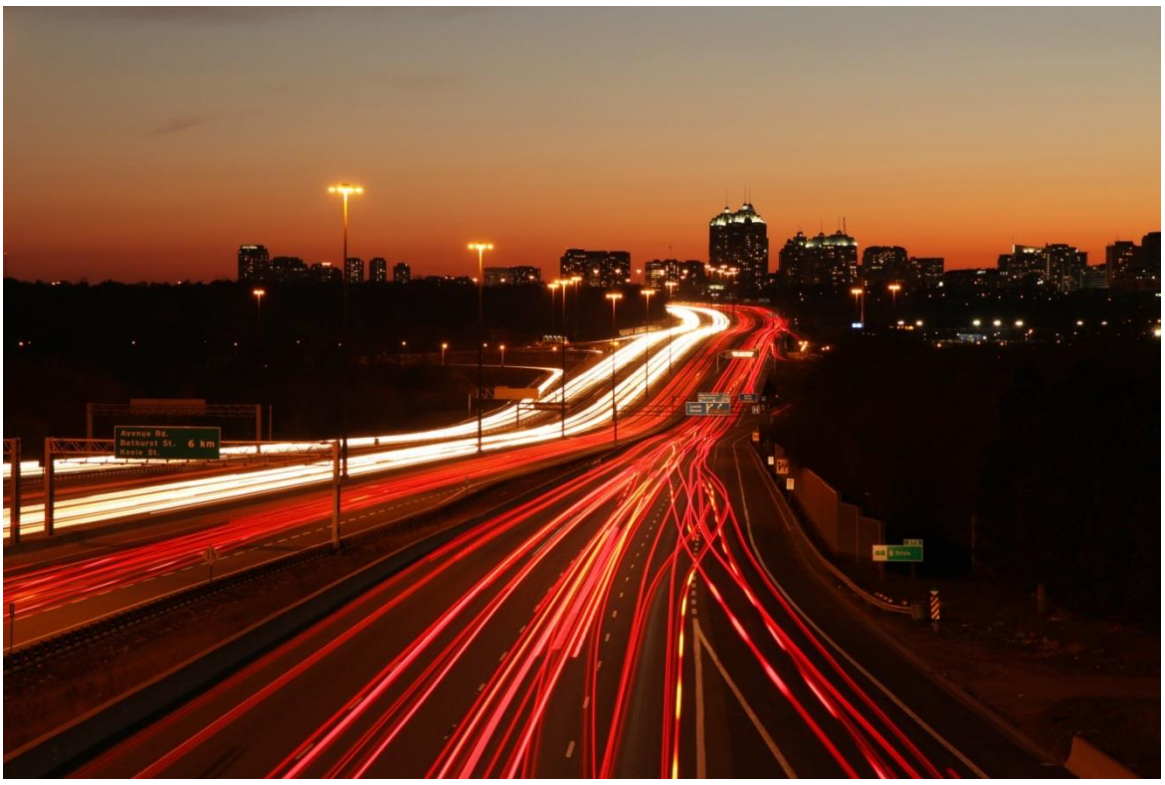
PROPOSED CENTRAL EXPRESSWAY PROJECT

Kadawatha to Dambulla (Sections 01, 02 and 04)

Final Environmental Impact Assessment Report

Volume I - Main Report
May 2016



Submitted to: Central Environmental Authority, Ministry of Mahaweli Development and Environment

Submitted by: Road Development Authority, Ministry of Higher Education and Highways

Prepared by: Center for Sustainability, Department of Forestry and Environmental Science, University of Sri Jayewardenepura.

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Department of Forestry and Environmental Science
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Gangodawila, Nugegoda
Sri Lanka

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List of Abbreviations

AG - Agricultural Plantations

AQ - Aquatic Habitats

BOD - Biochemical Oxygen Demand

CBA - Cost-Benefit Analysis

CBR - Cost-Benefit Ratio

CEA - Central Environmental Authority

CEB - Ceylon Electricity Board

CEP - Central Expressway Project

CFS - Center for Sustainability

CKAH – Colombo - Kandy Alternative Highway

CO – Coconut Plantations

COD - Chemical Oxygen Demand

CSC - Construction Supervision Consultant

DO - Dissolved Oxygen

ECBA - Extended cost-benefit analysis

EIA - Environmental Impact Assessment

EMMP - Environmental Management and Monitoring Plan

EMP - Environmental Management Plan

EO - Environmental Officer

ESCM - Environmental Safeguards Compliance Manual

ESDD - Environmental and Social Development Division

ESIA - Environment and Social Impact Assessment

FP - Forest Plantation

GP – Grassy Plains

GSMB - Geological Surveys and Mines Bureau

HeIA - Heritage Impact Assessment

HG – Home Gardens

IAS - Invasive Alien Species

IRR - Internal Rates of Return

NAAQ - National Ambient Air Quality

NBRO - National Building and Research Organization

NCS - National Conservation Status

NE - Not Evaluated

NEA - National Environmental Act

NF - Natural Forest

NIRP - National Involuntary Resettlement Policy

NPV - Net Present Value

NWP - North Western Province

NWP-EA - North Western Province –Environment Authority

NWS&DB - National Water Supply and Drainage Board

OCH - Outer Circular Highway

PE - Proposed Endemic

PF - Paddy Fields

PMU - Project Management Unit

RAP - Rehabilitation Action Plan

RO - Rock Outcrops

RS - Riparian Strips

SAIRC-Social Assessment and Involuntary Resettlement Compliance

SF - Sparse Forest

SIA - Social Impact Analysis

SLLRDC - Sri Lanka Land Reclamation and Development Corporation

SMEC - Snowy Mountains Engineering Corporation

SPL - Sound Pressure Levels

SPM - Suspended Particulate Matter

TIN - Triangulated Irregular Network

TOR - Terms of Reference

TP - Total Phosphorus

TSS - Total Suspended Solids

VOC - Vehicle operating costs

WBS - Work Breakdown Structure

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EXECUTIVE SUMMARY

The Government of Sri Lanka has decided to construct the Central Expressway starting from Kadawatha to Dambulla with a link expressway from Pothuhera to Galagedara. The Central Expressway Project (CEP) has been dived to four (4) sections as follows:

- Section 1 – Kadawtha to Meerigama, length of approximately 37.0 km
- Section 2 – Meerigama to Kurunegala, length of approximately 39.7km
  Meerigama to Ambepussa - length of approximately 9.1 km
- Section 3 –Pothuhera to Galagedara, length of approximately 32.5km
- Section 4 – Kurunegala to Dambulla, length of approximately 60.3 km

In order to ensure compliance with the relevant provisions under the National Environmental Act (NEA) and associated regulations, as well as other relevant legislation and policies linked to road works, an Environmental Impact Assessment Report with the Environmental Management and Monitoring Plan (EMMP) is prepared. This Environmental Impact Assessment (EIA) report has been prepared to assess the sections 1,2 and 4 of CEP Kadawatha to Dambulla stretch. The scope of the EIA covers the proposed expressway corridor from Kadawatha to Dambulla and Link road from Wilwatta to Ambepussa (Ambepussa Link Road), excluding Kadawatha System Interchange. Since the project covers a vast extent of land several other clearances and approvals need to be obtained some of which are already issued some of which are still pending.

The total length of the expressway from Kadawatha to Dambulla is 136.9 km and goes through 4 districts, Gampaha, Kurunegala, Kegalle and Matale. There will be 14 interchanges within the expressway, including 3 system interchanges (Kadawatha, Wilwatta and Pothuhera) and 12 service interchanges including Ambepussa Junction. The alignment generally traverses through lands which are privately owned with a few exceptions of government owned lands and institutions. The RDA has identified ROW corridor for the CEP, within which all lands will be acquired under the Land Acquisition Act, 1950 (LAA). All acquisitions of properties will be completed before the commencement of the project. The expressway will be constructed as an elevated structure using viaducts, bridges, culverts and earth fill embankments. Standard road construction techniques will be employed for the CEP, with most of the construction work to be undertaken using heavy machinery and equipment. The total project cost for the CEP will be around 445.30 billion LKR. Total Project Cost for the CEP Sections 1, 2 and 4 will be around 350.64 billion LKR.

Existing Environment

The study area considered for the assessment during the EIA preparation is the area specified in the Terms of Reference (TOR) of the EIA issued by the CEA. Special emphasis was given to the affected areas at interchanges located along the proposed expressway. An assessment of baseline conditions on the physical, biological and social-economic environment was carried out within the said corridor. In addition, all identified sensitive areas within approximately 1 km from the ROW, were subjected to assessment.

Section 1(Kadawatha to Mirigama): The Expressway commences at the interchange with Outer Circular Highway (OCH) and the trace passes over mainly paddy and uncultivated lands. After Gampaha the trace runs mostly parallel to the existing railway line.

Section 2 (Mirigama to Kurunegala): This Section is located over paddy fields, coconut estates and uncultivated lands. Within this section the expressway passes along the southern boundary of Weragalakanda Conservation forest.

(Mirigama to Ambepussa): This link road commences at Wilwatta interchange. The alignment passes over a hilly terrain with a forest patch which is a part of "Meerigama Kos Kele" plantation forest. The road ends at a junction with A006 Highway about 2 km from Ambepussa A001/ A006 Highway junction.

Section 4 (Kurunegala to Dambulla): This Section of CEP is located over paddy fields, coconut estates and uncultivated lands. Within this section the expressway passes along the Kirindigolla, Henegedaralanda, Hevanethanna, Omaragolla, Bamarakanda, kathiganakanda and Bandakkagala forests.

Overall Environment -

The proposed expressway goes through the wet zone and intermediate zone and primarily through paddy fields and low lying areas most of where floods are frequent. In addition it crosses a number of streams and canals or runs close to them. The proposed expressway is located on a sound basement rock and landslides are not dominant due to flat and low surface undulations. Geological investigations of the proposed expressway indicate low threats from land subsidence.

The proposed route traverses through a variety of natural, semi natural and human-modified landscapes and agro-ecosystems and home gardens are the major land uses affected by the proposed project. It goes through a few forest patches but does not traverse through any national parks, sanctuaries or declared wet lands. No migratory paths of wild animals (e.g. elephants) were encountered in the study area.

The proposed project transverses through four administrative districts; Gampaha, Kegalle, Kurunegala and Matale. It runs through 163 GN divisions in 18 DS divisions in those districts. Majority of the settlements are predominantly rural but highly exposed to the expansion of urbanization and modernization of infrastructure facilities. Even though economic development is well evident in the area, a considerable portion of population suffer from poverty.

Anticipated Impacts and Measures for Mitigation

Through an impact identification matrix it was identified that the most affected aspects would be Hydrology, Socio Cultural aspects and Ecological Aspects. A summary of the key impacts anticipated from the proposed project and mitigatory measures are given in Table A.

As the project is going through a considerable extent of paddy fields and low lying areas the construction related activities are bound to cause significant hydrological impacts such as increasing the incidences of flooding, change in flow patterns and disruption to continuity of irrigation canals. To overcome these numerous mitigatory measures will be undertaken through design. It will also be ensured that construction will take place in the dry period.

One of the main adverse impacts of the proposed project is on human settlements due to acquisition of land and significant number of resettlements which will bring about long lasting changes to the area. Changes in landuse pattern will also have a significant impact on livelihood and local economy. To address this issue the RDA through its PMU and in consultation with affected parties is preparing a comprehensive Resettlement Action Plan (RAP) for both permanent and temporary relocation of families and institutions. During construction the community would face short term impacts such as disruption on public utilities and infrastructure which will be minimized by discussing with relevant authorities and keeping the public informed of break downs ahead of time. As health and safety of workers and general public will be a concern all necessary measures would be taken to assure public safety and health during both the period of the construction and the operation of the proposed expressway.

On the other hand the proposed project is bound to develop the locality and the region by the reducing the travel time, improved infrastructure, increased land value and secondary developments and increased employment opportunities.

As the proposed project is going through a considerable area ecological impacts are inevitable. Although most of the sensitive natural habitats have been avoided during the initial design of the expressway there will be a substantial and permanent loss and fragmentation of natural terrestrial habitats, large stretches of paddy

fields, plantations of coconut and other minor crops and home gardens. Sensitive areas will be avoided to the extent possible failing which technical measures will be taken so as to minimise disturbances to natural habitats and flora and fauna.

As the trace crosses a number of water bodies impacts on water quality can be significant. All measures would be taken during construction and operation to minimise run off and spills to water bodies. Good housekeeping practices would be adopted. It would be ensured that construction camps have proper waste management facilities. Road cuts along the mountainous area can affect soil stability and groundwater stability and even rock slides may be expected when road cuts are going on across the escarpment slope of the mountain. Guidance of a geologist/geotechnical engineer would be sought with respect to road cuts and slope stability techniques would be implemented where necessary. Necessary slope stability methods would be applied during construction in areas prone to landslides.

Dust emissions and noise and vibration are the main causes of air pollution. In addition to doing construction during the wet period all possible measures would be taken to minimise dust generation through good house-keeping practices. Noise levels would be monitored and maintained during the construction phase and at work sites where high noise levels are inevitable appropriate protective gear would be provided. Noise reduction measures will be taken in construction equipments and machinery. Blasting would be done only at regular intervals and only after the community is informed. Nearby building structures would be regularly monitored in order to investigate any instability or damage following blasting.

The Environmental Management Plan (EMP) proposed in the report will be revised during the detailed design stage and the updated EMP will form part of the contract documents. The construction contractor would be responsible for implementing the EMP during the construction period and the implementation of mitigation measures which is outlined in the EMP would be monitored.

It can be concluded from the EIA that although the proposed project is anticipated to bring about certain significant negative impacts these can be mitigated through adopting the mitigatory measures proposed. It is imperative that the EMP and EMoP proposed in the EIA be strictly adhered to ensure that the mitigatory measures are implemented without failure and that the project is continuously monitored to ensure that there are minimal environmental impacts.

In the Extended Cost Benefit Analysis (ECBA) identified impacts were valued using standard tools of valuation. Under the assumptions made in the base case, the project is viable with a Rs billion 9.73 net present value.

Table A. A summary of the key impacts anticipated from the proposed project and mitigatory measures

Number	Environmental Aspects	Impact	Proposed mitigation measures
1	**Hydrological Impacts**		
1.1	Impacts of soil erosion and deposition	Erosion of unprotected earth fills and deposition at paddy fields, streams, tanks and anicults etc. at flood plains.	Planning earth fill related construction at flooding areas during the months with no heavy rainfalls expected.
1.2	Impacts on water supplies and drainage at the paddy fields	Supply of irrigation water supplies and drainage of paddy fields can be disturbed if no proper invert levels are maintained through the culverts.	During the detailed design stage, every irrigation canal and drainage canal will be positioned and designed to avoid any disturbance to irrigation supply or paddy field drainage. This will be done with the consent of the relevant irrigation engineer, agrarian officer and/or the relevant farm

Number	Environmental Aspects	Impact	Proposed mitigation measures
			organization.
1.3	Impacts on the existing drainage pattern	Disturbances to the existing drainage pattern due to improper placement and orientation of bridges and viaducts.	Bridges and culverts will be oriented along the flow direction and some viaducts will be extended or repositioned so that there will be no obstruction to the present flow pattern.
1.4	Impacts on the anicuts	Few anicuts will be intercepted by the expressway. Expressway road surface runoff can accumulate at nearby anicuts.	Viaducts will be provided to clear the anicuts, or a design change will be carried out during the detailed design stage with the consent of the relevant irrigation engineer or agrarian officer. Road surface drainage will be directed away from the anicuts using the embankment toe drains.
1.5	Flood impacts on the expressway	Expressway operation can be interrupted due to the frequent floods.	Expressway embankment will be high enough to clear the flood levels.
1.6	Impacts on the flood water levels	Expressway embankment reduces flood retention areas which can raise flood levels.	A disturbance free passage will be left next to the embankment where the loss of flood retention area is high for easy conveyance of the flood.
1.7	Impacts on tanks	Bunds of few small tanks are intercepted by the expressway.	Viaducts will be provided to clear the tanks or a design change to the road embankment or relocation of the affected part of the dam will be done with the consent of the relevant irrigation engineer or agrarian officer.
2	**Socio – Cultural impacts**		
2.1	Social impacts on settlements.	Around 4500 building structures are to be affected requiring permanent relocation for about 75% of them.	- A package of compensation based on the highest market value of their properties, businesses and livelihoods - Resettlement Plan in consultation with affected parties. - An effective mechanism to address public grievances.
2.2	Social impacts of relocation of communities.	Permanent relocation of families and institutions living on acquired land and Temporary relocation for construction activities	A comprehensive Resettlement Action Plan (RAP) in compliance with the legal requirements and the Grievance Redress Mechanism
2.3	Impacts of land acquisition	Landlessness for some families, decline in the profitable use of remaining portions of land, reduction in the paddy fields.	- Land acquisition in compliance with the legal provisions and the Grievance redress mechanism. Compensation paid before acquisition. - Temporary acquisition only after formal agreement on conditions of use - Prevailing market rates used for the calculation of compensations
2.4	Impacts on livelihood.	Full and partial loss of harvest, earnings from agricultural labor, business, home gardens and other means of livelihood	- Restoration of livelihoods - Grievance Redress Mechanism to address food security of the affected people - Employ affected parties for project

Number	Environmental Aspects	Impact	Proposed mitigation measures
			activities
2.5	Impact on infrastructure facilities**.**	Normal functioning of public utilities and other infrastructure will be disrupted.	- identify possible locations of breakdowns and adopt provide remedial measures
2.6	Impacts on public safety and health	Construction activities and worker camps may cause accidents and health hazards.	- Project activities controlled in terms of clearly stipulated security guidelines and make the contractors and work forces aware of them. - Special attention paid to prevent HIV/AIDS and other infectious diseases.
2.7	Impact on traffic	Traffic diversions and transport of construction material will disrupt normal traffic in the area	- Identify all the locations of possible traffic issues in advance and adopt appropriate measures to manage them. - Adjustments in the work schedules and traffic diversions
3	**Ecological**		
3.1	Impacts on terrestrial Natural Habitats	Expressway construction will result in loss, degradation and fragmentation of natural habitats	- Identify ecologically sensitive habitats and avoid them if possible - Maintaining connectivity between habitats through bio links or animal over passes and underpasses - Enrichment planting in selected areas to compensate for the loss of habitats - Proper and safe storage and disposal of materials, excavated soils and debris - Making workers and contractors aware of adopting engineering best practices
3.2	Impacts on terrestrial flora	During constructions, vegetation will be lost or disturbed due to cut/fill operations, removal of top soil, vehicle movements, dust ad workers' activities etc,, spread of invasive plants	- Making contractors and workers aware on environmental safeguard measures and incorporating appropriate guidelines and conditions into contractor documents - Enrichment planting - Establish green belts as noise and dust barriers - Irradiation of Invasive Alien Species (IAS) will be incorporated to landscape maintenance plan
3.3	Impacts on terrestrial fauna	Habitat loss, degradation and fragmentation, disturbances due to noise, Road kills in operation phase	- Maintaining connectivity between habitats through bio links or animal over passes and underpasses - Enrichment planting in selected areas to compensate for the loss of

Number	Environmental Aspects	Impact	Proposed mitigation measures
			habitats - Establish green belts as noise and dust barriers - Reducing animal access to express way, Signs to caution vehicles, and structural barriers to prevent birds flying low over the expressway
3.4	Impacts on aquatic habitats, flora and fauna	Aquatic Habitat loss and degradation, Obstructions to the movement of aquatic organisms, pollution	- Habitat degradation due to soil erosion and sedimentation can be controlled by adopting construction best practices - Locating solid waste disposal sites away from waterways. - Placement of culverts and drainage structures, their proper maintenance
4	**Water**		
	Impacts on water quality during construction	Water quality of water bodies, especially turbidity and TSS, will be deteriorated during construction due to wash off of sediments, waste material and contaminants	- Proper collection, treatment and disposal of waste, including wastewater generated at labor camps - Control of erosion and entrapment of sediments, pollutants and debris - Proper monitoring of water quality and timely action initiated to prevent pollution
	Impacts on water quality during operations	Water quality of water bodies will be deteriorated due to wash off of waste material and contaminants from roadside drainage and rest areas	- Appropriate methods adopted to collect, treat and disposal of waste from rest area - Sediment traps installed at locations at sensitive receivers; Establish erosion control plans by establishment of stable native vegetation along the embankment slopes. - Prevention of contaminants entering water bodies during maintenance work of road surfaces
5	**Soil/ Geology**		
	Soil Erosion	Soil erosion, sedimentation and compaction. Higher level of turbidity in the surface water bodies	- Excavation activities minimized during the rainy season. - During the dry season wind erosion reduced by spraying water to the surface of the excavated soil - Proper storage of soil and raw materials. - Weakly monitoring of turbidity levels of surface water bodies
	Impact on Land Form and	Natural landslides, landslides along the road cuts and	- Guidance of National Building Research Organization will be

Number	Environmental Aspects	Impact	Proposed mitigation measures
	Stability	possible land subsidence	necessary throughout the project - Road cuts done under proper supervision. - Slope stability techniques to be implemented where necessary. - Material transportation done along the available road network in order to prevent soil compaction - Stabilization of natural landslide localities - Frequent monitoring of slope stability around the road during and after construction.
	Air Quality		
	Deterioration of air quality during construction	Elevated levels of air-borne particles will deteriorate the air quality	– Effectively managing the dust generating activities such as earth works, handling and transporting of soil and aggregate during times of high winds or during more stable conditions with winds directed towards adjacent residences and other facilities. – All earthworks shall be covered in a manner minimizing generation of dust Dust emission will be minimized through measures such as frequent wetting or wet spraying of dusty surfaces and any exposed earthwork surfaces – The levels of dust generation from the crusher plants, loading of raw materials to the asphalt plants and concrete batch mixing plants will be controlled.
	Deterioration of air quality during operations	Elevated levels of air-borne particles will deteriorate the air quality	– Maintenance of the green belt and establishing more trees that would absorb emissions of CO2; emissions of other obnoxious gases such as SOx can be reduced by importing and using quality fuel with fewer impurities. – In addition, maintenance of a vegetation cover and replantation of trees to the extent possible near the highway area should be carried out to arrest dust and airborne pollutants
7	**Noise and Vibration**		
	Noise impacts to	High noise levels, if higher	– All machinery and equipment to

Number	Environmental Aspects	Impact	Proposed mitigation measures
	nearby settlements and habitats during construction	than the stipulated limits during construction works, will severely disturb the neighbourhood	be used for the construction phase needs to be regularly well maintained – All vehicles and equipment. should have good quality mufflers or silencers to reduce exhaust noise. – High noise emitting machinery and equipment and all other noisy works such as concrete mixing and batching, mechanical compaction, use of saws, excavation works using excavators, jack hammers, rock drills and rock breakers should not be used during the night time – Demolition of structures should be carried out using quieter methods especially near settlement areas – Transport routes for trucks and heavy vehicles to the construction site would be selected to minimise the impact on residential areas where possible.

CHAPTER 1: INTRODUCTION

1.1. Background of the project

Sri Lanka is situated in the Indian Ocean and it is about 28 kilometers off the south-eastern coast of India. It has a land area of about 65,000 km^2 and a population of about 20 million. Density is highest in the south west where Colombo, the country's main port and industrial center, is located. The net population growth is about 0.7%. Sri Lanka is focusing on long-term strategic and structural development challenges as it strives to transition to an upper middle-income country. Key challenges include boosting investment, including in human capital, realigning public spending and policy with the needs of a middle-income country, enhancing the role of the private sector, including the provision of an appropriate environment for increasing productivity and exports, and ensuring that growth is inclusive.

Transportation has become a major requirement in day to day life in the modern society. The proper and quicker transportation methods should be available for development of the country. Traffic congestion in Sri Lanka's urban areas has become not only a nightmare to the public, but also one of the main obstacles to development, causing massive economic losses to the state. Therefore the capacity of transportation facilities has to be developed to meet its specific demand within the requirements of the transport system as a whole.

The Government of Sri Lanka has decided to construct the Central Expressway starting from Kadawatha to Dambulla with expressway links from Meerigamata to Ambepussa and Pothuhera to Galagedara. In order to ensure compliance with the relevant provisions under the National Environmental Act (NEA) and associated regulations, as well as other relevant legislation and policies linked to road works, an Environmental Impact Assessment Report with the Environmental Management and Monitoring Plan (EMMP) is prepared.

Central Expressway Project (CEP) is considered as four (4) Sections as given in Table 1.1.

Table 1.1: List of Sections in CEP

Section	Description	Length (km)
Section 1	Kadawatha to Mirigama	37.0
Section 2	Mirigama to Kurunegala	39.7
	Mirigama (Wilwatta) to Ambepussa (Ambepussa Link Road)	9.1
Section 3	Pothuhera to Galagedara	32.5
Section 4	Kurunegala to Dambulla	60.3

After the Expressway alignment of CEP was proposed, the Road Development Authority requested for and obtained two separate TORs for the CEP from Central Environmental Authority (CEA). One TOR was for the Expressway from Kadawatha to Dambulla (Annex 1.1), and other one was for expressway link from Pothuhera to Kandy. This Environmental Impact Assessment (EIA) has been prepared to assess Sections 1, 2 and 4 of the Central Expressway Project. EIA for Section 3 and EIA for Kadawatha System Interchange are conducted as separate studies. Figure 1.1 presents the general area of Central Expressway Project.

The Road Development Authority (RDA) of Democratic Socialist Republic of Sri Lanka has engaged the Center for Sustainability (CFS) of Department of Forestry and Environment Science of University of Sri Jayewardenepura (USJP) to prepare an Environmental Impact Assessment Report for the (Kadawatha Dambulla section (sections 1, 2 and 4) Central Expressway Project in accordance with the TOR issued by CEA.

