction period.

Table 6.7 Monitoring Costs

Item no.	Description	Monitoring cost (Rs. M)
01	Institutional Fees of the Monitoring Institution	5.8
02	Full time monitoring officer (@ Rs. 50,000/-) and helper	3.4
03	05 nos. Experts in specific fields (@ Rs. 7,500/- each)	2.2
04	12 Members of the monitoring team (@ Rs. 1,000/- each per sitting)	0.7
05	Transport for Monitoring officer (@ Rs. 75,000/-)	4.4
06	Computers and printers (02 each) and capital cost of monitoring equipment	1.4
07	Consumables	0.3
08	Pre-construction phase monitoring	0.5
09	Construction phase monitoring	10.8
10	Operation phase monitoring	1.4
11	Social Impact Monitoring (including Training of the workers, the public and stakeholder awareness and resettlement issues) and for Monitoring and Evaluation of the resettlement plan operations.	1.7
	Total	**32.6**

CHAPTER 7

Chapter 7

Conclusion and Recommendation

The EIA Report presents a detailed assessment of the potential environmental impacts arising from the construction and operation of the proposed Moragolla Hydropower Project. The study has been carried out in accordance with the requirements of the Government of Sri Lanka, stipulated in the Terms of Reference issued by the Mahaweli Authority of Sri Lanka.

The approach to the EIA and engineering process in the feasibility study has been 'mitigation through planning and design' in respect of site selection and selection of the project layout. In the EIA several alternatives have been considered and possible environmental impacts such as possible loss of agricultural lands, inundation of populated areas and infrastructure, possible health hazards and environmental management aspects have been given consideration in addition to the costs of dam and waterways. Measures have been introduced to reduce such impacts from planning stage of the project. This means, possible environmental impacts and mitigation measures have been integrated into the planning and design process itself thus reducing as far as possible mitigatory measures otherwise would have been required resulting in reduced costs. This approach by 'Mitigation through Planning and Design' can continue even at the detailed design stage of the project.

Potential positive and negative impacts associated with both, construction and operational phases were assessed within the framework of the physical, ecological and socio-economic environment. Where necessary, mitigatory measures have been recommended.

One of the main environmental impacts will include resettlement and compensation of persons affected because of the proposed Moragolla Hydropower Project. Resettlement and compensation has to follow the guidelines given in the National Involuntary Resettlement Policy and a comprehensive resettlement plan will be developed by CEB according to the procedures and other principles of National Involuntary Resettlement Policy of the Government (NIRP- approved in 2001) at the detailed designs phase of the project. Arrangements have already been taken to allocate a land for resettlement purposes.

With respect to the other environmental impacts, it has been found that river water is already polluted fecally. The availability of industries in the watershed and non-availability of proper sewage treatment for residences may have been responsible for higher levels of fecal coliforms in the river water. The reduction in water flow during operation phase may perhaps enhance the problem and hence may adversely affect the domestic uses of the river water downstream of the dam such as for bathing and washing. Measures to be undertaken in order to correct the situation have been proposed such as extension of the effluent discharge pipe to a point downstream of the tailrace outlet. However, a detailed study is recommended to be undertaken by CEB in order to study the effects on water quality comprehensively.

Hydraulic Model studies indicates that there are no impacts on Mahaweli Ganga, Kothmale Oya and on Ulapane Oya due to construction of the proposed project in case of floods and normal reservoir operational conditions.

It is also noteworthy of mentioning that although the project does not have any additional impact on ponding of Ulapane Oya which even at present, occasionally experiences certain ponding in some areas upstream of the bridge over Ulapane Oya on the road from Gampola to Nawalapitiya during floods of higher return period. It is seen that this flood plain is being gradually encroached and some buildings are coming up. In future, once the project is in place, such flooding can be conceived to be due to the project by the communities who will not remember it as an old feature.

Therefore as a regulatory measure it is proposed to mark the area of Ulapane Oya below contour of 550m asl as an area not permitted for construction. Nevertheless a 100m wide strip around the perimeter of the reservoir will be declared as a reservation area that will be managed by CEB and will maintain the reservation area as a green belt (wherever feasible), and appropriate action will be taken to prevent earth slips, erosion etc. Any future constructions within this reservation will require CEB approval. With the assistance of the Attorney Generals Department, CEB will work out a suitable mechanism to exercise restrictions within the reservoir reservation area. This mechanism will be tied up to the current practice followed for obtaining required approvals from the local authority and / or any other authority.

Blockage of the river due to the construction of the dam resulting in disruption of the free movement of aquatic organisms especially fish, low flows in an approximately 3 km stretch of the river downstream of the proposed dam site affecting the habitat quality, loss and removal of trees due to inundation of the reservoir area and construction of temporary and permanent structures are some of the environmental impacts identified.

However, the project will not have a significant impact on the population of these fish species as their main habitat is located in the upper reaches of the Mahaweli ganga starting from about 400 m downstream of the dam site and extending upstream into the inundation area and to the upper reaches of the Mahaweli ganga. Since rare or endangered species of fish were not encountered in this stretch, the prescribed environmental flow of 1.5 m^3/s together with inflows arising from seasonal and perennial streams located in the stretch of the river subjected to low flows will be sufficient to meet the ecological demands of this stretch of river.

