CHAPTER 8

ENVIRONMENTAL IMPACT SURVEY

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8.1 Laws, Guidelines, and Procedures of Sri Lanka

Environmental Impact Assessment (EIA) in Sri Lanka is operated based on the National Environmental Act (NEA) amended in 1988. The detailed procedures are established in National Environmental (Procedure for Approval of Projects) Regulations No. 1 of 1993, as contained in gazette extraordinary No. 772/22 of June 24, 1993. The formats of the EIA documents are identified in the Guidance for Implementing the Environmental Impact Assessment Process No. 1: A General Guidance for Project Approving Agencies, Third Edition (Ministry of Forestry and Environment, Colombo, 1998), pp. 44-45, 49. In addition to this guideline, detailed guidelines for specific sectors such as the road sector and the agricultural sector have been established. However, no guideline for the energy and power sector has been issued.

8.1.1 Adapted EIA Category

According to National Environmental Regulation No. 1 (1993), EIA or IEE is applied to all projects in consideration of degree of environmental impacts, after screening. The Victoria Expansion project was categorized as EIA-applicable after screening by Mahaweli Authority (MASL), Project Approval Agency (PAA), on June 30, 2008.

8.1.2 EIA Procedure

The EIA procedure is established in National Environmental Regulation No. 1 (1993). First, the Project Proponent (PP) prepares the Preliminary Information (PI) and submits it to the Project Approving Agency (PAA). Second, PAA conducts screening, and issues the TOR for EIA or IEE. Third, PP carries out baseline survey and impact assessment and prepares the EIA report (EIAR). Fourth, PAA reviews EIAR, discloses EIAR to the public, and sends comments to PP. Fifth, PP replies to the comments of PAA. PAA reviews the reply from PP, and decides whether or not to approve EIAR. These procedures are shown in **Figure 8.1.2-1**.

The regulation stipulates the duration of scoping as 30 days excluding holidays. In practice, however, the operation duration is around 90 days including holidays, although the regulation states 30 days excluding holidays. Similarly, the duration of reviewing EIAR in practice is about 60 days including holidays in spite of stipulation of 30 days excluding holidays.

Study Team supported CEB from time after a scoping meeting up to time immediately before EIAR reviewing by PAA.

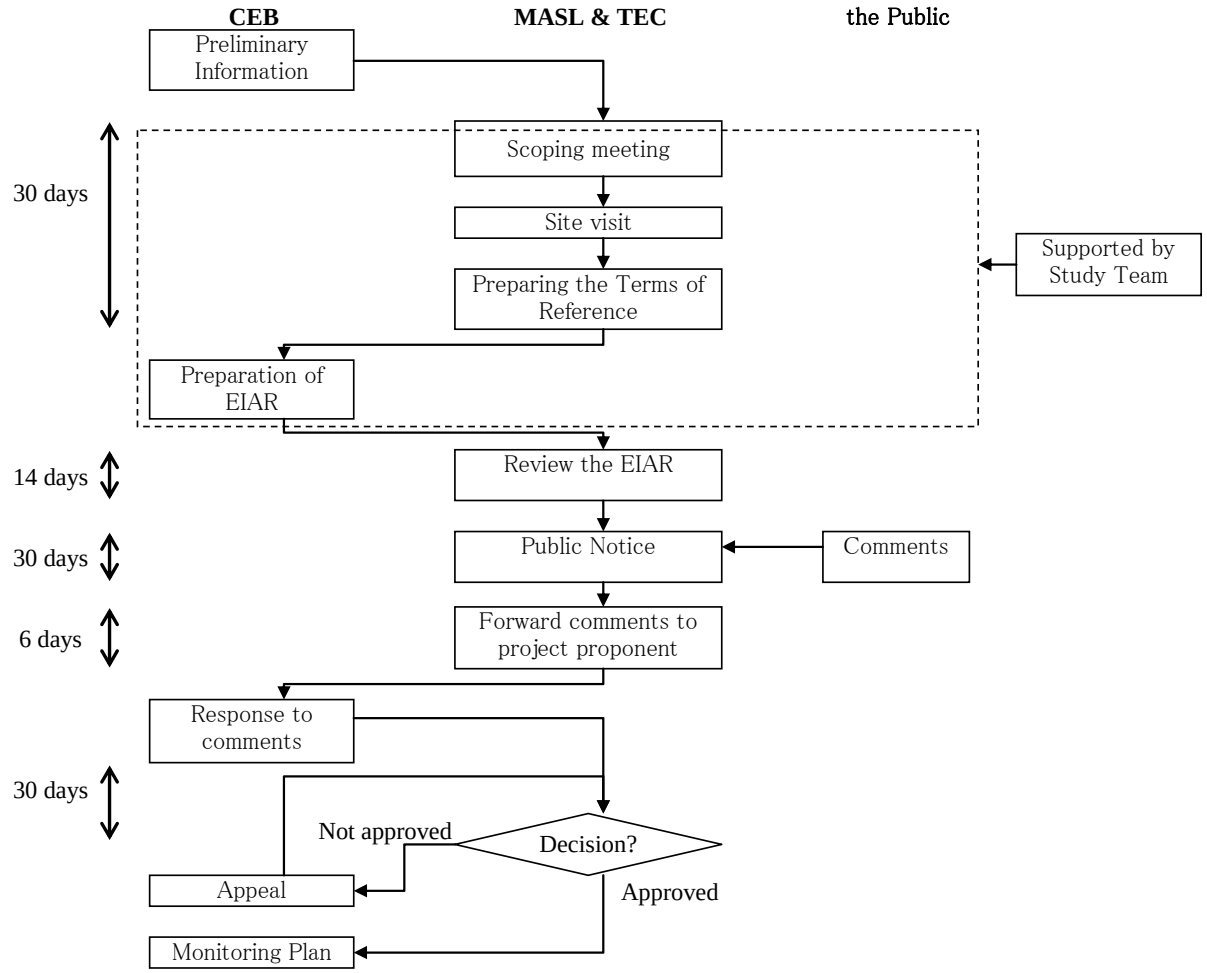


Figure 8.1.2-1 EIA Procedure

Procedure up to July 2008

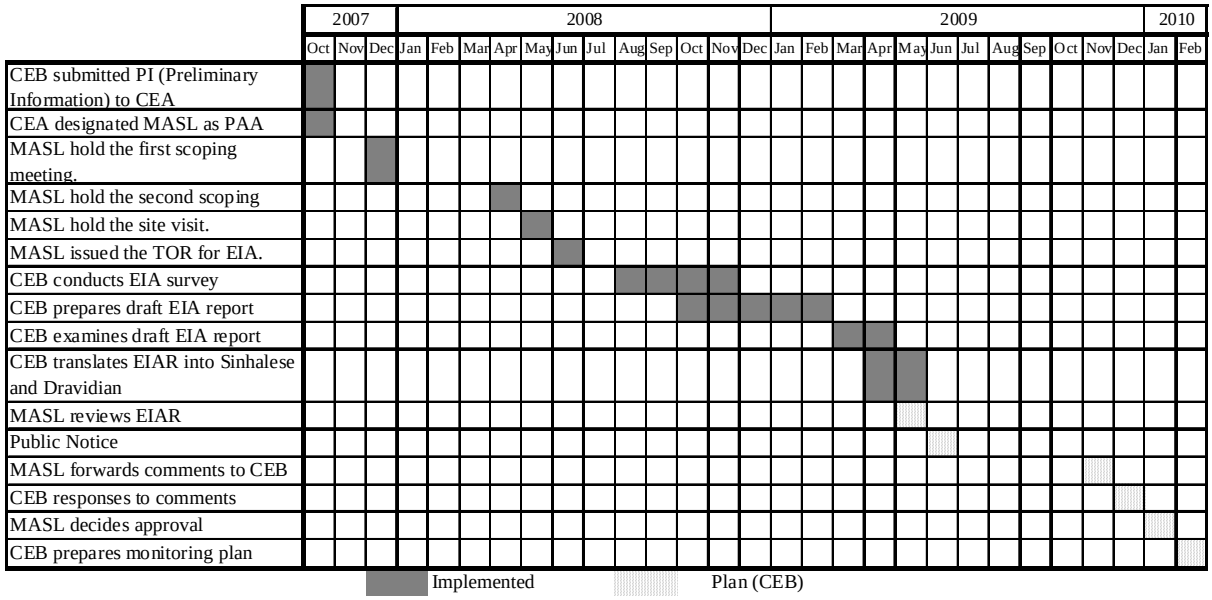
Procedures of EIA for the Study went through a different way from usual. The scoping meeting, which is to be held once, was held twice. After the first scoping meeting in December 2007, the procedure was suspended. As CEB had not selected any of the three options by the time of the meeting, the scoping committee decided to conduct thorough impact assessment for all three options. Then the Central Environmental Agency (CEA) suggested that PAA should issue comprehensive TOR for EIA, and PAA agreed to do so before PP's choosing any option. After then, the second scoping meeting was held in April 2008, and the TOR for EIA was issued at the end of June 2008. Eventually, it took five months, including holidays, from submitting PI to issuing TOR for EIA. This process usually takes 30 days excluding holidays. **Table 8.1.2-1** shows progress of EIA procedure for the Project.

Table 8.1.2-1 Progress of EIA Procedure on the Project (Until May 2009)

Date	Action	Remarks
14 Oct. 2007	CEB submitted PI (Preliminary Information) to CEA.	One option has not been selected from three options yet in the PI.
24 Oct. 2007	CEA designated MASL as PAA (Project Approving Agency)	
12 Dec. 2007	MASL hold the first scoping meeting.	CEB gave up continuing the EIA procedure, because TEC suggested CEB to assess the environmental impact for three options equally.
12 Mar. 2008	CEB send CEA an official letter to advice MASL for scoping.	
18 Apr. 2008	CEA send MASL an official letter to prepare a comprehensive TOR for EIA.	
29 Apr. 2008	MASL hold the second scoping meeting.	
22 May. 2008	MASL hold the site visit.	
30 Jun. 2008	MASL issued the TOR for EIA.	
25 May 2009	CEB submitted the EIA report to MASL	

The EIA site survey started in August 2008, and most of the survey has finished by November 2008. The EIA report was completed at the end of March 2009 and was submitted to MASL in May 2009. After Public Notice and reviewing EIAR, EIA for the project will be approved by January 2010 if there is no problem. The schedule for EIA is shown in **Table 8.1.2-2**.

Table 8.1.2-2 EIA Schedule



8.1.3 Related Organizations

The organizations related to this EIA procedure are PP, PAA, and Technical Evaluation Committee (TEC). **Table 8.1.3-1** shows the related organizations and their roles.

Table 8.1.3-1 Organizations Related to the EIA Procedure

Name	Organization	Role
Project Proponent (PP)	Ceylon Electricity Board (CEB)	Prepare PI, EIAR
Project Approving Agency (PAA)	Mahaweli Authority (MASL)	Hold scoping meeting and site visits, issue TOR/EIA, and approve or reject project
Technical Evaluation Committee (TEC)	Central Environmental Authority (CEA) Mahaweli Authority (MASL) Geological Survey and Mines Bureau Department of Archeology Department of Zoology, University of Colombo Divisional Secretaries and Chairmen of Local Authorities Wildlife Department	Participate in scoping meeting and site visits, prepare TOR for EIA, and prepare TEC report to be used in decision making

8.2 JICA Guidelines for Environmental and Social Considerations

This Expansion Project has been categorized as B because the project site is in the protected area, although the project does not construct a new reservoir. The Study follows "3.3.3.2 Study on Category B" in the JICA Guidelines for Environmental and Social Considerations (the JICA Guidelines), because it is a development study at the level of feasibility study.

EIA of the Study covers both TOR for EIA issued by MASL and the JICA guidelines.

8.3 Survey on Environmental and Social Considerations in Comparison Study of Alternative Options

8.3.1 Compared Options

The following three options have been compared:

(1) Basic Option

The existing intake facilities for expansion will be connected to a powerhouse in the area adjacent to the existing powerhouse. There is no need to lower the water level of the Randenigala reservoir during construction. The total water volume in average for power generation will hardly change, but the timing of utilizing water will change because of operation for peak demand.

(2) Downstream Option

A powerhouse will be located downstream of the existing powerhouse. The powerhouse will be of surface type.

The water level of the Randenigala reservoir needs to be lowered during construction. The total water volume in average for power generation will hardly change.

(3) Pumped Storage Option

In the pumped storage option, the Victoria reservoir functions as the upper reservoir, and the Randenigala reservoir plays the role of the lower reservoir. The powerhouse will be of underground type.

The water level of the Randenigala reservoir needs to be lowered during construction. The total water volume in average for power generation will hardly change, because water for generation is pumped up from the Randenigala reservoir to the Victoria reservoir and returned to the Randenigala reservoir after generation.

Figure 8.3.1-1 and **Figure 8.3.1-2** show the ground plan and profiles of the options, respectively.

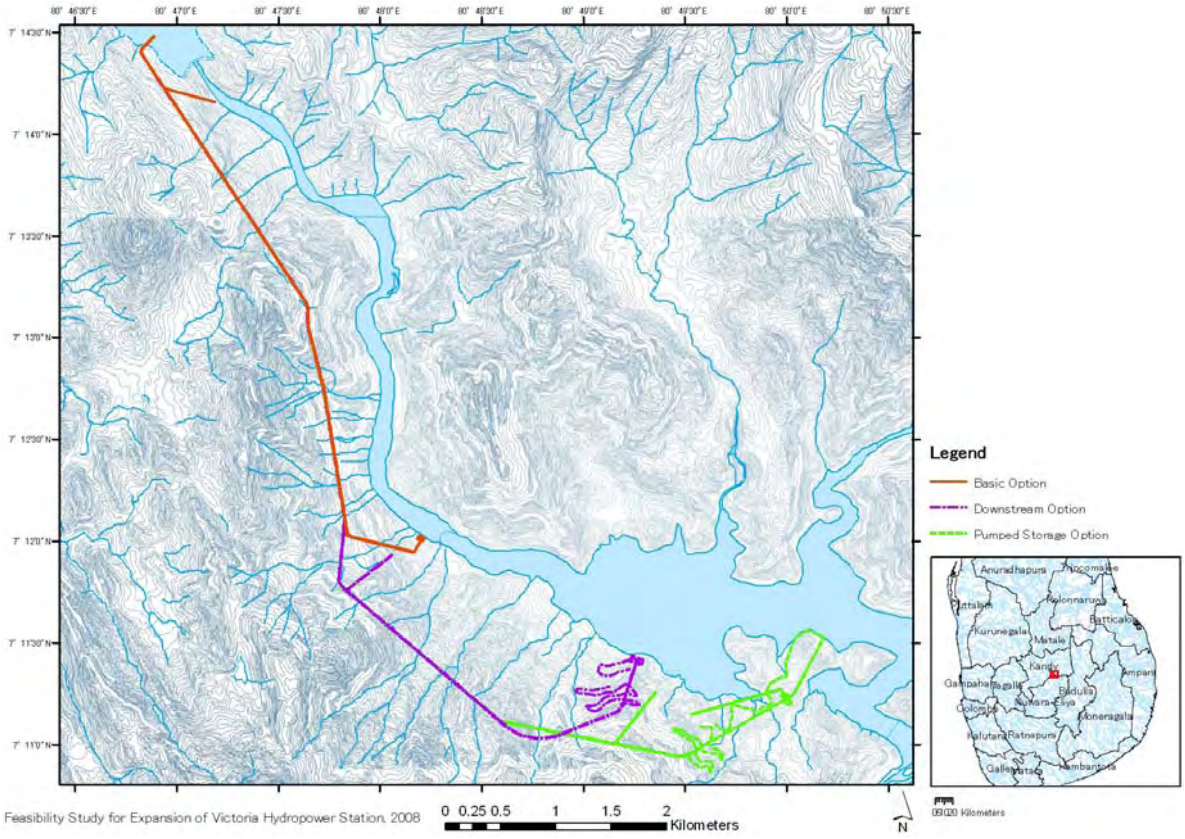


Figure 8.3.1-1 Options (Ground Plan)

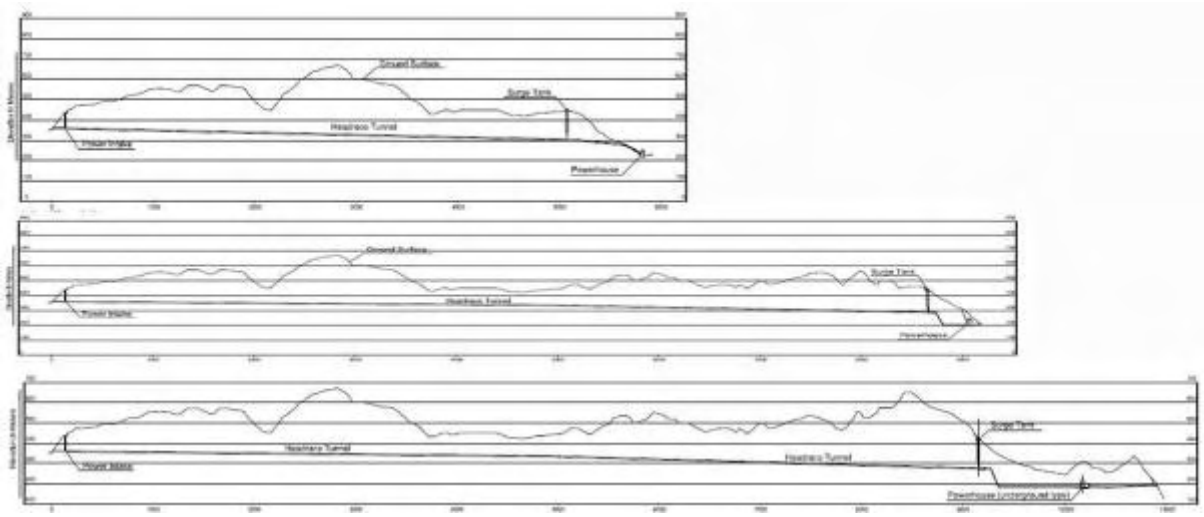


Figure 8.3.1-2 Options (Profiles)

8.3.2 Impact Assessment

(1) Economic and Technical Aspects

The evaluation in the economic and technical aspects is described in "**6.1 Comparative Study of Alternative Options**".

(2) Environmental Aspect (see EIA report 2.1 in detail)

1) Forest Cutting Area

Forest cutting is only caused by construction of new access roads and spoil bank areas because most of the structures are located underground. New access roads with the roadway width of 6 m are planned only for the downstream option and the pumped storage option. The forest cutting area is estimated only with the new access roads taken into consideration, because the layout of the spoil bank area was not identified during the comparison study. The forest cutting area due to the downstream option is 16,385 m^2, and that due to the pumped storage option is 20,677 m^2 (see **Table 8.3.2-1** and **Figure 8.3.2-1)**.

Table 8.3.2-1 Forest Cutting Area

Category	Basic Option (m^2)	Downstream Option (m^2)	Pumped Storage Option (m^2)
Forest (m^2)	0	16,385	20,677
Homestead	0	609	130
Scrub	0	-	1,581
Total	**0**	**16,994**	**22,388**

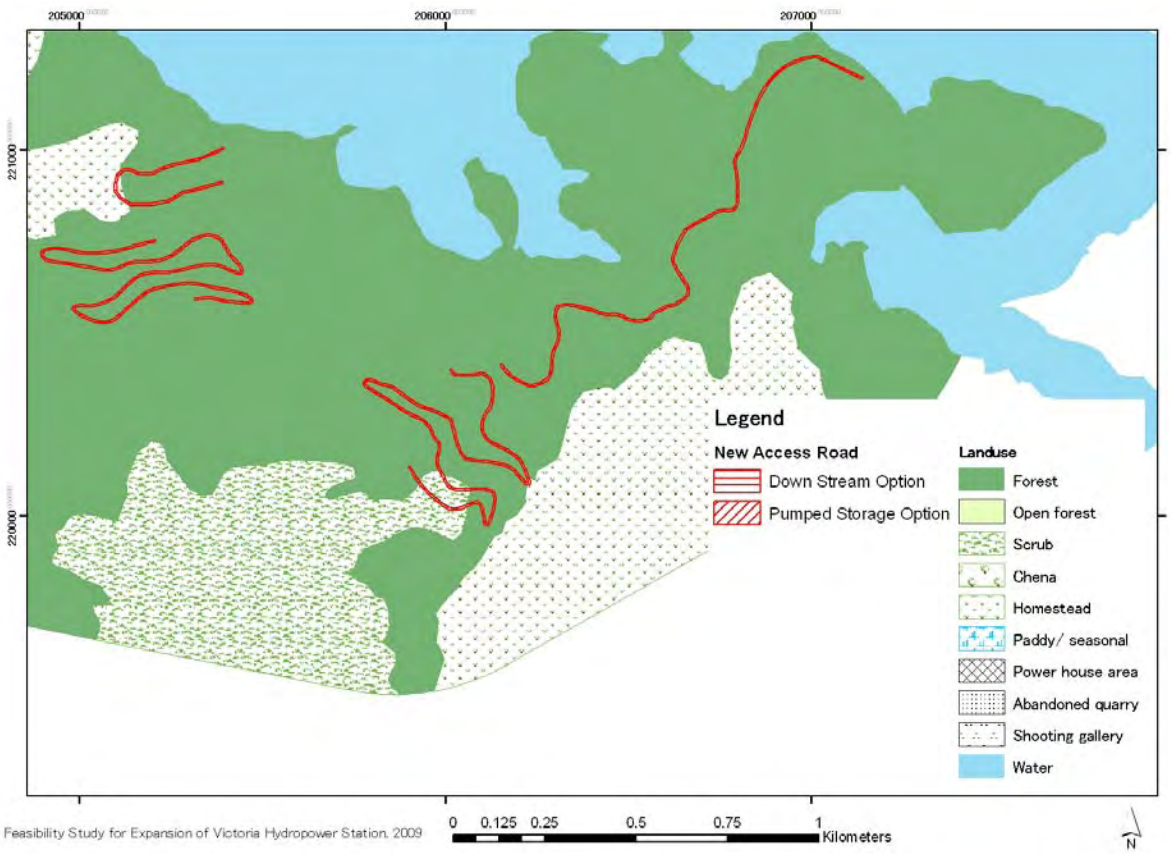


Figure 8.3.2-1 Forest Cutting Area by New Access Roads

2) Impact on Sanctuary

The impact area includes both the direct impact area and the indirect impact area. The direct impact area means the area where earth works are planned on surface. It includes new access roads and spoil bank areas. The indirect impact area means the area where groundwater might be lowered by tunnel excavation works or lowering the water level of the Randenigala reservoir. The indirect impact area is estimated to be within 600 m of both sides of the tunnel alignment, because the impact area is estimated as about twice of the earth cover depth, and the maximum earth cover depth along the tunnel alignment is 300 m (refer to **Figure 8.3.2-2**). Thus the estimated indirect impact area in the sanctuary is 206 ha by the basic option, 5,684 ha by the downstream option and 5,684 ha by the pumped storage option as shown in **Table 8.3.2-2**.