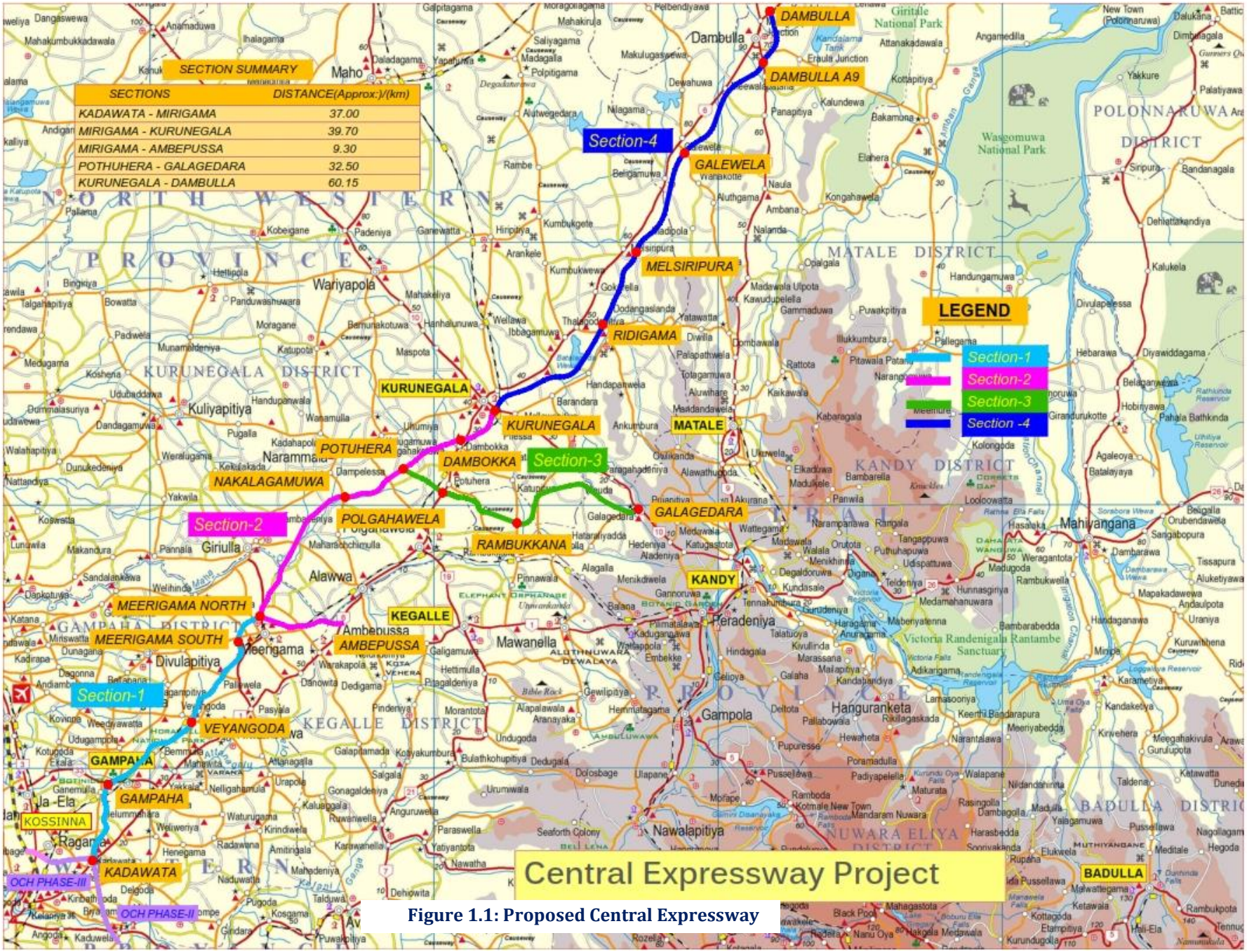

Figure 1.1: Proposed Central Expressway

1.2. Objective and justification of the project

The proposed expressway network is expected to inter-connect most of the regions in the country including the North and East and to expedite the development in the country. With the facilitation of the transport network, both national and international investments are expected to rise and boost the economy. It will also enhance the ease of access to tourist destinations, reduce travel times and improve fuel efficiency, thus contributing to sustainable development while ensuring the environmental and social safeguards.

The key project objectives of the CEP are mentioned below.

- Provide an efficient transportation network to expedite development plans in the Country,
- Facilitate the needs of expected industrial and social development of town areas located along the expressway corridor,
- Improve connectivity between key growth centers of Colombo, Gampaha, Kurunegala, Kandy, and Dambulla to the Northern and Eastern regions of the country,
- Handle the forecasted traffic at an adequate level of service,
- Protect and where possible, enhance environmental conservation,
- To establish an economically feasible expressway network system,

Specific Objectives of Kadawatha Dambulla Section

The main specific objective of the Kadawatha Dambulla Section of the CEP is to provide quick access to Northern, Central and Eastern Parts of the country.

Further, following benefits are expected to the public, after completion of the CEP:

- Availability of an efficient transportation system to the Northern, Eastern, North Western, North Central and Central Province,
- Exposure of the remote cities of Northern and Eastern provinces of the country for new investments,
- Increased motivation for foreign and private sector investors, thereby contributing to the expansion of new employment opportunities,
- Reduced travel times between Colombo and Gampaha, Kurunegala, Kandy, Dambulla, Jaffna and Trincomalee.
- Reduced delay costs and fuel costs thereby contributing to the national economy,
- Improved access to tourist destinations leading to the expansion of the tourism industry,
- Development of the towns around identified interchanges as economic centers,
- Enhancement of the value of land and property in the region,
- Improvement of economic and social development of agriculture based cities like Dambulla,
- Ease and advent of uniform resource distribution over the northern and eastern provinces.

The overall Project can be justified based on the above anticipated benefits which will ensure regional connectivity and development in Sri Lanka.

1.3. Objective of the EIA report

This Environmental Impact Assessment (EIA) Report pertaining to the development of the 137 km Expressway from Kadawatha to Dambulla and 9.1km Link road from Wilwatta to Ambepussa (Ambepussa Link Road) critically evaluates the anticipated project outcomes with respect to the positive and negative environmental impacts that are anticipated during project planning, construction and operational phases. Any possible adverse impacts from the project on the bio-physical and socio economic environment are being identified early on to decide on the environmental viability of the

project and to take necessary migratory measures to minimize such impacts. A monitoring plan is proposed to ensure that the recommended migratory measures are adopted and that they are effective to overcome any anticipated adverse environmental impacts. This monitoring plan includes identified parameters that are used as indicators, frequency of monitoring along with the responsibilities that should be held by the project proponent and the relevant regulatory agencies responsible for project monitoring during construction and operational stages enabling any unanticipated impacts to be determined through monitoring.

Since the project is located within the jurisdiction of the Central Environmental Authority the EIA was prepared to obtain environmental clearance set down by the National Environmental Act No 47 of 1980. Upon submission of preliminary project details by the project proponent, RDA to the CEA, the Terms of Reference (TOR) for the EIA had been issued to the project proponent.

1.4. Methodologies and technologies adopted in EIA report preparation

1:50,000 and 1:10,000 digital maps, soil and geological maps were procured from the survey department covering the entire project. Those digitized maps were used to prepare the required maps for this EIA Report by the GIS Specialist. Addition to the above, Environmental Senstive area map along the expressway corridor was procured from the CEA.

Topographical survey maps of CEP Sections 1, 2 and 4 and Google Pro maps were also used in the study.

1.4.1. Guidelines and policies

The following guidelines and policies were used:

- Guidelines for Implementing the EIA Process No. 1159/22 (November 2000)
- Environment Guidelines for Road Sector Projects, RDA 2005
- Environmental and Social Safeguards Compliance Manual Volume I – Environmental Safeguards Compliance Manual (ESCM), RDA, 2009
- Environmental and Social Safeguards Manual Volume II – Social Assessment and Involuntary Resettlement Compliance Manual (SAIRC), RDA, 2009
- Policies, Acts and other legislative instruments in connection with road construction and implementation.

1.4.2. Environmental investigations

The scope of the EIA covers the proposed expressway corridor from Kadawatha to Dambulla and Link road from Wilwatta to Ambepussa (Ambepussa Link Road), excluding Kadawatha System Interchange.

EIA Report of Colombo Kandy Alternative Highway (CKAH) and Resettlement Action Plan prepared for CKAH 1+000 – 10+000km were refered to as literature, In addition the studies that had been carried out by the RDA for the previously proposed Northern Expressway project were also studied in detail to identify available data and data gaps. Further studies were carried out using the available data.

1.4.3. Survey of existing literature

The following documents were reviewed during the EIAR preparation:

- Economic Feasibility Analysis for Central Expressway Project by the Transportation Engineering Division, Department of Civil Engineering of University of Moratuwa April 2016 for the expressway feasibility study
- Statistical Handbooks of Gampaha, Kegalla, Kurunegala and Mathale Districts, Department of Census and Statistics, 2010

- EIA Report on the Alternate Highway (Expressway) between Colombo and Kandy, RDA, December, 2001
- Hazard Profile of Sri Lanka - Disaster Management Centre, Ministry of Disaster Management, December, 2012
- All reports that had been prepred by the RDA for the previously proposed Northern Expressway Project

1.4.4. Scoping for Impact Identification

After preliminary investigations an impact matrix was prepared taking into consideration the environmental (including social aspects) of the area. The environmental aspects are categorized into the main groups of environment. In the impact matrix project activities (classified as pre-construction, construction and post-construction phase activities) are given in one axis whereas the environmental parameters are given in the other axis. A sign of "+" was placed to indicate beneficial impacts and a symbol of "-" to indicate negative impacts. The significance of the impact is indicated by allocating a numerical value 1, 2 and 3 to indicate low, medium or high impact respectively. The medium and high impacts were then further investigated for the impact assessment. The impact identification matrix filled for the scoping exercise is given in Annex 4.1.

1.4.5. Field Investigations

Field Studies were carried out from September 2015 to February 2016 to gather new information, and to verify and update the existing information on the proposed alignment.

1.4.6. Methodology for land use study

The existing land uses along the proposed Central Expressway were studied using information collected from field excursions and previous reports. The digital data (1:10,000 scale) of the survey department were used and updated with field evidences. The land use information was further analyzed using Google Earth images and available satellite images along the proposed central expressway. Especially, reserved forest areas were included into the digital data base using recent sources of the forest department. Thus, the updated digital land use data were finally used for the EIA discussions.

The study on existing land uses was done mainly for the recommended buffer zones. 60 m initial corridor from center line of the proposed expressway (total width of 120 m) and 100 m reservation area from the edge of the initial corridor (total with of 320 m) were separately used for the calculation of different land uses covered by the proposed project. Approximately sixty (60) digital 1:10,000 maps cover the proposed expressway. Projected national grid coordinate system for the country (meter scale) was used for the calculations. All the crossing points of the major rivers and roads across the proposed expressway were also discussed with respect to their crossing coordinates using spatial analyses.

1.4.7. Methodology for topographical analyses

Topography along the proposed expressway was initially identified as a critical parameter. According to initial observations topography of Colombo and Gampaha districts are flat with lower surface undulations. However, in Kurunagala and Matale districts the proposed road is going across isolated hillocks. Therefore, topography along the proposed road was studied in terms of elevation, contour, slope, aspect and land uses. Methodology used for the detailed land use study is given in the existing land use section. However, elevation and slope maps were developed based on 1:10,000 terrain data developed by the Department of Survey, Sri Lanka. Around sixty contour maps with projected national grid coordinate system for Sri Lanka (meter scale) were used for the topographical study. The 3D analysis in Arc GIS 9.3 was used to develop surface elevations using Triangulated Irregular Network (TIN) method. In addition, slope and aspect maps were developed using spatial analyses techniques using TIN.

The topographical study was also done for the recommended buffer zones. 60 m initial corridor from the center line of the proposed expressway (total width of 120 m) and 100 m reservation area from the edge

of the initial corridor (total with of 320 m) were separately used for the topographical investigation. In addition, major interchanging locations were considered in detail. However, topographical study did not consider the recommended buffer zone only. In addition, possible land subsidence locations across the proposed expressway were studied with respect to different topography.

The topography of the proposed central expressway is quite important due to possible occurrences of landslides due to road cuts as well. Therefore, necessary studies were also done in order to avoid possible landslides after the construction of the proposed expressway.

1.4.8. Methodology for geology, soil and natural disasters

In general, geotechnical investigations and design report of the feasibility study were used for this EIA. Using those information the underlying geology and geomorphology were also assessed. Borehole logs and soil samples from feasibility study were further used to discuss the land suitability, stability, soil types and their characteristics. In the geotechnical investigations, laboratory tests were carried out on the soil samples to determine atterberg limit, moisture content, particle size distribution, compaction, organic content and chemical parameters (pH, Chloride and Sulphate). Those parameters were used to discuss the conditions of soil around the proposed project where necessary.

The geology and soil investigations for this EIA were carried out through field investigations and analyses of 1:100,000 geology and structural maps developed by the Geological Surveys and Mines Bureau (GSMB). Basement rock type, strike, dip and other structures present across the proposed expressway were studied in detail where necessary. The structures of the basement rocks across the road are complicated, and hence several folds and shear zones were analyzed. Outcrops are limited in Colombo and Gampaha districts due to thick soil overburden and hence the studied buffer zone was extended around 500 m from the center line of the proposed expressway. Conversely, several outcrops can be seen in Kurunegala, Matale and Kandy districts. Structural geology of the basement was studied to investigate groundwater movements as well as natural disasters including possible landslides and rock slides. Around the Kandy district the proposed expressway is moving through complicated geology and structures. Therefore, detail discussions are carried out for the proposed EIA.

Soil along the proposed central expressway was further studied in terms of possible compaction and erosion, especially, along the sections through working paddy fields in Gampaha, Kurunagala, Kandy and Matale districts. Soil was studied for the possible issues on infiltration capacity and nutrient losses as well. In addition, investigation of terrain conditions with respect to the basement geology and structures were done in order to overcome the possible landslide threats along the road cuts. Further, investigations of possible land subsidence were done based on geology, soil and geotechnical reports. Geology and structures were mainly studied around the interchanging locations and system interchanges. Structural geology along the proposed expressway project was studied to discuss impacts on deep groundwater movements and other possible natural disasters.

1.4.9. Study on Hydrology

Investigations conducted were mainly based on review of the feasibility and preliminary design reports and the relevant EIA reports. At certain places where flooding is critical, information available in reports were verified through field investigations. Satellite images were used to get the land use and the topographic survey data collected along the ROW. Flooding and drainage issues along the corridor of ROW and 100m on each side of the ROW were looked into. 1:50,000 and 1:10,000 maps published by the survey department were used to verify the catchment boundaries of culverts, bridges and all other roadway hydraulic structures. Hydrological and drainage impacts were mainly assessed based on the information on the locations of proposed culverts, bridges, flood channels, drainage plans, flooding areas etc. given in the feasibility and preliminary design reports of the Colombo-Kandy Alternative Highway project and the reports available on previously proposed Northern Expressway project. Information collection and compilation is carried out in 4 sections covering different stretches of the road.

1. For Kadawatha to Gampaha stretch, Prefeasibility Study, Amendments to the Selected Road Traces, Colombo - Kandy Alternative Highway and Outer Circular Highway, University of Moratuwa, September 2006 and the Environmental Impact Assessment Report of Alternative Highway between Colombo and Kandy, prepared by Euro Infra Group with Resource Development Consultants in December 2001 were used to get relevant information.

2. From Gampaha to Kurunegala (including the Ambepussa link), relevant information was reviewed from the Feasibility Study, Preliminary Design Report, Stages 1 and 2, Volume 3 - Hydrology and Drainage, Snowy Mountains Engineering Corporation (SMEC) and OCYANA, April 2014 and report that had been prepared to obtain environmental clearance for the previously proposed Northern Expressway Project-Stage 1 , 2 and Ambepusa link, SKILLS International, October 2014.

3. From Kurunegala to Dambulla the Feasibility Study, Preliminary Design Report, Stage 4, Volume 3 - Hydrology and Drainage, SMEC and OCYANA, April 2014 and report that had been prepared to obtain environmental clearance for the previously proposed Northern Expressway Project - Stage 4, SKILLS International, October 2014 were referred to get hydrology and drainage related information of the proposed expressway section.

1.4.10. Ecological Component

- Information available in the ecological assessments of the previous EIA reports was used as secondary data. These reports were reviewed to determine their adequacy, and identify possible information gaps as well as to identify ecologically sensitive locations that need special consideration.
- Ecological assessment of the section from Kadawatha to Gampaha was completed back in 2001, and the existing information has limited applicability. As the land use had changed over the period, a comprehensive ecological assessment was carried out for this section.
- More comprehensive ecological assessments had been conducted for Expressway sections from Gampaha to Mirigama, Mirigama to Kurunegala, Mirigama to Ambepussa and Kurunegala to Dambulla. Intensive sampling had been done and a sound analysis of ecological information of habitats, sensitive locations, potential impacts and mitigation measures were available. Validation of information at pre-identified ecologically sensitive locations were done.

Methods used to get the missing information were:

Major habitat / land use types present in the study area were identified using Google images and 1:50,000 and 1:10,000 scale topographical maps. The presence of protected areas in close proximity to the study area was studied Using Google images and 1:10,000 maps. The habitat maps were verified through the reconnaissance survey. Using the verified habitat maps, the sampling intensity and sampling sites for each habitat/ land use type were determined within the study area. Detailed surveys were carried out in each identified sampling location. This survey included field sampling of both aquatic and terrestrial fauna and flora using a variety of methods. The sampling methods that were used are outlined below.

Fauna

- Line transect survey, plot survey and opportunistic observations were used to assess the terrestrial fauna while netting, trapping and visual observations were used to assess aquatic fauna within each identified habitat in the study area. The techniques used to collect information within transects or plots on the main taxonomic groups are shown in Table 1.2.

Table 1.2: The sampling methods to be employed in the fauna survey

Group	Technique
• **Birds**	• Variable Circular Plots (both direct and indirect observations to be used)
• **Butterflies and Dragonflies**	• Opportunistic observations
• **Herpetofauna and Land Snails**	• Quadrate Clearing and Opportunistic observations (both direct and indirect observations to beused)
• **Fish**	• Netting (Frame nets, casting nets, hand nets etc.), Trapping and visual observations
• **Mammals & Primates**	• Opportunistic observations & Counting (both direct and indirect observations tobe used)

Flora

- Gradsect (gradient-directed transect) sampling technique was used to gather data on plant diversity. Plots of 10 m x 5 m were carried out within each identified habitat to assess terrestrial flora in the study area. Within each plot, plants encountered were identified by their families, genera and species. Specimens of unidentified species were collected and numbered for subsequent identification at the National Herbarium of the Department of National Botanic Gardens, Peradeniya.

1.4.11. Socio-Economic investigations

1.4.11.1. Identification of baseline information

Data for the identification of social impacts of the proposed project and proper understanding of the socio-economic characteristics of the project area coming under the ROW of the proposed expressway, its buffer zone of 100 m on either side or the adjacent area were collected from primary sources and secondary sources. Field studies were carried out after gathering the available information from secondary sources. In particular, latest information published by the Department of Census and Statistics were studied for the explanation of the demographic and socioeconomic characteristics of the relevant communities. Furthermore, relevant Urban Councils, Pradeshiya Sabhas, Divisional Secretariat Offices, Divisional Engineer's Offices and Government hospitals were sources of data for the survey of secondary information. A profile of communities, institutions, businesses, infrastructure facilities and the use of resources including land in the project area was also prepared. Reports of the socioeconomic surveys conducted for the previously proposed Northern Expressway and Central Expressway in the recent past were also referred to obtain important data. Possible adverse social impacts of repeated social surveys in the same area on same and highly sensitive matters of peoples' residence, family and community life were avoided by such a strategic use of data already gathered recently.

The comprehensive Resettlement Action Plans which were prepared for CKAH 1+000 – 10+000km previously proposed NEP Stages 1, 2 & Ambepussa link and NEP Stage 4 were also used as secondary data.

Two categories of people and institutions have been identified. The first category is the project affected persons and institutions. This category includes all the households, institutions, organizations, properties, possessions, investments, businesses, infrastructure facilities, rights, material resources, community life, culture and social functioning of people in various capacities. The nature and the magnitude of the social impacts of the proposed project on those people and institutions and social processes were researched.

The second category include the persons and institutions having no visible or perceived adverse impacts from the project but are interested in it and would be beneficiaries of the proposed project.

1.4.11.2. Collection and analysis of primary data.

Sub task 1. Socioeconomic survey of households.

The data collected through standard tools of Questionnaire prescribed by the RDA for the EIA of the NEP in 2013 and 2014 were used considering their relevance to the areas coming under the proposed project. Information pertaining to new routes of the project which had not been studied earlier, were gathered from both secondary sources as well as through interviews with selected persons and institutions in those areas.

Sub task 2. State sector institutions and property survey.

Data collected through a separate Questionnaire prescribed by the SAIRC of RDA were used for identifying the state sector institutions and properties located in the project area which might be affected by the project.

Sub task 3. Private sector institutions and properties.

Commercial and other private sector institutions and properties located in the project area and likely to be affected by the project were also identified in terms of the information gathered through a separate Questionnaire prescribed by the SAIRC of the RDA.

Sub task 4. Focus group discussions.

Peoples' perceptions, ideas and attitudes regarding the project and its social impacts and their suggestions were identified in terms of the data collected by means of focus group interviews conducted in different communities that would be affected by the project.

Sub task 5. Key informant interviews.

Information were sourced from a group of key informants such as Grama Niladaris, Divisional Secretaries, Mayors, chairpersons of Pradeshiya Sabha, Heads of police stations, School principals, owners and managers of private institutions, land officers, hospital authorities, religious leaders, and individuals with special interest in the project.

information collected from various sources were properly analyzed using MS excel, SPSS etc. and was used for developing the socio-economic profile of the project affected area and public opinions and perceptions of the proposed project.

1.4.12. Cultural, Historical and Archaeology Heritage

The study on Cultural, Historical and Archaeology Heritage Component of the Environment and Social Impact Assessment (ESIA) has been conducted as the Heritage Impact Assessment (HeIA).

The methodology has been focused on;

a) Identifying the existing artifacts, sites and areas of historical, cultural and archaeological (including religious) heritage significance within the proposed road corridor
b) Mapping the location of artifacts, sites and areas of historical, cultural and archaeological heritage significance
c) Describing the potential impacts of the road corridor on historical, cultural and archaeological heritage

d) Developing appropriate recommendations and mitigation measures to minimise the impacts of the project historical, cultural and archaeological heritage

The study is being extended to assess the heritage properties under the range of (a) Cultural properties and attributes, which cover any cultural structures and their functions from present to past; (b) Historical properties and attributes considered as any historically important structures and functions from written period and (c) Archaeological properties and attributes covering Pre-historical, Proto-historical and to Historical structures and their functions which could be considered under the archaeological properties and attributes which are examined by a wide range of reconnaissance techniques to locate archaeological sites and properties and to investigate sites without prior approval for excavation. Broad Desktop studies, Surface surveys, Geophysical or geochemical surveys and Aerial surveys were to be conducted but due to lack of resources/ techniques only Desktop studies and Surface surveys were carried out.

As per the regular and succeeded assessments already conducted by recognized experts/ institutions in the field of heritage management; the methodology has been designed in order to achieve the scope of the study, which will be covered in the Heritage Impact Assessment in following categories;

- Cultural Properties and attributes
- Historical Properties and attributes
- Archaeological Properties and attributes

(Religious properties have been covered under mainly Cultural & Historical aspects)

Following tools have been applied to collect the required information and data, on desk and field basis;

- Literature Survey (Archaeology Department, University and Other Libraries, Government Offices like Central Cultural Fund, National Museums and Book-shops…etc)
- Key Informant's Discussions (Archaeology Department)
- Semi Structured Interviews (Sites)
- Direct Observations (Sites)
- Historical Profiles (Sites)
- Unsystematic Field Survey (Sites)
- Photographic Evidences (Sites)

Principles of PRA tools were also considered in field studies. In addition to the above a comprehensive Archaeological Impact Assessment has been conducted by the Department of Archaeological.

1.5. Conformity with government policies and plans

Under the manifesto of the current Government the Central Expressway has been identified as a major road sector development project. With this expressway which connects to the Pothuhera Galagedara Section at Pothuhera system interchange, the travel time from Kandy to Kadawatha will be reduced up to one and half hours. The CEP also connects to the Outer Circular Highway (OCH) (E2) at Kadawatha System Interchange which allows the users a clear path to Colombo Katunayake Expressway (E3) (with Phase III of OCH), Southern Expressway (E1) and proposed Ruwanpura Expressway and Colombo Elevated Highway which gives quicker access to most of the economically and administratively important locations.

1.6. Preliminary approvals needed for the project

Approvals will be required from the Department of Agrarian Services, the Paddy Cultivation Board and the Coconut Cultivation Board due to the impact of the project on paddy lands and coconut estates.

Consent of Irrigation Department and Provincial Irrigation Department – Western, North Western and Central Provinces especially on the structures will be required due to the impact on irrigation and drainage structures that will be crossed by the proposed expressway.

Concurrence of the Sri Lanka Land Reclamation and Development Corporation (SLLRDC) will be required with regards to the drainage provisions that will be adopted for the project.

The proposed expressway will cross the Main Line at several locations. Discussions with Sri Lanka Railways have been ongoing during the design development process.

Concurrence will also be required from the Ceylon Electricity Board (CEB), the National Water Supply and Drainage Board (NWSDB) and Sri Lanka Telecom for shifting or relocation of respective utility supply lines located in the project corridor.

Middle sections of the expressway fall within the Kurunegala district which comes under the environmental statute of North Western Province (NWP). Hence, it is required to get the consent of Provincial Environmental Authority to carry out construction works and material extraction for the proposed project within NWP.

Table 1.3: Summary of Approvals required for the Project

No	Institution/Department	Reasons for Required Approvals	Status of Concern
1	Department Agrarian Development	The alignment passes along the paddy fields and minor irrigation schemes	Addressed in the report
2	Irrigation Department	The alignment intersects inter provincial rivers and major irrigation schemes such as Bathalagoda	Addressed in the report
3	Ceylon Electricity Board (CEB) /Sri Lanka Telecom (SLT) /National Water Supply & Drainage Board (NWS&DB)	As the alignment will intersect/affect transmission lines/ water supply networks and telecommunication networks that may need shifting	Concerns of relevant agencies will be addressed during the detail designs
4	Sri Lanka Railway Department	The alignment trace is crossing the existing railway line at several locations	Addressed in the report
5	Forest Department	The alignment passes along few forest areas	Forest areas are avoided to the extent possible and other comments are addressed in the report
6	Department of Wildlife Conservation	To obtain the clearance due to the alignment along the forest and the proximity to the elephant migratory paths (corridors) at Dambulla etc.	No Wildlife areas within the proposed route
7	Department of Archaeology	The proposed trace may cut across unexplored archaeological sites if any.	Archaeological Impact Assesment Completed by Department of Archaeology
8	Mahaweli Authority of Sri Lanka	The alignment passes along Mahaweli areas at end of Section 4	Concerns of Mahaweli Authority will be addressed during the detail designs

Approvals and consent letters are given in Annex 8.1

CHAPTER 2: DESCRIPTION OF THE PROPOSED PROJECT AND REASONABLE ALTERNATIVES

2.1. Evaluation of alternatives

Construction of expressway from Kadawatha to Dambulla will be necessary to cater to the existing and projected traffic demand from Kadawatha to Kandy, Kurunegala, Dambulla, Northern and Eastern regions of the Country. In this section possible alternatives to the proposed project are discussed.

2.1.1. No Project Alternative

Sri Lankan economy is growing rapidly after the thirty years of civil war. The Northern and Eastern regions which were the regions primarily affected by the war are the main beneficiaries of those development projects and it will contribute significantly to the GDP. Under the proposed development projects of the Western Region Megapolis, the cities around Katunayake, Mirigama, Colombo, Homagama, Horana and other main cities will be developed thus adding unprecedented amount of traffic to the existing road network of the country. In order to sustain the socio-economic development it is apparent that the Northern, Central and Eastern provinces should be connected to Western region of the country through an "efficient" land based transportation system.