The impact on fish species arising due to the blockage of the river can only be mitigated with the construction of a fish ladder. However, this is not recommended as the river is subjected to blockage at many places downstream of the proposed dam and none of these dams contains measures to facilitate free movement of fish across the dam. Therefore, incorporation of measures to facilitate free movement in this particular instance will not be an affective measure.

Construction of new roads and road widening will account for the highest number of removal of trees while the establishment of the reservoir will account to the next highest. Removal of

trees due to other construction activities can be considered insignificant as most of these activities are carried out in abandoned lands or private land that has no natural habitats.

Main mitigation measures recommended with respect to the ecological environment are the replantation of a 100 m buffer zone which will be planted with native plant species around the high flood level of the proposed reservoir to compensate for the loss of trees and the release of 1.5 m^3/sec water continuously from the reservoir to satisfy the downstream water requirements including ecological demands.

In addition, impacts such as disturbance to man and wildlife due to noise and vibrations arising due to construction activities, pollution of air and surface water, soil erosion, influx of labor into the site have been identified.

There are two major users of the Mahaweli river waters downstream of the proposed dam, the Crysbro Broiler Processing Industry and the Gampolawela Irrigation Scheme fed by the Dunhinda Irrigation feeder canal using water from the Mahaweli Ganga. These users will be adversely affected by the project unless proper measures are taken to mitigate the impacts.

CEB will carry out all necessary modifications to the water intake of the Crysbro Industry at it's present location so that the required quantity of water is diverted through the intake throughout the year. All costs associated with such improvements will be borne by CEB.

The Dunhinda irrigation feeder canal conveying water to the Gampolawela Irrigation Scheme looses water on its way to the Scheme. In order to get the maximum benefit from the releases downstream, CEB will design and construct the existing diversion facilities and will repair rehabilitate the stretch of the canal within the proposed project premises. This will be looked into during the detailed design stage in consultation with the Irrigation Department.

These two major users of the river waters will benefit in terms of a reliable supply of water downstream during the operation of the project provided that a continuous downstream release is made from the reservoir during the operation of the project. In addition, the Crysbro Industry will benefit from improved access facilities in the area that will be developed under the proposed project. In these respect, during the operational phase, CEB will have to closely deal with the Irrigation Department and the Dept. Agrarian Development with regard to the water releases to the Irrigation Scheme and prepare a scheme to release the water requirements of the Crysbro industry avoiding any conflicting situations.

Sand miners are also a vulnerable section of the community due to the implementation of the project while there are some farmers who will be affected during construction works of the tunnel for a short period of time. Accordingly, measures to be undertaken to correct the situation have been proposed. CEB will also observe and study the sediment flow data to monitor the effects on these sand miners.

Reservoir FSL will lie very near to the Ulapane Industrial Estate and the stability of slopes in this area due to water level fluctuations is a concern of the investors of the Industrial Estate. It is therefore proposed that studies may be undertaken during detailed designs to assess the stability of these slopes around the reservoir area. Nevertheless measures to stabilize the embankments has been proposed.

During tunneling, there can be temporary lowering of ground water levels and disturbances to the drinking water wells located on the surface area of the land corridor demarcated for constructing the proposed tunnel. Small extent of paddy lands which depends on the waters from the nearby natural streams will also be affected by lowering of ground water levels. However in this project most of the water users will have access to pipe borne water from the Towns South of Kandy Water Supply Project of the Water Supply & Drainage Board.

Compensation for all those negatively affected have been proposed, be it temporary or of permanent nature.

The project would also generate positive environmental benefits besides those mentioned above as it will replace the need for Thermal power plant which would be the next generation alternative considering the capacity of the project. Being a hydropower project, it will produce cleaner energy than other options as it burns no fuel and does not produce greenhouse gas (GHG) emissions, other pollutants or wastes associated with fossil fuels which lead to climate change and its impacts. The country will also save on foreign exchange that would have otherwise spent on a fossil fuelled power plant operations.

Most of the impacts mentioned can be mitigated by following environmental best practices during design, construction and operation of the hydropower plant. Mitigation of these impacts will have to be achieved through rigorous monitoring programmes that will be implemented before the project commencement, during and after the projet construction.

Also in keeping with more recent governmental guidelines, EIA study has also looked at potential disasters in the context of failure of dam and on disaster management. Dam break modelling could be carried out during the detailed designs for preparing the Disaster Management Plan.

A Comprehensive Monitoring Plan including Compliance Monitoring and Impact Confirmation have been presented. The EIA study has given emphasis on the establishment of a reliable and sustainable institutional mechanism to monitor the impacts and has given the associated monitoring costs.

The functions of the Environmental Monitoring Committee which will play a vital role for the implementation of the Monitoring Programme will give due recognition to stakeholder participation and addressing public concerns.

On the basis of the above analysis and on the assumption that the recommended mitigatory measures are duly implemented and monitored in accordance with the guidelines given in the EIA study, it is concluded that there are no major adverse environmental impacts with the proposed construction and operation of the Moragolla Hydropower Project.