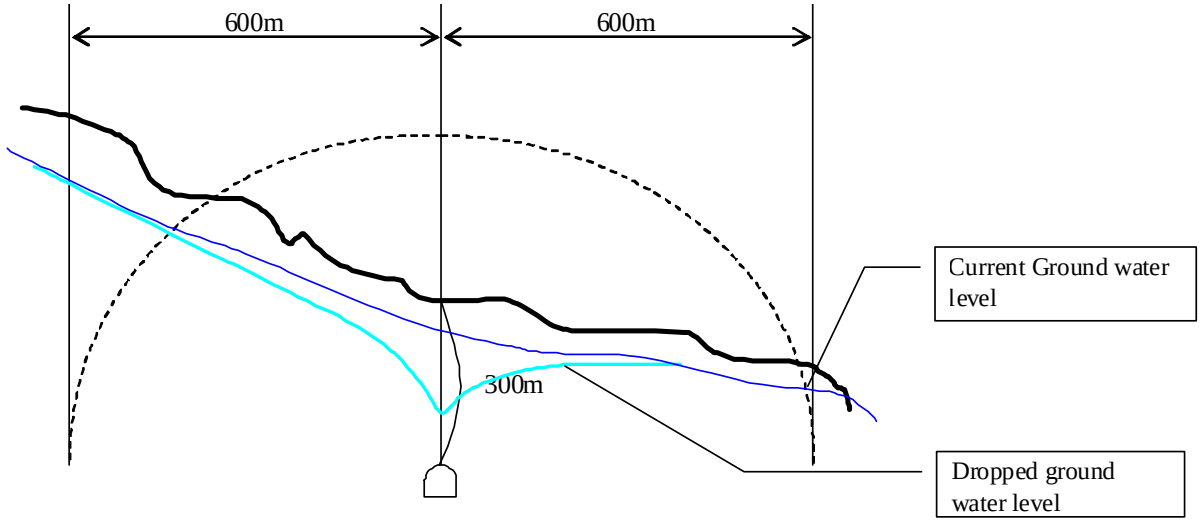


Figure 8.3.2-2 Image of the Mechanism of Dropping Ground Water Level

Table 8.3.2-2 Impacted Area on Sanctuary

Category		Basic Option	Downstream Option	Pumped Storage Option
Sanctuary	Direct Impact Area (ha)	0.0	1.7	2.2
	Indirect Impact Area (ha)	804.9	7,262.0	7,319.0
Proposed National Park	Direct Impact Area (ha)	0.0	0.0	0.0
	Indirect Impact Area (ha)	205.9	5,683.5	5,683.5

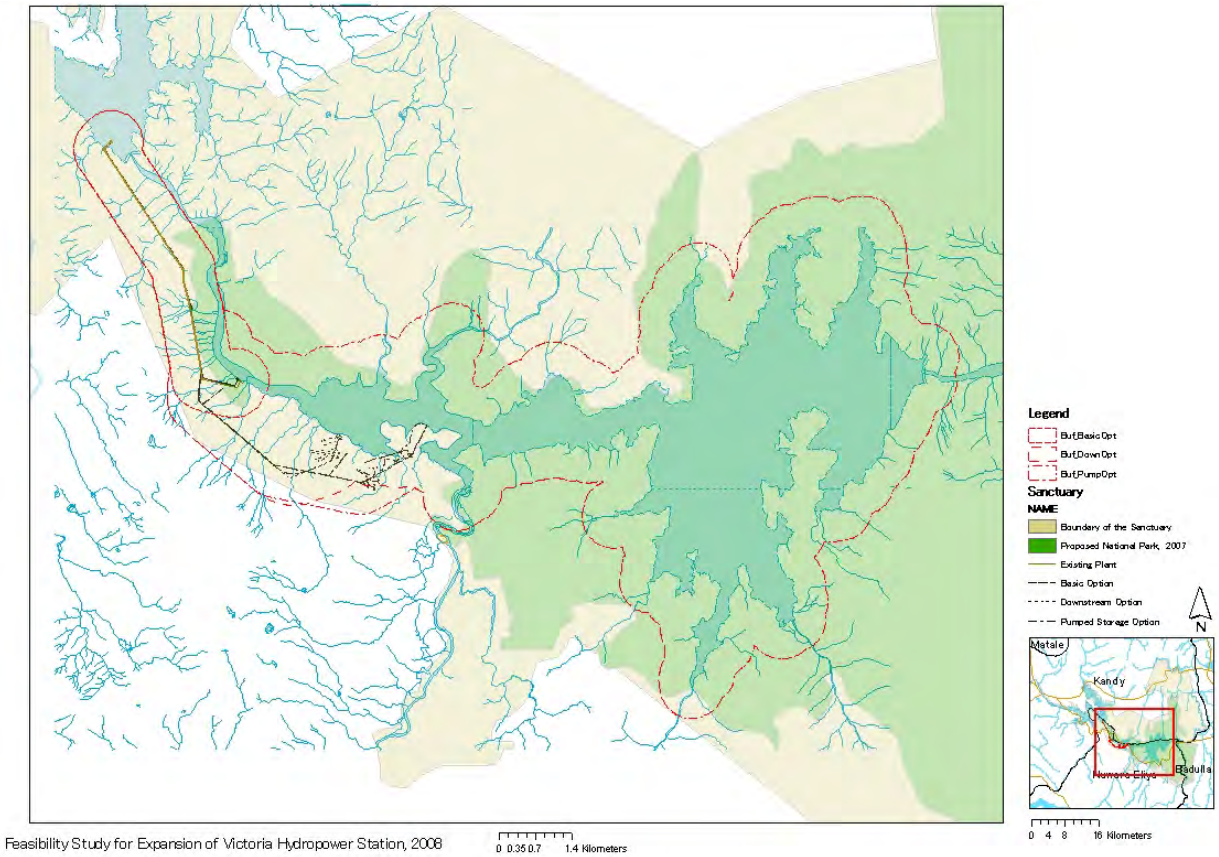


Figure 8.3.2-3 Indirect Impact Area on Sanctuary

3) Length of Access Road

New access roads are planned for the downstream option and the pumped storage option. The length of new access roads is 2.8 km for the downstream option and 3.7 km for the pumped storage option as shown in **Table 8.3.2-3**.

Table 8.3.2-3 Length of New Access Road

Item	Basic Option	Downstream Option	Pumped Storage Option
Road length (km)	0	2.8	3.7

4) Resettlement and Impact on Land Use

Resettlement and the impact on land use are estimated by overlaying the land use map and the direct and indirect impact areas. The land use map shows no resettlement. In the land use map, gardens, chena[1], and paddies are inside the indirect impact area (refer to **Figure 8.3.2-4** and **Table 8.3.2-4**).

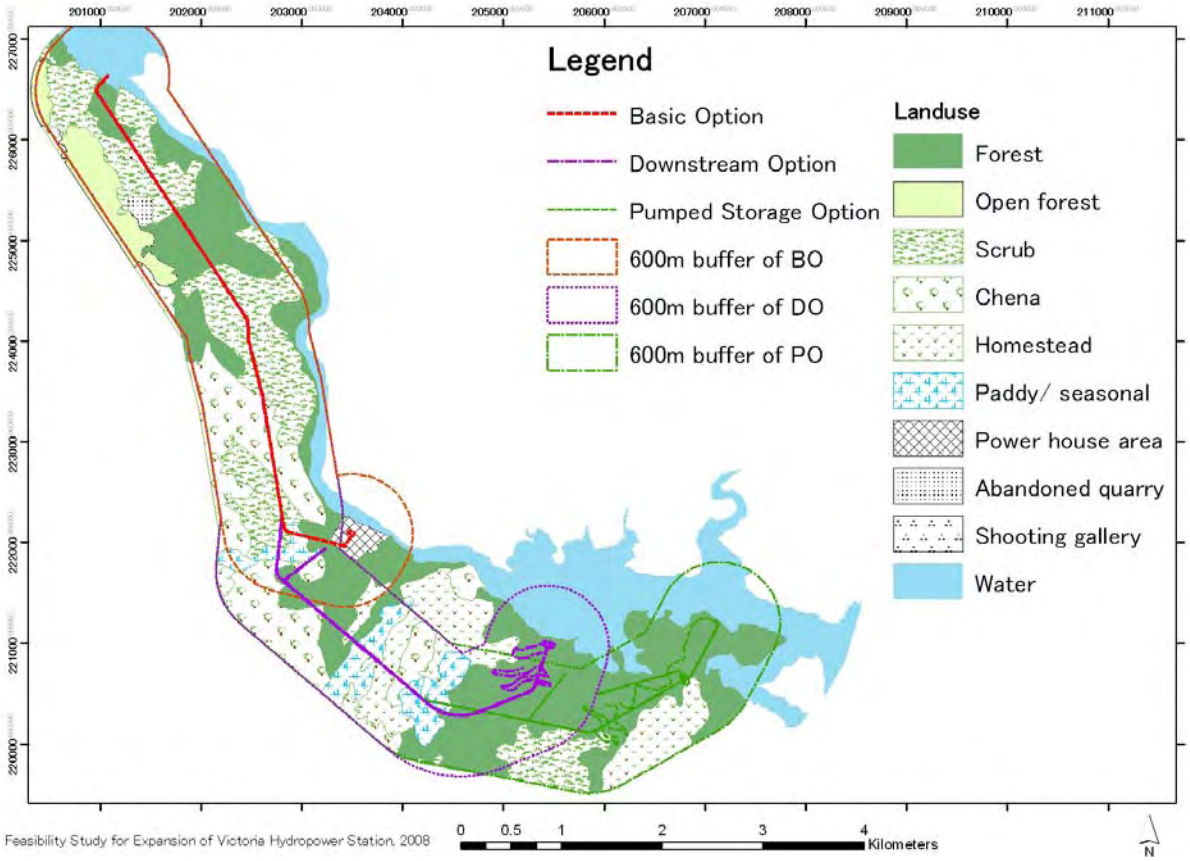


Figure 8.3.2-4 Indirect Impact Area on Land Use

[1] One of the swidden agriculture styles in Sri Lanka

Table 8.3.2-4 Land Use in the Impact Area (ha)

	Basic Option	Downstream Option	Pumped Storage Option
Forest	210.0	380.8	486.3
Open forest	52.0	52.0	52.0
Scrub	245.2	260.9	291.3
Chena	113.8	202.1	202.0
Homestead	10.6	68.2	116.4
Paddy/ seasonal	14.8	73.6	73.6
No vegetation	21.9	9.7	9.7
Total	**668.3**	**1,047.4**	**1,231.4**

(3) Social Aspect

1) Contribution to the Local Job Market

The impact on the local job market is to be estimated by comparing projected numbers of employment under different scenarios. However, it was difficult to estimate the number of jobs at this point as no detailed planning was ready. Thus the impact was estimated on the assumption that the impact depends on the size of construction works. Then the pumped storage option has the biggest impact, the downstream option the second biggest, and the basic option has the smallest impact on the job market.

2) Lowering Water Level of Randenigala Reservoir during Construction

During the construction of the outlet for the downstream option and the pumped storage option, the water level of the Randenigala reservoir will be lowered. As shown in **Table 8.3.2-5** below, the water level is estimated to be lowered by 23 m for one year in the downstream option and by 25 m for 1.5 years in the pumped storage option.

Table 8.3.2-5 Lowering of Water Level of Randenigala Reservoir

Category	Basic Option	Downstream Option	Pumped Storage Option
Lowering of water level	232 m → 232 m 0 m	232 m → 209 m 23 m	232 m → 207 m 25 m
Duration	-	1 year	1.5 years

3) Impact on the Existing Facilities above the Tunnel

The buildings above the tunnel alignment may be affected by both lowering groundwater level and vibration due to tunnel excavation. If the affected area is estimated to be within 600 m of both sides of the tunnel alignment, 57 buildings are affected by the basic option, 111 buildings by the downstream option, and 174 buildings by the pumped storage option (See **Table 8.3.2-6** and **Figure 8.3.2-5**).

Table 8.3.2-6 Estimated Impact on Buildings around Tunnel

Category	Basic Option	Downstream Option	Pumped Storage Option
Number of buildings	57 buildings	111 buildings	174 buildings
Duration	5 years	5.5 years	6 years

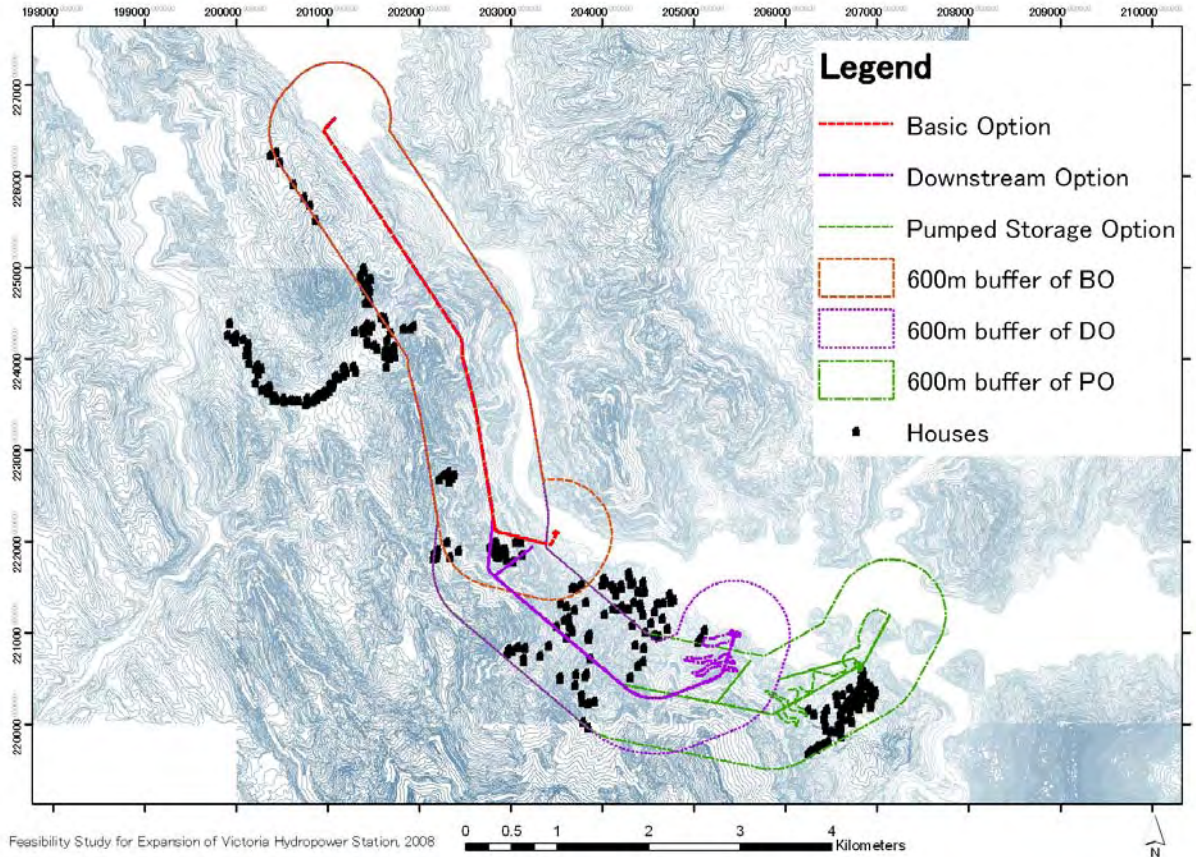


Figure 8.3.2-5 Buildings in the Affected Area

8.3.3 Results of Comparison

(1) Zero Option

If the Project and any alternative option are not implemented, there will be no negative environmental impact. However, power generation will not be able to meet power demand during peak time, and economic activities in the country and people's lives will be negatively affected.

(2) Comparison of Three Options

With all the items considered above, the basic option is preferable to the other options in both the economic and environmental aspects. **Table 8.3.3-1** shows a summary of comparison.

Table 8.3.3-1 Comparative Table for Three Options

	Items	Basic Option	Downstream Option	Pumped Storage Option
Economic aspect	Effective head (m)	** 170	*** 175	* 165
	Annual energy	*** 1.0	*** 1.0	** 0.9
	Construction period	*** 5.5 years	** 6.0 years	* 6.5 years
	Construction cost	*** 1.0	** 1.3	* 1.8
	Reduction in energy during construction	*** 0	** -11%	* -34%
Environmental aspect	Forest cutting area by access roads (m^2)	*** 0 m^2	** 16,385 m^2	* 20,677 m^2
	Impact on sanctuary (ha)	*** 804.9 ha	** 7,262.0 ha	* 7,319.0 ha
	Length of new access road (m)	*** 0 m	** 2,823 m	* 3,722 m
	Indirect impact on land use (ha)	*** Forest: 210 Scrub: 245 Chena: 114 Homestead: 10 Paddy: 15	** Forest: 381 Scrub: 261 Chena: 202 Homestead: 68 Paddy: 74	* Forest: 486 Scrub: 291 Chena: 202 Homestead: 116 Paddy: 74
Social aspect	Increase in jobs	*	**	***
	Decrease of water level of Randenigala reservoir during construction	*** 0 m	** 23 m, 1 years	* 25 m, 1.5 years
	Impact on the existing facilities	*** 57 buildings	** 111 buildings	* 174 buildings

***: Best **: Second best *: Worst

8.4 Survey on Environmental and Social Considerations for Optimal Option

8.4.1 Study Plan

(1) Selected Expansion Plan

Main permanent structures of the selected expansion plan consist of headrace tunnel, surge tank, penstock, and powerhouse. The intake and access tunnel in the middle have been constructed. In addition to the permanent structure, temporary facilities such as batching and crushing plants and spoil banks are needed (See Chapter **10**). **Figure 8.4.1-1** shows the tunnel alignment, temporary facilities areas and spoil bank areas.

Table 8.4.1-1 shows construction works and major construction machines and vehicles to be used at each construction site.