The existing transportation system is mainly through Colombo – Kandy (A001), Ambepussa – Kurunegala – Trincomalee (A006), Kandy – Jaffna (A009), Maradankadawala – Habarana – Tirikkondiadimadu (A011) Highways, Southern Expressway (E01) Colombo - Katunayake Expressway (E03) and Outer Circular Highway (E02). At present it takes more than 12 hours to travel a distance of approximately 400 kilometers between Colombo and Jaffna in the Northern Province or Colombo and Trincomalee and Batticaloa (nearly 300 kms) in the Eastern Province. Although rehabilitation and resurfacing works have been done in the recent past, these roads are mostly of two lanes with exceptions of a few town areas where there are four lane facilities. It should also be noted that even with the improved road surfaces the maximum operational speeds on these roads are limited to about 50 kmph within town areas and 70 kmph outside town area.

Projected socio-economic growth in the north and eastern regions and other key cities connected by above roads will exert an increased demand on the existing traffic flow along these roads. Such a situation will further increase the travel time between Colombo and key cities like Kurunegala, Dambulla, Jaffna, Trincomalee and Kandy. Already the sections of A001 Highway between Colombo and Ambepussa and Ambepussa to Kurunegala section of A006 Highway are highly congested with traffic. Increased travel time will lead to an increase in vehicle operational costs. Congestion gives rise to more vehicle emissions and waste of fuel. Further the existing road surface will deteriorate at a much faster rate leading to more frequent recurrent maintenance work.

Given the existing conditions, the option of not proceeding with the CEP is not considered to be acceptable. While the "no project" scenario would have no involuntary resettlement impacts and would not impact on the natural ecosystems which would not be disturbed, the avoidance of these impacts is not considered to outweigh the negative impact that the restriction of economic growth potential would bring. As a result, the option of not proceeding with the project is not considered acceptable and is therefore not examined further.

2.1.2. Improvement and widening of A001, A006, A009 and A011 Highways

Many sections of the A001, A006, A009 and A011 highways have been improved in the recent past and where possible widened to have four traffic lanes and some sections are already in the process of been upgraded to four lanes, the Colombo – Ambepussa section of A001 highway and Ambepussa – Kurunegala section of A006 highway could be considered equivalent to Section 1, 2 of the proposed CEP. At present these two highway sections have far exceeded their capacity. In order to sustain future traffic demand, the

Colombo – Ambepussa section of A001 highway would need to be widened to 6 lanes. Such a move would have an enormous amount of land acquisition and resettlement impacts given the dense land uses immediately adjacent to the road corridor. Furthermore, even if this section of highway is upgraded to 6 lanes, given the maximum speed limits imposed onnational roads, it would not allow for a significant gain in travel time. Additionally, there would be an increased risk of accidents for both vehicles and pedestrians.

As a result of above factors, it is considered that the improvement and widening of the key highways which represent the existing link between Colombo and the Northern and Eastern Provinces does not have a significant gain in travel time and thus is not considered a viable option to satisfy project objectives

2.1.3. Route alternatives considered for the Colombo – Dambulla (Sections 1, 2, and 4) of the Central Expressway

These links were identified in the proposed Central Expressway Project as follows:

- Section 1 – Colombo to Meerigama
- Section 2 – Meerigama to Kurunegala
- Section 3 – An expressway Link to Kandy
- Section 4– Kurunegala and Dambulla

2.1.3.1 Alternative analysis for Section 1

Four corridors were examined for Section 1; Two of them are starting from Enderamulla ; 1) one with an additional spur towards Danowita to allow traffic to access and egress the A1 (A-B-N), 2) the other following the A-B- N corridor from Enderamulla to Gampaha and then deviating to the west before falling back in to the A-B_N corridor at Meerigama (named as A-C-N). The other two are starting from a new interchange and Kadawatha interchange in OCH trace; 1) one to the east of the existing A1 (D) starting from an interchange between Kadawatha and Kotalawala interchanges, 2) the other starting from Kadawatha interchange to Gampaha using a new trace (Q) and ends at Meerigama. Then it continues as a new trace H to Ambepussa. This final alternative is named as Q-B-H. Figure 2.1shows the four alternatives (A-B-N, A-C-N, D and Q-B-H) considered for section 1. Figure 2.2 shows the proposed alternative traces in a Google map.

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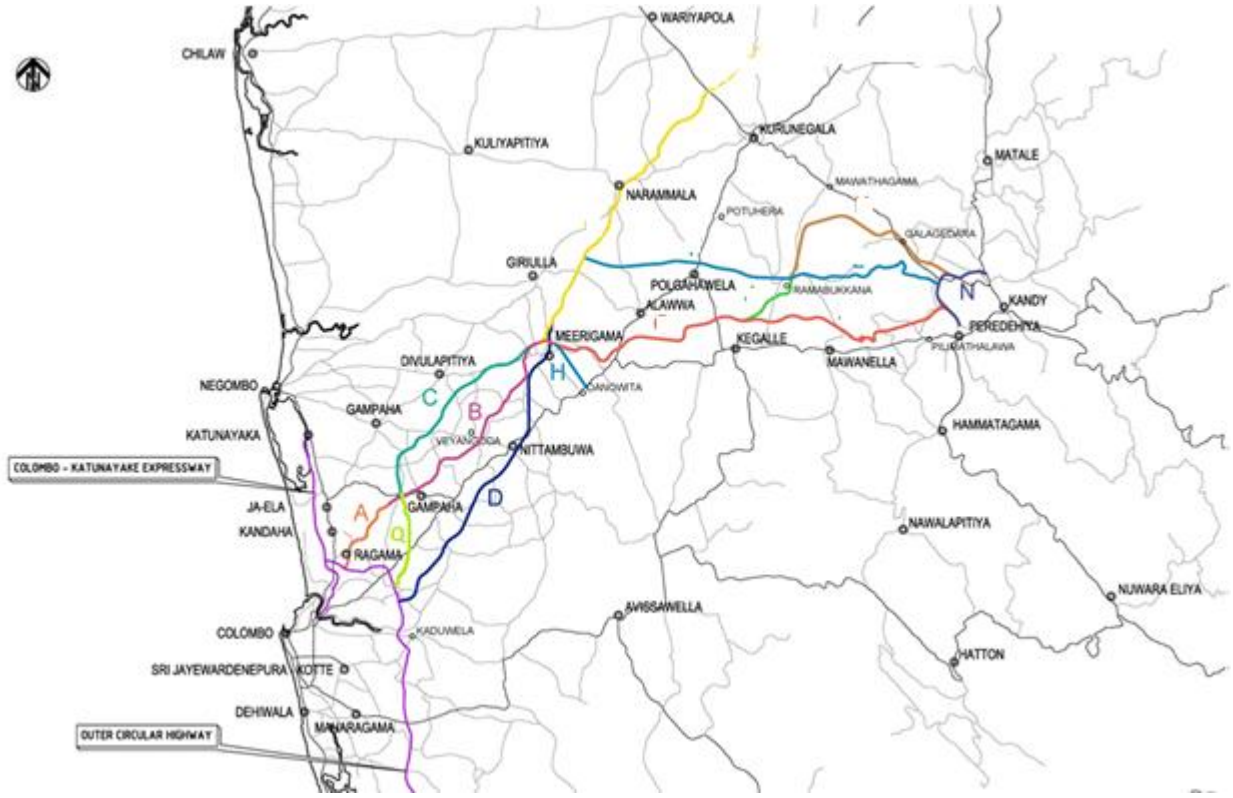


Figure 2.1 Corridors taken for section 1 and selected initial traces for section 2, 3 and 4

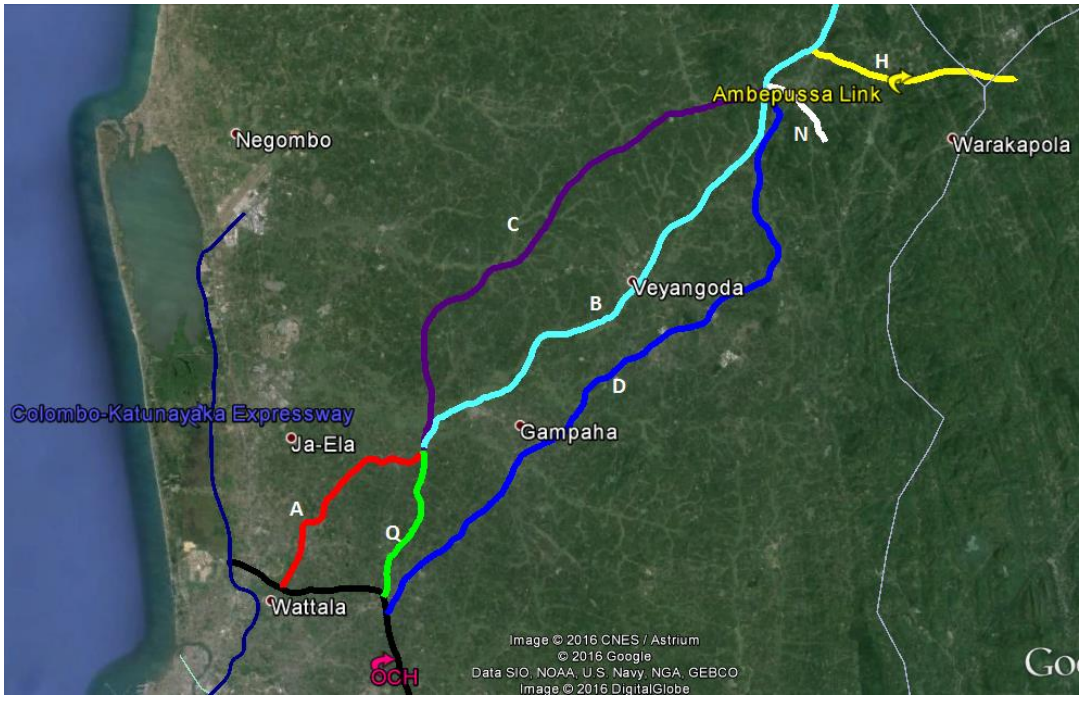


Figure 2.2 Traces considered for Section 1

Initial comparisons of the selected alternatives are indicated in Table 2.1 Probable construction costs of these, along with an assessment of the relative benefits and drawbacks associated with the options, are included in Table 2.1.

Table 2.1: Summary of Section 1 Alternative Corridors

Alternative Corridors	Length (km)	Probable Construction Cost (Rs billions)	Relative benefits	Relative Drawbacks
A-B-N	45	129	• Runs close to the railway corridor thereby minimizing resettlement and social impacts. • Affects least number of properties (791)	• High construction cost.
A-C-N	46	113	• Provides easy access to Bandaranayake International Airport.	• Affects highest number of properties (916). • Perceived high social impact. • High construction cost.
D	42	96	•Would alleviate traffic issues at New Kelani Bridge and OCH/CKE junction.	• Affects high number of properties (900) • Does not provide direct link to Colombo port. • Perceived high social impact. • Difficult to incorporate new interchange on OCH.
Q-B-H	36.5	128	• Would alleviate traffic issues at New Kelani Bridge and OCH/CKE junction • Runs close to the railway corridor thereby minimizing resettlement and social impacts • Shortest distance to OCH and south	• Does not provide direct link to port. • Affects moderate number of properties (800) • High construction cost

The costs given in Table 2.1 are illustrative only for the purposes of comparison between different routes and should not be assumed to be detailed cost estimates. In conclusion, was alternative Q-B-H was chosen for further study although the construction cost is relatively high since it has the lowest resettlement and social issues and consequently the lowest social costs., The fact that it has the shortest distance to OCH is an added advantage. South bound traffic can by- pass the busy interchanges in city center. Hence of the route alternatives considered Q-B-H was selected as the preferred alternative. In addition, it was assessed that land costs would be lower than for the other options due to the lower number of residential properties impacted and this would at least partially offset the highest construction cost.

Route QBH has the shortest distance to the OCH. South bound traffic can by- pass the busy interchanges in city center. The link 'N' to Danowita is discarded in preference link "H" from Meerigama to Ambepussa to connect to the A6. The main benefit of this alignment is that it allowed traffic on the A6 to easily access the expressway without having to travel along the already highly congested A1 between Ambepussa and Danowita.

2.1.3.2 Alternative Analysis for Section 2

Whereas an examination of other corridors had been undertaken, no serious alternatives meeting the shortest distance between Meerigama and Kurunegala and providing any significant benefits had been identified. Hence in the absence of any other viable alternatives only two alternatives identified as Section 2A and Section 2B were considered. ASection 2A commences at Meerigama and heads in an approx. North, North-East (N,NE) direction, terminating on the A10 at Pellandeniya. Section 2B deviates from Section 2A near Godakuruwa/Wilgamuwa, and terminates to the east of Kurunegala. There is one significant difference between the two. In 2B there is a deviation from the section 2A for the northern 22 km of section 2. This alignment, rather than terminating on the A10 at Pellandeniya west of Kurunegala, is headed in a more easterly direction and terminates on the A10 close to the Kurunegala railway station. The adoption of this proposal for the northern section of Section 2 results in shifting of the southern portion of Stage 4 eastwards, running from Kurunegala railway station to Melsiripura. Considering the connectivity to the Section 4 and to Kurunegala Section 2B was selected as the preferred alternative. Section 2B provide two interchanges; Dambokka and Potuhera in south of Kurunegala to alleviate traffic issues in Kurunegala and A6. Figure 2.3 shows alternatives considered for section 2 and 4.

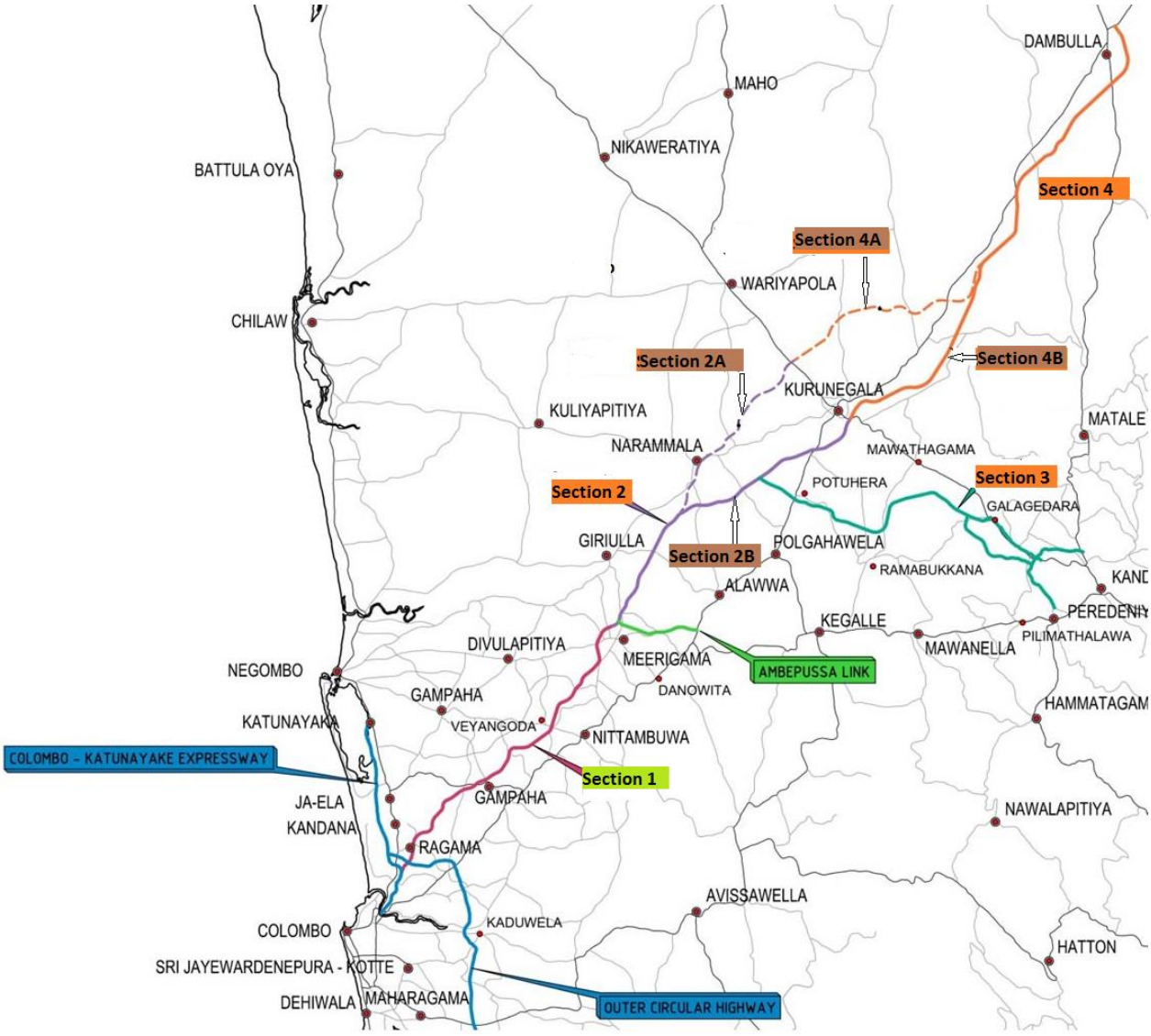


Figure 2.3 Alternatives considered for section 2 and 4

2.1.3.3. Alternative analysis for Section 4

Two alternatives for the southern part of the section 4 was proposed and named as section 4A and section 4B. Section 4A commences on the A10 at Pellandeniya west of Kurunegala where the section 2A terminates. Section 4A heads eastwards from Pellandeniya to cross the A6 close to Melsiripura and then runs roughly parallel to the A6 on its eastern side. This route was eliminated from further study as the topography would have resulted in an alignment which would have to lie at a significant distance to the west of the existing A6, and would therefore prove costly to link the expressway to the A6 which would be required to provide good connectivity between the existing and new road networks. In addition, the proposal by the Ceylon Electricity Board to construct a new high voltage electricity line in this area would provide additional constraints on the design. Therefore the decision was taken to follow the corridor from east of Kurunegala and run roughly parallel to the A6 to Dambulla.

Section 4B commences on the A10 approximately 1.7 km east of Kurunegala town centre and just to the east of Kurunegala railway station. Along its length, the alignment runs roughly parallel to the A6 although there are some large deviations from this route due to topography, existing settlements and numerous tanks. Current A6 road from Kurunegala to Dambulla cannot be improved to expressway standards due to existing road side developments and the existing tanks. The selected alignment heads north from the A10, crossing the existing railway line on two occasions and passes through government owned land to avoid a heavily populated area to the east. Care would be taken during detailed design in this area to ensure that the alignment allows the construction of the proposed rail link between Kurunegala and Harabana. In this respect, close co-ordination between the designers of Section 4 and the railway extension will be considered as essential. The alignment then continues in a generally north-westward direction, passing mainly through paddy lands and plantations before crossing the Deduru Oya and to the east of Batalagoda Tank. It then turns northwards, crossing the B409 Dodangaslanda Road and cuts through paddy lands and plantations before reaching Melsirapura. The proposals include a service interchange close to Melsiripura. Towards the north of Melsiripura the topography of the land becomes hillier, resulting in some sections of deep cut and fill before flattening somewhat on the approach to the next service interchange at Galewela. The alignment then passes through more paddy lands and plantations before crossing the A9 Kandy- Jaffna Highway around 4.5 km south of the centre of Dambulla. It then passes to the east of Dambulla, terminating on the A6 approximately 0.5 km north of Mirisgonioya Junction where the A9 meets the A6

The final corridors forming the proposed expressway are indicated in Figure 2.4

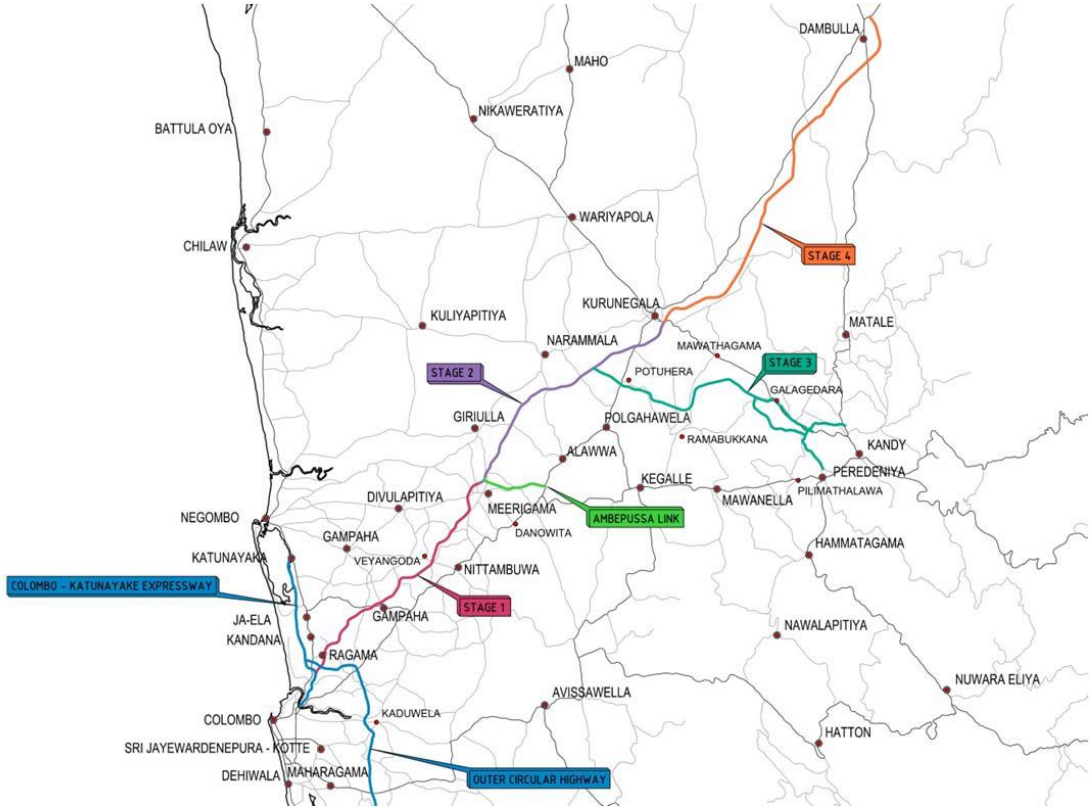


Figure 2.4 ; Final CEP Alignment

2.1.3.4. Selection of Final Trace

Considering all the alternatives the final traces selected for further study are:

1. Section 1 –Kadawatha – Meerigama – Ambepussa – Q-B-H starting from Kadawatha interchange to Gampaha using a new trace (Q) and ends at Meerigama and continuing as a new trace H to Ambepussa.
2. Section 2 – Meerigama – Kurunegala – Section 2B – Commences at Meerigama heads in an approx. North, North-East (N,NE) direction and terminates on A-10 near the Kurunegala railway station
3. Section 4 – Kurunegala – Dambulla – Section 4B - Section 4B commences on the A10 approximately 1.7 km east of Kurunegala town centre and just to the east of Kurunegala railway station. Along its length, the alignment runs roughly parallel to the A6.

2.2. Description of proposed project

The Central Expressway Links the Western Province to Northern and Central regions. The Sections 1, 2 and 4 of the CEP are located within the Western, North Western and Central Provinces of Sri Lanka.

2.2.1. Project location

Within the above provinces the expressway passes through the Gampaha, Kurunegala, Kegalle and Matale districts. The summary of affected District Secretariat (DS) Divisions, Local Councils and number of Grama Niladari (GN) divisions are presented in the Table 2.2. Map of affected administrative divisions and list of affected GN divisions are given in Annex 2.1.

Table 2.2: Administrative divisions affected in Section 1, 2 & 4 of CEP

Section	Province	District	DS Division	No of GN Divisions	MC, UC or PS
Section 1 (Kadawatha to Mirigama)	Western Province	Gampaha	Mahara	5	Mahara PS
			Gampaha	18	Gampaha PS
					Gampaha MC
			Minuwangoda	4	Minuwangoda PS
			Attanagalla	12	Attanagalla PS
			Mirigama	16	Mirigama PS
Section 2 Mirigama to Kurunegala	Western Province	Gampaha	Mirigama		Mirigama PS
			Divulapitiya	2	Divulapitiya PS
	North Western Province	Kurunegala	Alawwa	7	Alawwa PS
			Narammala	9	Narammala PS
			Weerambugedara	6	Polgahawela PS
			Polgahawela	14	
			Kurunegala	6	Kurunegala PS & Kurunegala MC
Section 2 (Ambepussa Link Road)	Western Province	Gampaha	Mirigama	13	Mirigama PS
	Sabaragamuwa Province	Kegalle	Warakapola	3	Warakapola PS
Section 4 (Kurunegala to Dambulla)	North Western Province	Kurunegala	Kurunegala	1	Kurunegala MC
			Mallawapitiya	7	Kurunegala PS
			Mawathagama	9	Mawathagama PS
			Ibbagamuwa	14	Ibbagamuwa PS
			Rideegama	5	Rideegama PS
	Central Province	Matale	Galewela	10	Galewela PS
			Dambulla	4	Dambulla PS
Total	**4**	**4**	**18**	**163**	**17**

DS – Divisional Secretariat

MC – Municipal Council (Local Authority)

UC – Urban Council (Local Authority)

PS – Pradeshiya Saba (Local Authority)

2.2.2. Project layout plan

The expressway sections have a total length of 136.9 km (from Kadawatha to Dambulla). There will be 14 interchanges within the expressway, including 3 system interchanges (Kadawatha, Mirigama North (Wilwatta) and Pothuhera) and 11 Service interchanges and Ambepussa Junction. Details of each interchange are described in Table 2.3.

Table 2.3: Details of interchanges within Section 1, 2 & 4 of CEP

Location of interchange	Distance from Kadawatha (0.000 km)	Type of interchange	Description
Kadawatha	0.000	System IC	System IC with Outer Circular Highway
Gampaha	11.3	Service IC	Gampha Minuwangoda New road
Veyangoda	22.0	Service IC	Service IC with Veyangoda – Ruwanwella (B445) road
Mirigama South	33.37	Service IC	Mirigama Divulapitiya Negambo road
Mirigama North	37.8	Service/System IC	Service IC Pasyala Giriulla road and System IC with Ambepussa link road
Ambepussa	47.1	Junction	Ambepussa – Kurunagala – Trincomalee Road (A006 Road)
Nakalagamuwa	55.5	Service IC	Service IC with Alawwa – Dampelessa (B008) road
Pothuhara	62.8	System IC	System IC with section 3 of CEP (expressway link to Kandy)
Dambokka	70.4	Service IC	Ambepussa – Kurunagala – Trincomalee Road (A006 Road)
Kurunegala	75.8	Service IC	Katugastota – Kurunagala – Puttalam Road (A 010 Road)
Rideegama	92.6	Service IC	Thalgodapitiya – Yatawatta – Dombawela Road (B409)
Melsiripura	101.9	Service IC	Ambepussa – Kurunagala – Trincomalee Road (A006 Road)
Galewela	115.4	Service IC	Ambepussa – Kurunagala – Trincomalee Road (A006 Road)
Dambulla (A- 9)	129.5	Service IC	Kandy – Jaffna Road (A009 Road)
Dambulla	136.9	Service IC	Ambepussa – Kurunagala – Trincomalee Road (A006 Road)

2.2.3. Ownership of project site

The Sections 1, 2 and 4 of the Central Expressway Project (CEP) alignment generally traverse through lands which are privately owned with a few exceptions of government owned lands and institutions.