The Moragolla hydropower project is therefore capable of meeting the demand for electricity with least environmental impacts.

REFERENCES

1. Bambaradeniya, C.N.B. (Editor), 2006. Fauna of Sri Lanka: Status of Taxonomy, Research and Conservation. The World Conservation Union, Colombo, Sri Lanka & Government of Sri Lanka. viii + 308pp

2. Bates, P.J.J. and Harrison, D.L. (1997). *Bats of the Indian sub continent.* Harrison Zoological Museum. London.

3. Bedjanic, M., Conniff, K. & G. de S. Wijeyeratne (2007) Dragonflies of Sri Lanka. Jetwing Eco holidadays.248p.

4. Central Engineering Consultancy Bureau, Al Habshi Consultants (Kuwait) (2009) Moragolla Hydropower Project Feasibility Study

5. Ceylon Electricity Board (2005), Long Term Generation Expansion Plan 2006-2020

6. Ceylon Electricity Board (2008), Long Term Generation Expansion Plan 2009-2022

7. Ceylon Electricity Board, Deutsche Gesellschaft Fur Technische Zusammenarbeit, Lahmeyer International – Decon Consulting Engineers, Central Engineering Consultancu Bureau (1988), Master Plan for Electricity Supply of Sri Lanka

8. d' Abrera B., (1998), *The Butterflies of Ceylon,* wildlife Heritage trust, Sri Lanka

9. Das, I. & Anslem de Silva. 2005. *Photographic guide to snakes and other reptiles of Sri Lanka.* New Holland Publishers, UK.Ltd. 144 pp.

10. Dassanayake, M. D. and Fosberg, F. R. (eds.) (1980). A Revised Handbook to the Flora of Ceylon, Vol. I, Amerind Publishing, New Delhi;

11. Dassanayake, M. D. and Fosberg, F. R. (eds.) (1981 - 1991). A Revised Handbook to the Flora of Ceylon, Vols. II - VII, Oxford & IBH Publishing, New Delhi;

12. Dassanayake, M. D., Fosberg, F. R. and Clayton, W. D. (eds.) (1994 - 1995). A Revised Handbook to the Flora of Ceylon, Vols. VIII - IX, Oxford & IBH Publishing, New Delhi;

13. Dassanayake, M. D. and Clayton, W. D. (eds.) (1996 - 2000). A Revised Handbook to the Flora of Ceylon, Vols. X – XIV, Oxford & IBH Publishing, New Delhi;

14. Dassanayake, M. D., Clayton, W. D. and Shaffer-Fehre, M. (eds.) (2006). A Revised Handbook to the Flora of Ceylon, Vols. XV Part A & Part B, Science Publishers, USA.

15. Dutta, S. K. & K. Manamendra-Arachchi, 1996. *The amphibian fauna of Sri Lanka.* Wildlife Heritage Trust of Sri Lanka, Colombo. 232 pp.

16. Environmental Impact Assessment Report for proposed Southern Highway, University of Moratuwa, 1996

17. Environmental Impact Assessment Report on 300 MW combined cycle power plant at Kerawalapitiya, 2003

18. Environmental Impact Assessment Report of the Proposed Hambanthota Sea Port, Central Engineering Consultancy Bureau , 2006

19. Goonatilake, S. de A. (2007) Freshwater fishes of Sri Lanka. Biodiversity Secretariat of Ministry of Environment and Natural Recourses, Sri Lanka. 134p.

20. Harrison, J. 1999. *A Field Guide to the Birds of Sri Lanka.* Oxford University Press.

21. IUCN (2008). The list of threatened species. WWW.IUCN.redlist.org

22. IUCN Sri Lanka and the Ministry of Environment and Natural Resources (2007) The 2007 Red List of Threatened Fauna and Flora of Sri Lanka, Colombo, Sri Lanka. xiii+148pp.

23. Kotagama S. & Fernando, P. (1994) A field geode to the Birds of Sri Lanka. WHT Publications, Sri Lanka. 224 pp.

24. Ministry of Environment and Natural Resources and Ministry of Lands,(2003) Guidelines for the preparation of a resettlement Action Plan (NIRP)

25. National Building Research Organization (2009) Report on Landslide Hazard Investigation for the Proposed Moragolla Hydropower Project

26. Natural Resource Management Centre, Department of Agriculture, Peradeniya (2009) Soil Conservation Plan for the Mitigation of Soil Threats for the proposed Hydropower Project

27. Phillips, W.W.A. 1935. *Manual of the Mammals of Ceylon.* Ceylon Journal of Science, Dulau and Company, London.

28. Rao, N.V. S. (1989) Handbook Freshwater Molluscs of India. Zoological Survey of India, Calcutta. 289p

29. Senaratna, L.K. (2001). A check list of the flowering plants of Sri Lanka. National Science Foundation, Colombo 451pp.

30. Wijeyeratne, G, De S. (2008) A Photographic guide to Mammals of Sri Lanka. New Holland Publishers (UK) Ltd. 128p.