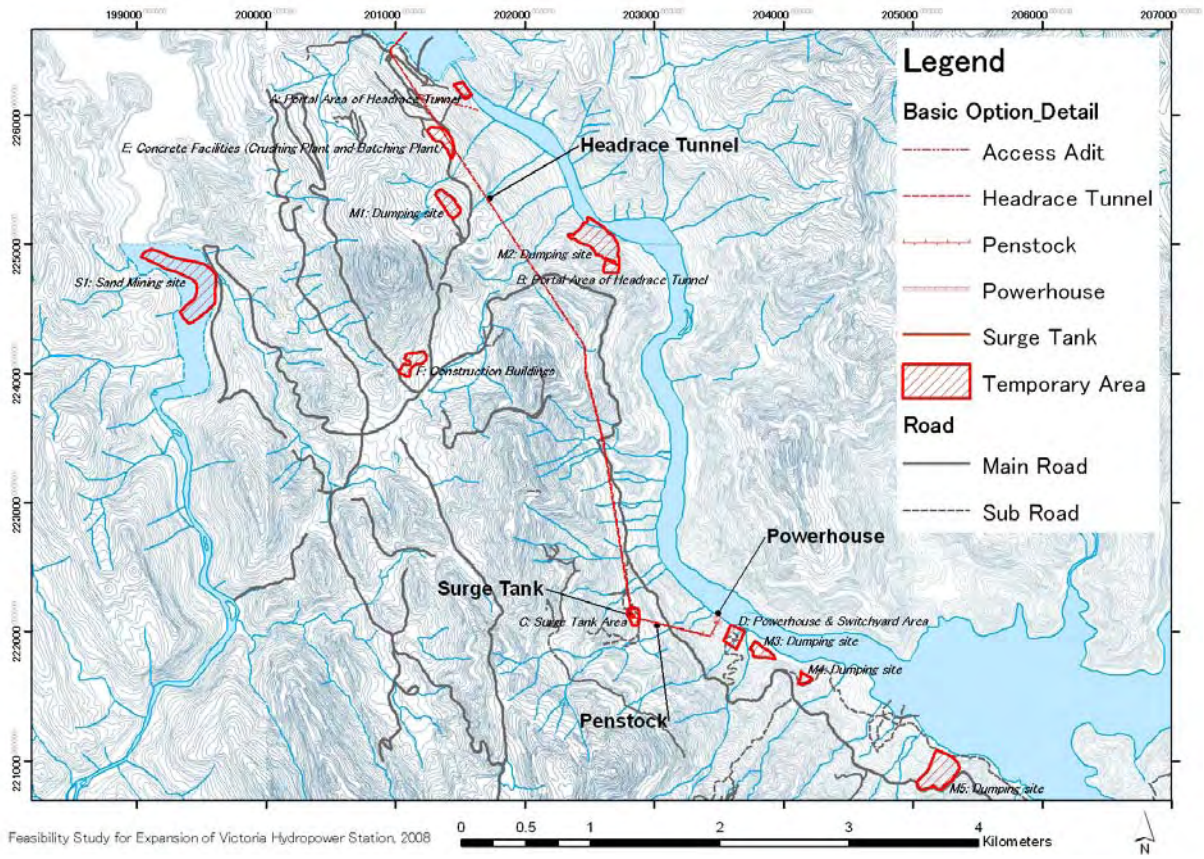


Figure 8.4.1-1 Layout of the Plan

Table 8.4.1-1 Location of Construction Plant, Machine, and Vehicle

No	Candidate for Temporary Facility Area	Kind of work	Major Construction Plant, Machine, and Vehicle
A	Portal Area of Headrace Tunnel (Upstream)	Excavation of Tunnel Portal, Support of Tunnel Works (mucking, ventilation, transportation of materials, repair of machines, etc.)	Agitating Truck, Concrete Pump, Air Compressor, Ventilating Fan Dump Truck, Bar Bender, Welding Machine, Pump, Generator for emergency
B	Portal Area of Headrace Tunnel (Middle stream)	Support of Tunnel Works (ventilation, repair of machines, etc.)	Agitating Truck, Concrete Pump, Air Compressor, Ventilating Fan, Dump Truck, Bar Bender, Welding Machine, Pump, Generator for emergency
C	Surge Tank Area	Excavation of Surge Tank Shaft, Support of Surge Tank Shaft Excavation (mucking, transportation of materials, repair of machines, etc.)	Muck Loader, Dump Truck, Drilling Machine, Air Compressor, Crane, Concrete Pump, Bar Bender, Welding Machine, Pump, Generator for emergency

No	Candidate for Temporary Facility Area	Kind of work	Major Construction Plant, Machine, and Vehicle
D	Headrace (Downstream) Penstock, Powerhouse & Switchyard Area	Excavation of Tunnel Portal, Support of Tunnel Works (mucking, ventilation, transportation of materials, repair of machines, etc.) Open Excavation Works, Installation of Steel Penstock Pipes, Concreting, Installation of Electromechanical Equipment	Excavator, Muck Loader, Bulldozer, Dump Truck, Air Compressor, Crawler Drill, Ventilating Fan, Concrete Pump, Bar Bender, Welding Machine, Agitating Truck, Vibrator, Crane, Truck, Flat Bed Truck, Pump, Generator for emergency
E	Concrete Facilities (Crushing Plant and Batching Plant)	Producing of concrete aggregates and concrete	Crushing Plant Batching Plant Dump Truck Wheel loader Agitating Truck, Generator for emergency, Water Treatment Plant, Pump
F	Construction Buildings	Office Work	Passenger car
S1	Sand Mining site	Mining sand, Loading sand	Backhoe, Dump Truck
M1	Dumping site (Existing Borrow Area)	Unloading of muck, Leveling	Dump Truck, Bulldozer
M2	Dumping site (Existing Spoil Bank for Headrace)	Unloading of muck, Leveling	Dump Truck, Bulldozer
M3	Dumping site (Existing Temporary Area for Powerhouse)	Unloading of muck, Leveling	Dump Truck, Bulldozer
M4	Dumping site (Existing Spoil Bank for Powerhouse)	Unloading of muck, Leveling	Dump Truck, Bulldozer
M5	Dumping site (Stream at 2.4 km Downstream of Powerhouse)	Unloading of muck, Leveling	Dump Truck, Bulldozer
L1	Tunnel route	Drilling, Blasting, Scaling/Trimming, Loading of muck, Shotcrete, Concreting, Grouting	2-(3) Boom Jumbo, Muck Loader, Shotcrete Machine, Concrete Pump, Vibrator, Pump
L2	Roads (Between the sites)	Transportation of muck, Transportation of materials and equipment parts	Dump Truck, Grader, Pick-up Truck, Flat Bed Truck, Grader

(2) Scoping

EIA Team hired by Study Team conducted informal public hearing at four places for three days as shown in **Table 8.4.1-2**. The EIA Team explained outlines of the project and asked the people about anticipated items at the hearings. Based on the result of the hearings (see **Table 8.4.1-3**) EIA Team reviewed the scoping matrix and revised the environmental impact items. Pointing evaluations are used for scoping methodology. The picked up items are a positive impact on decreasing CO_2, negative impacts on siltation in streams due to soil erosion at a spoil bank and on local culture, in addition to the items suggested by Study Team. The scoping results are shown in **Table 8.4.1-4** and **Table 8.4.1-5**.

Table 8.4.1-2 Date and Place of the Informal Public Hearing

Date	Place	Number of the participants	Covered GN Divisions
2008.09.08	Hingurukaduwa Temple	47	Hingurukaduwa, Ambewela
2008.09.08	Kottegoda Temple, Adikarigama	31	Bogahalanda, Gangaudagama, Adikarigama, Welikada, Idamalanda
2008.09.10	Sanasa Development Bank, Udawattha	23	Malulla, Udawaththa East and West, Galauda North and South
2008.09.11	Hilpenkandura Communityhall	27	Hipenkandura, Endiribedda

Table 8.4.1-3 Anticipated Impacts by Villagers

- Water Problems
  - Decrease the water level in the wells
  - Changing the rainfall systems
  - Difficult to access the drinking water sources
  - Drying water sources
  - Siltation
  - Impact to the ground water sources
- Agricultural Problems
  - Loss of the cultivated lands
  - Difficult to take water sources for cultivation lands
  - Difficult to cultivate the vegetables
  - Impacts from the wild animals
- Other Social Problems
  - Impacts to the houses (vibrations)
  - Problems of the compensation
  - Loss of the employment opportunities
  - Resettlements
  - Increasing the land slide problems
  - Increasing the human- elephant conflict

Table 8.4.1-4 Scoping Table

Environmental Parameter		Project Activities																														
		Planning Stage		Construction																							pearation		Restorat		Ranking	
		Surveying/feasibility study /EIA	Public Meetings	Tunnel												Camp sites and workshop							Building Access Roads		Power House related		Power House		Restoration of damaged sites	Conservation		
				Drilling	Blasting	Transport of explosives	Storage of explosives	Disposal of explosives	Waste transport	Waste dumping	Tunnel lining	Tunnel drainage	Ventilation	Water supply	Power supply	Land preparation	Construction of buildings	Construction of temp. facilities	Provision of Sanitary facilities	Material transport and storage	Equipment maintenance	Maintaining labour camps/workshops	Land preparation	Road surfacing and drainage	Land preparation	Construction	Operation of the plant	Maintaning the plant				Potential Impact
Physical	Soil			3	3			6		12						10							12		4				6	8	9	Soil erosion from waste dumps and road construction
	Slope stability			2	2											2							6		6				5	5		Landslides/slips
	Surface drainage			8	10					8		10				8	2	3					8	7	8							Temporary Alteration to Surface drainage patterns
	Ground water table			20	20																										2	Temporary lowering of ground water
	Surface water quality						4	16	6	16		16				12	4	4			14	10									5	Pollution of surface water from tunnel discharge
	Ground water quality							12		8		4							5		6										10	Ground Water Pollution
	Increased Noise and vibration			10	10											8	8				7		8									Incresed noise blasting sites/workshops/
	Air quality					2			6	8						8	8	6		6	4	6	8	10	8				8	8		Air pollution at plants/blasting sites
Existing Structures	Existing tunnel			16	20																										3	cracking
	Dam			1	1																											cracking
	Power house			1	1																											cracking
	Transport network			4	4											2	2	2		12											11	deterioration due to increase of heavy traffic
	Dwellings			4	4																											cacking
Biotic	Forest Cover									16						10							9								8	reduction of forest cover at dumping sites
	Species Diversity flora							12		16		8				10					8		9								7	reduction of forest cover at dumping sites
	Species Diversity fauna							12		16		8				10					8		9								7	migration of some species due to noise and activities
	Elephants									10						5											16					Drowning of elephants in the tailrace
Social	Employment opportunities					2	1	1	2	2																						
	Employment opportunities/local					1				6				8		10	10	12			6	12	12	9					12	12	9	Increase in regional employment opportunities
	Encroachment																															Increase in local economic opportunities
	Community cohesion																					10										Conflicts due to unequal benefits
	Atttitude towards the project	12	12																												10	Building a positive impression on the project
	Uncertainity on the future of AP	10	10																													Increase temporarily
	Migration																															temporary in-migration
	Local culture																					12									10	disturbances from the labourers
	Religious places																															increased contributons
	Health			16	16																										6	increase in work related accidents
	Dometic water supply			20	20																										2	Temporary reduction due to lowering of ground water
	Cultivation			20																											2	Temporary reduction due to lowering of ground water
	National Economy																										25				1	reduce carbon fuel/foreign exchage savings
	Local economy																					16						16	16	16	4	injection of capital to the local economy

Table 8.4.1-5 Identified Significant Impacts

Type of Impact		The Description of the Impact
NEGATIVE	1	Temporary lowering of ground water affecting domestic uses
	2	Temporary reduction in agricultural production (paddy) to lowering of ground water
	3	Impact on the integrity of the existing tunnel
	4	Pollution of surface water from tunnel discharge
	5	Increase in work related accidents
	6	Reduction of forest cover at dumping sites
	7	Disturbance some species due to noise and other activities
	8	Soil erosion at tunnel muck dumping sites
	9	Ground water pollution
	10	Disturbances to the community from the workers
	11	Deterioration due to increase of heavy traffic
	12	Obstruction to the migratory movement of elephants
	13	Loss of land due to tunnel muck dumping
POSITIVE	1	Reduce carbon fuel/foreign exchange savings
	2	Injection of capital to the local economy
	3	Increase in regional employment opportunities
	4	Building a positive impression on the project

8.4.2 Survey Results

(1) Natural Environment

1) Topography

The project site is located on slope land of EL. 250 to EL. 800 m. The headrace tunnel is planned underground of the steep west bank of the Mahaweli River, which runs in a northwest-southeast direction (**Figure 8.4.2-1**). A number of small tributaries that traverse the area flow in an easterly and northeasterly direction to join the Mahaweli river. The river valleys are covered with boulders fallen from the steep valley-side slopes. (See EIA report 3.1.2.)

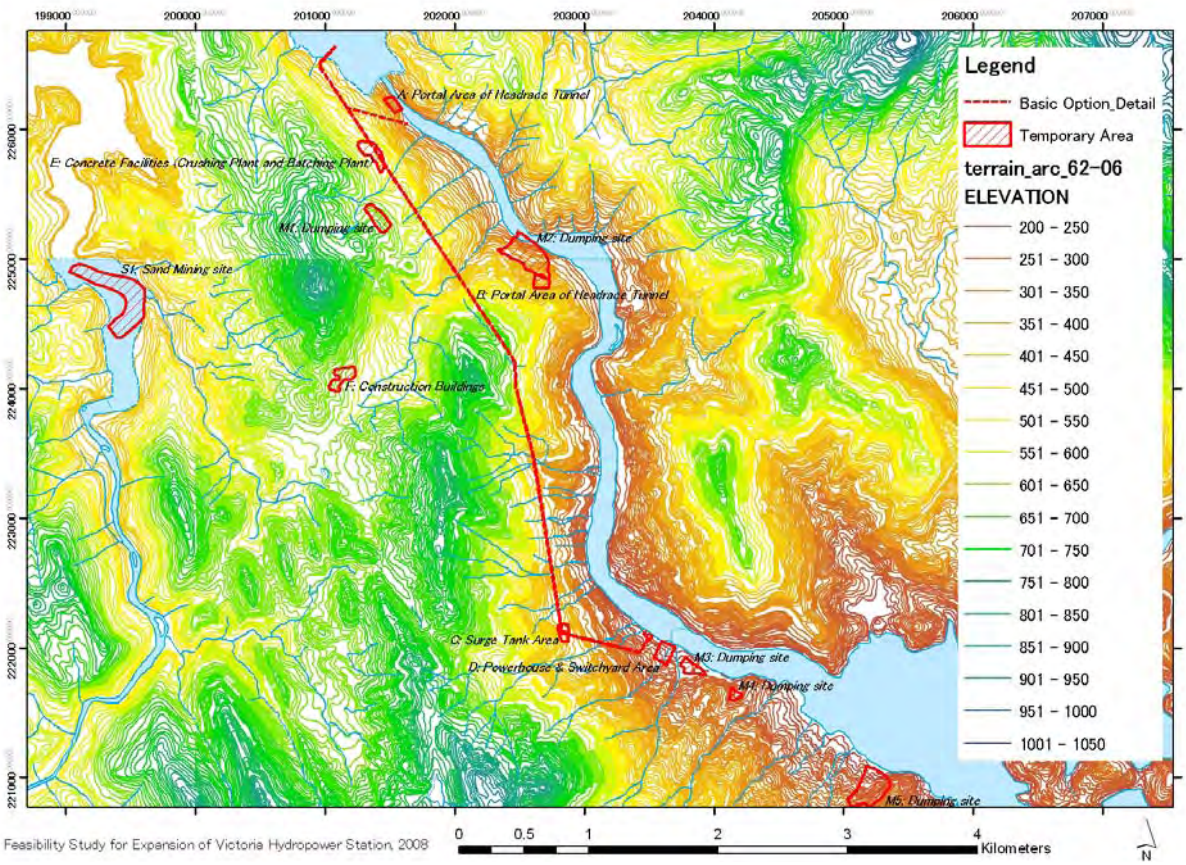


Figure 8.4.2-1 Topography

2) Geology

The Victoria hydropower station is located in the Central Highlands of Sri Lanka which lies in the tectonic province called the Highland Complex. The Highland Complex is composed of interlarded metamorphosed sediments of the Precambrian age, which have been folded and fractured in the pre-Jurassic age. The rock mass of the project area is composed of Gneisses, Granulite, Quartzite and Crystalline Limestone. Weathered zones and talus deposits are distributed in the surface of the area. **Figure 8.4.2-2** shows the geology map. (See EIA report 3.1.3.)

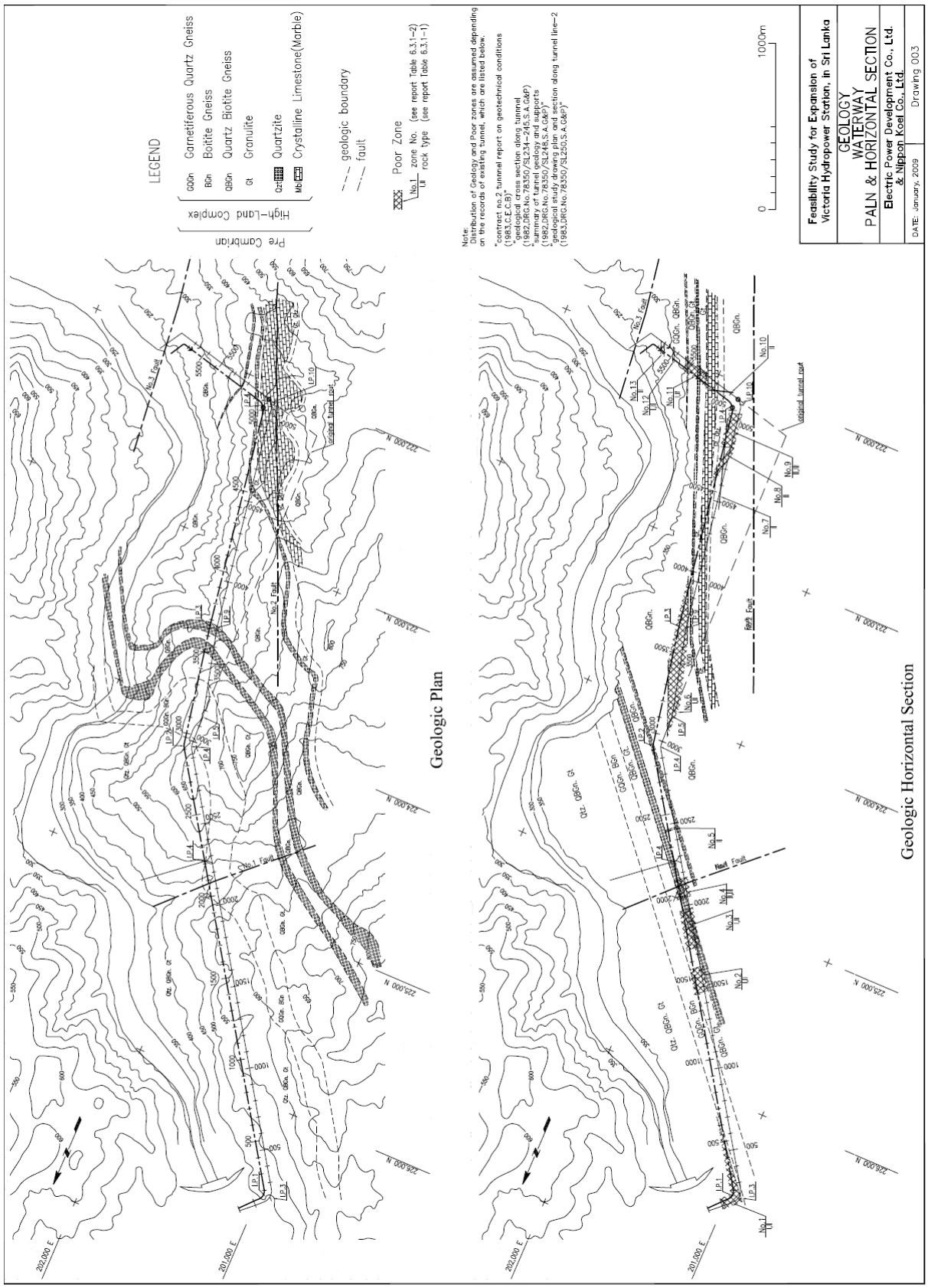


Figure 8.4.2-2 Geology

3) Meteorology

The closest rain gauging station to the Project site is the Victoria Dam. Here the level of rainfall is rather high from October to January, and low in other months. April appears to be comparatively high for inter-monsoons. (See EIA report 3.1.4.)

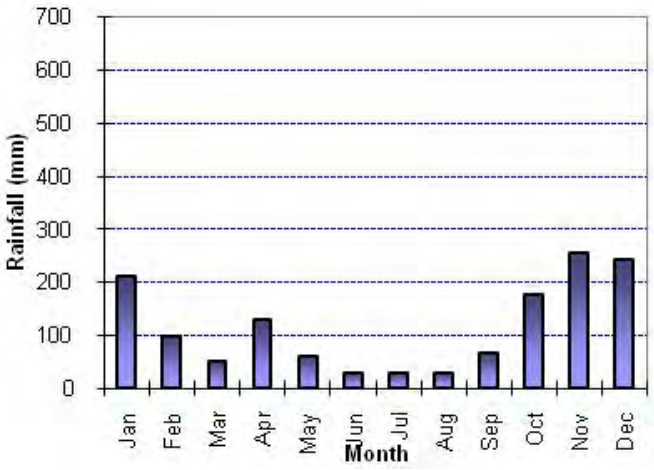


Figure 8.4.2-3 Monthly Average Rainfall at Victoria Dam

4) Water

Water Use

The water use in the surrounding neighborhood to the study area is mainly for paddy and vegetable cultivations. The agricultural activities rely on the rain water and a few ad-hoc diversions from creeks flowing through the area. Paddy is cultivated during the northeast monsoon period with higher rainfall and vegetables in the seasons immediately following. No cultivations are done during the drier period from June to August. (See EIA report 3.1.5.5.)