The RDA has identified ROW corridor for the CEP, within which all lands will be acquired under the Land Acquisition Act, 1950 (LAA). All acquisitions of properties will be completed before the commencement of the project. Therefore, when land acquisition is completed the land within the proposed corridor will be vested upon the RDA.

2.2.4. Design details of all project components

The Project Management Unit (PMU) has already finalized the designs of the proposed expressway section. The typical cross sections and interchange designs are presented in Annexes 2.5 and 2.6. Land acquisitions will be carried out along a wide corridor which allows for 6 lanes (2 Lanes for Ambepussa Link Road).

The expressway will be constructed as an elevated structure using viaducts, bridges, culverts and earth fill embankments. The summary of design details are presented in Table 2.4. There will be a service area at Mirigama. The Schedule of Structure is given in Annex 2.4

Table 2.4: Design details of all project components

Item	Design detail		Section 1	Section 2		Section 4
				Mirigama - Kurunegala	Ambepussa link road	
1	Length of trace (km)		37.0	39.7	9.3	60.3
2	Viaduct length (km)		10.2	1.6	-	0.8
3	Cut length (km)		3.3	5.0	2.7	9.5
4	Fill length (km)		23.3	33.0	6.6	49.9
5	Height of embankment (m)		08	06	-	06
6	Width of ROW# (m)		75	70	20	65
7	No. of lanes	Initial	04	04	02	04
		Ultimate	06	06	02	06
8	No. of interchanges	System		01*	-	-
		Service	04	04	-	05
		Junction	-	-	01	-
9	No. of underpasses		08	07	02	30
10	No. of over bridges		13	13	-	07
11	Drainage provisions		Both surface & subsurface Drainage shall be provided by considering the overall volume of water to be handled and the time distribution of the discharge (as per the detailed hydrological study). All drains shall be built up and necessary pipe culverts, side ditches, catch basing and head / wing walls, etc. will be provided.			
12	Service areas		01 (MIRIGAMA)			

01* - Pothuhera System Interchange # - Avearage ROW

2.2.5. Methodology of construction

2.2.5.1. General methodologies adopted during construction

Standard road construction techniques will be employed for the CEP, with most of the construction work to be undertaken using heavy machinery and equipment. Large-scale equipment such as backhoes, dozers, cranes and long arm grabbers would be used. Some water based equipments such as pontoon mounted equipment may be used to work especially in areas which cross rivers. There will also be some manual activities, such as the provision of finishes and lane marking.

2.2.5.2. Construction Planning

The construction processes are planned in advance to meet the project quality and environmental objectives. A detailed construction program has to be prepared based on the project master plan.

The construction activities will be defined and systematically structured into a Work Breakdown Structure (WBS). All activities will be scheduled by paying due consideration to the interactions between the activities to minimize the environmental impacts. Special care will be taken to identify activities with higher environmental impacts in order to mitigate the effects.

2.2.5.3 Quarry management and quantities of materials required

Specific quarry sites which will be used for construction material have not been identified at this stage, however a list of possible quarries have been identified. Only quarries with a valid EPL will be used for material procurement during construction. Separate approvals may be necessary for some new quarries. Necessary approvals will be obtained from GSMB/, Pradesiya Sabha, DS and

North Western Province –Environment Authority (NWP-EA) and/or CEA. Details of available licensed quarry sites are given in Annex 2.7. Summary of Estimated quantities of materials required for Sections 1, 2 and 4 of CEP are shown in Table 2.5

Table 2.5: Estimated quantities of materials required for Sections 1,2 and 4 of CEP

	Length Km	Earth m3	Aggregate m3	Cement Mt	Sand m3	Reinforcement Mt
Section 1 **Kadawatha-Meerigama** (0+500-37+090)	36.59	3,036,601.55	1,063,871.81	266,491.63	400,180.53	72,393.52
Section 2 **Meerigama-Kurunegala** (37+090-76+810+ (9+300))	39.72 + 9.3	7,415,348.31	1,046,832.40	151,277.32	220,570.93	36,902.20
Section 4 **Kurunegala-Dambulla** (76+810-137.110)	60.3	11,048,405.07	1,480,297.82	193,673.48	278,138.66	38,726.22
Total	**136.61**	**21500354.93**	**3591002.03**	**611442.43**	**898890.12**	**148021.94**

2.2.6. Requirement and availability of workforce

Construction work will be awarded to a recognized major construction contractor who will recruit the necessary labour force based on the stages of the project. Labourers will be brought to the site in shifts and there will not be any resident labourers in labour camps at the site within the ROW. However, a limited number of workers will remain at the site throughout the construction period to maintain the site and to provide security for construction material and equipment. Most of skilled and unskilled labourers will be recruited from nearby villages and a limited number of highly skilled personnel will be recruited from elsewhere. There will also be a limited number of foreign labourers.

2.2.7. Any maintenance requirement during operation period

Maintenance of the expressway is the primary way in which the expressway authority carries out its goal of providing a safe, efficient and high speed road system for the public. Expressway maintenance includes maintenance of the carriageway, the shoulders, major structures, drainage structures and surfaces, safety furniture and other expressway furniture.

The maintenance of the expressway will be through a maintenance centre. The CEP will include the provision of equipment and facilities necessary for a maintenance centre for the expressway.

It is also recommended that a maintenance manual be prepared. The manual should include a comprehensive methodology for routine and other types of maintenance activities to be undertaken in the operational phase of the expressway. It will be based on the following guidelines:

- Provide users with information regarding maintenance standards and levels of service being provided on the expressway.
- Outline the maintenance department's responsibilities relating to the delivery of maintenance activities on the expressway.
- Ensure uniformity and consistency of the maintenance service levels.

2.2.8. Details of Land acquisition, rehabilitation/ relocation of communities, compensation procedures

The comprehensive Resettlement Plans have been prepared to cover each section of the CEP, the land acquisition, rehabilitation and relocation of communities. The compensation will be made according to the applicable government rules and regulations. Compensation will be made according to the 2013 regulations.

2.2.9. Details of any phased development activities and time schedule

The Central Expressway Project is identified as a priority project of the government. Construction of all the sections of the CEP will be completed within the next five years. Civil works of the CEP is to commence in the end of second quarter of 2016. The Table 2.6 shows the Schedule of Construction Activities

Table 2.6: Schedule of Construction Activities

Section	Activity/ Year	2016				2017				2018				2019				2020			
	Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Section 1 Kadawatha to Mirigama	Awarding of contract																				
	Civil works																				
Section 2 Mirigama to Kurunegala	Awarding of contract																				
	Civil works																				
Section 2 Mirigama to Ambepussa	Awarding of contract																				
	Civil works																				
Section 4 Kurunegala to Dambulla	Awarding of contract																				
	Civil works																				

2.2.10. Future expansions

The expressway connects to the Section 3 of the CEP at Pothuhera System Interchange which will give access to Kandy. The expressway will be expanding to the Northern and Eastern Parts of the Country from Dambulla. The expressway has provisions for future widening up to 6 lanes by outer widening.

2.2.11 Project cost, investment and funding sources

The total project cost for the CEP will be around 445.30 billion LKR. Total Project Cost for the CEP Sections 1, 2 and 4 will be around 350.64 billion LKR. The Table 2.7 shows the summary of Costs of CEP. The Kadawatha to Mirigama Section will be funded by the EXIM Bank of China. The Section 2 is expected to be funded by the ADB and Section 4 will be funded by the Government of Sri Lanka.

Table 2.7: The summary of costs for CEP

Contract package	Section	Length km	Cost Rs. Bn (Without Vat)	Cost Rs. Bn (With Vat)
Section 1	Kadawatha - Mirigama	36.54	127.88	141.95
Section 2	Mirigama - Kurunagala	39.72	77.08	86.71
	Ambepussalink Road (9.3 km)	9.3	9.60	10.81
Section 3	Pothuhara - Galagedara	32.5	94.66	106.51
Section 4	Kurunegala - Dambulla	60.15	136.08	153.10
Total for CEP			**445.30**	

Source (Road Development Authority)

CHAPTER 3: DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1. Study area

The study area considered for the assessment during the EIA preparation is the area specified in the Terms of Reference (TOR) of the EIA issued by CEA. The survey primarily focused on the strip of 320m width, which includes the Right Of Way (ROW) i.e. 60 m on either side of the centre line of the expressway trace, and a reservation zone of 100 m width on either side from the edge of the ROW from Kadawatha (Ch 0+000) to Dambulla (Ch 136+960) and Wiwatta (Ch 0+000) to Ambepussa (Ch 9+174).

Special emphasis was given to the affected areas at interchanges located along the proposed expressway. An assessment of baseline conditions on the physical, biological and social environment was carried out within the said corridor. In addition, all identified sensitive areas such as forests, religious places, schools and archaeologically important places that fall within approximately 1 km from the ROW, were subjected to assessment. The area of focus was extended to the upstream catchment areas and downstream lead away destinations in the assessment of hydrological impacts. Initial field surveys were conducted from October 2013 to May 2014 and additional field surveys were conducted from October 2015 to February 2016 to verify/update the existing data.

3.2. Physical environment

3.2.1 Topography Geology and Soil

3.2.1.1 General and geotechnical description of the basement

Basement geology along the proposed road was studied for a 2 km buffer zone on either sides of the road due to lack of rock outcrops. Investigations were done using both field studies and 1:100 000 maps developed by geological surveys and mines bureau (GSMB). In general, all the basement rock layers are located across the proposed road and thus the weaker zones and rock contact boundaries are generally across the proposed road. Major rock types present in the area can be explained as follows (Annex 3.2.3.),

- Undifferentiated charnockite
- Undifferentiated banded gneiss
- Charnockite gneiss
- Granite gneiss
- Biotite hornblende gneiss
- Hornblende biotite gneiss
- Quartzite
- Pegmatitic granitoid

Undifferentiated charnockite/ Undifferentiated banded gneiss

The undifferentiated charnockite and banded gneiss mainly reflect the limited availability of rock out crops along the proposed expressway. However, possible rock layers can be explained using nearby basement formations and field evidences around the road. Thus the available rocks can be only explained as undifferentiated charnockite and banded gneisses. Undifferentiated charnockite are grey gneisses appearing as charnockite. Mineral hypersthenes are scattered and are often available as ridge forming outcrops. Lack of outcrops further implies strong weathering of the basement and hence the soil layer is significantly developed on top of the basement (Annex 3.2.3).

Charnockite gneiss

Restricted outcrops are often ridge forming and are typically course grained with characteristic green greasy lustre, may lack of hypersthenes, includes patchy in-situ charnockite as well as partially

retrogressed. The rate of weathering and geotechnical properties of the rocks seem to be stronger than the other metamorphic rocks. Therefore any foundation construction for a civil engineering structure is more stable than the other rocks.

Granite gneiss

Granitic gneiss available in the area is massive leucrocratic quartzofeldspathic gneiss with mpre than 20% of quartz and a few percentages of mica. Geotechnical prosperities of the granitic gneisses are somewhat similar to the charnockitic gneisses. However, the rate of weathering can differ with respect to the amount of feldspar present in the rock. Rock strengthening characteristics can be significantly different in a wide range. Therefore, civil engineering constructions on top of such a rock formation should be carefully investigated.

Hornblende biotite gneiss

These are massive to compositionally layered grey gneiss with more than 20% quartz and 10% plagioclase andgarnet. According to geotechnical characteristics hornblende-biotite gneiss and biotite-hornblende gneiss are considerably weaker rocks. However, those rocks are somewhat stronger than the quartzo-feldspathic rocks.

Quartzite

Pure course grained ridge-forming quartzite with <5% of sillimanite, kaolinised feldspar or biotite. Quartzite is also a geotechnically weak rock as quartzo-feldspathic gneiss. It is a highly fractured rock and significantly important as a groundwater bearing formation. However, availability of the quartzite is not dominant along the proposed expressway and hence they are not significantly stable enough for any construction.

Pegmatitic granitoid

Simple quartz-feldspar pegmatite with magnetite and/or allanite. The rate of weathering and geotechnical properties of quartzo-feldspathic rich rocks seem to be weaker than that the other biotite gneiss. Therefore more attention should be paid in the designing of foundations of important civil engineering structures on the quartzo-feldspathic gneiss, as far as the durability is concerned.

Economic mineral deposits

Any economically important mineral deposits had not been identified along the proposed expressway. Therefore, there is no threat from the proposed road on valuble earth resources available in the country.

3.2.1.2. Structural geology

Structural changes in the basement rocks highly rely on environmental impacts, specially on groundwater, surface water, natural disasters and civil engineering constructions. Basement rocks with structural maps along the proposed expressway are given in the annexes. The general trend directions of the rock layers are from west to east and dipping usually towards south and north directions (see the structural map in the annex). Field and laboratory studies further imply that most of the rock layers are extended across the proposed road. Therefore, it would be possible to identify significant lateral variation of the basement rocks and structures during the constructions.

According to the field observations and literature review rocks are usually massive and hence joint and fracture density is relatively low. This leads to lower the possibilities of groundwater accumulation and movement in the aquifer. The proposed expressway is located on a sound basement rock. However, a number of several weak zones (shear zones) are identified in Arial photographical studies as well. In addition, most of the rock boundaries are present across the proposed road and they are considered as geologically and structurally weak areas (see the geology map in the annex 3.2.3).

3.1.2.3. Land subsidence and other natural disasters

Land subsidence and landslides are critical environmental issues recorded with rapid development projects. However, geological investigations of the proposed expressway indicate low threats from land subsidence. Geological and structural conditions of the terrain are quite stable and there are no kast topographical conditions which would usually indicate that subsidence is taking place. However, crystalline small scale marble layers were occasionally found along the road.

Land subsidence can also take place due to excessive uses of groundwater. Thus, there has to be proper management of the groundwater and surface water sources around the proposed expressway to prevent any damages on soil embankment. Geomorphology studies along the proposed expressway concluded that landslides are not dominant due to flat and lower surface undulations. However, when the road is moving towards Kurunegala area slope cuts will be required along the basement and strongly weathered soils in order to maintain the level of the road. Therefore, suitable slope cuts and angles should be designed with respect to the soil type and rock types to stabilize possible earth slips. In general, for some locations suitable slope stability methods may have to be considered. Geological investigations further reveal that there are no threats from local earthquakes. However regional scale earthquakes can trigger local earth tremors and hence foundations of the proposed project should consider possible minor earth vibrations.

3.1.2.4. General description of soil

The major soil type available along the proposed expressway is red yellow podzolic which represent soft and hard laterite. Steeply dissected hills and strongly mottled forms of red yellow podzolic soils are present around the laterite formation. In addition, alluvial soil with variable drainage and texture is occasionally present. Bog and half-bog soils are only identified in a few locations specially where marshy lands are present. Color of the soil is red, yellow or yellow brown and is commonly known as laterite soil. Thickness of soil in natural lands is in between 25 cm to 40 cm. However the layer is very thin in cultivated lands. Soil is acidic and it is not subject to erosion easily.

3.1.2.5. General engineering properties of major soils

Red yellow podzolic/Laterite soil

Lateritic soils are highly weathered and altered residual soils formed by the in-situ weathering and/or decomposition of rocks in the tropical and sub-tropical regions with hot and humid climatic conditions. The process of weathering produces a wide variety in the thickness, grade, chemistry and ore mineralogy of the resulting soils. Lateritic soils are rich in aluminum oxides, iron oxides and low silicates but may contain appreciable amounts of kaolinite. The soil almost lacks fertility and is generally not suitable for agriculture. The results obtained for the common soil testing experiments showed that the lateritic soils could be used in a number of engineering applications including roads, earth embankment and as building material. However it has been estimated that granite gneiss derived laterite soil is suitable for use as fills for embankments. Conversely, the amphibolite derived laterite soil will have to be compacted more to improve the engineering properties.

Along the proposed expressway both granitic and amphibolite rocks are alternatively present (Fig. 1). Hence, considerable variation of engineering properties of the laterite soils can be seen along the proposed line. The Fe-rich laterite is what is mostly present in the area and they are usually harder at surface condition due to exposure to the air and consist of secondary minerals of hematite and goethite. Therefore, Fe-rich laterite is usually used as a construction material (bricks) in civil engineering works. In addition, relatively soft Al-rich layers are also present within the dominant Fe-rich laterite formation. Laterite soil profiles are uniform in horizontal direction and clays are usually subjected to seasonal volume changes especially in Al-rich areas. It will cause to weaken the foundations and thus proper soil compaction should be applied before any civil engineering construction.

The natural process of harder laterite formation in Fe-rich soil will help to avoid possible earth slips (landslides) along the road cuts during the construction of proposed project. Moreover, the excess road

cutting materials (laterite) can be used for earth embankments in other areas of the road construction since the laterite consist of suitable physico-chemical properties for land filling materials in civil engineering.

Alluvial soil

Alluvial soil is rich in nutrients and may contain heavy metals. These soils are formed when streams and rivers slow their velocity. The suspended soil particles are too heavy for the decreasing current to carry and are deposited on the riverbed and river banks. Alluvial soils vary in mineral content and specific soil characteristics depending on the region and geologic makeup of the area.

The alluvial soils present along the proposed road are not strongly developed and they are mainly associated with occasional flooding of the area. Thus the alluvial layers are developed on top of the hard and soft laterite formation. Field evidences indicate that the thickness of the soil layer is about one meter. The soils usually consist of fine grained low ridges of sand, silt or silty clay deposited by a stream on its floodplain and banks of its channel. According to geotechnical properties, these soils are generally considered as favorable soils for the foundation constructions. However, necessary level of compaction should be applied for strengthening the foundation for the proposed expressway to improve the engineering properties.

Paddy soil

Also, rice growing soils are varying on properties such as texture, drainage, nutritional status and edaphic problems. These soils are in various topographical, pedological and hydrological conditions in various land-forms.

Major paddy soils of the Gampaha area belongs to low country wet zone (according to agro ecological zone WL1). Medium to short age rice varieties are grown in both the seasons in these mineral soils. Iron toxicity is the main problem in some of the rice fields. The main soil types of the region are Red Yellow Podzolic soils in soft laterite and alluvial soils in almost flat terrain in various drainagerial classes. Therefore engineering properties of the soils are similar to laterite and alluvial soils.

The major paddy soils in Kurunegala area belongs to low country intermediate zone (according to agro ecological zone **IL1**). Rice growing soil groups in this region are Low Humic Gley Soils situated in undulating to rolling terrain and River Alluvial in flat terrain. Imperfectly drained Red Yellow Podzolic soils with strongly mottled sub soil are also used for paddy cultivation to a certain extent. Well drained to moderately well drained soils are good for other food crops (vegetables).

Bog half bog soil

Bog soils are accumulations of organic material formed in place by the growth and subsequent decay of plant life. They are usually dark in color and are very compressible and entirely unsuitable for supporting the foundation. However, this soil is not commonly available along the proposed expressway, and is only present in the marshy environment (0 - 2 km stretch) and river beds.

3.1.2.6. Specific description of geology and soils along the proposed road

Field observations, geotechnical report, geological map (1:50 000), structural map (1:50 000), soil map (1:50 000) and remote sensing data have been used for specific descriptions of geology, soil and hydrogeology in the key locations along the proposed expressway.

3.1.2.7. Major intersection/interchange locations

There are nine major intersection/interchange areas along the stretch. Status of the present environment on earth materials can be explained as follows.

(i) Kadawatha System Interchange

The area is also covered by undifferentiated gneisses and forms the contact zone with hornblende gneiss. A weaker zone is developed along the contact zone of two rock types. Significant level of weathering and erosion can be expected along the shear zone. Therefore, construction across the area should consider the shear zone. Major soils present in the area are low humic paddy soils underplayed by red laterite.

(ii) Gampaha Interchange

The interchange is located on cultivated paddy land. According to geological maps, major rock types present in the area are granite gneiss, cordierite gneiss, hornblende biotite gneiss and undifferentiated gneisses. However, most dominant type is undifferentiated gneisses. Those rock layers are present across the proposed expressway as narrow rock bands. Therefore several contact boundaries are present and those boundaries can be generally weak due to strong weathering.

Major soil type present around the area is red laterite in natural land. Conversely, paddy lands consist of highly weathered yellow color low humic grey soils. However, soils in paddy fields near the Aththanagalu Oya are covered with organic matter rich soils indicating alluvial formations.

(iii) Veyengoda Interchange

Major rock types present in the area are granite gneiss, charnockite gneiss and biotite hornblende gneiss. According to the basement geology, the area is stable for any type of civil engineering construction. Because, the charnockite and granite rocks are usually massive they have relatively lower densities of weaker surfaces such as fractures, joints and shear zones.

The proposed intersection is located on cultivated paddy lands. The pristine soil around the land usually consists of laterite. However, paddy soils are with alluvial clays and they are blackish brown in color due to richness in organic matter. The soil may have transported from adjoining river channels.

(iv) Mirigama Interchange

Charnockitic gneiss, pegmatitic granitoid gneiss and granite gneiss are the major rock types in the Mirigama intersection area. Those basement rocks are usually sound and massive and intersection is proposed to be located away from the three major shear zones in the Mirigama area. Hence there is no significant threat for the stability of the foundation.

Major soil type present in the area is red yellow podzolic soil with soft and hard laterite. The podzolic soil is predominant in the paddy fields with low humic grey color. The laterite is present in the natural land. Geomorphological observations indicate that some road cuts will be required around the intersection. However, along the hard laterite formation slope cuts will be probably stable without any support from retaining walls. Conversely, if road cuts run through the soft laterite suitable slope angles should be maintained to protect the earth slips.

(v) Wilwatta Service Interchange

Major rock types present in the area are undifferentiated charnockite and cordierite gneiss. Therefore the basement is sound enough for stable constructions. The interchange is proposed to be locate on the paddy field and geomorphology is relatively flat. Hence, there is no significant threat from landslides and

rock slides. Main soil type available in the area is red yellow podzolic soils with soft and hard laterite. However, paddy lands usually consist of low humic grey soil.

(vi) Nakalagamuwa Interchange

Nakalagamuwa Interchange is also located on a flat terrain, The major rock type present in the area is undifferentiated charnockite. However, granite gneiss and banded undifferentiated gneiss are occasionally present.

(vii) Boyagane(Dambokka) Interchange

The Boyagane interchange is basically located on top of the massive charnockite rock formation and therefore foundations are quite stable in these environments. In addition to charnockite less developed quartzite bands are occasionally present in the area. However quartzite has no significant impacts on foundation stability. Soils of the area are somewhat different from previous locations since they are mostly strongly mottled red yellow podzolic soils and reddish brown earth,

(viii) Kurunegala Interchange

Major rock type present in the region is granite gneiss and it is most suitable for stable foundation construction. Also, structural geologically there are no weak zones around the Kurunegala service interchange area. Soils of the area are similar to the previous locations and they are mostly strongly mottled red yellow podzolic soils and reddish brown earth.

(ix) Rideegama Interchange

Major rock types present in the region are granite silimanite biotite gneiss and hornblende biotite gneiss. They have strong ability for stable foundations. Also, according to the structures of the rock there are no weak zones around the Rideegama interchange area. Soils of the area are similar to the previous locations and they are mostly strongly mottled red yellow podzolic soils.

(x) ***Melsiripura Interchange***

Major rock types present in the Melsiripura region is quartzo-feldspathic gneiss and a small marble layer is also present. Both quartzo-feldspathic gneiss and marble have weaker features than other rocks. Also, according to the structures of the rock there are weak shear zones around the Melsiripura interchange area. Soils of the area are similar to the previous locations and they are mostly strongly mottled red yellow podzolic soils and reddish brown earth.

(x) ***Galewela Interchange***

Major rock types present it the Galewela region is granitic gneiss, biotite hornblende gneiss, metagabro and quartzo-feldspathic gneiss. Except for quartzo-feldspathic gneiss all other rocks have a strong ability for stable foundations. Also, according to the structures of the rock there are no weak zones around the Galewela interchange area. Soils of the area are similar to the previous locations and they are mostly strongly mottled red yellow podzolic soils and reddish brown earth.

(xi) Dambulla A 9 Interchange

Major rock types present it the Dambulla A 9 region are biotite hornblende gneiss and hornblende biotite gneiss. Those rocks have a strong ability for stable foundations. According to the structures of the rock there is a shear zone around the Dambulla A 9 interchange area. However due to flat terrain there is no impact of them on the proposed construction. Soil of the area is and reddish brown earth which reflect the insitu weathering conditions.

(xii) Dambulla Interchange

There are significantly different rock types present in the area of the Dambulla Interchange location. However, there are no possible environmental issues from them.

3.1.2.8. Other important locations along the stretch

(i) Stretch from 1 to 5 Km

The first five kilometers of the stretch predominantly consists of abandoned paddy fields and marshy lands. Soils in the paddy field are commonly rich in organic matter and with the urban settlements irrigation channels of the area are significantly polluted due to anthropogenic inputs. Temporary water accumulations are common in the middle of the abandoned paddy lands. This may be due to lens shaped consolidated clay layers in the paddy field weathering profile. Those clay layers are not consistent and thus water accumulation is not common everywhere. However, even those lands are not functioning for agricultural activities, they are important as for local and regional groundwater recharge activities. Geologically paddy fields are considered as highly fractured zones of the basement and hence permeability and porosity of the soil and partially weathered rocks are very high. This may lead to significant level of rain water infiltration and higher groundwater flow.

Marshy lands are available around the paddy fields of the area. Peat and bog soils are common in the marshy lands and thickness of the soil layer seems to be not significant. Marshy lands of the area are mainly developed by previous irrigation channels. Movement of water in the irrigation channels are blocked by human activities and thus channels are extended towards the paddy lands and form wider fresh water marshes.

(ii) Stretch from 12 - 20 Km and 24 - 26Km

Along the above stretch of the proposed road Aththanagalu Oya flood plain is extended and consists of extensively developed alluvial soil deposit. Those soils are mostly present in the paddy fields around the Aththanagalu Oya and its tributaries. The proposed road in the area is significantly crossing the alluvial deposit. Therefore, proper geotechnical investigations are necessary prior to the constriction. The alluvial deposits mainly consist of unconsolidated soil, rich in organic matter and hence is highly fertile for the agricultural activities. During the field survey some soil profiles of the area are observed to have extensively developed fine grained sand layers as well.

(iii)Stretch from 5 - 7 Km, 42 - 45 Km, 49 - 50 Km, 67 - 69 Km and 74 - 76 Km

The sections of the road given above mainly consist of folded basement rock layers. In most instances fold axis of the rocks are located across the proposed expressway. Therefore, weak basements are observed in each location. However, dipping of the rock layers are directed perpendicular to the proposed road reflecting the stable conditions from dip -slip type of earth slips along the possible road cuts.

(iv) Stretch from 68 Km - 76 Km

In terms of geology, this section is the most significant area for the proposed expressway since the area is mostly similar to the isolated rock hill plain. Several isolated rock exposes could be identified during the field investigation and map analyses. Most common rock type present along the stretch is charnockite gneiss. They consist of low fractures and joint density and are usually massive and ridge forming. Exfoliation type of weathering is commonly present in the charnockite and therefore most of the outcrops are rounded in shape.

In addition banded gneisses are present in the area such as granite gneiss, hornblende biotite gneiss and quartzite. In general, granite gneiss and hornblende biotite gneiss are present across the proposed expressway. They are usually associated with the margins of the folded basements. However, limited outcrops are identified in the field due to higher weathering intensity than in charnockitic gneiss.

Quartzite rock is the other major rock type present along the given stretch. The rocks are usually available as folded bands and are present along and across the proposed road. They are commonly present in the strongly fractured form and mineral feldspar is also present as a major mineral and thus weathering is relatively higher than the pure quartzite. Therefore, available quartzite in the area is suitable for groundwater accumulations.

The type of rocks and their engineering properties are important for large scale projects such as expressways. Most of the rock types present in the area are formed from several outcrops along the proposed stretch. For instance, blasting of charnockite and granite gneiss type of rocks should be carefully considered for possible environmental impacts such as earth vibrations and air quality. However, a steep slope can be maintained along the road cuts due to its low fracture density and massive nature. Conversely, hornblende biotite gneiss and quartzite are relatively weak and therefore if a steep slope is maintained along the road cuts it can later create rock slides. In addition, quartzite is the most weak rock type present in the area. The quartzite rocks with significant levels of feldspar usually form weak road cuts and commonly trigger rock slides. It is necessary to apply suitable slope stability methods along the road cuts across the quartzite types of rocks to avoid environmental damages and further slope stability and to manage the groundwater system surrounded them.

(v) Stretch from 107+680 Km - 107+900 Km

In terms of geology, this section is the most significant area for the expressway due to proposed tunnel construction. The area is similar to the isolated rock hill plain. Several isolated rock exposes could be identified during the field investigation and map analyses. Most common rock types present along this stretch are quartzo feldspathic gneiss and quartzite. In general, quartzofeldspathic gneiss is a weak rock which can be weathered easily and on the other hand quartzite are highly fractured rock types. Therefore, any type of construction on those rocks need comprehensive feasibility study.

(vi) Stretch from 108+110 Km - 108+390 Km

This section is also an important area for the expressway due to tunnel construction proposed as an alternative. The area is similar to the isolated rock hill plain. According to map analyses most common rock type present along this stretch is quartzite.

(vii) Stretch from 110+890 Km - 111+240 Km

The area is similar to the isolated rock hill plain. According to map analyses the most common rock type present along this stretch is quartzo feldspathic gneiss and biotite-hornblende gneiss.

3.2.2. Climate and meteorological features

The climate of Sri Lanka is heavily influenced by the mountainous topography of the south-central region and the wind regimes of southwest and northeast monsoons (Department of Meteorology, 2013). The country is characterised into 4 climatic seasons:

- First inter monsoon season from March to April
- Southwest monsoon season from May to September
- Second inter monsoon from October to November
- Northeast monsoon from December to February

The majority of the proposed expressway alignment of Sections 1, 2 and 4 are located within the south western portion of the island which is known climatically as the wet zone, with parts of the Section 2 and 4 trace falling within the intermediate zone. Agro-ecologically, Gampaha and Mirigama are located within WL3 zone, while Ambepussa is located within WL2b and Kurunegala is located within the agro-ecological zone IL1a. The 75% expectancy values of annual rainfall in these three zones are greater than 1,700 mm, 2,200 mm and 1,400 mm respectively.

Spatially the annual average mean sea level pressure over the island varies between 1,010 hectopascal (hPa) and 1012 hPa. The pressure values over the island are generally minimal during the months of May, June, July and August, while they are at maximum during the months of December, January, February and March.

Wind direction and wind speeds in the western and north western regions and the country are depended on the pressure gradients developed between Siberian high and Mascarine high. Wind roses developed for months of January, April, July and October by the Department of Meteorology are presented in Figure 3.5 below. According to the wind roses the wind directions and speeds within the western and northwestern regions could be described as follows:

- January - Northerly direction with average speed of 7.2 – 9.4 kmph
- April - Calm wind with average speed of 5.4 – 7.6 kmph
- July - South west direction with average speed of 7.6 – 15.5 kmph
- October - South west direction with average speed of 5.8 – 9.0 kmph

The mean monthly temperatures of the country differ on the seasonal movement of the sun with some influence caused by rainfall. Colombo and Kurunegala are two important cities with respect to Sections 1,2 and 4 of the CEP, and the section below describes the climate of these two main cities.

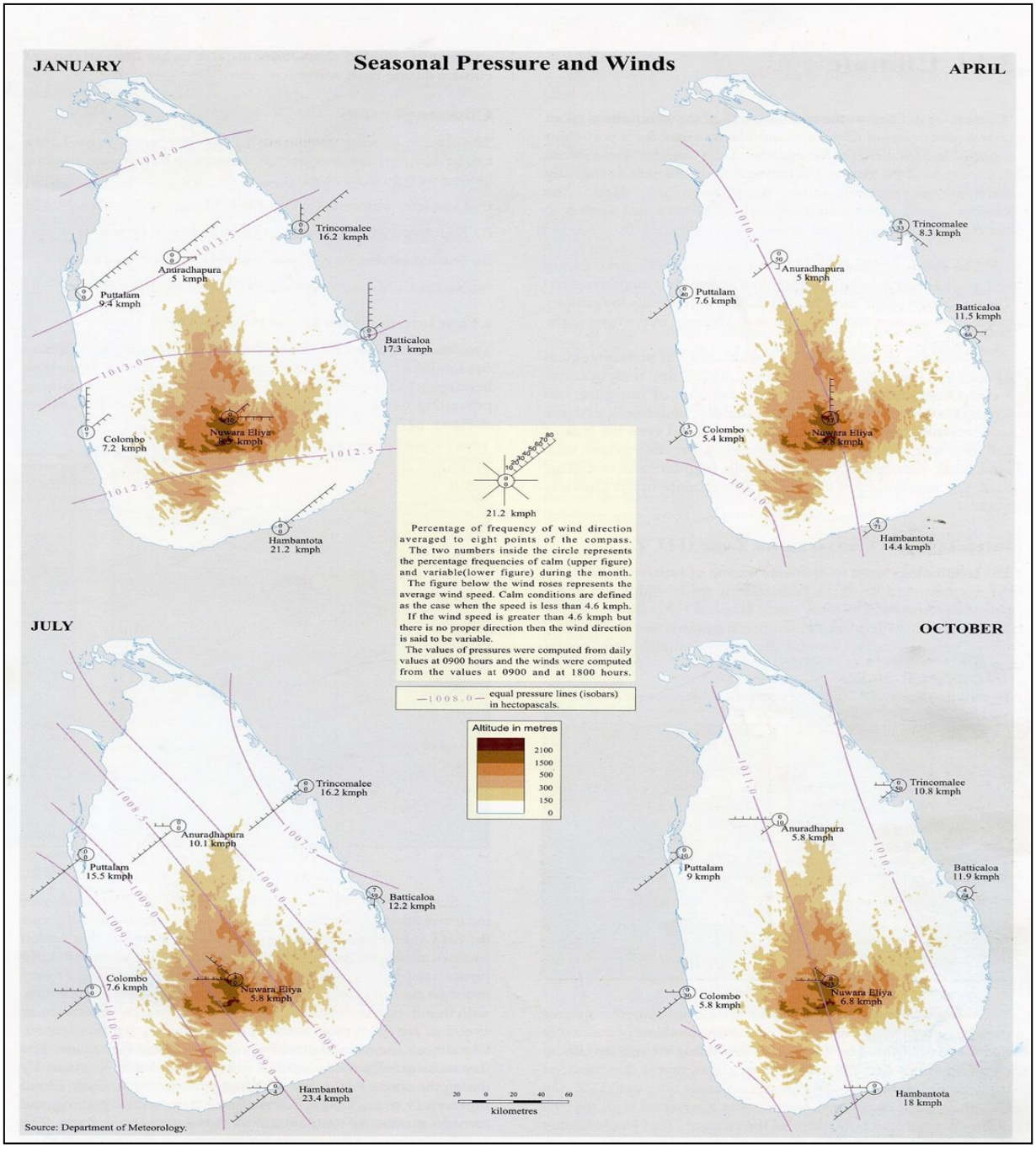


Figure 3.1: Wind roses for months of January, April, July and October developed by Dept. of Meteorology (Source: National Atlas, 2nd edition)

Colombo features a tropical monsoon climate under the Köppen climate classification, falling just short of a tropical rainforest climate. Colombo's climate is fairly temperate throughout the year. From March to April the temperature averages around 31^{0}C maximum. The only major change in the Colombo weather occurs during the monsoon seasons from May to August and October to January. This is the time of year where heavy rains can be expected. Colombo sees little relative diurnal range of temperature, although this is more marked in the drier winter months, where minimum temperatures average 22^{0}C. Rainfall in the city averages around 2,400 millimeters a year. Table 3.1 below summarizes the climatological data of Colombo.

Table 3.1: Climate data of Colombo

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Average high ^{0}C	30.9	31.2	31.7	31.8	31.1	30.4	30.0	30.0	30.2	30.0	30.1	30.3	30.64
Daily mean ^{0}C	26.6	26.9	27.7	28.2	28.3	27.9	27.6	27.6	27.5	27.0	26.7	26.6	27.38
Average low ^{0}C	22.3	22.6	23.7	24.6	25.5	25.5	25.2	25.1	24.8	24.0	23.2	22.8	24.11
Precipitation mm	58.2	72.7	128.0	245.6	392.4	184.9	121.9	119.5	245.4	365.4	414.4	175.3	2,523.7
% humidity	69	69	71	75	78	79	78	77	78	78	76	73	75

Source: World weather information centre – Colombo, World Meteorological Organization

Kurunegala features a tropical rainforest climate under the Köppen climate classification[1]. The city's climate is tropical and hot all throughout the year. The surrounding rocks play a major role in determining Kurunegala weather since these rocks increase and retain the heat of the day. During the month of April the temperature can rise up to about 35 ^{0}C. The only major change in the Kurunegala weather occurs during the monsoons from May to August and October to January, this is the time of year where heavy rains can be expected. While the city does experience a noticeably drier weather during January and February, it does not qualify as a true dry season as average precipitation in both months are above 60 millimeters. In general, temperatures from late November to mid-February period are lower than the rest of the year. The average annual rainfall in Kurunegala is about 2,000 millimeters. Table 3.2 below summarizes the climatological data of Kurunegala.

Table 3.2: Climate data of Kurunegala

Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Year
Average high ^{0}C	30.8	33.1	34.5	33.5	32.2	31.0	30.8	31.1	31.5	31.3	30.9	30.1	31.7
Daily mean ^{0}C	25.7	27.0	28.4	28.6	28.3	27.6	27.3	27.4	27.5	27.0	26.5	25.9	27.3
Average low ^{0}C	20.7	20.9	22.4	23.6	24.4	24.2	23.9	23.8	23.5	22.8	22.1	21.7	22.8
Precipitation mm	62	92	138	262	194	156	114	93	159	359	327	139	2,095
% humidity	65	59	60	69	73	74	73	71	71	74	74	72	69.6

Source: World weather information centre – Colombo, World Meteorological Organization

3.2.4 Surface and groundwater hydrology and drainage

3.2.4.1 Salient Features of Hydrological Landscape

Section 1

A total of about 29.6 km length, out of the 38.2 km of Kadawatha to Mirigama of the proposed road are on paddy fields and low lying areas. Most of the paddy fields in the Kadawatha to Mirigama are on low lying areas where floods are very frequent. Total length of the flood area is about 24.5 km. Uruwal Oya, Attanagalu Oya, Deeli Oya, a tributory of Deeli Oya, Maha Oya and Kuda Oya at Ambepussa are the main rivers encountered by the proposed road. Table 3.3 shows the details of the hydrologically important sections of proposed expressway alignment.

[1] The Köppen climate classification is one of the most widely used climate classification systems.

Table 3.3: Hydrologically Important Stretches of Proposed Alignment in Section 1

Hydrologically vulnerable sections	Length (m)	Land use	Flood	Most sensitive Sections	Remarks
0+000 - 1+700	1700	Paddy field	No flood	-	Only local drainage
2+800 - 3+500	700	Paddy field	No flood	-	Only local drainage
3+900 - 4+100	200	Paddy field	No flood	-	Only local drainage
4+400 - 4+900	500	Paddy field	No flood	-	Only local drainage
4+900 - 13+900	9000	Paddy field	High Flood	8+500	Uruwal Oya
				13+250	Ketawala Anicut is only 25m away from road embankment
				13+800	Attanagalu Oya
				15+100	Doranagoda Anicut is about 225 m away
				15+500	Deeli Oya
14+100 - 19+650	5550	Paddy field	High Flood	16+200	Bemmulla Anicut is about 275m away
				17+700	Deeli Oya
				18+200 - 18+450	Run parallel to Deeli Oya (less than 20m from toe)
				19+000	Deeli Oya
				19+600	Deeli Oya
				19+300	Maowita Anicut 170 m away
19+650 - 20+050	400	Paddy field	High Flood	19+900 - 20+000	Run parallel to Deeli Oya (along the centerline and crosses at 19+950)
20+300 - 20+450	150	Paddy field	High Flood	20+300 - 20+450	Run parallel to Deeli Oya (stream is on the embankment toe)
20+650 - 20+750	100	Marsh on RHS	High Flood	20+650 - 20+750	Run parallel to an stream (stream is on the embankment toe)
20+900 - 21+650	750	Paddy /Marsh	High Flood	21+000	Deeli Oya
				21+100	Irrigation canal
				21+250	Major drainage canal
				21+250 - 21+650	Run parallel to a major drainage canal (river training is proposed)
				21+450	Panugala Anicut is 250m away
				21+625	Major drainage canal
21+700 - 22+200	500	Paddy field	High Flood	22+200	Kachcheri Amuna (Anicut) is very close and the exit ramps intercepts Anicut spillway.
22+450 - 22+750	300	Paddy field	High Flood	22+550	Deeli Oya
				22+600 - 22+650	Mole Amuna (Anicut) is at the toe of the embankment. Toe of the embankment touches Deeli Oya at the bend.
22+800 - 25+450	2650	Paddy field	High Flood	23+050	Irrigation drainage canal
				23+100	A branch of Deeli Oya
				23+100 - 23+300	Run parallel to and almost on the stream
				23+300 - 25+100	Embankment occupies about 20% of the flood plain
				23+900 - 24+700	Diversion of irrigation drainage canal is necessary.
				24+900	Major irrigation drainage canal
				25+050	Irrigation canal
25+700 - 26+150	450	Paddy field	High Flood	25+850	Irrigation canal
				25+925	Deeli Oya
				25+500 - 25+900	Parallel to and over an irrigation canal
26+300 - 27+600	1300	Paddy/ Marsh	High Flood	26+600	Kumbaloluwa Anicut is about 90m away
				26+900	Deeli Oya
				26+900 - 27+300	Run parallel to Deeli Oya (road is on the stream and river training is proposed)
				27+150	Palu Oya
27+800 - 28+500	700	Paddy field	High Flood	27+800 - 28+500	Narrow (width 70m to 30m) flood plain
29+125 - 29+250	125	Paddy field	High Flood		
29+500 - 34+000	4500	Paddy field	High Flood	29+550	Irrigation canal
				29+600	Pallewela Anicut is 90m away
				29+900	Stream/ Irrigation drainage
				29+950	Anicut is 100m away

Hydrologically vulnerable sections	Length (m)	Land use	Flood	Most sensitive Sections	Remarks
				30+000	Irrigation drainage canal
				30+600 - 34+000	Run parallel to the stream. Flood plain is 100 to200 m wide.
				31+600, 31+750, 32+150, 32+550, 32+650,33+900	Irrigation and drainage canals
34+000 - 34+750	750	Paddy on LHS	No flood		Only local drainage
35+700 - 37+600	1900	Paddy on RHS	No flood		Only local drainage
37+600 - 38+200	600	Paddy field	No flood		Only local drainage

A. Uruwal Oya

From 3+900 km to 8+700 km, the expressway goes across Uruwal Oya flood plain. At 8+500 km it crosses Uruwal Oya. According to the Hydrological Study Report of North East Expressway (Colombo- Kandy Alternative Highway) Project, prepared by SLLRDC (2011), high flood level for 100 year return period at Uruwal Oya is about 7.6 m MSL. At the flood plain from 8+000 km to 10+000 km, overbank flow of Uruwal Oya mergers with that of Attanagalu Oya to make a continuous flood pool during high flood events.

B. Attanagalu Oya

From 9+000 km to 14+000 km, expressway alignment is in the same general direction of Attanagalu Oya. It merges with Deeli Oya at the west side of expressway around 12+500km. However, during high floods, the two streams meet about a kilometre upstream due to the overbank flow. From 13+100 km to 13+900 km, expressway is only about 50m away from the Attanagalu Oya. Preliminary Design Report - Stage 3 - Volume 3 - Hydrology and Drainage, prepared by SMEC (2014), estimates a 100 year peak discharge of 1700 m^3/s at this section. At 13+800 km, Attanagalu Oya crosses the proposed alignment and move away eastwards in the upstream flood plain. According to the same report, Attanagalu Oya brings about 1060 m^3/s during a 100 year flood, into the common flood plain it shares with the Deeli Oya.

C. Deeli Oya

From 14+100 km to 22+750km and from 25+700 km to 34+750 km, the proposed road alignment is in the general direction of Deeli Oya and its tributaries. As shown in the Table 3.4, proposed road goes across Deeli Oya at 17+700 km, 19+000 km, 19+600 km, 21+000 km, 22+550 km, 25+925 km and at 26+900 km. It runs very close to the stream, intersects the irrigation and drainage canals at several locations. Almost all these locations have undergone heavy flooding several times in the recent past. Preliminary Design Report - Stage 3 - Volume 3 - Hydrology and Drainage, prepared by SMEC (2014), estimates a 100 year peak discharge of 800 m^3/s at 16+000 km. At Veyangoda from 22+800 km to 25+450 the proposed road runs through a narrow valley occupying about 20% of the flood retention area where the estimated 100 year flood discharge is about 210 m^3/s. Further, from 30+600 km to 34+000 km the proposed road embankment is on a 100 to 200 m wide valley.

D. Maha Oya

Proposed centre line is within a distance of 100m from the bank of Maha Oya at 7+000 km of the Ambepussa link of the proposed road. However, the ROW does not intersect with the stream, and the stream is at an elevation about 30m below the road.

E. Attanagalu Oya Irrigation Scheme

Proposed road runs along the Attanagalu Oya Irrigation Scheme of the Irrigation Department from 4+000 to 33+000 km. There are about 3800 Acers of paddy fields under this scheme. The system of Anicuts,

gates and channels are operated and maintained by the Irrigation Engineer, Gampaha. There are 37 Anicuts and numerous irrigation canals in this system. Proposed expressway runs within 250m distance to Ketawala, Doranagoda, Bemmulla, Maowita, Panugala, Kachcheri Amuna, Mole Amuna, Kubaloluwa and Pallewela Anicuts. Exit ramps of the Veyangoda interchange, intercepts an edge of the spillway of Kachcheri Amuna Anicut. From 26+900 to 27+300 km, the water retention area of the Kubaloluwa Anicut will be shifted eastwards due to the proposed river training works.

Section 2

A total of about 23.4 km length, out of the 38.1 km of Mirigama to Kurunegala section and about 3.3 km out of the 9.1 km of Ambepussa Link of proposed road (section 2) is on paddy fields and low lying areas. According to the residents, most of the paddy fields in the Kuda Oya basin (44+000 km to 59+000 km) have experienced floods several times in the recent past. Total length of the flood area is about 13.5 km. Maha Oya, Kuda Oya, and the upstream reaches of Maguru Oya are the main rivers encountered by the proposed road. Table 3.4 shows the details of the hydrologically important sections of proposed expressway alignment.

Table 3.4: Hydrologically Important Stretches of Proposed Alignment in Section 2

Hydrologically vulnerable sections	Length (m)	Land use	Flood	Most sensitive locations	Land use/ Streams and drains
38+400 - 41+450	3050	Paddy field	No flood	39+950 - 40+300	Irrigation drainage canal
			Flood	40+600	Irrigation drainage canal
			Flood	40+750 - 41+100	Narrow (about 80m wide)valley
			Flood	41+100	Irrigation drainage canal
			Flood	41+350 - 41+400	Irrigation drainage canal
41+650 - 41+900	250	Paddy field	Flood		Paddy field
42+350		Maha Oya	No flood		High banks, deep gorge
42+900 - 43+450	550	Paddy field	Flood		Paddy field
43+750 - 44+050	300	Paddy field	High Flood		Paddy field
44+050 - 44+300	250	Coconut	No flood		Only 70m to Kuda Oya and runs parallel to it
44+300 to 46+850	2550	Paddy/ low lying	High Flood		Only 40m to 150 m to Kuda Oya and runs parallel to it
				44+800	Kuda Oya
				45+700	Kuda Oya
				46+000	Kuda Oya
				45+100 - 45+400	Road is on Kuda Oya. Need diversion
				45+550 - 45+750	Road is on Kuda Oya. Need diversion
47+100			Flood		Kuda Oya
47+150 - 47+500	350	Paddy field	High Flood		Paddy field
47+800 - 49+900	2100	Low lying/ shrub	High Flood	48+000 - 48+450	Road is on Kuda Oya. Need diversion
			High Flood	48+450	Kuda Oya
			High Flood	49+600	Tributary of Kuda Oya, Paddy field drainage
50+100		Stream	No flood		Stream
50+300 - 50+550	250	Shrub/ Paddy	Flood		Shrub/ Paddy
50+700 - 50+900	200	Paddy field	Flood		Paddy field
51+050 - 51+150	100	Paddy field	Flood		Paddy field
51+250 - 52+250	1000	Paddy field	Flood	51+400	Irrigation drainage canal
			Flood	51+500	Irrigation drainage canal
			Flood	52+050	Irrigation drainage canal
			Flood	52+150	Stream
52+450			Flood		Kuda Oya
52+750 - 53+100	350	Shrub/ Paddy	Flood		Shrub/ Paddy
53+250			Flood		Kuda Oya
54+250 - 54+500	250	Shrub	High Flood	54+400	Kuda Oya
55+050 - 55+650	600	Shrub/ Paddy	High Flood		Shrub/ Paddy
55+650 - 56+750	1100	Shrub/ Paddy	High Flood		Kuda Oya is less than 100m away
56+750 - 57+650	900	Paddy field	High Flood	57+450	Irrigation drainage canal

Hydrologically vulnerable sections	Length (m)	Land use	Flood	Most sensitive locations	Land use/ Streams and drains
57+650 - 59+200	1550	Shrub / Highland	Flood		Kuda Oya is only 50 to 100m away
				57+870	Kuda Oya
				57+950	Kuda Oya
				59+050 to 59+100	Runs parallel to Kuda Oya. Diversion needed.
60+000 - 60+250	250	Paddy field	No flood	60+220	Irrigation drainage canal
60+650 - 61+250	600	Shrub/ Paddy	No flood		Shrub/ Paddy
62+050 - 62+850	800	Paddy field	No flood	62+350	Irrigation drainage canal
				62+600 - 62+700	Minor stream in paddy field. Diversion needed.
63+420 - 64+150	730	Paddy field	No flood	63+600	Irrigation drainage canal
64+430 - 64+820	390	Paddy field	No flood		Paddy field
64+900 - 65+120	220	Paddy field	No flood		Paddy field
65+720 - 65+820	100	Paddy field	No flood		Paddy field
66+650 - 67+700	1050	Paddy field	No flood	66+930	Minor stream in paddy field
				67+100	Minor stream in paddy field
68+800 - 69+350	450	Shrub/ Paddy	Flood	69+300	Maguru Oya
69+450 - 69+650	200	Paddy field	No flood		Paddy field
70+350 - 70+520	170	Paddy field	No flood		Paddy field
70+650 - 72+300	650	Paddy field	No flood		Narrow (50 to 150 m wide) flood plain. Loss of retention area.
74+020 - 75+520	1500	Paddy field	No flood	74+400 to 75+000	Irrigation drainage canal. Needs diversion.
				75+170	Irrigation drainage canal
				75+350	Wendaru wewa RB spill drainage
75+700 - 76+250	550	Paddy field	No flood		Paddy field
Ambepussa Link					
Hydrologically vulnerable sections	**Length (m)**	**Land use**	**Flood**	**Most sensitive locations**	**Remarks**
2+200 - 3+900	1700	Paddy field	No flood		
4+900 - 5+600	700	Paddy field	No flood		
6+100 - 6+200	100	Paddy field	No flood		
6+900 - 7+200	300	High ground	No flood		Run parallel to Maha Oya but at very high elevation.
8+500 - 9+000	500	Flood plain	Flood	8+950	Ambepussa Kuda Oya

A. Maha Oya

First major stream encountered by the proposed road in this stretch is Maha Oya at 42+350 km. According to the anecdotal evidences there had been two major floods in the flood plains of Maha Oya in 1957 and in 1978. The bridge site is an elevated land with no possibility of flooding. However, flooding occurs in the paddy fields and low lying area draining into Maha Oya from 39+500 to 41+900 km. There is a water intake and a low level weir at about 150m upstream of the location of the proposed expressway bridge at Maha Oya. Kuda Oya falls into Maha Oya through its right bank about 2 km downstream.

B. Kuda Oya

From 44+000 km to 59+000 km, expressway alignment is in the same general direction of Kuda Oya. Proposed road alignment crosses Kuda Oya at 10 places and stream diversion is required at 5 locations. According to the residents 43+800 km to 49+900 km and 54+300 km to 56+300 km, flooding is frequent. At 47+250 km on Alawwa-Boyawalana road, a flood depth exceeding 1m has been experienced several times in the recent past.

C. Maguru Oya

At 66+920 km, 67+100 km and 69+300 km the proposed road crosses the upstream ends of Maguru Oya. From 68+900 km to 69+350 km more than one metre of floods above the average ground level of the paddy fields had been experienced during the most recent floods which occurred in 2012.

D. Wendaru Wewa canals

Proposed road is about 400m downstream of the bund of Wendaru Wewa from 74+400 km to 75+500 km. There are three canals at 75+350 km, 74+900 km and at 75+530 km coming from Wendaru Wewa passing through the proposed road embankment. From 74+700 km to 74+900 km diversion of a drainage canal is necessary as the proposed road encroaches into the drain.