Surface Water Quality

In order to investigate the existing state of the surface water quality of the area, field investigations were carried out at selected locations during November to December 2008 under both wet and dry weather conditions. Samples were collected from six sites in total with two locations in the Mahaweli river, three locations in the surrounding creeks and one from the tributary where the sand mining for the Project is proposed (see **Figure 8.4.2-4**). High concentrations of phosphorus (0.03 to 0.19 mg/l as $PO_4^{3-}P$) sampled in creeks and river water indicate eutrophic conditions. However the 5-day biochemical oxidation demand (BOD_5) show low figures less than 2.2 mg/l except No. 21 sampled in creek 3 where BOD_5 is 21 mg/l. At No.20 suspended solids content was fairly high during both dry and wet conditions, and affect on soil erosion is suggested. (See EIA report 3.1.5.6.)

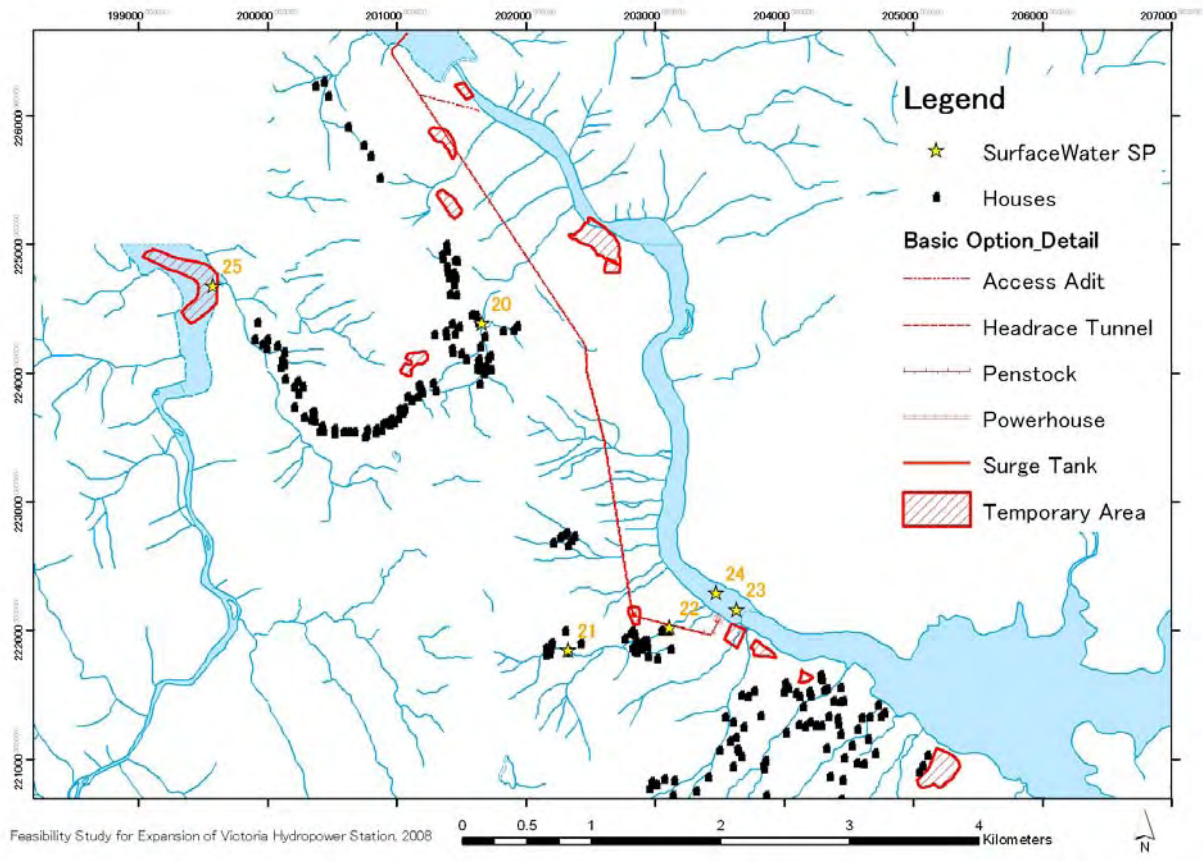


Figure 8.4.2-4 Locations of Surface Water Samplings

Table 8.4.2-1 Surface Water Quality (Refer to Figure 8.4.2-4 for locations)

Location	22 (Creek1)		20 (Creek2)		21 (Creek3)	23 (River)*	24 (River)*	25 (Stream)
	Dry	Wet	Dry	Wet	Dry	Wet	Wet	Wet
Temperature °C	25.0	24.2	25.0	24.4	24.6	24.9	25.1	24.6
pH	7.6	7.8	7.4	7.9	7.2	7.6	7.2	7.4
Conductivity (µS/cm)	455	456	645	790	498	326	102	164
Dissolved Oxygen (mg/l)	8.03	8.05	5.51	5.54	3.03	6.10	7.87	8.93
Alkalinity total (mg/l as $CaCO_3$)	190	170	240	130	210	140	40	50
Nitrogen (NO_3^- -N) mg/l	1.1	0.4	0.2	<0.1	0.5	0.1	0.3	0.3
Phosphorous (PO_4^{3-}-P) mg/l	0.05	0.05	0.03	0.19	0.10	0.11	0.08	0.10
Total Hardness (as $CaCO_3$) mg/l	190	186	240	260	210	110	35	53
BOD_5 (mg/l)	1.4	1.13	2.2	1.11	21	1.67	1.33	1.0
TSS (mg/l)	20	14	202	240	76	16	90	152
TDS (mg/l)	292	364	238	260	688	96	136	20
Iron (mg/l)	0.01	0.01	0.22	<0.01	0.37	0.06	0.20	0.29
Turbidity (NTU)	0.43	0.4	2.5	0.26	8.2	0.7	4.2	5.8
Color (PtCo APHA units)	40	20	19	12	27	9	35	34
Total Coliform (pfu/100ml)	0	42	0	200	0	260	140	30
Fecal Coliform (pfu/100ml)	0	0	0	60	0	12	06	22

* *Sampling of the Mahaweli river is carried out just upstream of the proposed power plant and just downstream the proposed power plant.*

Groundwater Level

The survey carried out by identifying groundwater levels at several locations where existing wells are in operation (see **Figure 8.4.2-5**). These locations are confined to two major clusters, one in Welikada and the other in Hakurutale where human settlements are found. In Hakurutale majority of the people affirmed the water level decrease in their wells at the Phase I construction, while in Welikada some did and some did not. (See EIA report 3.1.5.7.)

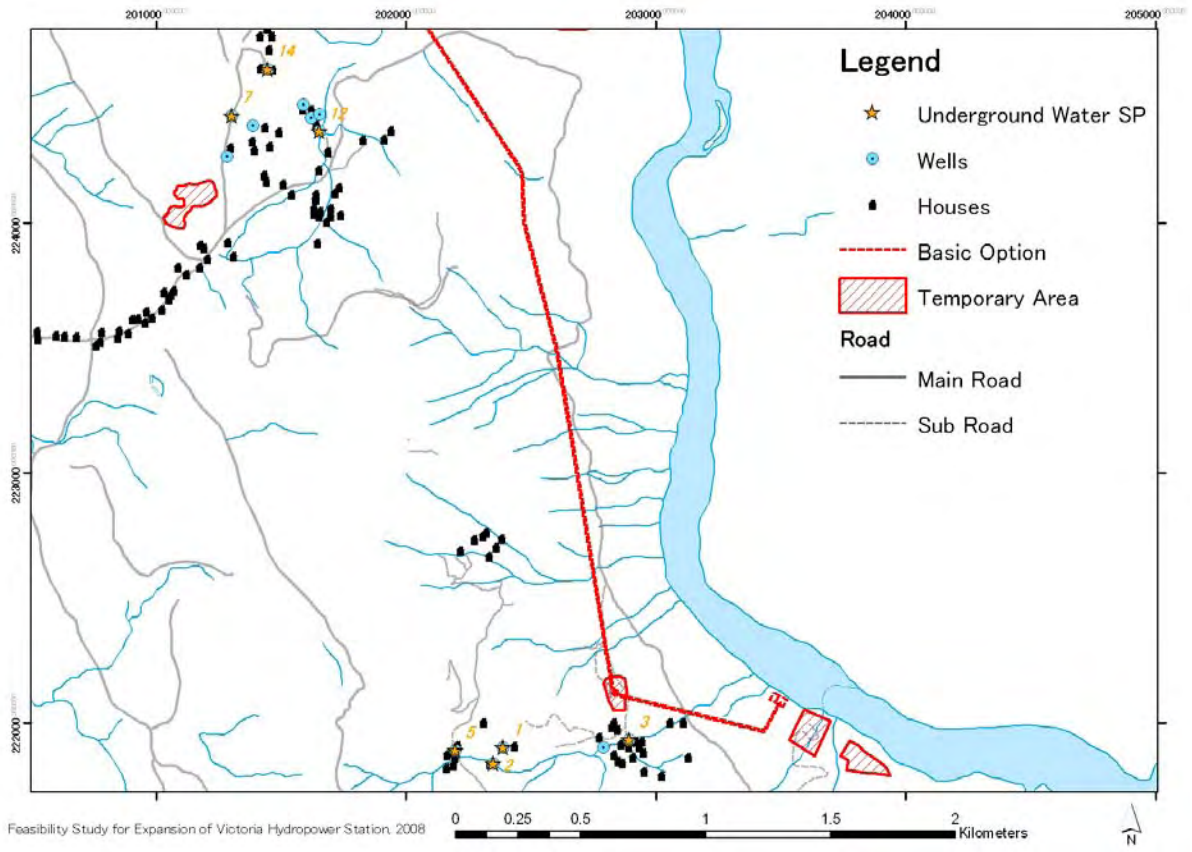


Figure 8.4.2-5 Ground Water Measurement Points

Table 8.4.2-2 Water Level
(meters below ground surface Refer to Figure 8.4.2-5 for locations)

Well Location	1	2	3	5	7	12	14
Groundwater level (m)	0.90	0.50	0.40	1.20	0.30	0.50	1.45

Groundwater Quality

To evaluate the state of groundwater quality of the area, field investigations were carried out at selected locations. The investigation focused only on shallow wells as there was no access to deep wells (see **Figure 8.4.2-5**). Selected study locations included wells in the impact area where they are used both for drinking as well as for other purposes. Fairly high concentrations of phosphorus (0.03 to 0.12 mg/l as PO43--P) sampled in wells indicate eutrophic conditions

(see **Table 8.4.2-3**). However, the 5-day biochemical oxidation demand (BOD_5) show low figures (less than 1.63 mg/l), thus indicating that the nutrient source may be from agriculture activities rather than from domestic wastewater. (See EIA report 3.1.5.8.)

Table 8.4.2-3 Current Groundwater Quality of the Area (refer to Figure 8.4.2-5 for locations)

Well Location Number	1	2	3		5	7	12	14
			Dry	Wet				
Temperature °C	25.8	26.3	25.9	24.2	24.6	26.3	26.4	23.4
pH	7.3	7.4	8.6	7.5	7.6	7.5	7.3	7.2
Conductivity (µS)	683	504	556	553	722	877	719	540
Dissolved Oxygen (mg/l)	7.06	5.46	7.26	6.92	5.93	7.16	5.19	5.75
Alkalinity (mg/l)	260	200	200	200	260	300	320	219
Nitrogen (NO_3^- -N) mg/l	0.2	>0.1	2.0	1.2	0.3	0.3	0.9	0.6
Phosphorous (PO_4^{3-}-P) mg/l	0.05	0.03	0.03	0.11	0.05	0.04	0.03	0.12
Total Hardness (as $CaCO_3$) mg/l	260	210	213	210	280	326	360	230
BOD_5 (mg/l)	1.19	1.53	1.62	1.33	1.50	1.53	1.42	1.88
TSS (mg/l)	78	172	266	144	142	188	316	88
TDS (mg/l)	386	158	34	130	344	362	202	74
Iron (mg/l)	0.03	0.01	0.04	0.01	0.03	0.01	<0.01	0.08
Turbidity (NTU)	0.9	0.3	0.45	0.35	0.6	0.45	0.44	0.97
Color (PtCo APHA units)	11	40	34	35	32	6	12	7
Total Coliform (pfu/100ml)	0	0	0	25	0	0	0	0
Fecal Coliform (pfu/100ml)	0	0	0	0	0	0	0	0

5) Land Slide

Some parts of the PIA have been identified as having a high landslide hazard potential (see **Figure 8.4.2-6**). However, no serious landslides have been reported in the area in the past. Though there were widespread landslides in 2007, any land slide except for a few slips at road cuttings in Hakurutale was not recorded. The local residents also indicated that they did not experience any landslides during the construction of the existing Victoria tunnel. (See EIA report 3.1.5.18.)

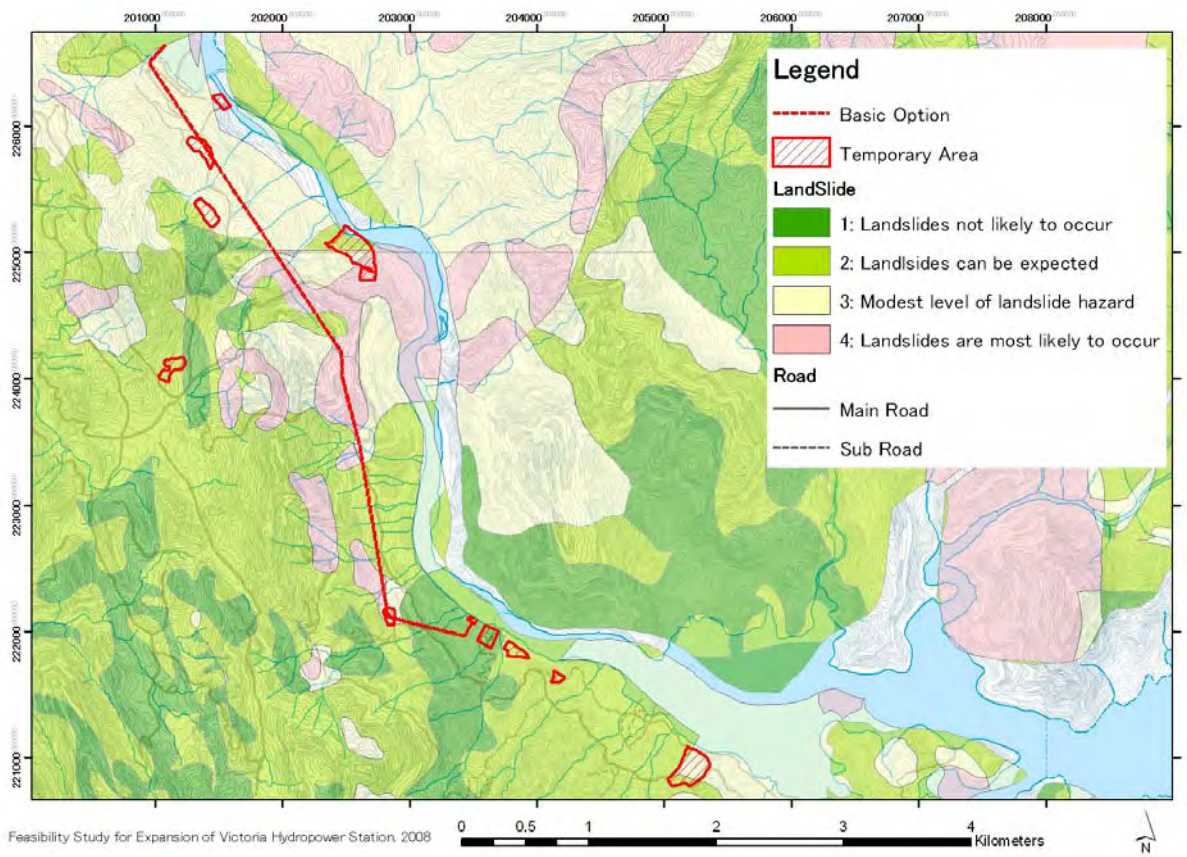


Figure 8.4.2-6 Landslide Zonation Map

6) Land Use

Until the construction of the Mahaweli Rajamawatha in early 1980s, the whole PIA remained inaccessible to the outside world. The traditional livelihood of the people was subsistence agriculture. The construction of Mahaweli Rajamawatha under the Accelerated Mahaweli Project opened up the region to the outside world, and the subsistence economy of the traditional villages became closely integrated with the rest of the country. Establishment of the Victoria Randenigala Rantambe Sanctuary (VRRS) in 1987 has restricted human land use to a certain extent. Cultivation of traditional agricultural lands is allowed within the VRRS, but cultivation of new lands or cutting trees even in private lands is not allowed.

Ten categories of land use were identified in the area. These land use categories can be grouped into three major categories, as agricultural land use, natural and semi-natural areas, and miscellaneous land use. Under agricultural land use, three categories can be identified. They are home gardens, chena lands, and paddy/vegetable/tobacco lands. (See EIA report 3.1.6.)

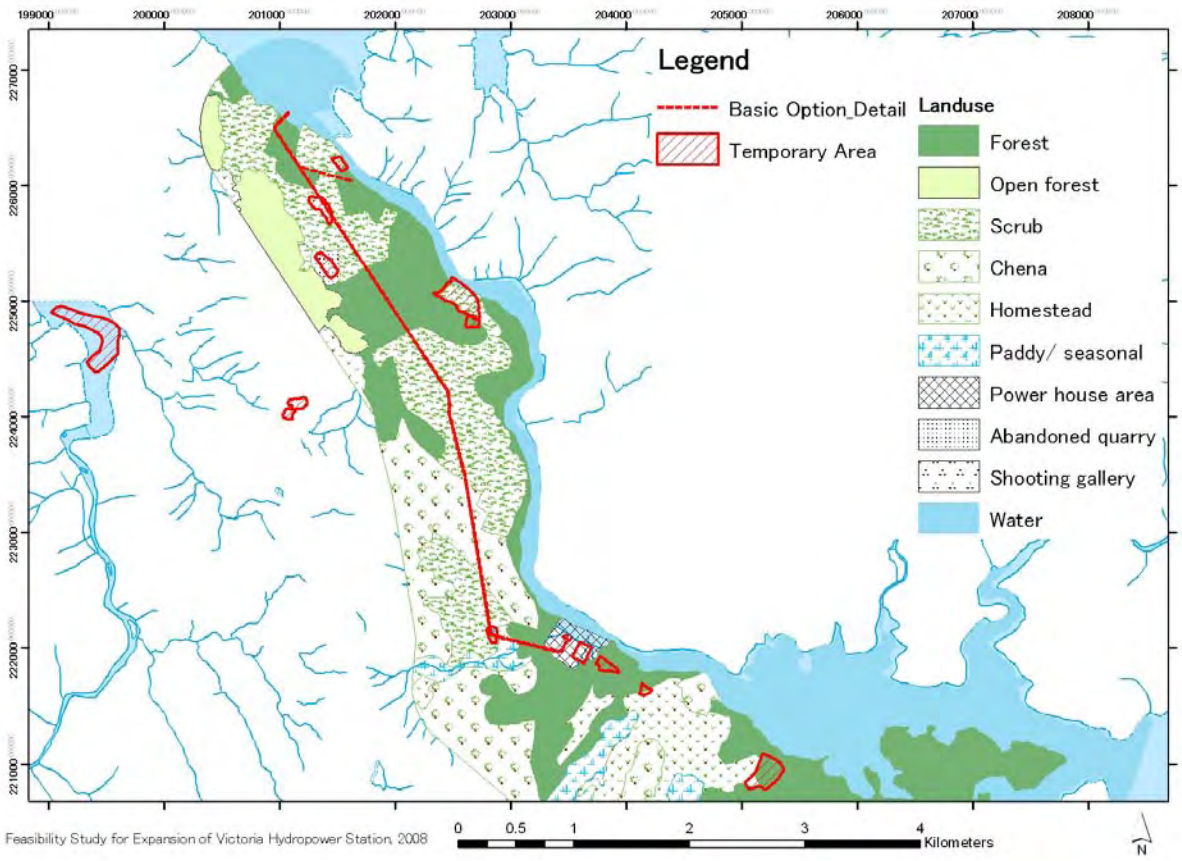


Figure 8.4.2-7 Land Use (Project Area)

Table 8.4.2-4 Land Use in the Project Impact Area by GN Divisions

GN name	Closed Canopy Forest	Secondary Forest	Scrub and grassland & Grasslnds	Chena	HG	Paddy/ Vege	SLArmy Shoot. Gallery	Water	Powerhouse Surge Chamber	Quarry
Ambewela	16.2	15.3	54.7	32.7	12.9	-	2	23.1	-	-
Bogahalanda	18	17.1	58.9	18.9	0.2	-	-	9.8	-	-
Hakurutale	0.4	105.7	79.4	71.2	1.8	8.9	-	14.9	13.5	-
Hilpankadura	-	19.5	2.2	0.4	0.02	-	-	1.2	1.6	-
Hingurukaduwa	2.4	-	-	0.8	0.3	-	-	12.8	-	-
Malulla	-	0.02	-	3.4	0.1	-	-	-	-	-
Walikada	-	64.8	44.3	18.5	31.1	-	-	7.7	-	6.1
Total	**37**	**205.62**	**239.5**	**145.9**	**46.1**	**8.9**	**2**	**69.5**	**15.1**	**6.1**
%	4.7	26.0	30.3	18.4	5.8	1.1	0.3	8.8	1.9	0.8

Picture 8.4.2-1
Home Garden

Picture 8.4.2-2
Land Preparation for Cehna Cultivation

Picture 8.4.2-3
Land Preparation in Home Gardens

Picture 8.4.2-4
Chena Land

Picture 8.4.2-5
Grasslands

Picture 8.4.2-6
Secondary Forests

Picture 8.4.2-7
Scrublands

Picture 8.4.2-8
Stream Bank Vegetation

7) Protected Area

Since the entire PIA lies within the VRRS, it comes under the management plan of the Sanctuary (DWLC, 1999). This management plan has divided the Sanctuary into two zones, Core Area Zone and the Buffer Zone (see **Figure 8.4.2-8**). Core Area Zone has been recommended that this zone has minimum human intervention, and the plan "allows critical ecological processes to continue unhindered and unaltered" (DWLC, 1999:62). In order to achieve this objective, it has been proposed that the Core Area Zone be declared a National Park. This will involve resettlement of existing villagers within this zone. The Buffer Zone is the area between densely populated villages and the Core Area. This area is highly disturbed and comes under heavy pressure from surrounding villages as well as villages located within this area. The rotational grazing arrangement of domestic animals in a sustainable way is allowed in the Buffer Zone, but consumptive uses are prohibited (DWLC, 1999:78-72). (See EIA report 3.1.6.3 and EIA report Annex VI-6.)