E. Ambepussa Kuda Oya

Towards the end of the Ambepussa link, at 8+950 km, the expressway crosses Ambepussa Kuda Oya where a 100 year peak discharge of 400 m^3/s is estimated in the Preliminary Design Report - Stage 3 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014). A section of about 400 m is known to undergo flooding.

Section 4

A total of about 28.6 km length, out of the 61.1 km of Kurunegala to Dambulla section of proposed road (Section 4) is on paddy fields and low lying areas. Due to the relative dryness of the area, except for a few places, low lying areas are not swampy but get flooded during the rainy season. Total length of the flood area is about 4.1 km. Deduru Oya, Kimbulwana Oya, Welamitiya Oya, Dambulu Oya and Mirisgoniya Oya are the main rivers encountered by the proposed road. There are several tank cascade systems in this section which can be directly or indirectly affected by the road. Bathalagoda Wewa, Kimbulwana Wewa and Ibbankatuwa Wewa are the main irrigation tanks where the road intercepts their watersheds. Table 3.5 shows the details of the hydrologically important sections of proposed expressway trace.

Table 3.5: Hydrologically Important Sections of Proposed Alignment at Section 4

Hydrologically vulnerable sections	Length of the stretch (m)	Land use	Flood	Most sensitive locations	Streams, drains and tanks
76+700 - 78+350	650	Paddy, Marsh, Railroad	No flood	77+950	Irrigation drainage canal
78+830 - 79+270	440	Paddy field	No flood	79+000	Irrigation drainage canal
80+550 - 80+650	100	Paddy field	No flood	80+600	Irrigation drainage canal
81+250 - 81+500	250	Paddy field	No flood		
81+900 - 82+100	200	Paddy field	No flood	82+050, 82+100	Irrigation drainage canal
82+450 - 82+550	100	Paddy field	No flood		
83+150 - 83+600	550	Paddy field	Heavy flood	83+420	Irrigation drainage canal
83+600 - 83+700	100	River	Heavy flood		Deduru Oya
83+700 - 84+830	1130	Coconut	No flood		
84+830 - 86+400	1570	Paddy field	Flood	84+950	Irrigation drainage canal
			Flood	85+800	Irrigation canal
			No flood	86+120	Irrigation drainage canal
		Canal	No flood	86+360	Major irrigation canal (Ibbagamuwa offtake canal)
86+700 - 87+620	920	Canal	No flood	86+700	Major irrigation canal (Ibbagamuwa offtake canal)
		Cana	No flood	87+400	Major irrigation canal (Ibbagamuwa offtake canal)
87+950 - 88+300	350	Paddy field	No flood		
89+350 -o 89+550	200	Paddy field	No flood		

Hydrologically vulnerable sections	Length of the stretch (m)	Land use	Flood	Most sensitive locations	Streams, drains and tanks
89+730 - 89+820	90	Paddy field	No flood		
90+500 - 90+900	400	Shrub	No flood		
91+600 - 91+800	200	Paddy field	No flood		
92+050 - 92+400	350	Paddy field	No flood	92+200	Irrigation drainage canal
92+500 - 93+000	500	Shrub	No flood		
93+600 - 95+500	1900	Shrub, Paddy Stream	No Flood	94+850	Stream
96+100 - 97+400	1300	Shrub, Paddy	No Flood	97+200	Irrigation drainage canal
98+200 - 98+350	150	Tank	Inundation		Tank
98+450 - 98+600	150	Paddy/ marsh	Inundation		
99+100 - 99+200	100	Paddy field	No flood		
100+000 -o 100+200	200	Paddy field	No flood		
101+150 - 101+900	750	Paddy field	No flood		
102+750 - 103+050	300	Low lying/ grass	No flood for 200m	102+800 - 102+900	Tank
104+030		River	No flood		Kimbulwana Oya
112+200			Flood		Creek
112+700 - 113+000	300	Paddy field	No flood		
114+900 - 116+000	1100	Shrub/ chena/ paddy	No flood		
116+000 - 116+350	350	Shrub/ chena/ paddy	No flood		
117+250 - 119+000	1750	Shrub/ chena/ paddy/Tank	No flood	18+400	Tank
119+900 - 120+150	250	Paddy	No flood		
120+150		Canal			Major Transbasin canal (of Mahaweli Authority)
120+150 - 121+100	950	Paddy field	No flood		
121+100 - 122+100	1000	Paddy field	No flood		
122+100		River	Flood		River
122+100 - 122+700	600	Paddy field	No flood	122+150	A branch of Welamitiya Oya
123+500		River	Flood		Welamitiya Oya
123+500 - 124+000	500	Paddy field	No flood		
124+050		River	Flood		A branch of Welamitiya Oya
124+100 - 124+550	450	Paddy field	No flood		
125+200 - 127+200	2000	Shrub/ chena/ paddy	No flood	125+250	Stream
127+800 - 128+700	900	Shrub/ chena/ paddy	No flood	126+750	Stream
128+700		River	Flood		Dambulu Oya
128+700 - 129+600	900	Shrub/ chena/ paddy	No flood		
130+300		Stream	No flood		Stream
130+300 - 131+800	1400	Shrub/ chena/ paddy	No flood	131+000	Stream
		Stream	No flood	131+450	Stream
		Stream	No flood	131+600	Spillway lead away stream
		Canal	No flood	131+640	Irrigation canal
		Stream	No flood	131+700	Spillway lead away stream
		Tank	Inundation	131+800	Very small tank
134+250 - 137+456	3206	Stream Paddy field	Flood	134+400	Stream/ Drainage canal
		Stream	Flood	134+950 - 135+200	Stream diversion
		canal	Flood	135+650	Drainage canal
		River	Flood	136+300	Mirisgoniya Oya / spillway leadaway canal of Kandalama tank

Hydrologically vulnerable sections	Length of the stretch (m)	Land use	Flood	Most sensitive locations	Streams, drains and tanks
		Canal	Flood	136+350 to 136+550	Diversion of Irrigation canal
		Canal	Flood	136+580	Irrigation canal
		Canal	Flood	136+700	Drainage canal
		Canal	No flood	137+080	Irrigation canal
		Canal	No flood	137+180	Irrigation canal

A. Deduru Oya

First major stream encountered by the proposed road in this stretch is Deduru Oya at 83+600 to 93+000 km. Road reaches Deduru Oya at 83+600 and is in the general direction of the river for the next 10 km. There is a water intake and a low level weir about 1.5 km downstream of the location of the proposed expressway bridge. An anicut (diverting water to Bathalagoda tank) is also there about 5 km upstream. Kospothu Oya falls into the Deduru Oya through its left bank about 1.2 km upstream. According to the anecdotal evidences there had been floods with overbank flow several times during the past 10 years with the flood occurred in 2012 been the latest. The bridge site is on a bend of the river with a rocky bed. However, there is no possibility of overbank flow bypassing the bend during high floods due to the elevated ground at the inside of the bend. According to the Preliminary Design Report - Stage 4 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), 100 year flood discharge is about 1250 m^3/s. During the 2012 flood, flood depth above the riverbanks at the proposed bridge site was about 2m and the flood had lasted for about 2 days. Deduru Oya is known to carry a lot of debris during high floods and the flow velocities are very high compared to the rivers of similar size in the country due to the steep slope of the river bed. From 90+600 to 90+850 km, the river is only about 50m away from the proposed road centre line. From 83+700 to 84+700 km, and from 90+500 to 90+850 km, the distance between the centre line of the road and the river is about 100 m.

B. Kimbulwana Oya

At 104+030 km expressway alignment intercepts with Kimbulwana Oya. According to the Preliminary Design Report - Stage 4 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014),100 year flood discharge of this stream is about 230 m^3/s. Overbank flow during high flood is limited due to the elevated riverbanks.

C. Welamitiya Oya

At 122+150, 123+500 km and at 124+050 km the proposed road crosses the upstream reaches of Welamitiya Oya. The stream at 123+500 km is the main river whereas the others are tributaries. According to the anecdotal evidences, this is not a major flood plain but the paddy fields within a distance of about 30m from the main stream go under water during high floods. According to the Preliminary Design Report - Stage 4 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), 100 year flood discharge of this stream is about 450 m3/s.

D. Dambulu Oya

Proposed road intercepts Dambulu Oya at 128+700 km. Ibbankatuwa Wewa (tank) to which Dambulu Oya drains is only about 4 km downstream. During high floods raised water levels at the tank retards the flow in Dambulu Oya and flooding occurs at surrounding paddy fields. According to the Preliminary Design Report - Stage 4 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), 100 year flood discharge of this stream is about 258 m3/s.

E. Mirisgoniya Oya

Mirisgoniya Oya intercepts with the proposed road at 136+300 km. During high floods, from 134+700 to 136+900 km, paddy fields undergo flooding. Kandalama tank spills aggravate flooding as the spillway is directly connected to Mirisgoniya Oya. According to the Preliminary Design Report - Stage 4 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), 100 year flood discharge of this stream is about 505 m^3/s.

3.2.4.2 Minor Drainages

Section 1

For the section 9+000 km to 38+200 km and for the Ambepusa link, Preliminary Design Report - Stage 3 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), identified 71 minor and medium streams, creeks, irrigation and drainage canals and valleys where culverts have to be provided to send the water across the proposed road. Appendix - C Stage 3 Catchment Data, of the same report gives the peak discharges and other relevant information at these locations. In addition, for 0+000 to 9+000 km section, there are 34 streams and canals identified in the Hydrological Study Report of North East Expressway (Colombo- Kandy Alternative Highway) Project, prepared by SLLRDC (2011).

Section 2

From Mirigama to Kurunegala, Preliminary Design Report - Stage 2 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), identified 67 minor and medium streams, creeks, irrigation and drainage canals and valleys where culverts have to be provided to send the water across the proposed road. This is in addition to 13 major bridges at Maha Oya, Kuda Oya, Maguru Oya, their tributaries and at Wendaru Wewa spill. Appendix - C Stage 2 Catchment Data, of the same report gives the peak discharges and other relevant information at these locations.

Section 4

From Kurunegala to Dambulla , Preliminary Design Report - Stage 4 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), identified 90 minor and medium streams, creeks, irrigation and drainage canals and valleys where culverts have to be provided to send the water across the proposed road. This is in addition to 7 major bridges at Deduru Oya, Kimbulwana Oya, Welamitiya Oya, Dambulu Oya and Mirisgoniya Oya. Appendix - C Stage 4 Catchment Data, of the same report gives the peak discharges and other relevant information at these locations.

3.2.4.3 Retention Areas and Retention Times

Section 1

Generally, low lying paddy fields and marshes act as retention areas during high floods. From Kadawatha to Mirigama, expressway is on low lying areas or paddy fields through a total length of 29.7 km. From 3+300 to 32+000 km in Attanagalu Oya system, the land is a very flat land with a general slope not exceeding 1:1000. River meanders, numerous bunds, anicuts and gates, thick vegetation, road embankments etc make this an ideal retention area. This retention area is very important as it retards and attenuate the floods reaching Bemmulla, Gampaha, Minuwangoda, Ja Ela, Ekala, Kotugoda and other downstream areas which are highly populated. A Flood takes about 24 hrs to travel through a length of 25 km from Ganegoda to Gampaha, the most critical flood stretch affected by the proposed expressway. Without the retentions, flood movement will be much quicker and the travel time will be reduced by about 50%.

Section 2

Along Kuda Oya from 44+000 km to 59+000 km, there are wide flood plains which have a potential to act as retention areas during high floods. Residents in this stretch have experienced high flood levels lasting for more than 24 hours which is an indication of a system of effective retention areas mainly due to several narrow flow passages, the stream and its flood plain have on the way towards Maha Oya.

Section 4

Presence of tanks (Wewa) at most of the valleys in this section of the proposed expressway, helps to retard the flood flow movement and to attenuate the flood heights. The efficiency of tanks in flood retention depends on the available capacities to hold more water when the floods occur. Therefore the amount of flood retention at tanks depends on the season. Most of the paddy fields also have a potential to act as retention areas during high floods. However, the flood plains are not so wide and therefore the retention is minimal.

3.2.5. Water quality and sources of water pollution

Sections 1 & 2

The water bodies that are directly or indirectly affected by alternative options for the proposed highway trace were carefully noted before the field visits. The existing water quality parameters of such rivers/streams, lakes/tanks and several other low lying areas were then measured. Likely pollution scenarios were predicted as a result of the proposed project, and subsequent impacts were quantified.

Surface and groundwater sampling was carried out at around 60 locations of the project area. The water samples were analyzed to establish the baseline data. To assess the present status of water quality in the project area, surface and groundwater samples were collected and analyzed to determine the following parameters:

1. Physical parameters: pH, Temperature, Electrical Conductivity (and Salinity), Turbidity
2. Chemical parameters: Dissolved Oxygen (DO) concentration, Total Hardness (as $CaCO_3$), Total Suspended Solids (TSS); Biochemical Oxygen Demand (BOD); Chemical Oxygen Demand (COD), Nitrates and Free Ammonia (both as N), Oil & Grease, Chlorides, Sulphates
3. Microbiological parameters: Faecal and Total Coliform

Location details of all sampling points, parameters tested and existing water quality of few locations are presented in Tables 3.6 and 3.7 respectively.

Table 3.6: Locations for surface water quality monitoring

Sample Location	Location Co-ordinates	Sample Location	Location Co-ordinates
WP12	7° 5' 15.83" N 79°58' 46.96" E	WP37	7° 14' 41.76" N 80° 6' 44.10" E
WP13	7° 5' 46.30" N 79°59' 25.10" E	WP38	7° 15' 14.57" N 80° 7' 07.90" E
WP14	7° 6' 11.75" N 80° 0' 13.11" E	WP39	7° 16' 36.49" N 80° 8' 15.12" E
WP15	7° 6' 17.30" N 80° 0' 15.12" E	WP40	7° 17' 25.20" N 80° 8' 49.20" E
WP16	7° 6' 35.99" N 80° 0' 21.74" E	WP41	7° 17' 51.00" N 80° 9' 07.68" E
WP17	7° 6' 50.97" N 80° 0' 53.57" E	WP42	7° 17' 58.73" N 80° 9' 08.93" E
WP18	7° 7' 12.84" N 80° 1' 6.39" E	WP43	7° 18' 11.59" N 80° 9' 16.59" E
WP19	7° 7' 42.13" N 80° 1' 27.73" E	WP44	7° 18' 22.63" N 80° 9' 10.65" E
WP20	7° 7' 52.15" N 80° 2' 16.58" E	WP45	7° 19' 04.28" N 80° 9' 28.49" E
WP21	7° 7' 58.39" N 80° 2' 22.49" E	WP46	7° 19' 08.98" N 80° 9' 37.67" E
WP22	7° 8' 05.01" N 80° 2' 36.00" E	WP47	7° 19' 20.20" N 80° 9' 47.12" E
WP23	7° 8' 17.22" N 80° 2' 49.40" E	WP48	7° 19' 34.56" N 80° 9' 56.21" E
WP24	7° 7' 30.44" N 80° 1' 08.17" E	WP49	7° 21' 04.00" N 80° 10' 37.2" E

Sample Location	Location Co-ordinates	Sample Location	Location Co-ordinates
WP25	7° 9' 16.89" N 80° 3' 53.63" E	WP50	7° 21' 54.1" N 80° 11' 04.0" E
WP26	7° 10' 05.48" N 80° 4' 02.55" E	WP51	7° 22' 19.3" N 80° 11' 31.8" E
WP27	7° 10' 34.24" N 80° 4' 10.82" E	WP52	7° 22' 31.6" N 80° 11' 48.7" E
WP28	7° 10' 32.27" N 80° 4' 17.00" E	WP53	7° 23' 17.0" N 80° 13' 26.3" E
WP29	7° 10' 55.79" N 80° 4' 45.68" E	WP54	7° 24' 15.3" N 80° 15' 50.5" E
WP30	7° 10' 54.01" N 80° 4' 45.97" E	WP 55	7° 26' 44.8" N 80° 20' 24.9" E
WP31	7° 10' 52.48" N 80° 4' 52.11" E	WP56	7° 27' 03.2" N 80° 21' 25.8" E
WP32	7° 11' 08.39" N 80° 4' 04.57" E	WP57	7° 28' 25.6" N 80° 22' 12.0" E
WP33	7° 11' 39.24" N 80° 5' 23.89" E	WP58	7° 14.198' N 80° 05.032' E
WP34	7° 11' 58.37" N 80° 5' 37.50" E	WP59	7° 15' 09.0" N 80° 10' 44.3" E
WP35	7° 12' 25.74" N 80° 6' 02.52" E	WP60	7° 15' 33.7" N 80° 08' 18.5" E
WP36	7° 13' 38.69" N 80° 6' 47.06" E		

Table 3.7: Results of the baseline surface water quality monitoring

Parameters		Temperature (^{0}C)	Electrical Conductivity (µS/cm)	pH	Turbidity NTU	Coliform Total (MPN/ 100ml)	DO (mg/l)	BOD_5 (mg/l)
Standard Criteria	**Class I Extraction for drinking water**	**Natural**	-	**6.0 - 9.0**	-	**1,000**	**5**	**4**
	Class II Fish & aquatic life	**Natural**	-	**6.0 - 8.5**	-	**20,000**	**3**	**4**
Locations	WP17	25	29	5.7	12	900	7.13	<0.0
	WP39	25	43	5.8	04	250	6.17	07
	WP43	25	54	5.6	04	250	5.98	06
	WP49	25	163	5.6	24	1800	5.25	01
	WP51	25	72	4.8	01	550	6.23	<0.0
	WP55	25	508	6.6	13	1800	7.01	05
	WP57	25	305	5.4	01	900	6.88	<0.0

Standard Criteria: "Proposed Ambient Water Quality Standards for Inland Waters of Sri Lanka" (CEA, 2001)

3.2.5.1. Surface Water Quality

In general, the water quality, both surface and groundwater is relatively unpolluted from anthropogenic activities in comparison to that of more densely populated areas in the Western part of the country. However, agricultural activities, especially paddy cultivation contribute numerous pollutants (especially discharges rich in nitrogen and phosphorous and pesticides) as non-point sources contaminating both surface and groundwater. Several town centers, households and small-scale industries discharge considerable amounts of oxygen demanding wastes directly into major rivers and streams, which passes such populated areas. At present, surface water sources, such as rivers and streams and irrigation tanks, are used for bathing and washing, agriculture, fishing, recreational purposes, industrial operations and for a certain extent for drinking. Groundwater is the primary source of drinking water and for domestic water uses in most of the areas, however, pipe-borne water is available in most of the urban areas.

The water quality analysis of the project area revealed that organic pollution is relatively high (Annex 3.1.1). The BOD_5 levels vary from 4 mg/L to 15 mg/L and exceed the CEA Proposed (ungazetted) Ambient Water Quality Standards for Inland Waters. Possible reasons may be due to cattle urine and faecal

contamination (with both total and feacal coliform levels < 1800 MPN / 100 mL) and there is no flushing and dilution of the water.

All the waterways showed contamination with total and faecal coliform matter possibly due to runoff containing substances such as faecal matter (Annex 3.1.1). Water pH is within the range of 6-9 and shows suitability for the existence of most biological life. The levels are within the CEA proposed Inland Water Quality Standards.

3.2.5.2. Groundwater Quality

The ground deposits will change the quality of the water depending on the water chemistry of the area. The solubility of iron in such areas enriches the groundwater with various ions and changes could take place in accordance with oxic and anoxic conditions prevailing in such areas.

Groundwater is the primary source of drinking water and domestic water uses in most of the areas. However, pipe-borne water is available at most of the urban areas. Significant iron levels were not detected in the groundwater and pH levels are acceptable with reference to WHO and SLS 614 (Part I Drinking Water Guidelines 2001). However, all the groundwater sources are contaminated with faecal matter due to the usage of soakage pits to dispose black water (Annex 3.1.1) with turbidity levels > 4 NTU (limits stipulated for drinking waters by SL614:2013 & WHO, 2001).

Furthermore, groundwater samples tested appeared to be moderately hard at all the locations (as total hardness is between 75 mg/L and 150 mg/L), except at one (Location 7) where the water seems to be hard (as total hardness is between 150 mg/L and 300 mg/L). It seems that there is non-carbonate hardness too as total alkalinity is less than the total hardness (refer to Annex 3.1.1).

3.2.5.3. Sources of water pollution

The following waterways are possible recipients of agricultural runoff, rich in NO_3^- and total phosphorus (TP) due to their location within paddy field areas on which chemical fertilizers are applied:

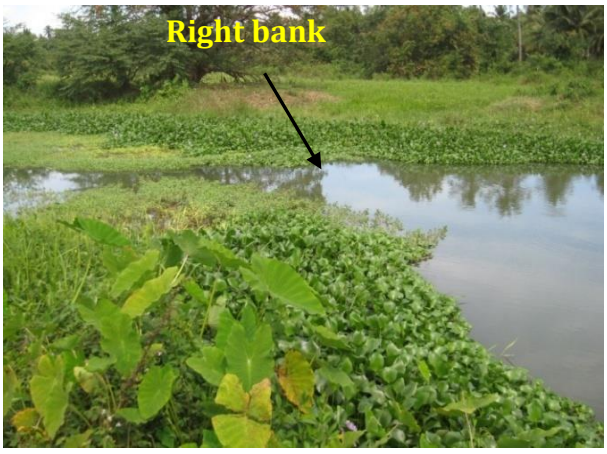
- Irrigation canal; Pahalagattuwana 77+450 km
- Denagamuwa Ela (irrigation canal) 78+650 km
- Canal linking Bathalagoda wewa; Ch 86+000 km
- Bambawa Temple wewa; Ch 116+000 km
- Large irrigation canal; Ch 119+750 km
- Ketiganakanda wewa (Irrigation T ank); Ch 120+750 km (close to the Walaswewa blasting area)
- Irrigation tank at Ch 118+100 km
- Irrigation tank Ch 131+300 km
- Mirisgoni Oya Ch 135+900 km

Although the water tanks/ wewas and many of the slow moving irrigation canals in the project area did not exhibit signs of cultural eutrophication, nutrient enrichment was visually evident in some canals such as the canal linking the Bathalagoda wewa (Ch 86+000 km; see Figure 3.2 and the large irrigation canal at Ch 46+060 km due to the occurrence of aquatic weeds such as water hyacinth (*Eichhornia crassipes* (Mart.) Solms).

Water quality analysis studies revealed that the nutrient content is high in the waterways supporting the premise of agricultural run-off entry from the surrounding agricultural lands Annex 3.1.1 ; NO_3^- levels exceed 5 mg/L (CEA Proposed Ambient Inland Water Quality Standards) and in most of the waterways the PO_3^{4-} levels > 0.7 mg/L (CEA Proposed Ambient Inland Water Quality Standards). Gokarella water supply stream (at N-07^0 33.876' E-080^0 29.424) is also polluted according to the nutrient levels and faecal coliform count. However, considering the relationship between water quality and dissolved oxygen (DO)

levels only, all the waterways seem to be slightly polluted as DO is between 6-8 mg/L (Ileperuma, 2000). Nevertheless, survival of most fish is possible because DO is ≥ 2 mg/L.

The wewa at Melsiripura Farm; Ch 102+ 960 km from Dambulla which is used by cattle for bathing is a possible recipient of nutrient rich runoff from the farm lands and nutrient enrichment by cattle manure and urine. However, there were no signs of visual pollution. Some of the wewas (e.g., Ketigana Wewa; and Uda Tuttiri Wewa) are subjected to complete drying during the drier spells (Figure 3.2).During the recent-past many areas of the Deduru Oya in the North-western Province have experienced significant river bank erosion as well as high damage to paddy and the luxuriant coconut cultivations with the lowering of water tables and increased saline water intrusions as a result of excessive river sand mining (Kularatne, 2014b). Also, some areas of the Deduru Oya and some sections of the left bank of the Dambulu Oya (Ch 128 + 320 km) showed signs of erosion as rills. Downstream areas of the Welametiya Oya exhibited stagnant or slow moving conditions (water pockets were evident in some areas) due to extensive siltation caused by excessive sand mining. Furthermore, significant bank erosion was evident at Welametiya Oya and the water appeared to be very turbid (visual inspections) (Figure 3.2).



A view of the canal linking the Bathalagoda wewa showing the growth of water hyacinth

Irrigation canal at Pahalagattuwana showing high turbidity following a rainy event

Denagamuwa Ela (irrigation canal)

Some close views of the downstream section of the Welametiya Oya showing heavy siltation with the waters almost stagnant and very turbid (visual inspections)

Mirisgoni Oya is a slow moving waterway during drier spells with relatively turbid waters (visual inspections)

Some of the wewas such as the Uda Tuttiri wewa at (left photograph) and the Ketiganakanda Wewa (right photograph) are subjected to complete drying during the dry season

Figure 3.2: Waterways within the Project Area

3.2.6. Ambient air quality

SECTION 01 & 02

Table 3.8 presents the location details where ambient air quality measurements were carried out during April 2014. Table 3.9 presents the results of above investigations with a comparison between measured values and National Ambient Air Quality (NAAQ) Standards (2008). The weather during the monitoring period appeared to be dry with fairly windy conditions.

The ambient air quality levels of the project area were identified through the primary data collection along the project trace. The measurements for Section 1 and 2 were undertaken by SGS Lanka (Pvt) Ltd. Excluding the town centres of Gampaha, Veyangoda, Mirigama and Kurunegala, the current air quality in the project area appears to not be significantly polluted. Atmosphere near Boyagane, where the proposed expressway crosses the A006 highway, may also contain pollutants as there is a significant vehicle movement. According to these results it is evident that all air pollutant levels are well below the permissible levels given in Table 3.9 considering the fact that the project area has few industries and that agriculture (paddy cultivation) is the main economic activity in the project area. Furthermore, the project area experiences relatively low traffic in comparison with major cities such as Colombo in the Western Province.

Table 3.8: Description of the locations of air quality monitoring

Location No.	Main City	Local coordinates (G.P.S point)	
A2	Gampaha	N 07° 05.445'	E 079° 58.485'
A3	Veyangoda	N 07° 09.088'	E 080° 03.806'
A4	Mirigama	N 07° 14.688'	E 080° 06.691'
A5	Nakalagamuwa	N 07° 23.113'	E 080° 13.245'
A6	Dambokka/ Boyagane	N 07° 26.775'	E 080° 20.433'
A7	Kurunegala	N 07° 28.404'	E 080° 22.318'

Table 3.9: Concentration of each air quality parameter at each sampling location

Location No.	Nitrogen Dioxide (mg/m³)	Sulfur Dioxide (mg/m³)	Ozone (mg/m³)	Carbon Monoxide (mg/m³)	Carbon Dioxide (ppm)	PM_{10} (mg/m³)	$PM_{2.5}$ (mg/m³)	SPM (mg/m³)
NAAQ standards	**0.100 (24hr)***	**0.080 (24 hr)***	**0.200 (1hr)***	**10 (8hr)***	**N/A**	**0.100 (24hr)***	**0.050 (24hr)***	**0.30 (24hr)****
A2	0.005	<0.025	<0.020	3.1	456	0.042	0.023	0.052
A3	0.004	<0.025	<0.020	1.4	426	0.043	0.020	0.055
A4	0.010	<0.025	<0.020	2.9	412	0.040	0.028	0.041
A5	0.008	<0.025	<0.020	3.6	420	0.062	0.042	0.069
A6	0.007	<0.025	0.029	2.4	416	0.074	0.049	0.082
A7	0.005	<0.025	0.038	2.4	408	0.070	0.027	0.071

Note: * *As given in NAAQ stipulated under Extraordinary Gazette No. 1562/22, August 2008.*
** *Maximum permissible level for Suspended Particulate Matter (SPM) is based on the NAAQ regulations gazetted in 1994.*

All the measured ambient air quality levels at selected locations were within the permissible level of the ambient air quality standards stipulated by CEA.