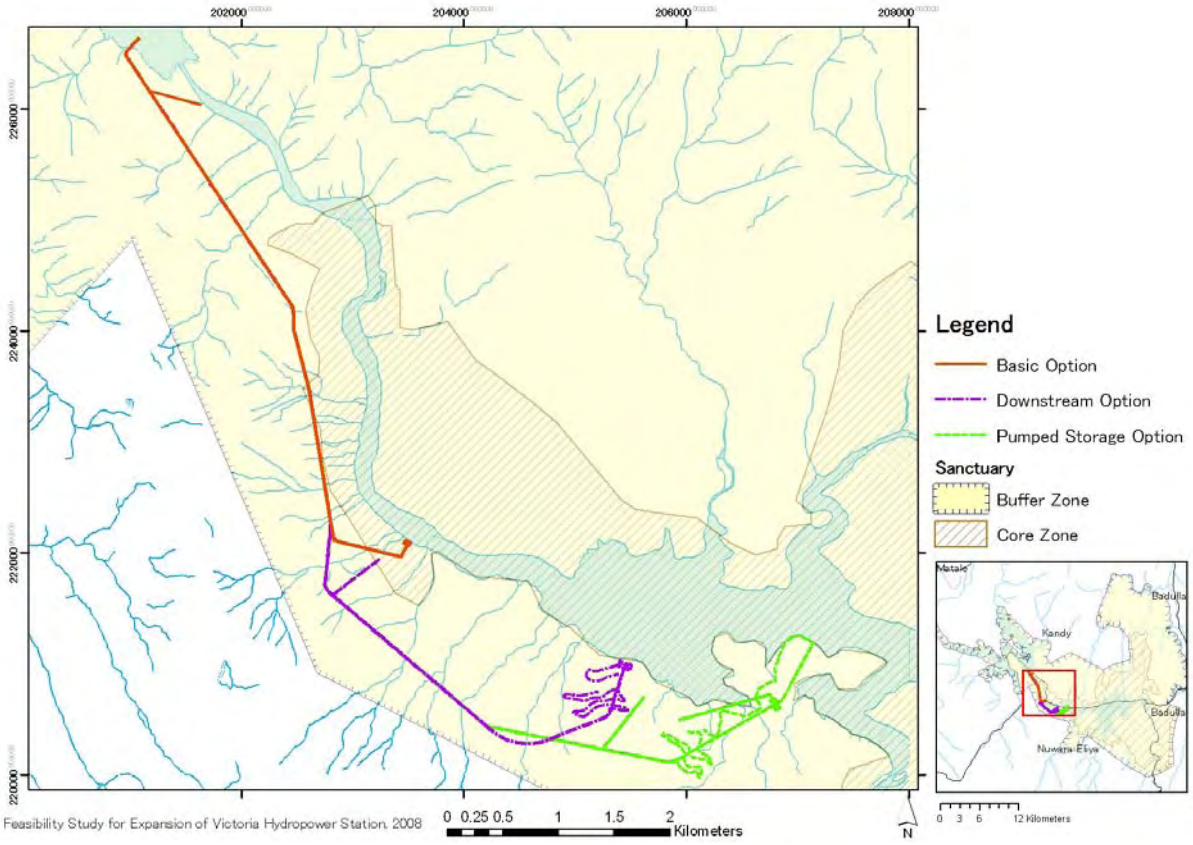


Figure 8.4.2-8 Protected Area

8) Air Quality

Site specific monitoring was conducted in December 2008. This investigation was carried out at four locations shown in **Figure 8.4.2-9**. The result of measurement of air quality is shown in **Table 8.4.2-5.** The results indicate that the air quality in the project area was good during the evaluation period with no concerns shown. (See EIA report 3.1.7.1.)

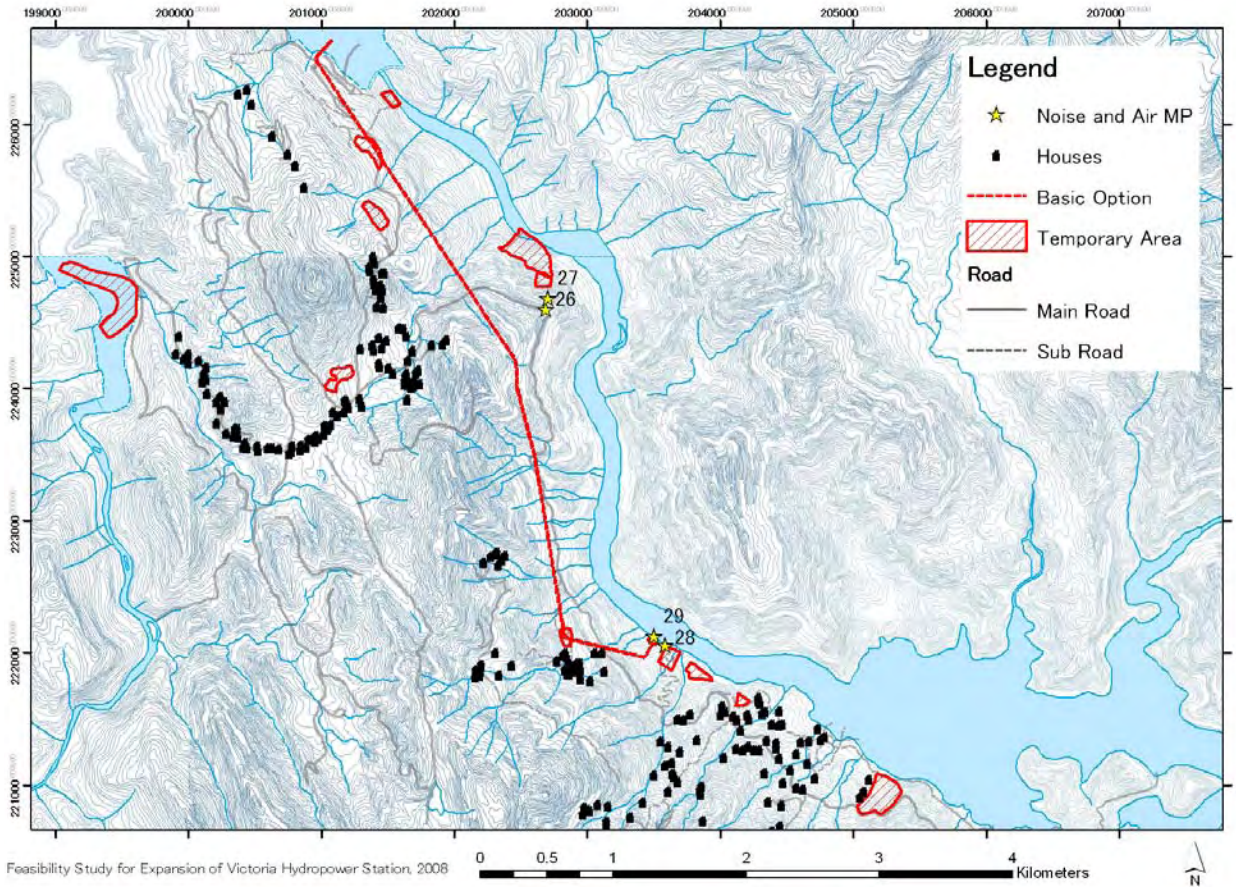


Figure 8.4.2-9 Air Quality and Sound Level Measurement Locations

Table 8.4.2-5 Observed Air Quality of the Impact Area
(refer to Figure 8.4.2-9 for sampling locations)

Location	CO ppm	CO_2 ppm	NO_x ppm	SO_2 ppm	Particulate matter ($\mu g/m^3$)
Road side - Victoria Tunnel Office (26)	< 0.1	< 0.1	< 0.1	< 0.1	95
Summer Hut - Victoria Tunnel Office (27)	< 0.1	< 0.1	< 0.1	< 0.1	14
Near the Power Station Transformers (28)	< 0.1	< 0.1	< 0.1	< 0.1	35
Near the Proposed Tunnel Outlet (29)	< 0.1	< 0.1	< 0.1	< 0.1	15

9) Noise

Project site belongs to the Low Noise Region, categorized in Noise and Vibration Standards of Pollution Control Division, Central Environmental Authority. The existing standards of noise levels are shown in **Table 8.4.2-6** (See EIA report 3.1.7.2).

Table 8.4.2-6 Existing Standards of Noise Levels (SCHEDULE I)

Maximum Permissible Noise Levels in dB at Boundaries (as $L_{ACq\,T}$ - A-weighted sound pressure determine over a T hour time interval) under Noise Control Regulation

Area	Area definition	Day time (06.00 – 18.00 hrs)		Night time (18.00 – 06.00 hrs)	
		Sri Lanka	Inter-national [a]	Sri Lanka	Inter-national [a]
Silent Zone	Area covered by a distance of 100 m from the boundary of a, courthouse, hospital, public library, school, zoo, sacred areas, and areas set apart for recreation and environmental purposes	50	-	45	-
Low Noise	An area located within any Pradeshiya Sabha	55	55	45	45
Medium Noise	An area located within any Municipal or Urban council area	63 [b]	55	50	45
High Noise	Export processing zones established by the BOI or industrial estate approved under part IV C of NEA	N/A	70	60	70

a - World Bank Guidelines
b - Provided that the noise level should not exceed 60 dB (A) inside existing houses, during day time

The measurements made on the existing noise levels show that the existing values at most times are well within the standards for low noise areas. Because the Kandy-Randenigala highway is running through the project area, the roadside noise levels during vehicle movement exceed the 55 dB limit. Anyhow the 20 -minute average noise levels are within the standards required. The measurement results are shown in **Table 8.4.2-7**.

Table 8.4.2-7 Existing Noise Levels

Location	Sound level (dB)		
	Traffic	No traffic	Average (20 min)
1. Tunnel office, side of main highway	60.1-84.5	41-44	49
2. Behind tunnel office	35-42	30-37	38
3. Victoria power station entrance*	-	48-55	50
4. Victoria power station at proposed powerhouse site*	-	50-54	52

** During no power generation*

10)Biological Environment

Fauna and Flora

Fauna and flora were surveyed for each habitat in and around the expansion project area. The biodiversity of “Scrub and grasslands”, “Honegardens”, “Secondary forests”, and “Stream bank vegetation” is relatively high (see **Table 8.4.2-8** and **Table 8.4.2-9**). Eleven kinds of fishes are found at tide pool of the Mahaweli river and downstream of the power plant (see **Table 8.4.2-10**). (See EIA report 3.2.0.)

Table 8.4.2-8 Summary of the Floral Composition of Tunnel Trace

Habitat	Families	Species	Trees	Shrubs	Liana
Homegardens	34	77	51	16	10
Chena	13	14	12	2	-
Grassland	14	21	4	5	12
Scrub and grasslands	36	83	52	18	13
Secondary forests	17	38	27	7	4
Stream bank vegetation	32	74	42	11	21

Table 8.4.2-9 Summary of Fauna Observed during Sampling

Habitat	Group	Families	Species	Endemics
Home gardens	Butterflies	6	30	-
	Land snails	2	2	-
	Amphibians	1	1	-
	Reptiles	7	11	-
	Birds	22	30	3
	Mammals	6	12	1
	Total	**44**	**86**	**4**
Chena	Butterflies	5	25	-
	Land snails	3	3	-
	Amphibians	-	-	-
	Reptiles	5	11	1
	Birds	11	15	-
	Mammals	4	7	-
	Total	**28**	**61**	**1**
Grasslands	Butterflies	5	16	-
	Land snails	-	-	-
	Amphibians	-	-	-
	Reptiles	2	2	-
	Birds	3	5	-
	Mammals	4	4	-
	Total	**14**	**27**	**0**
Scrub and grasslands	Butterflies	6	28	-
	Land snails	2	2	-
	Amphibians	1	1	-
	Reptiles	8	11	-
	Birds	19	34	2
	Mammals	8	11	1
	Total	**44**	**87**	**3**
Secondary forests	Butterflies	5	26	-
	Land snails	-	-	-
	Amphibians	1	1	1
	Reptiles	6	9	1
	Birds	21	27	4
	Mammals	11	11	1
	Total	**44**	**74**	**7**

Habitat	Group	Families	Species	Endemics
Stream banks	Butterflies	5	26	-
	Land snails	1	1	-
	Amphibians	1	1	-
	Reptiles	4	6	-
	Birds	20	30	2
	Mammals	8	10	1
	Total	**39**	**74**	**3**

Table 8.4.2-10 Fish Species Recorded from the Spray Zone of the Victoria Powerhouse

Family	*Scientific name*	Common name	Abundance
Cyprinidae	*Devario malabaricus*	Giant Danio	++
Cyprinidae	*Garra ceylonensis**	Stone Sucker	++
Cyprinidae	*Labeo fisheri**	Mountain Labeo	+
Cyprinidae	*Puntius sarana*	Olive barb	++
Cyprinidae	*Puntius singhala**	Filamented barb	+
Cyprinidae	*Tor khudree*	Mahseer	++
Cyprinidae	*Rasbora daniconius*	Striped Rasbora	+
Cichlidae	*Oreochromis niloticus*	Tilapia	+++
Cichlidae	*Oreochromis mossambicus*	Tilapia	+
Cichlidae	*Etroplus suratensis*	Green Chromide	++
Heteropneustidae	*Heteropneustes fossilis*	Stinging Catfish	+

Abundance: + (<20 individuals); ++ (21 – 50 individuals); +++ (> 50 individuals)
*Sampling effort (10 cast net samplings), Endemic species: **

Rare Species

Confirmed rare species in and around of the expansion project area is 25 including 7 flora, 1 butterfly, 1 land snail, 3 amphibians, 3 reptiles, 4 birds, 3 mammals, and 3 fishes. The list of rare species except fishes is shown in **Table 8.4.2-11**. The list of rare fishes is shown in **Table 8.4.2-10**. (See EIA report 3.2.0.9.)

Table 8.4.2-11 Rare Species Recorded Near the Project Site

Items	Name	Common name	Category[2]	Hone Gardens	Chena	Grasslands	Scrub Fores	Secondary Forest	Stream Bank Vegetation
Flora	*Ziziphus lucida*	Eraminiya(S)	CR	+	+	+	+	+	+
	Argyreia populifolia	Giri-tilla(S)	Endemic	+	+	+	+	+	+
	Wendlandia bicuspidate	Rawan-idala(S)	Endemic	+	+	+	+	+	+
	Syzygium assimile	Damba(S)	Endemic	+	+	+	+	+	+
	Micromelum minutum	Wal-karapincha(S)	Endemic	+	+	+	+	+	+
	Derris parviflora	Kalawel(S)	Endemic	+	+	+	+	+	+
	Strychnos trichocalyx	Kaduru (S)	Endemic	+	+	+	+	+	+
Butterflies	*Troides darsius*	Common Birdwing	NT	+	-	-	-	+	+
Land snails	*Cyclophorus ceylanicus*	Common Snail	NT	-	-	-	-	-	+

[2] NT-Near Threatened / VU-Vulnerable / EN-Endangered / CR-Critically Endangered

Items	Name	Common name	Category[2]	Hone Gardens	Chena	Grasslands	Scrub Fores	Secondary Forest	Stream Bank Vegetation
Amphibians	*Duttaphrynus melanostictus*	Common house toad	Endemic	+	-	-	+	-	-
	Lankanectes corrugatus	Corrugated water frog	Endemic	-	-	-	-	-	+
	Fejervarya kirtisinghei	Montain paddy field frog	Endemic	-	-	-	-	-	+
Reptiles	*Chrysopelea taprobanica*	Sri Lankan Flying Snake	VU	-	-	-	+	-	-
	Bungarus ceylonicus	Sri Lankan Krait	NT	+	-	-	+	-	-
	Chrysopelea taprobanica	Green Pit-Viper	VU	-	+	-	-	+	-
Birds	*Ocyceros gigalensis*	Sri Lanka Grey Hornbill	Endemic	+	-	-	-	+	+
	Gallus lafayettii	Sri Lanka Jungle fowl	Endemic	+	-	-	+	+	+
	Loriculus beryllinus	Sri Lanka Hanging Parrot	Endemic	+	-	-	+	+	-
	Pellorneum fuscocapillum	Brown-capped Babbler	NT	-	-	-	-	+	-
Mammals	*Macaca sinica*	Toque monkey	NT	+	-	-	+	+	+
	Semnopithecus priam	Grey Langur	NT	+	-	-	+	+	+
	Manis crassicaidata	Indian Pangolins	NT	-	-	+	-	-	-

Elephant

About 100 wild elephants live in the VVRS. They move on both sides of the Mahaweli river. Although the staff of the power station witnessed not so often, the frequency of the appearance of the elephants near the project site is unclear. Elephant migration route is shown in **Figure 8.4.2-10**. (See EIA report 3.2.0.10.)

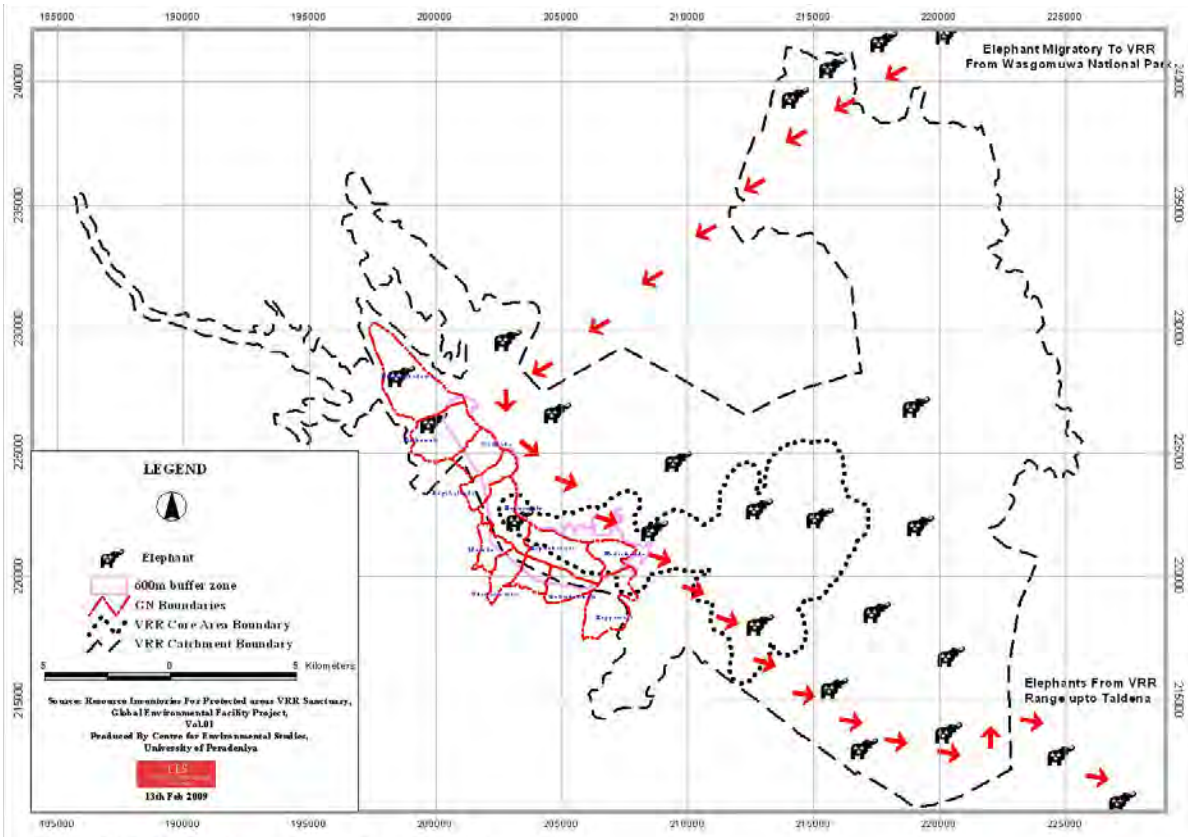


Figure 8.4.2-10 Elephant Migration Route and Habitat

(2) Social Environment

1) Administrative Boundaries

The groundwater impact area, 600 m around tunnel excavation route, lies in Hanguranketha Division of Nuwara Eliya District in Central Province and covers six Grama Niladari divisions; Hingurukaduwa, Ambewela, Welikada, Bogahalanda, Hakurutale, Hilpenkandura. The sand mining site and construction buildings are in Idmaland GN division. (See EIA report 3.3.1.)