SECTION 04

The recent studies done by the NBRO (2014) within the Section 4 CEP project area revealed that the existing ambient air quality levels with respect to SO_2, NO_2, CO, PM_{10} and $PM_{2.5}$ were well below the Ambient Air Quality Standards Extraordinary Gazette No. 1562/22, August 15, 2008). Results are shown in Table 3.10.

Table 3.10: Results of ambient air quality measurement within the Section 4 project area

Location No	GPS Coordinates	Location Description	Sampling Date	Time average	Concentration				
					SO_2 (g/m³)	NO_2 (g/m³)	CO (ppm)	PM_{10} (g/m³)	$PM_{2.5}$ (g/m³)
AQ1	07°30’ 24.04”N 80°25’49.35”E	Mr.M.K. Somarathne, No 26, Ambalanyaya, Orandana, Hidagolla	17-18.04.2014	8hrs	-	-	<1	-	-
				24hrs	6	7	-	12	5
AQ2	07°37’ 21.19”N 80°30’37.97”E	Udammita Maha Vidyalaya, Udammita	17-18.04.2014	8hrs	-	-	<1	-	-
				24hrs	11	16	-	15	8
AQ3	07°38’ 19.05”N 80°31’1.37”E	Mr. Jagath Weerasooriya, Ragedara Road, Kandawala, Malsiripura	17-18.04.2014	8hrs	-	-	1	-	-
				24hrs	12	18	-	25	14
AQ4	07°44’44.81”N 80°34’20.48”E	Bambawa Raja Maha Viharaya, Palapathwela Road, Galewela	17-18.04.2014	8hrs	-	-	1	-	-
				24hrs	13	20	-	19	11
AQ (only dust)	07°46’28.84”N 80°36’1.05”E	Mr. M.G.Jayakody, No 428, Kethigane, Walaswewa, Galewela	17-18.04.2014	24hrs	-	-	-	10	5
				8hrs	-	-	2	-	-
AQ6	07°53’ 18.18”N 80°39’20.46”E	Mr. Siril Rathne Vidusene, Mirisgoniyawewa, Dambulla	17-18.04.2014	24hrs	20	26	-	38	20

Note that there may have been some occult deposition (largely SO_2 and NO_X) and wet deposition of particulate matter during wet weather conditions (Source: NBRO, 2014).

3.2.7. Noise and vibration levels and noise sensitive locations

SECTION 1&2

The proposed expressway corridor spans mainly through paddy fields, marshy lands and coconut estates which have a calm environment and less noise generating activities. However during land preparation and harvesting seasons where machinery is used the noise levels may increase. Also, the movement of trains along the railway line in the project area could be considered as another source of noise. Noise generated by moving vehicles along the existing highways and rural roads in the project area is another contributory factor to noise levels. The above two sources also contribute to the existing vibration levels observed in the project corridor. Locations used to measure ambient noise levels and vibrations are presented in Table 3.11, while the measured 24 hour noise levels and one (1) hour vibration levels are presented in Table 3.12 and Table 3.13, respectively.

Table 3.11: Description of the locations of ambient noise and vibration level monitoring

Location	Description	Local coordinates (G.P.S point)	
N2/ V2	At the premises of Ms. R.A. Manika. 88/D/1 G. Hendrigewatta, Pahalagama, Gampaha.	7°05' 27.03"N	79° 59' 0.20"E
N3/ V3	At the premises of Mr. PremWasanthaJayasinghe. 165, Circular Road. Paththalageda, Veyangoda.	7° 09' 5.98"N	80° 03' 48.43"E
N4/ V4	Sri Munindaramaya, Haple, Mirigama.	7°14' 42.05"N	80° 06' 41.59"E
N5/ V5	At the premises of Mr. J. Hettiarchchi. Nakalagamuwa, Narammala.	7°23' 11.02"N	80° 13' 14.40"E
N6/ V6	Sanasa office, 1811 Boyagane.	7°26' 46.31"N	80° 20' 25.29"E
N7/ V7	Sri Vidarshananramaya, Ambalanpitiya, Kurunegala.	7°28' 24.10"N	80° 22' 17.70"E

Table 3.12: Observed 24 hours noise levels at each sampling location

Date	Measurement Location	Assessment Time Period- Day dB(A)			Assessment Time Period- Evening dB(A)			Assessment Time Period- Night dB(A)		
		ABL	RBL	ENL	ABL	RBL	ENL	ABL	RBL	ENL
04,05 January 2014	N1	39	43	69	43	46	68	47	49	45
30,31 January 2014	N2	44	45	51	47	48	51	44	45	48
10,11 March 2014	N3	39	43	53	42	45	50	42	43	46
17,18 March 2014	N4	41	45	59	48	54	57	44	46	52
13,14 March 2014	N5	40	42	52	38	41	49	31	32	41
20,21 March 2014	N6	40	42	47	39	40	45	37	38	44
20,21 March 2014	N7	38	41	49	40	44	40	42	44	48

Note: ABL-Assessment Background Level ($L_{A90,15min}$), RBL- Rating Background Level ($L_{A90,15min}$), ENL- Existing Noise Level ($L_{Aeq,h}$) h- hour

The locations selected for establishing the baseline noise levels of the project area were chosen due to their proximity to the existing railway line, existing roads, places of worship and settlements. Out of the seven sample locations, N1 recorded the highest noise levels during day time and evening, which can be attributed to the movement of trains. An interesting observation on above data is the relatively high night time noise at location N4 which is located in a temple premises. It was observed that the sharp sounds generated by some nocturnal insects and animals as the main cause for such high noise level readings during night time.

Table 3.13: One hour vibration levels observed at each sampling location

Location	Description	Assessment Period	Time			
			0-15 min	15 – 30 min	30-45 min	45-60 min
V1	Category of the Structure	Day time	Type 3	Type 3	Type 3	Type 3
	Result -Vibration					
	Max. Peak Value in velocity mode(mm/sec)		0.089	0.109	0.312	0.107
	Frequency range(Hz)		>50	>50	>50	>50
	Pre dominant Frequency(Hz)		96.50	67.00	67.50	68.50
V2	Category of the Structure	Day time	Type 3	Type 3	Type 3	Type 3
	Result -Vibration					
	Max. Peak Value in velocity mode(mm/sec)		0.085	0.075	0.078	0.080
	Frequency range(Hz)		0-10	10-50	10-50	10-50
	Pre dominant Frequency(Hz)		8.00	22.50	11.00	11.00
V3	Category of the Structure	Day time	Type 3	Type 3	Type 3	Type 3
	Result -Vibration					
	Max. Peak Value in velocity mode(mm/sec)		0.083	0.084	0.085	0.090
	Frequency range(Hz)		>50	>50	>50	10-50
	Pre dominant Frequency(Hz)		87.00	89.00	89.50	36.50
V4	Category of the Structure	Day time	Type 3	Type 3	Type 3	Type 3
	Result -Vibration					
	Max. Peak Value in velocity mode(mm/sec)		0.077	0.060	0.082	0.084
	Frequency range(Hz)		>50	>50	>50	>50
	Pre dominant Frequency(Hz)		119.00	58.50	110.00	48.00
V5	Category of the Structure	Day time	Type 3	Type 3	Type 3	Type 3
	Result -Vibration					
	Max. Peak Value in velocity mode(mm/sec)		0.083	0.063	0.062	0.081
	Frequency range(Hz)		>50	>50	>50	>50
	Pre dominant		67.50	68.50	68.50	64.00

Location	Description	Assessment Period	Time			
			0-15 min	15 – 30 min	30-45 min	45-60 min
	Frequency(Hz)					
V6	Category of the Structure	Day time	Type 3	Type 3	Type 3	Type 3
	Result -Vibration					
	Max. Peak Value in velocity mode(mm/sec)		0.146	0.082	0.085	0.094
	Frequency range(Hz)		>50	10-50	>50	>50
	Pre dominant Frequency(Hz)		100.00	38.50	82.00	81.50
V7	Category of the Structure	Day time	Type 3	Type 3	Type 3	Type 3
	Result -Vibration					
	Max. Peak Value in velocity mode(mm/sec)		0.075	0.081	0.120	0.082
	Frequency range(Hz)		>50	>50	>50	>50
	Pre dominant Frequency(Hz)		87.00	71.50	73.50	70.00

All structures observed within the sampling locations are of Type 3 as per ISO4966: 1990 (E) standards. Type 3 structures are defined as single and two storied houses and buildings made of lighter constructions using lightweight materials such as bricks, cement blocks etc. not designed to resist earthquakes. Sources of vibration at sampling locations are typically the movement of vehicles and the movement of trains in the case of location V1. As per the above readings, it could be concluded that the existing vibration levels are well within the limits specified for Type 3 structures.

SECTION 4

Studies done by the NBRO (2014) within the Section 4 project area revealed that the measured baseline noise levels during the day at roadside locations were relatively high at around 70 dB, whereas in rural areas noise levels were lower than 50 dB. Measured baseline noise levels at night were around 58 dB at rural areas and 58 dB at road sides (refer to Tables 3.14).

Table 3.14: Ambient noise level measuring locations (Section 4 of the CEP)

Location No:	GPS Coordinates	Location Description
N1	70 30’ 26.12” N 800 25’ 49.75” E	At roadside, close to Deduru oya, Orandana, Hidagolla
N2	70 37’ 19.88” N 800 30’ 39.16” E	At the roadside, close to Udammita Maha Viddiyalaya, Udammita
N3	70 38’ 19.22” N 800 31’ 1.62” E	Roadside, close to the premises of Mr. Jagath Weerasooriya,Ragedara Road, Kandawala, Malsiripura
N4	70 39’ 36.58” N 800 31’ 52.25” E	Ehalagolayaya, Koskelle
N5	70 44’ 44.60” N 800 36’ 16.08” E	At the premises of Bambawa Raja Maha Viharaya, Palapathwela Road, Galewela
N6	70 46’ 28.85” N	At the premises of Mr. M.G.Jayakody, No.428, Kethigane,

	800 36' 0.73" E	Walaswewa, Galewela
N7	70 50' 40.55" N 800 39' 15.75" E	At the roadside, A-9 road, close to the Moon Power Cottage,Kapuwatta, Dambulla
N8	70 53' 18.18" N 800 39' 20.46" E	At the roadside, close to the premises of Mr. Siril Rathne Vidusene, Mirisgoniyaw, Dambulla

(Source: NBRO, 2014 - Field measurements)

3.2.8. Records on past natural disasters

Floods are the most common disaster occurring in Sri Lanka. Flooding can be attributed to both natural and manmade reasons. Overflow of the Attanagalu Oya during the inter monsoon and south west monsoon periods causes human displacement and property damage in Gampaha district. Floods in 2010 caused damages to the dwellings of around 150 families in the villages of Alawala, Thihariya and Kahataovita in Attanagalle DSD. Floods that occurred during May 2013 caused impacts to more than 500 families. The figures below present an aerial photograph taken during the floods and people moving to safety.

Figure 3.3: Aerial photograph of a part of Gampaha district during floods in May, 2013 (Source: The Sunday Times)

Figure 3.4: People moving to safety (Source: The Island)

Other than the natural floods caused by overflowing of Attanagalu Oya, improper drainage management and blockage of drainage canals in settlement areas have caused flash flood situations in the Gampaha district.

Compared to the Gampaha district, the Kurunegala district is much less prone to natural disasters. However, in the recent past (April 2014), the town of Kurunegala was hit by strong winds with heavy rains. Although no human casualties were recorded, this event caused substantial damages to many houses in the town area, the police station, a school, and electricity and telecommunication cables.

The Kegalla district has been declared as a landslide prone area by National Building and Research Organization (NBRO). Forty six (46) slope failure events were recorded during the month of May 2011. Seven (7) of these events were classified as landslides by NBRO. Three fatalities occurred during these events.

Figure 3.5: Damaged property due to a landslide in Kegalla district (Source: NBRO)

3.3. Biological environment

3.3.1. General description of the Project Area

The study segment from Kadawatha to Dambulla of the proposed CEP consists of Section 1 - Kadawatha to Mirigama, Section 2 – Mirigama to Kurunegala including Ambepussa link, and Section 4 – Kurunegala to Dambulla. The proposed trace traverse through the wet (Gampaha and Kegalle Districts), intermediate (Kurunegala District), and dry climatic zones (part of Matale District) of the country.

Biogeographically, the entire route from Kadawatha to Dambulla falls under three floristic zones; I I : Dry and arid lowlands (within dry zone), III: Northern Intermediate Lowlands (within the intermediate zone) and V: Northern Wet Lowlands (within the wet zone) (Ashton and Gunatilleke, 1987). Dry and arid lowlands are dominated by dry-mixed evergreen forests. Typical natural vegetation formations found in the floristic zone III include Tropical Moist evergreen Forests while Tropical Wet Evergreen Forests comprises the natural vegetation formations in the floristic zone V: Northern Wet Lowlands. The proposed route further falls within bioclimatic regions Dry zone, Northern Intermediate zone and Lowland wet zone (Wijesinghe et al., 1993).

An ecological survey was conducted along a 100m wide corridor of the entire ***stretch under*** section 1,

2 and 4 of the CEP. The proposed route traverses through variety of natural, semi natural and human-modified landscapes. Much of the original forest cover has been cleared for human settlements, agricultural plantations, and infrastructure development. Agro-ecosystems and home gardens are the two major land-use types that will be affected by the proposed project. Despite being human modified habitats, wet and intermediate zone home gardens were observed to be rich in floral and faunal diversity.

3.3.2. Proximity to any sensitive reserves

The proposed expressway does not traverse through any national parks, sanctuaries or declared wetlands. However the proposed expressway traverses near the Henerathgoda Botanical Garden in Gampaha near Ch 11+000 of Section 1 (approximately 150m from the center line). The closest wildlife reserve is Horagolla National Park, located approximately 2.5km linear distance from Ch 21+500 in Section 1. The section between Ch 7+000 and 7+400 of Ambepussa link road of section 2 traverses through "Mirigama Kos Kele" forest which is a naturalized plantation forest.

The segment Ch 58+200 to 59+600 of Section 2 of the expressway will be located on the edge of the southern boundary of Weragalakanda forest, which could be described as a scrub forest. Human settlements, rock excavation and plantations are present in the area through which the proposed expressway is laid. The expressway will traverse through/near the Kirindigolla forest near Ch 90+200, Henagederalanda forest reserve at Ch 104+380 to 105+400, and Hevanethenna Ch 107+650, Omaragolla near Ch 110 + 350, Bamarakanda near Ch 110 + 350 and Kethiganakanda Ch 90+100 of Section 4. Map of Sensitive areas along the expressway available in Annex 3.3.3.

3.3.3. Major habitat types along the proposed corridor

The proposed route spans over a variety of natural and man-made habitat types including terrestrial, aquatic and semi-aquatic systems in II: Dry and arid lowlands, III: Northern Intermediate Lowlands and the V: Northern Wet Lowlands floristic regions. Field investigations identified 08 major terrestrial habitat/ vegetation types and 02 inland aquatic/wetland habitat types in the project-affected area. These can be classified into following terrestrial and aquatic or wetland habitats.

I. Natural terrestrial habitats: Wet zone Naturalized Mixed Forest Plantations, Intermediate zone Naturalized Mixed Forest Plantations, Intermediate zone Secondary moist semi-evergreen forests, Scrub forests, Riparian Vegetation, Rock outcrops
II. Anthropogenic terrestrial habitats: Home Gardens, Coconut plantations, Rubber plantations
III. Natural aquatic/wetland habitats: Streams/rivers, marsh
IV. Anthropogenic aquatic/wetland habitats: Paddy fields

Short descriptions of each habitat type are provided herein.

3.3.3.1. Natural terrestrial habitats

A. Wet zone Naturalized Mixed Forest Plantations

Naturalized plantation forests are the major forested habitats encountered closest to the study corridor within wet zone (Northern wet lowlands floristic zone). Although these plantations have been initially established by the Forest Department for the purpose of timber extraction, they've been left unmanaged over the years, and hence the forests have been regenerated with native species, and now bears close resemblance to a natural forest in the wet zone although the trees are much smaller in height and girth. Kos Kale is a wet zone naturalized mixed forest plantation encountered between Ch 7+000 and 7+400 of Ambepussa link.

Mirigama Kos Kale (Kendahena)

Kos Kele forest in Mirigama is a Jak Mahogani mixed Plantaion managed by Forest Department. The extent of the this forest patch is about 57.9 ha. This plantaion is older than 100 years and has been subjected to selective felling. However at present, the plantation has been colonized by native vegetation. Some of the common floral species in the forest patch include *Macaranga peltata* (Kenda), *Trema orientalis* (Gadumba), *Mallotus tetracoccus* (Bu Kenda), *Acacia caesia* (Hinguru Wel), *Alstonia macrophylla* (Havari Nuga), *Anamirta cocculus* (Titta Wel), *Melia azedarach* (Lunu Midella), *Cipadessa baccifera* (Hal Bebiya), *Microcos paniculata* (Kohu Kirilla), *Ziziphus rugosa* (Maha Eraminiya), *Mussaenda frondosa* (Mussenda), *Acronychia pedunculata* (Ankenda), *Syzygium caryophyllatum* (Dan), *Symplocos cochinchinensis* (Bombu), *Michelia champaca* (Sapu), *Pothos scandens* (Pota Wel), *Caryota urens* (Kitul) and *Helicteres isora* (Lihiniya). The endemic Sri Lanka Toque Monkey and endangered Sri Lanka Purple-Faced leaf monkey are common in this plantation forest. A comprehensive list of flora and fauna are provided in Annexures 3.3.1. and 3.3.2. respectively.

Figure 3.6: Mirigama Kos Kale forest

Horakela

Horakela FR is bisected by the Ambepussa link road of Section 2 at Ch ≈ 1+970 to 2+170. These are naturalized Jak Mahogani mixed plantaions under the jurisdication of the Forest Department. . At present, being an isolated and fragmented forest, Horakela FR is relatively less in biological diversity. However, in the landscape context, it functions as an important refuge for many faunal species including reptiles and birds. A comprehensive list of flora and fauna are provided in Annexures 3.3.1 and 3.3.2 respectively.

B. Intermediate zone Naturalized Mixed Forest Plantations

Several naturalized mixed forest plantations are encountered along and outside the study corridor of proposed trace. These are areas where forest plantations have been established by the Forest Department with exotic species, but have become naturalized due to lack of management.

The main exotic species in the planted forests are *Artocarpus heterophyllus* (Kos) and *Swietenia macrophylla* (Mahogani). The understories of such forests are inhabited by natural (natives and endemics) plant species such as *Mallotus philippensis* (Hamparilla), *Mallotus rhamnifolius* (Molabe), *Macaranga peltata* (Kenda), *Polyalthia korinti* (Ul Kenda), *Polyalthia suberosa* (Kalati), *Miliusa indica* (Kekili Messa), *Artabotrys zeylanicus* (Kalu Bambara Wel), *Nothopegia beddomei* (Bala), *Stenosiphonium cordifolium* (Bu Nelu), *Pagiantha dichotoma* (Divi Kaduru), *Eranthemum capense*, *Pothos scandens* (Pota Wel), *Caryota urens* (Kitul), *Garcinia terpnophylla*, *Connarus monocarpus* (Radaliya), *Maba buxifolia*, *Adenanthera pavonina* (Madatiya), *Derris parviflora* (Kala Wel), *Hydnocarpus venenata* (Makulu), *Salacia reticulata* (Kotala Himbutu), *Curculigoorchioides* (Heen Bin Tal), *Nothapodytesnim moniana*, *Neolitsea cassia* (Dawul Kurundu), *Anamirtacocculus* (Titta Wel), *Antiaristoxi caria* (Riti), *Streblus asper* (Netul), *Streblus taxoides* (Gon Gotu), *Strombosia ceylanica* (Pub Beriya), *Tropidia thwaitesii*, *Piper sylvestre* (Wal Gam Miris Wel), *Ventilago madraspatana* (Yakada Wel), *Ziziphus rugosa* (Maha Eraminiya), *Ixora coccinea* (Ratambala), *Atalantia ceylanica* (Yakinaran), *Glycosmis mauritiana*, *Murraya paniculata* (Etteriya), *Madhuca longifolia* (Mi), *Schleichera oleosa* (Koon), *Pterospermum suberifolium* (Welan), *Memecylon capitellatum* (Dedi Kaha), *Berrya cordifolia* (Hal Milla), *Celtis philippensis* (Meditella), *Vitex altissima* (Milla), *Elytraria acaulis*, *Polyalthia coffeoides* (Omara), *Combretum albidum* (Kaduru Ketiya Wel), *Margaritaria indicus* (Karavu), *Leea indica* (Gurulla), *Cipadessab accifera* (Hal Bebiya), *Glycosmis pentaphylla* (Dodan Pana), *Allophylus cobbe* (Kobbe), *Dimocarpus longan* (Mora) and *Filicium decipiens* (Pehimbiya).

Five endemic plant species, *Derris parviflora* (Kala Wel), *Hydnocarpus venenata* (Makulu), *Garcinia terpnophylla*, *Uvaria sphenocarpa*, *Memecylon capitellatum* (Dedi Kaha); four endangered (EN) plant species (including one endemic), *Garcinia terpnophylla*, *Tropidia thwaitesii*, *Salacia reticulata* (Kotala Himbutu), *Polyalthia suberosa* (Kalati); two vulnerable (VU) plant species, *Strombosia ceylanica* (Pub Beriya), *Margaritaria indicus* (Karavu) and six near threatened (NT) plant species, *Nothapodytes nimmoniana*, *Antiaristoxi caria* (Riti), *Vitex altissima* (Milla), *Madhuca longifolia* (Mi), *Ziziphus rugosa* (Maha Eraminiya), *Combretum albidum* (Kaduru Ketiya Wel) are among the natural (natives and endemics) plant species in forest plantations.

A few exotics, *Alstonia macrophyl la* (Havari Nuga), *Syngonium angustatum* (Wel Kohila) *Castilla elastic* (Panama Rubber), *Coffea arabica* (Kopi) are also found within the forest plantations other than the planted species. Plant species recorded in forest plantations during the field ecological study are listed in Annex 3.3.1.

Kiridigolla Forest (around Ch ≈ 90 +200)

This forest has been established as a forest plantation consisting primarily of Jak and Mahogony, but has become naturalised since no selective felling has been carried out by the Forest Department for 50 years. This forest is declared as a reserve by the Forest Department. This forest is multi-storeyed and contains

trees 30-40m in height that provide ideal refuge and nesting habitats for endemic and native birds such as Grey Hornbill. Mammals recorded here included the spotted deer. Several endangered species of orchids and other flora are also found here. The forest is also bordered by the Nikamada estate and the Deduru Oya. The stream edge comprises riparian vegetation. The river (Deduru Oya) serves as a source of water for the animals inhabiting the forest. The proposed CEP will pass through the forest close to the edge of the river.

(a) Nikamada estate

(b) Kiridigolla forest

Figure 3.7 (a): Nikamada estate (bordering the Kiridigolla forest *(Ch ≈ 90 +200) and* (b) The interior of the Kiridigolla forest

Henagederalanda (around Ch ≈ 103+700)

Henagederalanda which is also known as Diyathure is a naturalised plantation forest. It is a proposed conservation forest under the jurisdiction of the Forest Department. It is in close proximity to the larger Pallekele reserve jointly managed by both the Forest Department and the DWLC. This forest, like Kiridigolla, is multi-storied and comprises a relatively healthy mix of plants and animals. The proposed CEP will traverse the forest's edge at two locations and will also obstruct access to the adjoining stream which is very likely the water source of the animals in the forest.

Figure 3.8: Inside the Diyathure forest (Henagederalanda)

Hevanethenna (Oyadeka) (Ch ≈ 107+580)

The Hevanethenna forest comprises natural and plantation segments. It is situated adjoining the Henagederalanda reserve and is also declared as a reserve by the Forest Department. The vegetation here at the higher altitudinal areas is natural. This forest is disturbed at the edge near the coconut estate (one border) but relatively undisturbed towards the interior. It comprises important species of native flora and fauna. The proposed CEP will pass through the natural forest areas in Hevanathenna.

Figure 3.9: Naturalized areas within the Hevanathenna forest

Omaragolla (around Ch ≈ 110 + 350)

The Omaragolla Forest comprises Acasia plantations and is declared as a reserve under the Forest Department. Although Acasia trees were visible on the slopes, many native, endemic and threatened floral species have now invaded the forest (Figure 3.9). The forest understory is relatively dense even on slopes and it provides suitable habitats for birds and reptiles. The roadway will bisect the Omarogolla forest complex.

Figure 3.10: The Omaragolla forest

C. Intermediate zone Scrub forests

These are natural forests that have been subjected to long term human disturbances over the years and at present, resembles the characteristics of a degraded/scrub forest with relatively open and discontinuous canopy.

Weragalakanda Forest

Weragalakanda forest is a reserved forest under Forest Department. This is 164ha in extent. Parts of the eastern boundary of the forest have been encroached in the past and it is now under natural regeneration. Nonetheless, it harbors a variety of mammals such as wild boar, Sri Lanka Toque monkey, Porcupine, Black-Naped Hare, and Giant Squirrel.

Figure 3.11: Weregalakanda scrub forest area

D. Intermediate zone Secondary moist semi-evergreen forests

Moist semi-evergreen forests are the typical natural vegetation formation in the Northern Intermediate Lowlands floristic region (within the intermediate zone). Such forests encountered along the study corridor have been subjected to human interferences over time, and hence can be described as secondary moist semi-evergreen forests.