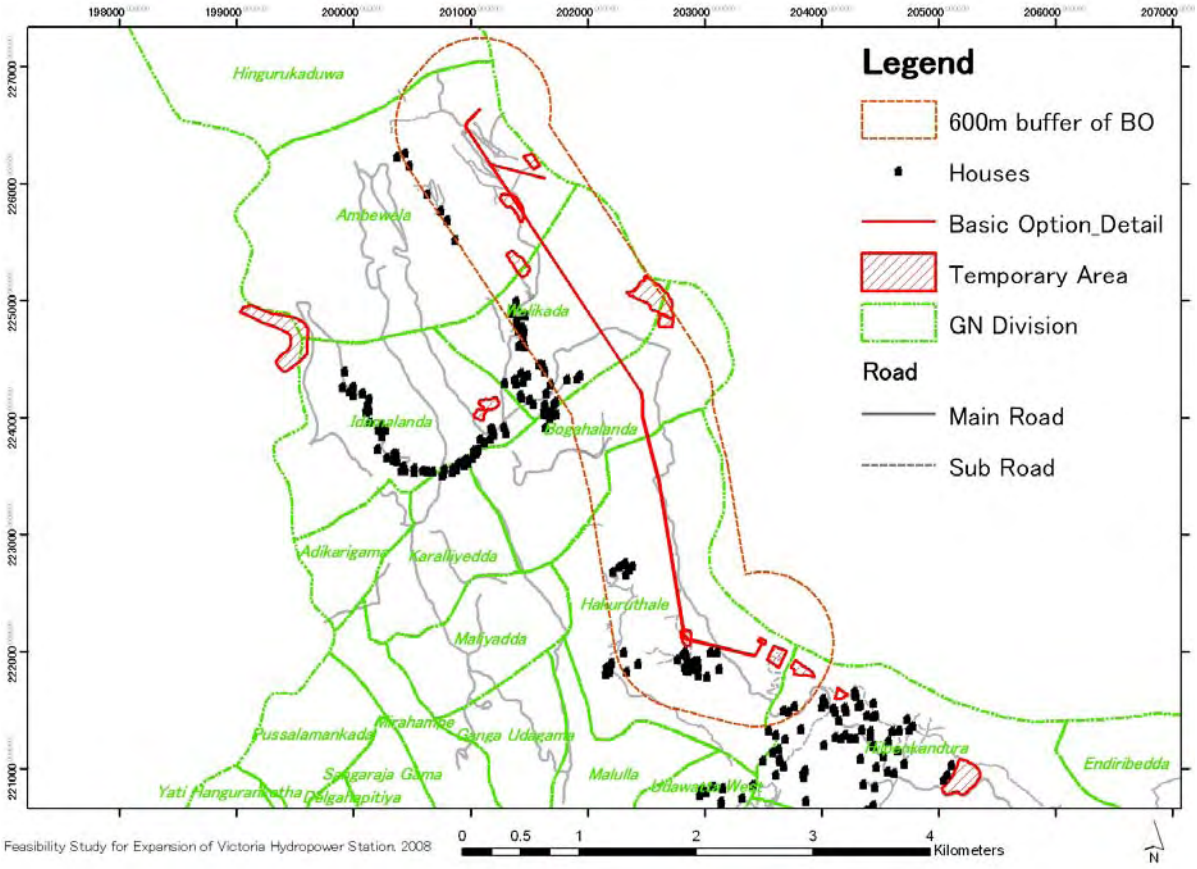


Figure 8.4.2-11 Administrative Boundaries

2) Population

Total population of six Grama Niladari divisions around the project site is 3,458 including 241 (57 households) in the groundwater impact area (see **Table 8.4.2-12**). (See EIA report 3.3.1.)

Table 8.4.2-12 Area, Total Population and Population Density of the Impact Area

GN Division	Total Population of GN Division	Area falling within the Project Impact Area				
		Area (ha)	Total no of households	Total population	Population density person/ha	% of total population of the division
Hingurukaduwa	630	18.0	0	0	-	0
Ambewela	694	165.7	6	30	0.18	4.3
Welikada	770	144.7	19	77	0.53	10.0
Bogahalanda	760	92.6	0	0	-	0
Hakurutale	191	271.3	29	119	0.44	62.3
Hilpenkandura	413	11.9	3	15	1.26	3.6
Total	**3,458**	**704.2**	**57**	**241**	**2.91**	**6.9**

Source: Social survey

3) Income

The project area is a relatively poor agricultural area. The average income per household is Rs.11,137.93 per month, while the per capita income is Rs.2,634.28. The area can be considered as a poor area as most of the families are Samurdhi, a kind of welfare, recipients. (See EIA report 3.3.2.)

Table 8.4.2-13 Economic Profile of the Impact Area (income and Samurdhi)

GN Division	Total no of households	Average Income per HH (Rs.)	Per Capita income (Rs.)	% of Samurdhi receipients of total households
Hakurutale	29	11,308.62	2,755.88	11 (37.9%)
Heelpenkandura	3	10,124.36	2,024.87	3 (100.0%)
Welikada	19	10,763.16	2,655.84	6 (31.6%)
Ambewela	6	12,006.47	2,401.29	3 (50.0%)
Total impact area	57	11,137.93	2,634.28	23 (40.4%)

Source: Social survey

4) Income Generation Sources

The major source of income for the groundwater impact area is agriculture. About 60% of the total number of employed people is engaged in agriculture. Paddy cultivation is the main source of livelihood, while vegetable cultivation is also undertaken simultaneously. Tobacco is grown as a cash crop in the Hilpenkandura division. The second category of income generation is casual labor which occupied about 27% of the total employed population. According to the Census 2001, about 25 people have gone to Middle East for employment. (See EIA report 3.3.4.)

Table 8.4.2-14 Major Employment Types of the Impact Area

	Farmers	Labors	Soldiers	Teachers	Others
Welikada	14	10	4	1	0
Hakuruthle	24	15	3	0	3
Hilpenkandura	6	2	0		2
Ambewela	8	4	1	0	2
Total	**52**	**31**	**8**	**1**	**7**

Source: Social survey

5) River Uses

The inhabitants in the divisions located upstream of the powerhouse do not use the river much, but those who are in the downstream areas use the river primarily for bathing and washing purposes. They do not use the river water for agriculture or any other economic purposes. However, they use the reservoir for fishing on a very small scale. (See EIA report 3.3.3.)

6) Existing Environmental Considerations

The inhabitants of 115 households of the 184 households (63%) in the project impact area have been living in the same place where they lived during Stage 1 of the Victoria Hydropower Station project. They are more aware of the potential impacts of the Project than those who have settled after Stage I. 75 families out of the 184 acknowledge that there are environmental problems related to Stage I, while 59 said they either were not aware of or did not mention any such problems. They identify the decreasing groundwater table as the most prominent environmental issue that directly affects them. Changing rainfall patterns and biodiversity rank second and third. Soil degradation and the mixing of limestone into drinking water are other problems that the people have pointed out.

A majority of the people in the area consider the VRRS to be a problem. Many point out threats from the elephants and other wild animals such as monkeys and wild pigs to their agriculture.

Field survey results indicate that there is a potential for landslides in the Udawatta west division. Generally, the field survey results also mention the difficulty of obtaining water because the springs and wells tend to dry out in the dry season. Obtaining water for their crops is a major problem mentioned by most of the inhabitants in the area. (See EIA report 3.3.5.)

7) Cultural and Archeological Protected Reserves

There are no culturally and historically protected reserves and sites of archaeological significance within the groundwater impact area. The temple Siri Dalanda Viharaya is located on the boundary of the area. At present a stupa is being built on a large rock located inside the area. The chief incumbent of the temple has expressed concern over possible impacts of vibration on the stupa. (See EIA report 3.3.6.)

8) Road and Buildings

Overall, the lack of accessibility due to not having sufficient roads is frequently quoted as a major infrastructural problem in PIA. The main highway from Kandy-Mahiyangana, which was extended to Raja Mawatha during stage 1, runs through the GN divisions in the area. However, Welikada is the only division benefited by the highway as it is close to the highway. Major settlements in Hakurutale are located away from the highway. Field survey results indicate that the Hakurutale primary school was closed due to the difficulty of transportation for the teachers. Certain minor road projects are being carried out at the moment under national "Maga Neguma" road development program (for instance, in the Hilpenkandura division).

All GN divisions in PIA have electricity.

The Victoria National School is located near the existing turn off to the Victoria dam site from the main road. The school is located just outside the main impact area of the proposed project, but all the children living in the impact area come to this school for education. (See EIA report 3.3.7.)

9) Water Supply

The main source of water supply in the area is spring-based wells. Most of the wells are common dug-wells on the springs near the streams, while some are in private land-based wells. **Table 8.4.2-15** gives the rank order for each source of water supply for domestic use including bathing in each GN division. Some villages have a central spring as the main source of water supply for the inhabitants (for e.g., the diya bubula in Hakurutale).

In all the divisions, rain water is predominantly used for the purpose of irrigation, except for occasional use of common wells to supply water for vegetable cultivation. (See EIA report 3.3.8.)

Table 8.4.2-15 Rank Order of Water Sources for Domestic Use

Water source	Ambewela	Hakurutale	Hilpenkandura	Welikada
Taps	1	-	3	2
Spring/common wells/home wells	2	1	2	1
Water projects	3	-	-	-
Reservoir	4	-	-	-
Streams	5	2	1	1
Wells	6	-	-	6

8.4.3 Impact Assessment

Main items of assessed impact are shown as follows. (See the details in Section 4 of the EIA report.)

(1) Impact on Existing Water Extraction for Drinking Purposes

Excavation of the waterway tunnel will cause drawing down of groundwater table. Estimated impact area (hereafter possible impact area) is 600 m (twice the maximum ground cover 300 m) away from the tunnel center line (see **Figure 8.3.2-2**). Higher possibility of drawing down area (hereafter significant impact area) in the possible impact area is also estimated as within 600 m radius from the surge tank through the construction record of the stage 1 and hearing survey. It is estimated that draw-down of the water table will remain within the significant impact area and recover upon completion of the construction, as was the case with Stage I. There are 57 houses and 10 wells in the possible impact area and 22 houses and 4 wells in the significant impact area. Then 4 wells and 22 household will have problems on water and 6 wells and 35 households would be possibly affected. (See EIA report 4.7.14.)

Table 8.4.3-1 Number of Houses Affected by Groundwater Deterioration

GN Division	Number of households		
	Significant impact area	Possible impact area	Total
Hinguruladuwa	0	0	0
Ambewela	0	6	6
Welikada	0	19	19
Bogahalanda	0	0	0
Hakurutale	22	7	29
Hilpenkandura	0	3	3
Total	**22**	**38**	**57**

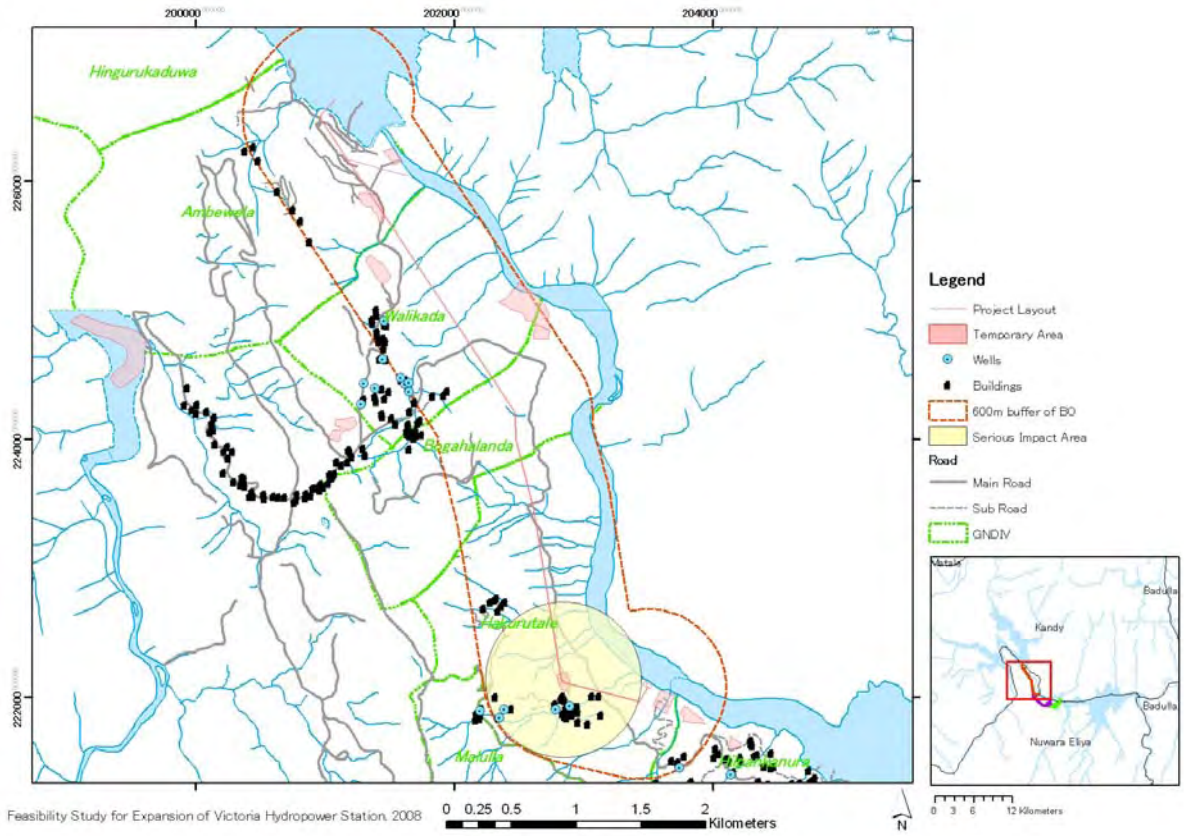


Figure 8.4.3-1 Temporary Lowering of Groundwater Affecting Domestic Uses

(2) Impacts on Agricultural Fields

The drawing down of groundwater table during construction might affect the agricultural production in the impact area. Assume that all the agricultural land in the impact area will be affected, the estimated maximum economic loss would be 373,700 Rs./year for rice field, 5,576,200 Rs./year for chena land, and 1,272,530 Rs./year for homestead. (See EIA report 4.4.)

Table 8.4.3-2 Estimated Economic Loss of Paddy Cultivation

Land use	Impact Area	
	Serious impact area	Project impact area
Paddy/ seasonal (ha)	14.5	14.8
Average yield (bushels/ha)	148	148
Price (Rs/bushel)	588	588
Cost of cultivation (Rs/ha)	61,774	61,774
Economic loss from paddy production (Rs./year)	366,125	373,700

Table 8.4.3-3 Estimated Economic Loss of Chena Cultivation

Land use	Impact Area	
	Serious impact area	Project impact area
Chena (ha)	39.7	113.8
Net Income (Rs/ha)	49,000	49,000
Economic loss from chena (Rs./year)	1,945,300	5,576,200

Table 8.4.3-4 Estimated Economic Loss of Home Gardens

Land use	Impact Area	
	Serious impact area	Project impact area
Homestead (ha)	12.2	10.6
Net Income (Rs/ha)	49,000	49,000
Economic loss from home gardens	597,800.00	1,272,530

(3) Impacts of Blasting Operations

The maximum allowable vibration limit is determined to prevent the existing structures from damaging due to the blasting for the construction works for the Project (see **9.2**). The following empirical equation is used to estimate vibration of a structure due to blasting with assumed explosive volume at planning construction works for the waterway. It provides the vibration levels depending the distance from the blasting point to the observation point on the structure. It has been confirmed by using the equation that vibrations of the existing structures do not exceed the maximum allowable vibration limit.

According to available Japanese literature, when vibration velocity is less than 0.2 kine (cm/s) no damage on houses is generated, but when it is 0.2 to 0.5 cm/s slight damages on houses may occur. The house nearest to the blasting point is located 105 m from the point. With the assumed explosive volume, vibration in the nearest houses is estimated at around 0.3 cm/s, no serious

damage seems to be caused. The estimated vibration is also well within the standards published by the Central Environmental Authority of Sri Lanka. (See EIA report 4.14.)

Velocity of vibration is estimated by following empirical equation.

$V = K \cdot W^{2/3} \cdot D^{-2}$

V: Velocity of vibration (cm/s)

K: Coefficient related to blasting conditions (Center-cut: 750, Side hole blasting: 350)

W: Loading of explosive per 1 rotation (kg) (Center-cut: 9.0 kg, Side hole blasting: 15.5 kg)

D: Distance from the center of blasting

Velocity of vibration is converted to vibration level by following empirical equation.

$VL = 20 \log V + 83$

VL: Vibration level (reference acceleration of vibration 10^{-5} m/s^2)

Relation between D and V, VL is shown in **Table 8.4.3-5**.

Table 8.4.3-5 Relation between D and V, VL

D (m)		50	100	150	200
V (cm/s)	Center cut	1.29	0.32	0.14	0.08
	Side hole blasting	0.87	0.22	0.10	0.05
VL (dB)	Center cut	85.2	73.2	66.2	61.2
	Side hole blasting	81.8	69.8	62.7	57.7

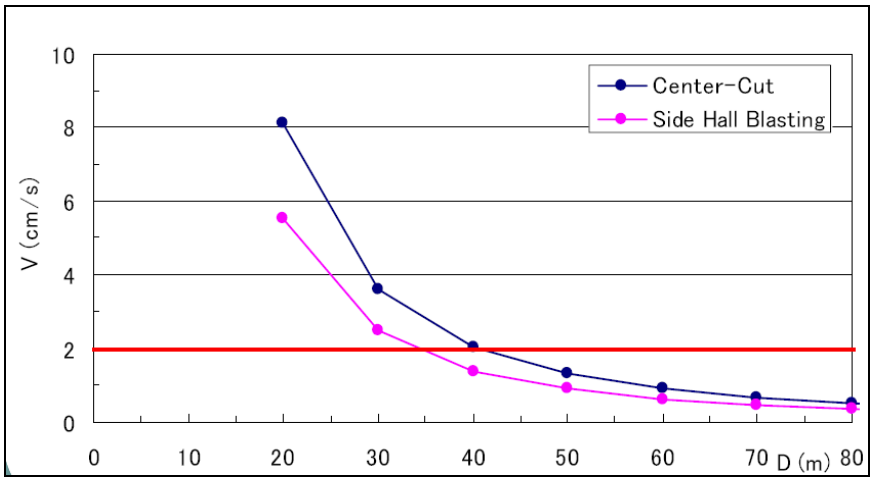


Figure 8.4.3-2 Velocity Curve by Distance from the Tunnel

(4) Water Pollution

During the construction period, no major water flows are expected in the streams. However, the following events may negatively affect both the surface and groundwater quality of the area. Estimated impact area is shown in **Figure 8.4.3-3**. Proposed mitigation is shown in **Table 8.4.3-6**. (See EIA report 4.2.1.)

(i) Erosion and runoff caused by construction activities, including forest cutting and accidental water releases

(ii) Sanitary effluents from the construction camps

(iii) Oil and chemical spills from machinery and vehicles

(iv) Leaching of ammonia and nitrogen from the tunnel blasting and spoil rock deposits

Table 8.4.3-6 Waste Water Impact Area

Type of water pollution	Location	Control measures	Number of affected houses
Leaching of ammonia and nitrogen	Adit, Dumping site	Settling basin	0
Oil and chemical spills	Batching plant	Chemical treatment and Settling basin	0
Sanitary effluents	Construction Buildings	Settling tank and effluent treatment	0
Turbid water	Sand mining area	Settling basin	0

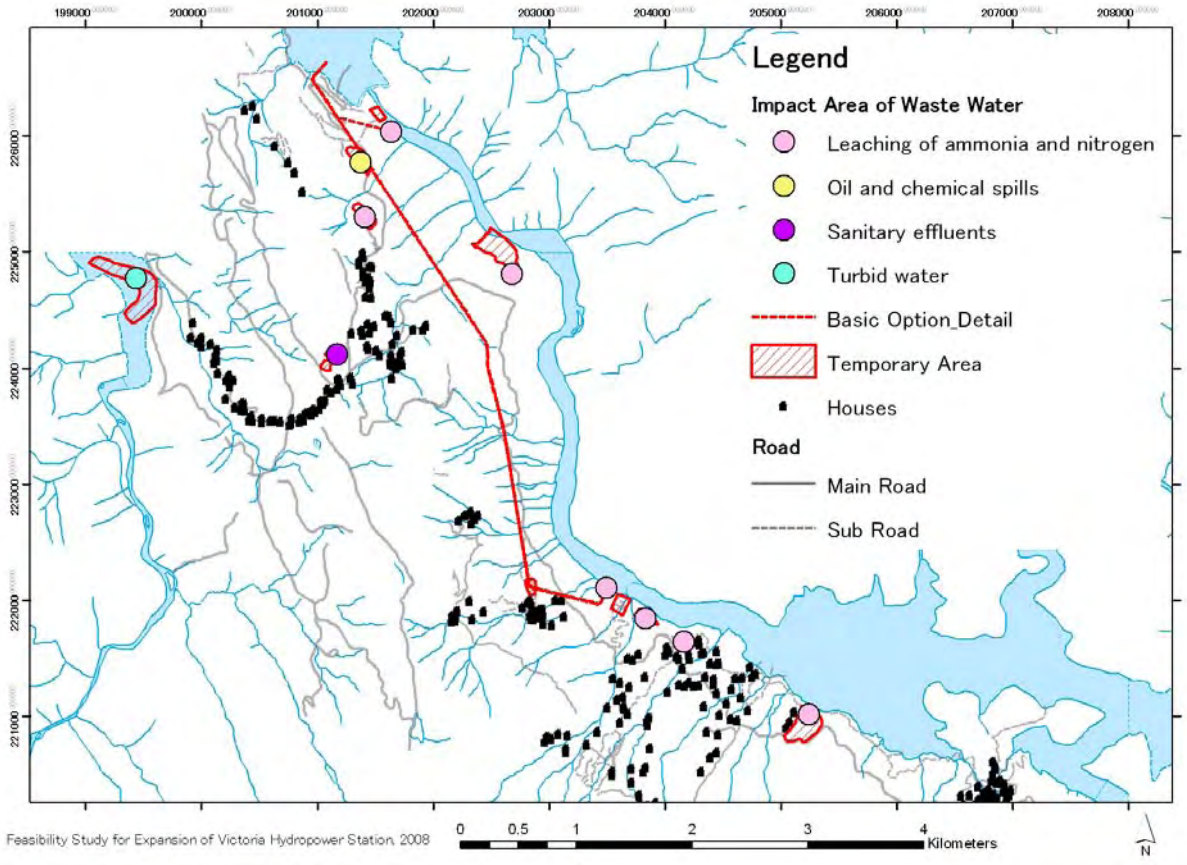


Figure 8.4.3-3 Waste Water Impact Points

(5) Construction Hazards

Major construction hazards taken into account in construction planning for the Project are as follows:

(a) Impact on blasting against the existing structures

(b) Selection of temporary facilities areas and spoil banks (muck damping areas)

(c) Precautions and measures against accidents during the construction period

Because the existing structures such as the dam, its abutments, intake, tunnel, and powerhouse are located near new structures, control blasting methods will be adopted.

Since the project area is located in the VRRS, temporary facilities areas and spoil banks are selected from the areas previously used for construction or owned by CEB/other organizations.

With regard to item (c), traffic accidents caused by vehicles for the works, fire disasters in the tunnel due to incorrect handling of explosives, human accidents due to lack of oxygen caused by malfunction of tunnel ventilation, accidents due to heavy leakage water in the tunnel, those due to muck scattered by blasting are considered significant during the construction period. As precautions, it is proposed that correct handling of explosives by qualified workers, installation of ventilation systems with enough capacity and continuous maintenance, providing escape routes for evacuees at the time of heavy water leakage in the tunnel, installation of safety nets to prevent muck from scattering will be undertaken by the contractor. (See EIA report 4.8.1.)

(6) Loss of Forest

Expansive forest cutting will not happen because most of construction works for the Project will be done underground. Some forest cutting is to be conducted in tunnel muck dumping sites, portal area of the headrace tunnel and so on. Estimated forest cutting area by overlaying vegetation maps and project layout drawings would be 8.33 ha for forest and 7.70 ha for scrub. **Table 8.4.3-7** shows the cutting are by vegetation and **Figure 8.4.3-4** shows the map of the area. (See EIA report 4.3.7.)

Table 8.4.3-7 Estimated Loss of Vegetation by Temporary Facility Area (ha)

Temporally facilities		Forest	Scrub	Paddy/ seasonal	Home-stead	No vegetation	Total
A	Portal Area of Headrace Tunnel	0.22	0.65	0.00	0.00	0.00	0.87
B	Portal Area of Headrace Tunnel	0.94	0.07	0.00	0.00	0.00	1.01
C	Surge Tank Area	0.00	0.96	0.00	0.00	0.00	0.96
D	Powerhouse & Switchyard Area	0.00	0.00	0.00	0.00	1.61	1.61
E	Concrete Facilities (Crushing Plant and Batching Plant)	0.00	0.31	0.00	0.00	1.86	2.17
M1	Dumping site	0.00	0.00	0.00	0.00	2.06	2.06
M2	Dumping site	0.23	5.71	0.00	0.00	0.00	5.94
M3	Dumping site	1.33	0.00	0.00	0.00	0.00	1.33
M4	Dumping site	0.54	0.00	0.00	0.00	0.00	0.54
M5	Dumping site	5.07	0.00	0.00	0.72	0.00	5.79
Total		**8.33**	**7.70**	**0.00**	**0.72**	**5.53**	**22.28**

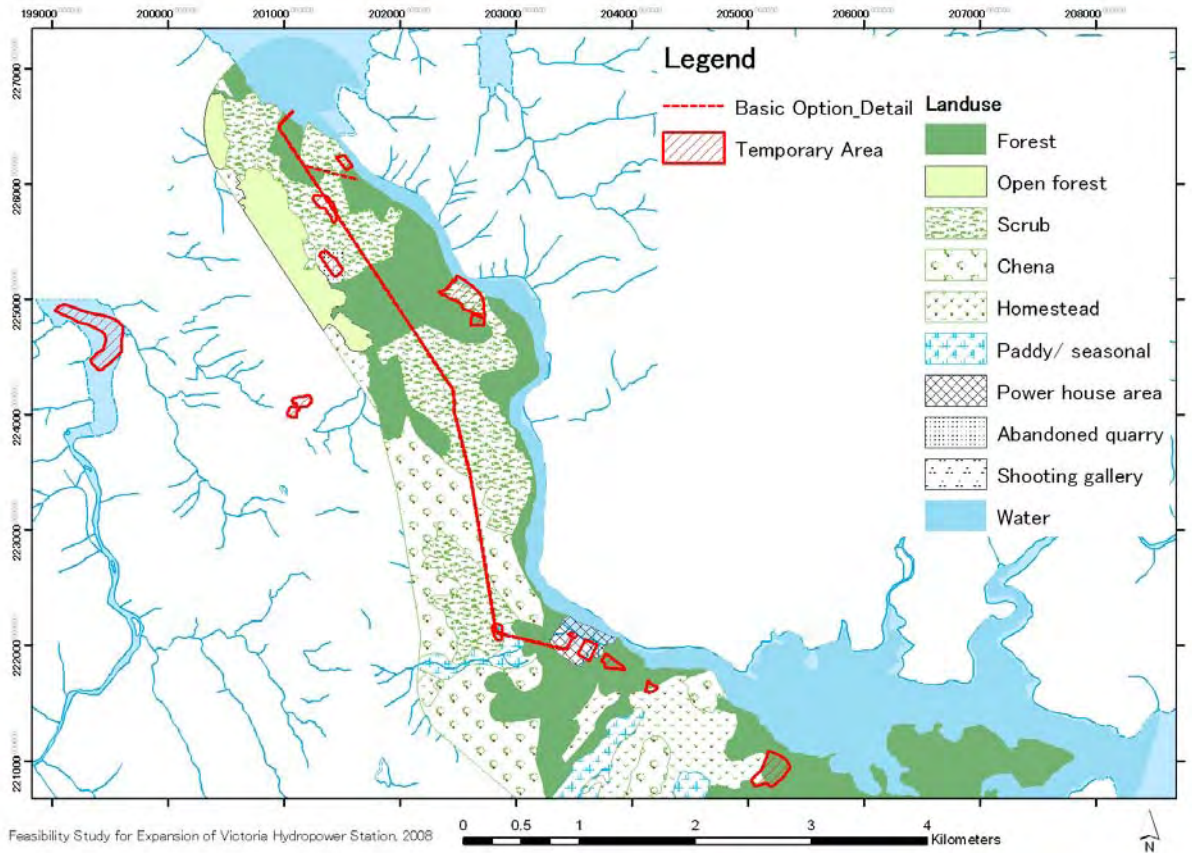


Figure 8.4.3-4 Loss of Forest by Temporary Facility Area

(7) Impact on Rare Species

25 rare species are confirmed by the field survey in and around the project area. Three kinds of fishes might be affected by polluted water from the construction site and dumping sites, because they are living in the tide pool of the Mahaweli river. 18 out of 22 terrestrial species might be affected, because a part of habitat vegetation, such as Secondary forest and Scrub forest, will be lost by the construction. **Table 8.4.3-8** shows the list of rare species. Although a part of habitat is lost, none of the species will be extinct in regional level. (See EIA report 4.3.14.)

Table 8.4.3-8 Endemic Species

Items	Name	Common name	Category[3]	Hone Gardens	Chena	Grasslands	Scrub Forest	Secondary Forest	Stream Bank Vegetation	Impact
Flora	*Ziziphus lucida*	Eraminiya(S)	CR	+	+	+	+	+	+	+
	Argyreia populifolia	Giri-tilla(S)	Endemic	+	+	+	+	+	+	+
	Wendlandia bicuspidate	Rawan-idala(S)	Endemic	+	+	+	+	+	+	+
	Syzygium assimile	Damba(S)	Endemic	+	+	+	+	+	+	+
	Micromelum minutum	Wal-karapincha(S)	Endemic	+	+	+	+	+	+	+
	Derris parviflora	Kalawel(S)	Endemic	+	+	+	+	+	+	+
	Strychnos trichocalyx	Kaduru (S)	Endemic	+	+	+	+	+	+	+
Butterflies	*Troides darsius*	Common Birdwing	NT	+	-	-	-	+	+	+
Land snails	*Cyclophorus ceylanicus*	Common Snail	NT	-	-	-	-	-	+	-
Amphibians	*Duttaphrynus melanostictus*	Common house toad	Endemic	+	-	-	+	-	-	+
	Lankanectes corrugatus	Corrugated water frog	Endemic	-	-	-	-	-	+	-
	Fejervarya kirtisinghei	Montain paddy field frog	Endemic	-	-	-	-	-	+	-
Reptiles	*Chrysopelea taprobanica*	Sri Lankan Flying Snake	VU	-	-	-	+	-	-	+
	Bungarus ceylonicus	Sri Lankan Krait	NT	+	-	-	+	-	-	+
	Chrysopelea taprobanica	Green Pit-Viper	VU	-	+	-	-	+	-	+
Birds	*Ocyceros gigalensis*	Sri Lanka Grey Hornbill	Endemic	+	-	-	-	+	+	+
	Gallus lafayettii	Sri Lanka Jungle fowl	Endemic	+	-	-	+	+	+	+
	Loriculus beryllinus	Sri Lanka Hanging Parrot	Endemic	+	-	-	+	+	-	+
	*Pellorneum fuscocapillum**	Brown-capped Babbler	NT	-	-	-	-	+	-	+
Mammals	*Macaca sinica*	Toque monkey	NT	+	-	-	+	+	+	+
	Semnopithecus priam	Grey Langur	NT	+	-	-	+	+	+	+
	Manis crassicaidata	Indian Pangolins	NT	-	-	+	-	-	-	-

(8) Erosion from Tunnel Muck Dumping Site

Soil erosion may occur in the tunnel muck dumping sites. But except the dumping sites the other construction sites such as power plant, tunnel excavation site etc. has no possibility of soil erosion. No houses and farm lands will be affected by erosion, because the elevations of the tunnel muck dumping sites are lower than houses and farm lands. The place which might cause erosion is shown in **Figure 8.4.3-5**. (See EIA report 4.1.1.)

[3] NT-Near Threatened / VU-Vulnerable / EN-Endangered / CR-Critically Endangered

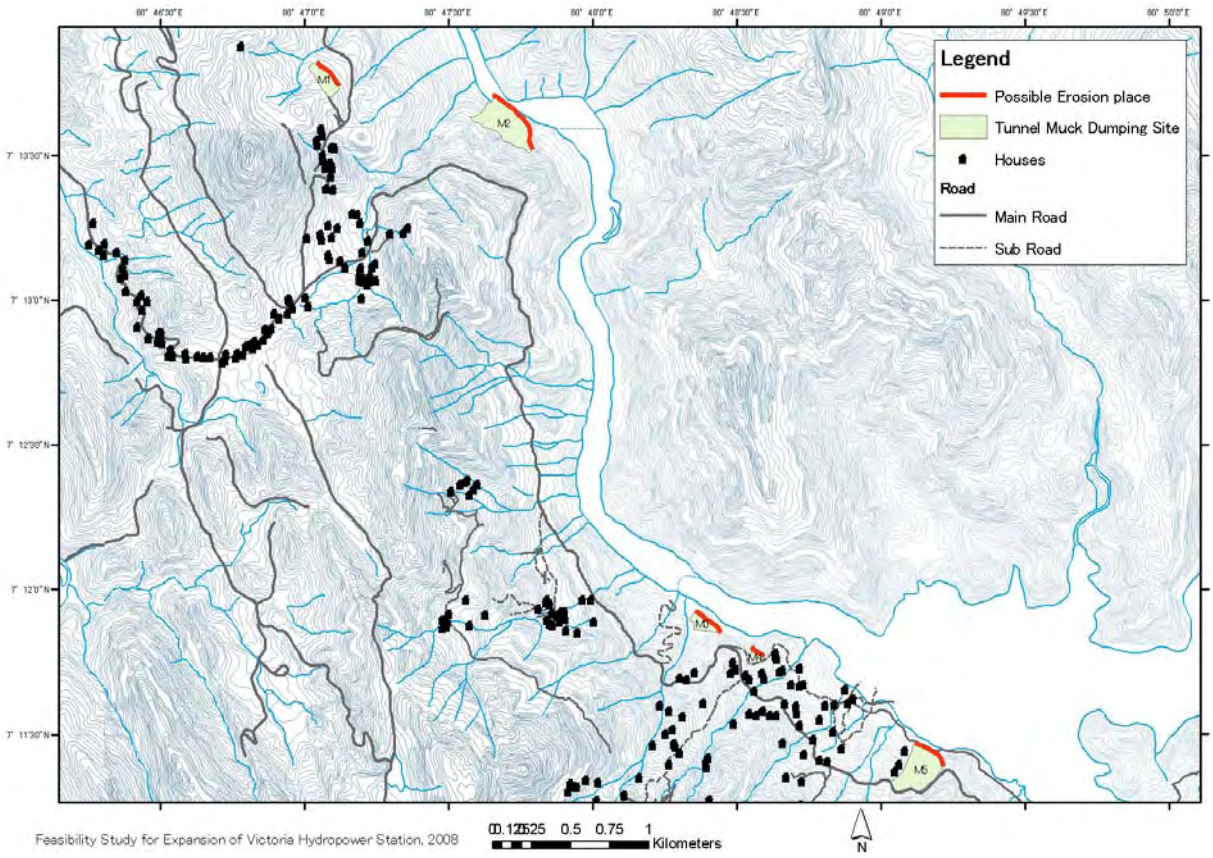


Figure 8.4.3-5 Possible erosion Place

(9) Degradation of Roads by Heavy Transportation

As the tunnel is excavated in the deep underground, tunneling will not have an effect on transportation. However, the transportation of tunnel muck on the roads to the dumping sites will have a negative impact on the smooth flow of traffic at present. 18 km of the existing roads will be affected for 4 years. **Figure 8.4.3-6** shows the location of the possibly affected roads. (See EIA report 4.7.12.)

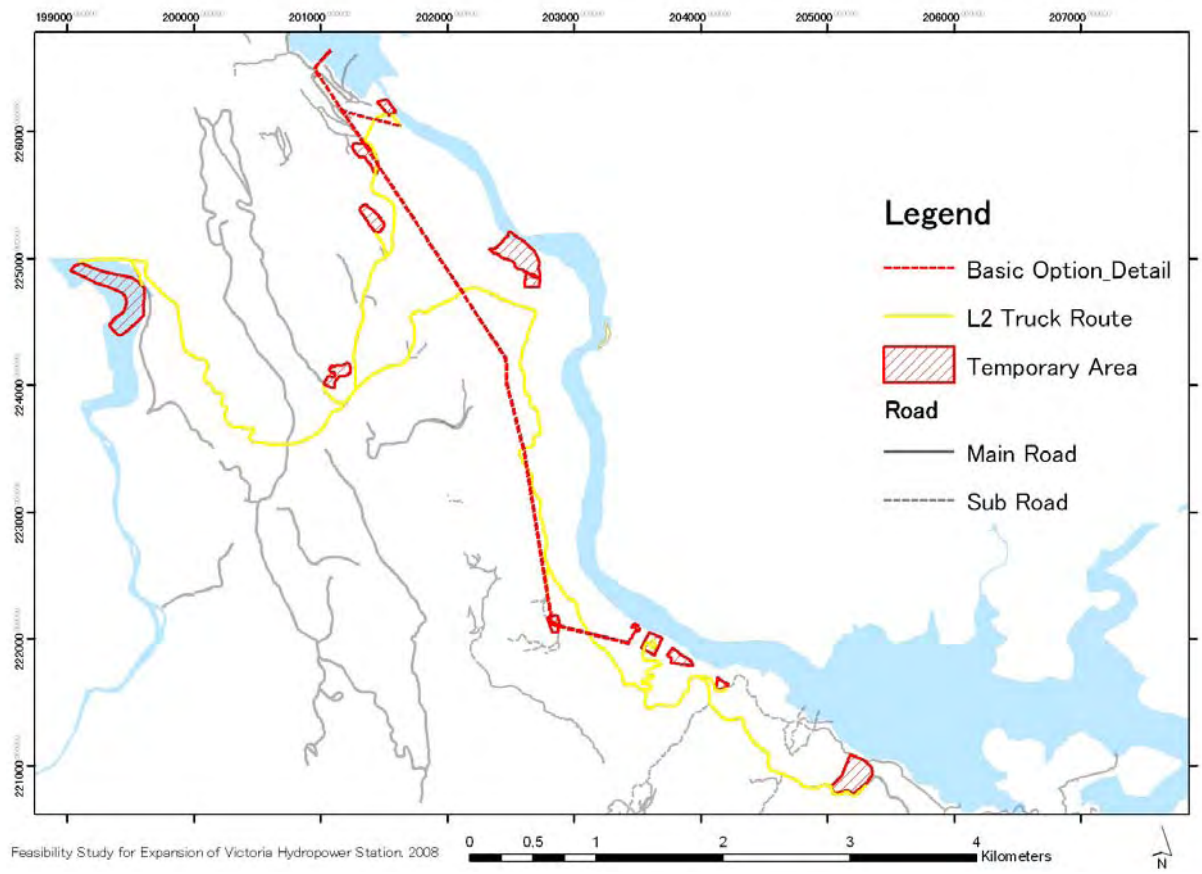


Figure 8.4.3-6 Heavy Trucks Routes

(10) Impacts on Elephant

There is a possibility for noises and vibrations caused by the construction works during the construction period to disturb activities of wild elephants.

It has been estimated that the water level of the Mahaweli river downstream of the powerhouse can go as high as 2 meters in maximum during the time of peak operation when both the existing and new power plants are generating and the water level of the Rangenigla reservoir is at the practical Minimum Operational Level (MOL) of elevation at.209 m (see Annex 3.4 of EIA report). This could most probably prevent the elephants from crossing the river within that stretch. On very rare occasions, it is also possible that the rise of water and the high velocity of flow could cause injury to elephants who are already in the channel.

Elephant movements in the Kohaombagana area may also get disturbed, once tunnel muck dumping is started at this area. (See EIA report 4.3.4.)

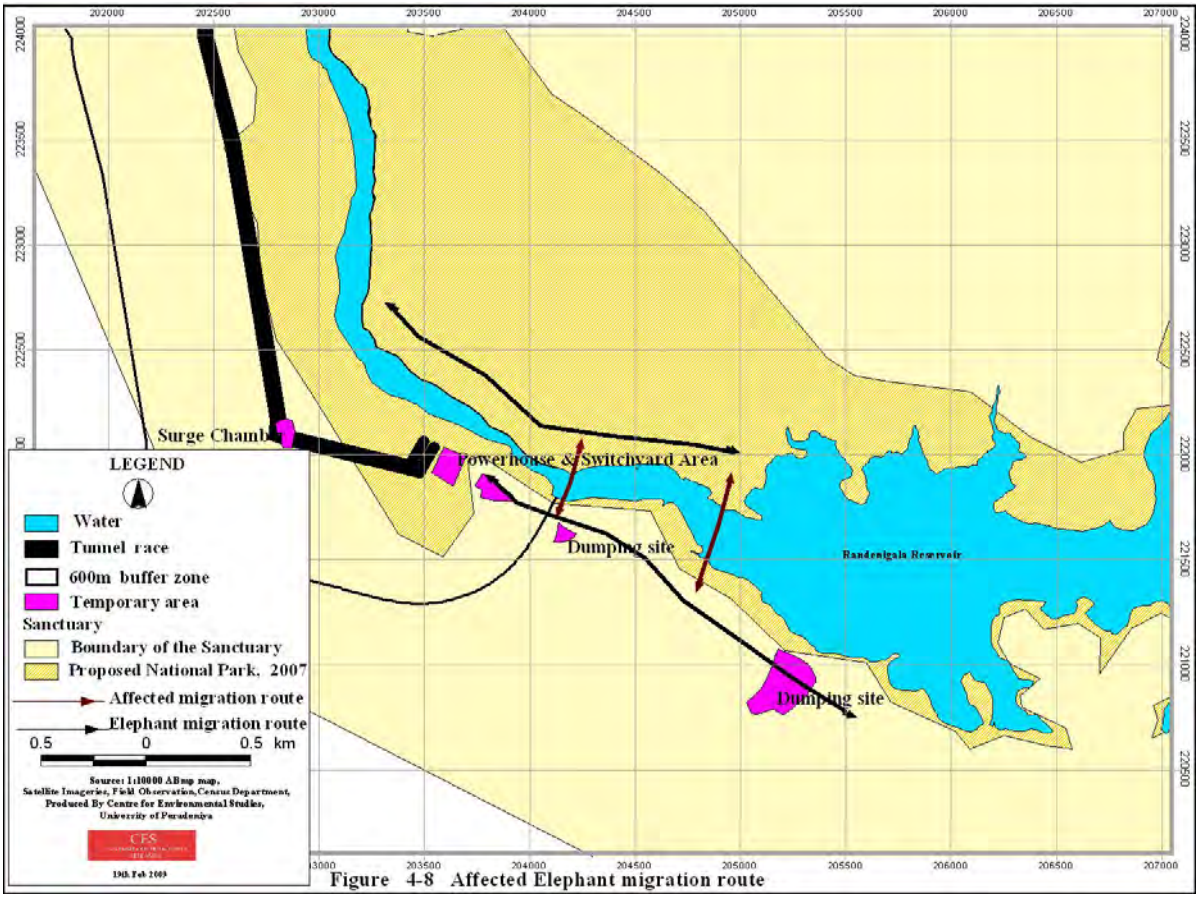


Figure 8.4.3-7 Affected Elephant Migration Route

(11) Loss of Private Land of Kohombagana

The loss of private land is limited to Kohombagana, because most of the construction area is official land such as quarry area and tunnel muck dumping sites used in the stage I, the land owned by CEB, and the shooting gallery owned by army. The possible loss of private land would be 5.79 ha including 5.07 ha of forest and 0.72 ha of homestead. (See EIA report of 4.7.6.)

Table 8.4.3-9 Estimated Impact Area (ha)

Temporally facilities		Forest	Scrub	Paddy/ seasonal	Homestead	Total
M5	Dumping site	5.07	0.00	0.00	0.72	5.79

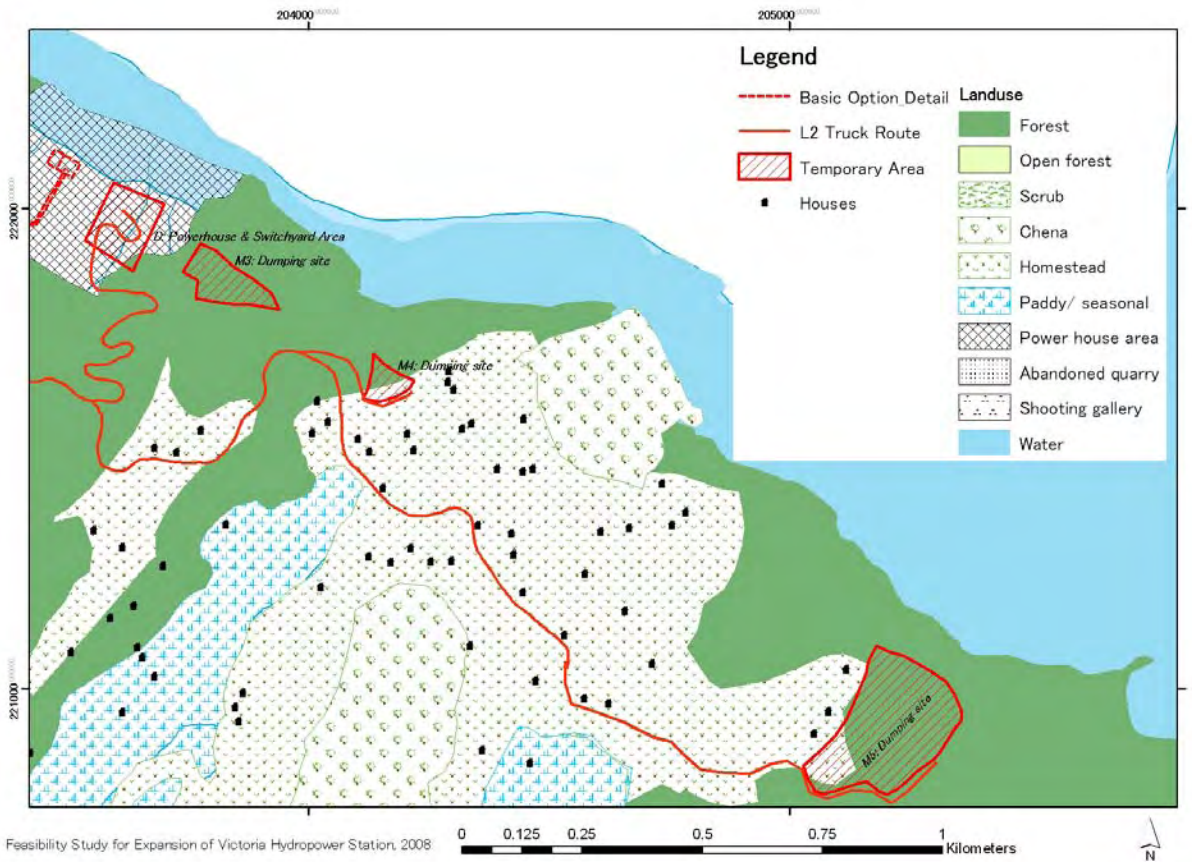


Figure 8.4.3-8 Loss of Private Land at Tunnel Muck Dumping Site in Kohombagana

8.4.4 Mitigation Measures

The following mitigation measures are planned. Detail mitigation measures are shown in Chapter 5 of EIA report.

(1) Provision of Water Supply to the Affected Families for the Loss of Groundwater

57 houses consisting of 241 people in the impact area would possibly be in a target for water supply. Since there is no natural water source to establish a piped-water system in these two villages this impact has to be mitigated by supplying water with water tank trucks as required. The water supply is only during construction, because the drawing down period is estimated only during construction. The daily requirement of water in the rural sector has been estimated at 100 liters/day per person (National Water Supply and Drainage Board, 2006). Thus the total volume of water that would have to be supplied annually is 8,796.5 m^3 if all the wells dry up and no rain water is available in the area during the construction period. This would require roughly 8 water tank trucks (with a 3 m^3 in capacity) a day. (See EIA report 5.1.)

(2) Cash Compensation for the Loss of Agricultural Production

The total maximum value of the cash compensation for the loss of agricultural production is Rs.28.9 million including Rs.22.3 million for Chena, Rs.5.1 million for Homestead, and Rs.1.5 million for Paddy (see **Table 8.4.4-1**). (See EIA report 5.2.)

Table 8.4.4-1 Estimated Compensation Cost for the Loss of Agricultural Production

Type of Agriculture	Economic loss (Rs./year)	Year	Compensation cost (Rs.)	Remarks
Paddy	373,700	4	1,494,800	Table 4-8, EIAR
Chena	5,576,200	4	22,304,800	Table 4-9, EIAR
Home Gardens	1,272,530	4	5,090,120	Table 4-10, EIAR
Total			**28,889,720**	

(3) Mitigation for Vibration Impacts

The construction of the Project carries out underground and open-air works near the existing Victoria dam, intake for expansion, existing waterway and powerhouse. The maximum vibration limit was set for blasting work for the construction works (See 9.2). The amount of explosive must be controlled in order to keep under the acceptable value. The contractor should carry out several times of trial blasting, each time loading different amount of explosives, in the new access adit to confirm appropriate blasting method with the maximum allowable blasting vibration, and measure the velocity of vibration with vibrographs at the intake gate shaft and/or in the dam inspection galleries. The contractors should strictly watch the blasting method, amount of explosives, etc., with the trial blasting. Vibration due to the blasting during construction period should be measured on the existing structures and/or rock surfaces with the vibrographs to confirm safety of the existing structures. (See 10.2.2 and EIA report 5.3.)

As mentioned in **8.4.3 (3)** the impact on the houses would be small if the amount of the explosive of the blasting does not affect the existing structures. The excavation of the surge tank in the Hakurutare GN division will be done only in daytime (around 10 hours) in order to prevent the villagers from receiving the serious noise and vibration impact of blasting during night time.

(4) Control Spillage/Treating the Tunnel Discharge

Tunnel discharge will contain high amounts of suspended particles. In addition it could also contain nitrates from explosive materials, oil and grease from machinery, and other impurities based on the mineral composition of the excavated materials. All tunnel waste water must be treated for suspended solid removal, oil and grease removal, nitrogen compound removal and any other substance that is in excess of the prevailing discharge standards. The use of a grease trap followed by a settling/lagooning tank should be adequate to treat this waste water up to the required levels. (See EIA report 5.4.)

(5) Strict Safety Measures to Prevent Work Accidents

The local workers should be educated and trained to follow safety measures. Proper safety equipment should be made available to the construction crew and visitors. Notices displaying the safety warnings and precautions must be placed at all work fronts. The workforce and the visitors should be compelled to follow the safety guidelines and regulations strictly. A stock of basic first aid medicine with trained personnel should be available around the clock. An ambulance also should be made available. The Project Proponent should maintain comprehensive daily records on the safety of its workers at all construction sites. (See EIA report 5.5.)

(6) Environmental Restoration Program to Prevent Soil Erosion

The rehabilitation of forest cover at the dumping sites consists of three components; soil conservation, rehabilitation and replanting, and maintenance. The proposed soil conservation measures are given in section 5.22, EIA report. The total area of the dumping sites is estimated at 15.66 ha. (See EIA report 5.6.)

(7) Mitigation for Noise Impact

The PP should request the contractor not to use old machinery and to maintain them in excellent working conditions so that they generate only the minimum noise. This is especially applicable to the heavy vehicles transporting sand and muck. (See EIA report 5.7.)

(8) Mitigation for Groundwater Pollution

All waste waters must be properly treated (to comply with the existing discharge standards) before releasing it into the surrounding. In addition all toilet waste disposals must be guaranteed as safe for area groundwater. All toilet waste water from camps and construction sites must be separated and treated on sites by using conventional septic tank systems. Hazardous wastes such as vehicle maintenance waste should not be dumped on open ground and must be collected separately and disposed of in an appropriate manner. (See EIA report 5.9.)

(9) Awareness Programs for the Workers

A general awareness program for the workers should be conducted by professionally qualified experts on socially communicable diseases on a regular basis during the construction period and also on the need to respect the socilcultural environment of the local communities. (See EIA report 5.10.)

(10) Repairing of the Damaged Road

The total length of the existing road that will be used during construction is estimated at 18 km. In total, a 10-ton damp truck will make 115,500 trips during the construction period estimated to last 52 months. However, it has not been estimated how much damage that could cause taking into consideration the weight of the vehicle and number of trips. Therefore, the RDA cost estimation for

patching damaged roads were used in calculating the mitigation cost. Either the Project itself can repair the roads or enter into an agreement with the RDA to effectively repair the road on a continuous basis. (See EIA report 5.11.)

(11) Installing Flash Lights and CCTV Cameras to Monitor the Migration of Elephants

To ensure that impacts on elephant migration are mitigated, the first requirement is to build a sufficient database on the actual migration pattern of elephants across the stream downstream of the proposed powerhouse. For this purpose, as a preliminary measure, eight CCTV (Closed Circuit Television) cameras will be installed at an early stage of the construction, if possible one year before the commencement of the construction works, at reasonable intervals on the right bank of the channel to observe the presence of elephants on the stretch of the river bed concerned. The ethological specialists including those of DWLC will be appointed for elephant survey and analysis. If the elephants' presence is confirmed during the observation in the pre-construction period, it is suggested controlling the blasting timing in consideration of the activity time and area of the elephants during the construction period. And installation of flash lights is also suggested in the operation stage. The flash lights will be installed in the river bed and flash 15 minutes before the commencement of plant operation to warn the elephants. Eight lamps will be installed at 8 defined cross sections downstream of the powerhouse. The mitigation measures for elephants will be continually revised based on the survey and analysis results. (See EIA report 5.12.)

(12) Compensation for the Loss of Private Land at the Dumping Site at Kohombagana

About 6.2 ha of land at the Kohombagana candidate muck dumping site is owned privately, but the land is now abandoned and is overgrown with vegetation. Although there is no market for land in this area due to the declaration of the VRRS, it is important that the rightful owners receive cash compensation for the land. After several discussions with the villagers and officials, it is proposed that they will be compensated with a hypothetical value of Rs.100,000.00 per acre. (See EIA report 5.13.)

8.4.5 Monitoring Plan

(1) Monitoring Committee (See EIA report 7.1)

The monitoring program proposed is based on both internal and external monitoring. All construction related impacts, i.e., safety issues, noise and vibration, integrity of the existing tunnel will be monitored internally by the Project Proponent with the consultant and the contractors. The impacts on the physical, biotic and social environment will be monitored externally by a monitoring committee headed by an independent environmental consultancy firm/organization. The monitoring committee consists of the following.

- A representative of the Project Proponent (CEB)
- A representative of the consultant employed by CEB for project implementation
- A representative of each contractor

- Grama Niladari of the Welikada and Hakurutale divisions
- A representative of the MASL/MSO
- A representative of the DWLC
- An environmental and social impact assessment specialist stationed at the project site during the entire construction period
- A reputed scientific organization specializing in environmental research, assessment and monitoring

The Monitoring Committee shall meet once a month during the construction period and inspect and review the monitoring program and suggest any changes or modification necessary. The Monitoring Committee should submit monthly progress review reports. The monitoring committee shall have access to all construction sites, and the contractor shall provide all necessary information. The Monitoring Committee will function during the entire construction period and additional six months. At this point, the monitoring responsibility will be transferred to the Project Proponent.

(2) Monitoring Program (See EIA report 7.2)

The Monitoring Committee will be primarily responsible for implementing the Monitoring Program given below (see **Table 8.4.5-1** and **Table 8.4.5-2**). The monitoring program is designed primarily to ensure the effective implementation of the mitigation of the significant impacts.

Table 8.4.5-1 Mitigation and Monitoring (Negative Impact)

Impact	Nature of Impact	Mitigation Measure	Monitoring					
			Parameter	Locations	Method	Frequency	Duration	Responsibility
(1) Temporary lowering of ground water affecting domestic uses	57 house holds will be affected.	Provision of mobile water supply to the affected families	The number of affected houses getting the supply	Houses	Enumeration of changing ground water level	Weekly	One year in pre-construction stage if possible, construction period and additional one year	Monitoring committee/ Preconstruction ground and surface water levels and quality survey is recommended.
(2) Temporary reduction in agricultural production (paddy, home garden) to lowering of ground water	139.2 ha (Rice field and vegetable field)	Cash compensation for the loss	The affected agricultural plots	Plots	Enumeration	Every four months	Construction period and additional six months	Monitoring Committee
(3) Impact on the integrity of the existing tunnel and other structures	Blasting is controlled by the use of appropriate specific charges in the blasting rounds to limit peak particle velocity not exceeding 2 cm/sec.	Use of modern and safe technology Recording actual status of the existing structures in the pre-construction stage is recommended	Blasting vibration	Dam/Power House/Other affected places and houses (Tunnel will not be directly monitored as it is in operation)	Continuous monitoring using vibrometers and spot checks	Continuous/ when required	Construction period	MASL and CEB
(3b) Impact on the integrity of the existing houses	Blasting is controlled by the use of appropriate specific charges in the blasting mentioned in (3) above.	Use of modern and safe technology Pre-construction structural distress survey (crack survey) is recommended	Use of machines and methods	Sites of Operations	Observation	Monthly	Construction period	Monitoring Committee
(4) Pollution of surface water from tunnel discharge and at tunnel muck sites	10 locations are estimated as possible impact area. But no houses will be affected.	Control spillage/Treating the tunnel discharge through oil traps	Water Quality parameters and the proper functioning of the treatment	Discharge sites	Inspection and measure	Fortnightly	Construction period	Monitoring Committee

Impact	Nature of Impact	Mitigation Measure	Monitoring					
			Parameter	Locations	Method	Frequency	Duration	Responsibility
(5) Increase in work related accidents	Traffic accidents, tunnel accidents, fire, etc.	Follow strict safety measures	Use of safety methods and equipments	Workplaces	Observation	Daily	Construction period and additional six months	Monitoring Committee
(6) Reduction of forest cover at dumping sites	Reduction of forest cover is 8.14 ha	Implement a environnemental restoration program	Regrowth Establishment and regeneration	Dumping sites	Observation measure and count	Twice a year for flora/Monthly for Fauna	Construction period and additional three years	Monitoring Committee with an ecologist
(7) Disturbance of some species due to noise and other activities	During construction some species will be affected.	Use low noise machinery/ some noise is not mitigable	Sound levels	Sites of Operations	Measure sound levels	spot checks	Construction period	Monitoring Committee
(8) Soil erosion due to tunnel muck dumping and access road construction	Length of the rubble is 1253 meter	Use appropriate soil conservation methods during construction (parallel with impact 6)	Methods	Dumping sites and access roads	Observation	Monthly	Construction period and additional six months	Monitoring Committee
(9) Ground Water Pollution from Tunnel discharge	Partially mitigable	Treating the waste water before discharging into the ground	Ground Water Quality parameters	Selected wells in the PIA	Measure	Once in two months	Construction period	Monitoring Committee
(10) Disturbances to the community from the workers	Partially mitigable	Awareness programs for the workers	Complaints from villagers	Villages	Enumeration	When required	Construction period and additional six months	Monitoring Committee
(11) Damages to Road due to increase in heavy traffic	Affected road is 18 km, 4 years.	Immediate repairing of the damaged roads	Road damages	Along the roads	Inspection and observation	Weekly	Construction period and decommissioning period.	Monitoring Committee
(12) Disturbance to the migration patterns of elephants	Migration routes from Power station to Randenigala Reservoir will be affected during operation.	Installing 8CCTVs to monitor elephants on the bed. And flash lights at 8points (cross sections) along right bank of the channel from the powerhouse	The presence of elephants on the river bed	Location where lights and CCTVs are installed.	Observation and monthly review	Automatic recording and monthly review	During construction and continue only if there is a need. Flash light will be used only if necessity is confirmed.	Monitoring Committee with the DWLC. The information will be useful for DWLC.
(13) Loss of private land at tunnel muck dumping site in Kohombagana	5.79 ha would be affected by temporary facilities in Kohombagana.	Payment of compensation for the loss of land at Rs. 100,000 per acre	Amount paid	Village	Check and verification	Twice	At the time of valuation and paying compensation	Monitoring Committee

Table 8.4.5-2 Enhancement Measures and Monitoring (Positive Impact)

Impact	Nature of Impact	Mitigation Measure	Monitoring					
			Parameter	Locations	Method	Frequency	Duration	Responsibility
Reduce carbon fuel/foreign exchange savings	Beneficial	CEB to explore the possibility of getting carbon credit benefits						No monitoring required
Injection of capital to the local economy	Enhanceable	Buy local raw material/employ local people	The amount of local produce bought The number of locals hired	Project Area and adjoining villages	Rapid Survey	Every Six months	Construction period and decommissionin g period.	Monitoring Committee
Increase in regional employment opportunities	Enhanceable	Give preference to locals in hiring for all jobs	The number of locals hired	Project Area and adjoining villages	Rapid Survey	Every Six months	Construction period and decommission-ing period.	Monitoring Committee
Building a positive impression of the project	Enhanceable	Open an office to public Contribute to community development programs	Functioning state of the art audio visual equipments at the visitor center	Visitor Center and villages	Observation	Every Six months	Construction period and additional six months	Monitoring Committee