Species composition typically include *Vitex altissima* (Milla), *Filicium decipiens* (Pehimbiya), *Pterospermumsuberifolium* (Welan), *Lepisanthes senegalensis* (Gal Kuma), *Neolitsea cassia* (Dawul Kurundu), *Dimocarpuslongan* (Mora), *Mallotus philippensis* (Hamparilla), *Mallotus rhamnifolius* (Molabe), *Nothopegia beddomei* (Bala), *Artabotrys zeylanicus* (Kalu Bambara Wel), *Polyalthia coffeoides* (Omara), *Uvaria sphenocarpa*, *Mitrephora heyneana*, *Polyalthia korinti* (Ul Kenda), *Stenosiphonium cordifolium* (Bu Nelu), *Miliusa indica* (Kekili Messa), *Grewia orientalis* (Wel Keliya), *Glycosmis mauritiana*, *Streblus asper* (Netul), *Clausenaindica* (Migon Karapincha), *Gomphia serrata* (Bo Kera), *Celtis philippensis* (Meditella), *Berrya cordifolia* (Hal Milla), *Discospermum sphaerocarpum*, *Ventilago madraspatana* (Yakada Wel), *Anamirta cocculus* (Titta Wel), *Streblus taxoides* (Gon Gotu), *Pisonia aculeata* (Vavul Lairitiya), *Margaritaria indicus* (Karavu), *Combretum albidum* (Kaduru Ketiya Wel), *Salacia reticulata* (Kotala Himbutu), *Dioscorea oppositifolia* (Hiritala), *Pachygone ovata*, *Capparis rotundifolia* (Balal Katu), *Connarus monocarpus* (Radaliya), *Derris parviflora* (Kala Wel) are common inhabitants.

Two endemic plant species, *Derris parviflora* (Kala Wel), *Uvaria sphenocarpa*, one endangered (EN) plant species, *Salacia reticulata* (Kotala Himbutu), two vulnerable (VU) plant species, *Margaritaria indicus* (Karavu), *Pachygone ovata* and five near threatened (NT) plant species, *Mitrephora heyneana*, *Dioscorea oppositifolia* (Hiritala), *Pisonia aculeata* (Vavul Lairitiya), *Vitex altissima* (Milla), *Combretumalbidum* (Kaduru Ketiya Wel) are among the plant species within forests in the intermediate zone. The detailed plant species recorded in forest plantations during the field ecological study listed in Annex 3.3.1.b. Bambarakanda is a secondary moist semi-evergreen forest patch in the study area.

Bamarakanda (Ch ≈ 110 + 350)

This is a natural forest declared as a reserve by the Forest Department. The forest has a unique structure of rocky outcrops, sloping areas and flat terrains. Thus the vegetation found here is a mix that could be expected to occur in these different terrain conditions. The vegetation of the forest ranged from short sparse forests to tall relatively thick forests. Another unique feature is that the forest is not continuous but is composed of a few isolated hillocks. One particular rock is popularly known as Natangala or Deyangala because of its unique form and position (see Figure 3.11). The forest was seen to support many species of native and endemic birds, mammals (including bats) and herpetofauna. The proposed trace will go through this forest, isolating the Natangala rock area from the rest of the forest.

Vitex altissima (Milla), *Filicium decipiens* (Pehimbiya), *Pterospermum suberifolium* (Welan), *Lepisanthes senegalensis* (Gal Kuma), *Neolitsea cassia* (Dawul Kurundu), *Dimocarpus longan* (Mora), *Nothopegia beddomei* (Bala), *Artabotrys zeylanicus* (Kalu Bambara Wel), *Croton lacciferus* (Gas Keppetiya), *Euphorbia antiquorum* (Daluk), *Phyllanthus polyphyllus* (Kuratiya), *Hiptage benghalensis* (Puwak Gediya Wel), *Lannea coromandelica* (Hik), and *Trema orientalis* (Gadumba) comprised typical vegetation in this forests.

(a) (b)

Figure 3.12: (a) Natangala Forest which is part of the Bambarakanda forest *(Ch ≈ 114+ 300)* and (b) rock cave at Natangala

E. Rock outcrops

Found exclusively in association with rock outcrops, this vegetation formation resembles dry mixed characteristics. Several distinct rock outcrop associated forest patches are found along the proposed route, especially within the intermediate and dry zone.

Kethiganakanda (Ch ≈ 90+200))

This forest contains some rock outcrops and natural vegetation, and is located close to the Kethigana wewa. This forest, probably because of its small area, has not been declared as a reserve, but is an important habitat for many small mammals (porcupine and rats), reptiles (skinks, snakes and lizards) and butterflies. The proposed CEP would pass through this forest obstructing access to the Kethigana wewa.

Figure 3.13: Kethiganakanda

Bandakkagala (Ch ≈127+600)

This forest is gazetted under the name Bandakkagala which is also referred to as Punchi Dambulugala, and is formed of a series of forests and rocky outcrops creating a unique natural landscape. Sparse forests are found in rocky areas while the slope and hills comprise taller natural vegetation. Together with the tanks and other water sources, the overall habitat has a rich biotic component. The section of the forest, referred to as Maligathenna by villagers. It is also a part of the declared forest (by the Forest Department) reserve complex which is known as Bandakkagala. It comprises scrubland (sparse forests) wedged between the natural forest segments, and thus it serves as an important corridor for animals. This is another forest with a largely rocky terrain and as a result it supports a diversity of rock-dwelling species. A rocky cave was observed here supporting a large colony of bats (*Rhinolophus rouxii*) (Figure 3.13). Other species of interest recorded were skinks and lizards.

(a) **Maligathenna**

(b) **Bat cave in Maligathenna**

Figure 3.14: (a) Maligathenna Forest ((Ch≈ 127+100) (which is a part of the larger area of the Bandakkagala forest complex) and (b) a bat cave in Maligathenna)

Common plant species recorded on rock outcrops include *Croton lacciferus* (Gas Keppetiya), *Euphorbia antiquorum* (Daluk), *Hugonia mystax* (Bu Getiya), *Tarenna asiatica* (Tarana), *Grewia damine* (Daminiya),

Phyllanthus polyphyllus (Kuratiya), *Lannea coromandelica* (Hik), *Jasminum angustifolium* (Wal Pichcha), Vitex *altissima* (Milla), *Flueggea leucopyrus* (Heen Katu Pila), *Strychnos nux-vomica* (Goda kaduru), *Trema orientalis* (Gadumba), *Osbecki aaspera* (Bowitiya), *Cipadessa baccifera* (Hal Bebiya), *Litsea glutinosa* (Bomee), *Anisochilus carnosus* (Gal Kapuru Walliya), *Agave vera-cruz* (Hana), *Chionanthus zeylanica* (Geratiya), *Kalanchoe pinnata* (Akkapana), *Ziziphus oenoplia* (Heen Eraminiya), *Cissampelos pareira* (Diya Mitta), *Albizia odoratissima* (Suriya Mara) and *Derris scandens* (Bo Kala Wel).

One endemic plant species; *Argyreia* populifolia (Giritilla), two vulnerable (VU) plant species; *Margaritaria indicus* (Karavu), *Strychnos nux-vomica* (Godakaduru), and two near threatened (NT) plant species; *Vitex altissima* (Milla) and *Osbeckia aspera* (Bowitiya) are among plant species recorded on rocky outcrops within the segment of the proposed trace that traverses through intermediate and dry zones.

All these forest patches could be identified as sensitive habitats which are directly or indirectly affected by the proposed project. Locations of these forest patches with respect to proposed trace and study corridor of Section 4 are indicated in figure 3.14.

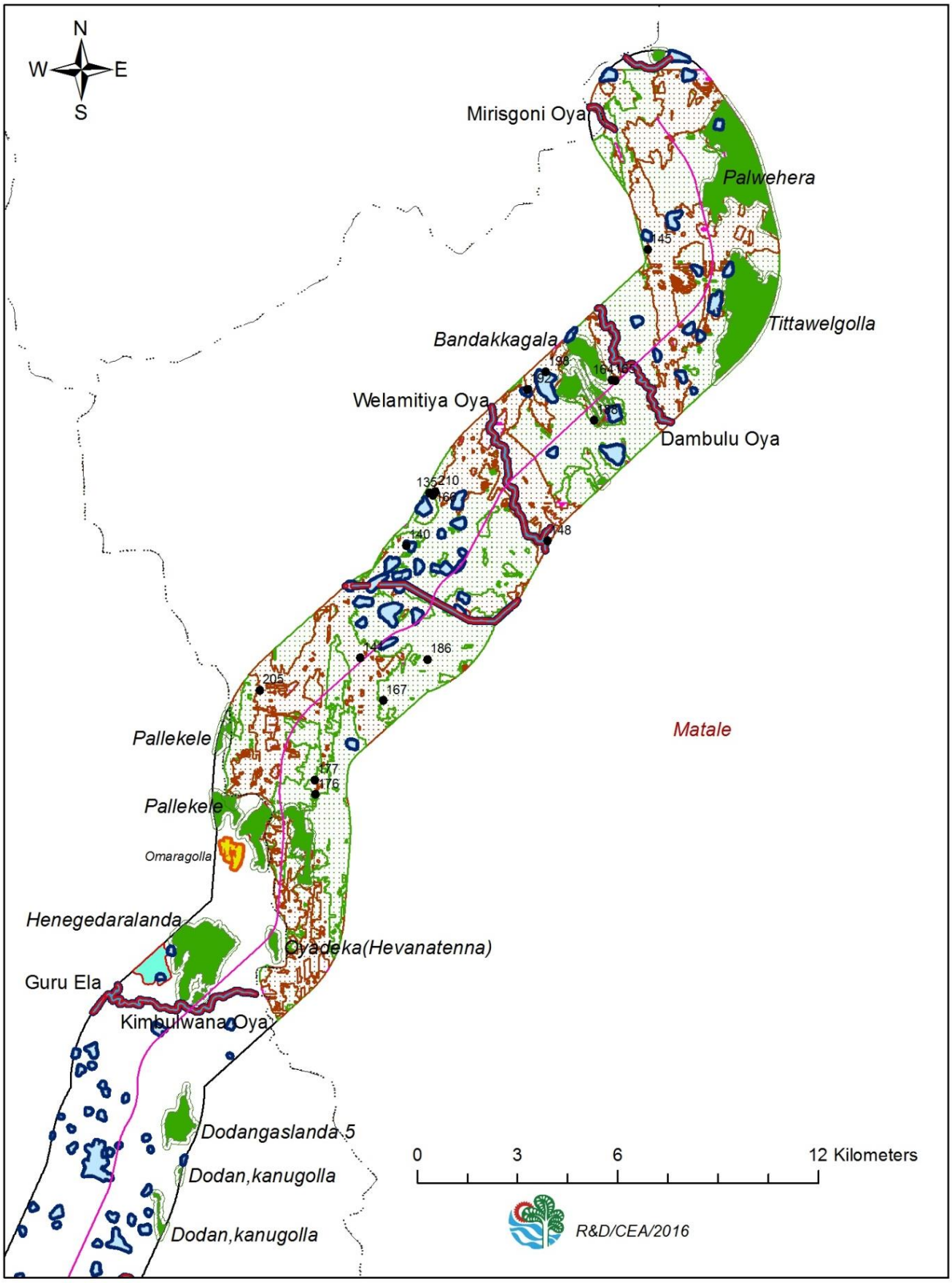


Figure 3.15: Map of forests closer or intersected by CEP Section 4

F. Riparian Vegetation

The proposed CEP route crosses or goes parallel to several small to medium waterways, thus affecting the riverine/ riparian vegetation directly or indirectly. The nature of this vegetation affected is, however, highly variable and depends on the surrounding land use. During the field investigations, Attanagalu Oya, Maha Oya, Daduru Oya and Mirisgoniya oya were identified as places where riparian vegetation would be affected. These streams are perennial and contain sufficiently large amounts of water throughout the year, although a temporary reduction in the flow takes place during the dry season.

The riparian strips along the Deduru oya, the elbow-bend in Mirisgonia Oya and the Dambulu Oya comprised tall trees and ground cover. In other areas the riparian vegetation strip was as thin as 3m and it consisted of shorter trees and a thick under-storey. Some of the commonly observed flora species associated with wateways were *Terminalia arjuna* (Kumbuk), *Pongamiapinnata* (Magul Karanda), *Erythrinafusca* (Yak Erabadu), *Ficusracemosa* (Attikka), *Streblusasper* (Netul), *Ixoracoccinea* (Ratambala), *Naucleaorientalis* (Bakmi), *Hydnocarpusvenenata* (Makulu), *Polyalthialongifolia* (Owila), *Bambusavulgaris* (Kaha Una), *Combretumalbidum* (Kaduru Ketiya Wel), *Eranthemum capense*, *Justiciabetonica* (Sudu Puruk), *Crinumdefixum* (Heen Tolabo), *Colocasia* esculenta (Gahala), *Cryptocorynebeckettii* (Athiudayan), *Dilleniaindica* (Hondapara), *Diospyrosmalabarica* (Timbiri), *Cleidionspiciflorum* (Okuru), *Dimorphocalyxglabellus* (Weli Wenna), *Berrya cordifolia* (Hal Milla) and *Madhuca longifolia* (Mi).

Four endemic plant species, *Derris parviflora* (Kala Wel), *Mangifera zeylanica* (Etamba), *Cryptocoryne beckettii* (Athiudayan) and *Hydnocarpusvenenata* (Makulu), two vulnerable (VU) plant species (including one endemic) *Cryptocorynebeckettii* (Athiudayan) and *Cleidionspiciflorum* (Okuru) and three near threatened (NT) plant species, *Madhuca longifolia* (Mi) *Combretumalbidum* (Kaduru Ketiya Wel), and *Erythrinafusca* (Yak Erabadu) were found in these habitats. Plant species recorded in riparian zones are given in Annex 3.3.1.b with necessary information.

3.3.3.2. Anthropogenic terrestrial habitats

A. Home Gardens

Home gardens are habitats that have been subjected to long-term human manipulations. However, many home gardens encountered along the proposed route within intermediate zone resembles the structure of traditional Kandyan home garden systems with stratification in vegetation. These densely vegetated home gardens provide important habitats for flora and fauna, and are valuable as habitat links providing connectivity between natural habitats. A large number of home gardens of varying size and complexity will be affected by the proposed expressway.

B. Coconut

Coconut plantations represent the second most affected land use type within the project area. These are primarily located between Mirigama, Kurunegala, Dambulla and some parts of Ambepussa link. Many of these plantations are quite extensive and well-established. Intercropping is practiced in some estates and in some plantations.

C. Rubber and Other Plantations

Rubber and other plantations such as teak and mahogany were recorded along the project corridor; however they did not comprise a significant proportion of identified land uses.

3.3.3.3. Natural aquatic/wetland habitats

A. Streams, rivers and canals

Many natural streams, rivers and man-made canals are found along the ROW and in the reservation zones. The majority of these were noted to have clear water (by observation only) and fauna of significant conservation value.

Significance:

- Freshwater habitats from Kurunegala to Dambulla are important because they support several species of native and endemic fish and other aquatic fauna.
- Some of the natural streams and rivers support riparian strips that are important for bank stability and biodiversity.
- Many of these streams carry water to tanks which are used for fishery purposes.
- Most of these streams supply water to seasonal tanks which are used for irrigation. Biota in the paddy fields therefore indirectly benefit from these streams.

Sites of particular concern are:

- *Deduru Oya and its tributaries (Ch.≈ 90+300)* The proposed expressway will cross, or run alongside the banks of, Deduru Oya at many points. One of the main locations will be at the Kiridigolla forest (Ch≈ 90+400).
- *MIrisgonia Oya and its tributaries (Ch≈136+250)*

  The elbow bend is of particular significance due to the location and shape of the stream.
- *Welamitiya Oya (Ch≈ 123+480) and Dambulu Oya* (Ch≈ 128+120) *and their tributaries* will be crossed by the proposed expressway at several locations.

(a) Deduru Oya

(b) Mirisgonia Oya

(c) Dambulu Oya

Figure 3.16: The crossing points of Rivers at (a) Deduru Oya (Ch≈ 90+300), (b) Mirigonia Oya (Ch≈ 135+700) and (c) Dambulu Oya (Ch≈ 128+300))

3.3.3.4. Anthropogenic aquatic/wetland habitats

A. Tanks

A large number of water tanks occur along the Section 4 CEP alignment. Many of these tanks are seasonal and thus they were completely or significantly dry during the dry season when the habitat surveys were done.

Significance:

- These water tanks are significant for the inland fishery industry, which is an income-generating source, and harvested fish is a nutritional supplement for the rural communities. Two species that are commonly harvested are *Loola* and Tilapia. Harvesting of fish was observed (e.g. *Ahaspokunuwewa* water hole*)* even during the height of the dry season.
- The lakes are temporary or permanent (depending on the amount of water) and serve as refuges for fish, amphibians, terrapins and other aquatic invertebrates, which in turn are food for aquatic birds and mammals. Many of these tanks also have aquatic vegetation.
- Many of these irrigation tanks are old and environmentally stabilised. Vegetation and fauna in the surrounding areas are closely linked to it as they are biologically rich water bodies. Hence they functions as independent ecological units.

Sites of particular concern are:

- Bathalagoda (perennial) – outside the expressway alignment
- Bambawa (perennial) **(**Ch≈ 116+160)
- Ipatawewa (seasonal(Ch≈ 120+250)
- Thuthiruwewa (seasonal) (Ch≈ 117+160)
- Uda wewa (118+400)
- Ahaspokunuwewa (seasonal)

Ahaspokunuwewa

Bambawa Tank

Thuthiriwewa

Figure 3.17: Tanks directly or indirectly affected

A. Paddy Lands

Paddy is one of the major cultivations that will be impacted by the CEP because much of the route traverses over paddy lands. The project design has sought to utilize paddy lands as much as possible in order to minimise the impacts on settlements. The range of plant species in these habitats are given in Annex 3.3.1. These habitats are also vital for the maintenance of a rich component of both aquatic and terrestrial fauna. Some of the aquatic bird species commonly observed in association with the paddy fields were cormorants, herons, egrets, water hens, stilts, king fishers and storks.

3.3.4. An assessment of the current ecological status

3.3.4.1. Floral Diversity

A total of 729 floral species belonging to 126 families were recorded from field observations (conducted in October 2013 – May 2014, October 2015 and February 2016) along the ROW. Table 3.15 shows a summary of the floral species recorded during the field survey. Most of them were native species (58.43%), while thirty (30) endemic species were also recorded during the field survey (Table 3.16). According to the National Red List 2012, forty six (46) threatened thirty two (32) near-threatened and three (3) data deficient flora species were identified among recorded species during the field survey (Table 3.17). Most of the threatened and endemic species were found mainly in home gardens and associate with paddy lands which are manmade habitats. Some endangered species are not native to the area and purposely grown as ornamental plant or medicinal plant (eg. Phyllanthus myrtifolius, Basella alba, Phyllanthus emblica) . Two Critically Endangered Species were recorded during the field survey, and one species is considered as possibly extinct species. But both of these Critically Endangered species have considerably large populations in the study area and its surrounding. It clearly reveal that when evaluate these two species for preparing the National Conservation Status have made a mistake. It should be noted that Introduced Species were Not Evaluated (NE) in the National Conservation Status (NCS) 2012.

Recorded sixteen (16) plant species of the study area are named as protected species under the Fauna and Flora Protection (amendment) Act, No. 22 of 2009. According to this act it is banned to remove or destroy these species in the place where it grows. It is necessary to get the prior approval or recommendation from the Department of Wildlife Conservation for remove these species. Recorded protected plant species are given in Table 3.18.

Most of the project area has been altered by human activities. As a result, numerous invasive species are evident in the area such as *Stachytarpheta cayennensis, Pennisetum polystachion, Mikania cordata, Mimosa invisa, Ludwigia peruviana, Panicum maxicum, Sphagneticola trilobata, Chromolaena odorata, Clidemia hirta, Annona glabra, Dillenia suffruticosa*, and *Lantana camara*.

Table 3.15: Summary of floral species recorded during the field survey

No. of Families	No. of Species	Origin						NCS 2012						
		Endemic	%	Native	%	Introduced	%	CR	EN	VU	NT	LC	DD	NE
126	729	30	4.11	426	58.43	273	37.44	2	8	36	32	367	3	273

Note : CR- Critically Endangered , EN Endangered, Vu – Vulnerable, NT- Near Threaten, LC- Least Concern, DD - Data deficient, NE -Not Evaluated

Table 3.16: List of endemic floral species recorded in the project area

Family Name	Scientific Name	Common Name (S)	Habit	NCS 2012
Achariaceae	*Hydnocarpus venenata*	Makulu	T	LC
Anacardiaceae	*Mangifera zeylanica*	Atamba	T	LC
Anacardiaceae	*Semicarpus nigro-viridis*	Geta badulla	T	LC
Annonaceae	*Uvaria sphenocarpa*		C	LC
Annonaceae	*Goniothalamus gardneri*	Kalu-kera	T	VU
Apocynaceae	*Walidda antidysenterica*	Wal-Idda	S	LC
Apocynaceae	*Petchia ceylanica*	Wasa-Kaduru	S	NT
Araceae	*Lagenandra praetermissa*	Ketala	H	LC
Araceae	*Cryptocoryne beckettii*	Athiudayan	H	VU
Asteraceae	*Vernonia zeylanica*	Papula	S	LC
Calophyllaceae	*Calophyllum calaba*	Gurukina	T	LC
Calophyllaceae	*Mesua thwaitesii*	Diya-Na	T	LC
Centroplacaceae	*Bhesa ceylanica*	Palang	T	LC
Clusiaceae	*Garcinia terpnophylla*	Kokatiya	T	EN
Clusiaceae	*Garcinia zeylanica*	Ela Goraka	T	EN
Clusiaceae	*Garcinia quaesita*	Rat Gorka	T	LC
Connvolvulaceae	*Argyreia populifolia*	Girithilla	C	LC
Dilleniaceae	*Tetracera sarmentosa*	Korasawel	C	LC
Dipterocarpaceae	*Dipterocarpus zeylanicus*	Hora	T	NT
Fabaceae	*Derris parviflora*	Kala-wel	C	LC
Lauraceae	*Litsea longifolia*	Rat-Keliya	T	LC
Lauraceae	*Cinnamomum verum*	Kurundu	T	VU
Melastomataceae	*Memecylon capitellatum*	Weli-Kaha	S	LC
Melastomataceae	*Osbeckia octandra*	Heen-bovitiya	S	LC
Moraceae	*Artocarpus nobilis*	Bedi-Del	T	LC
Myristicaceae	*Horsfieldia iryaghedhi*	Ruk	T	VU
Myrtaceae	*Cleistocalyx operculatus*	Bata-damba	T	LC
Phyllanthaceae	*Phyllanthus myrtifolius*	Gangawerella	S	VU
Phyllanthaceae	*Aporosa lanceolata*	Hin-Kebella	T	LC
Poaceae	*Ochlandra stridula*	Bata	S	LC

Note : Habit - T - Tree, S - Shrub, C- Creeper (including liana) H - Herbs, NCS = National Conservation Status CR- Critically Endangered , EN Endangered, Vu – Vulnerable, NT- Near Threaten, LC- Least Concern, DD - Data Deficient, NE -Not Evaluated

Table 3.17: List of threatened flora species recorded in the project area

Family Name	Scientific Name	Common Name	Habit	Taxonomic Status	NCS 2012
Combretaceae	*Combretum acuminatum*		S	N	CR(PE)
Simaroubacea	*Ailanthus triphysa*	Wal-Biling	T	N	CR
Basellaceae	*Basella alba*	Niviti	C	N	EN
Celastraceae	*Salacia reticulata**	Kotala-himbutu	C	N	EN

Family Name	Scientific Name	Common Name	Habit	Taxonomic Status	NCS 2012
Menispermaceae	*Hyserpa nitida*	Niri-wel	C	N	EN
Orchidaceae	*Tropidia thwaitesii**		Or	N	EN
Annonaceae	*Polyalthia suberosa*	Kalati	S	N	EN
Ebenaceae	*Diospyros ebenum*	kaluwara	T	N	EN
Clusiaceae	***Garcinia terpnophylla****	Kokatiya	T	E	EN
Clusiaceae	***Garcinia zeylanica****	Ela Goraka	T	E	EN
Nymphaeaceae	*Nymphaea nouchali*	Manel	aq-H	N	VU
Annonaceae	*Artabotrys hexapetalus**	Yakada-wel	C	N	VU
Apocynaceae	*Anodendron paniculatum*	Gerandi-Dul	C	N	VU
Arecaceae	*Calamus thwaitesii*	Ma-wewel	C	N	VU
Fabaceae	*Caesalpinia globulorum*	Kalu wauletiya	C	N	VU
Menispermaceae	*Pachygone ovata*		C	N	VU
Menispermaceae	*Tinospora cordifolia*	Rasa-Kinda	C	N	VU
Moraceae	*Plecospermum spinosum*	Katu-Timbol	C	N	VU
Cactaceae	*Rhipsalis baccifera*	Nawahandi	ep	N	VU
Poaceae	*Coix lacryma-jobi*	Kirindi	G	N	VU
Aponogetonaceae	*Aponogeton crispus*	Kekatiya	H	N	VU
Aponogetonaceae	*Aponogeton natans*		H	N	VU
Asteraceae	*Erigeron sublyratus*		H	N	VU
Dioscoreaceae	*Trichopodium zeylanicum**	Bim-pol	H	N	VU
Eriocaulaceae	*Eriocaulon thwaitesii*		H	N	VU
Rubiaceae	*Hedyotis neesiana*	Pita sudu pala	H	N	VU
Orchidaceae	*Vanda tessellata**	Rassana	Or	N	VU
Apocynaceae	*Carissa inermis*		S	N	VU
Anacardiaceae	*Spondias pinnata*	Wal ambarella	T	N	VU
Euphorbiaceae	*Cleidion javanicum **	Okuru	T	N	VU
Fabaceae	*Pericopsis mooniana**	Nadun	T	N	VU
Loganiaceae	*Strychnos nux-vomica*	Goda-Kaduru	T	N	VU
Loganiaceae	*Strychnos potatorum*	Ingini	T	N	VU
Meliaceae	*Aphanamixis polystachya*	Ela-hirilla	T	N	VU
Olacaceae	*Strombosia ceylanica*	Kanu	T	N	VU
Phyllanthaceae	*Phyllanthus emblica*	Nelli	T	N	VU
Phyllanthaceae	*Margaritaria indica*	Maha karawu	T	N	VU
Rutaceae	*Chloroxyclon swietania*	Burutha	T	N	VU
Sapotaceae	*Manilkara hexandra*	Palu	T	N	VU
Simaroubacea	*Quassia indica*	Samadara	T	N	VU
Thymelaeaceae	*Gyrinops walla*	Walla patta	T	N	VU
Araceae	***Cryptocoryne beckettii***	Athiudayan	H	E	VU
Phyllanthaceae	***Phyllanthus myrtifolius***	Gangawerella	S	E	VU
Lauraceae	***Cinnamomum verum***	Kurundu	T	E	VU
Myristicaceae	***Horsfieldia iryaghedhi***	Ruk	T	E	VU

Family Name	Scientific Name	Common Name	Habit	Taxonomic Status	NCS 2012
Annonaceae	***Goniothalamus gardneri****	Kalu-kera	T	E	VU
Arecaceae	*Calamus rotang*	Polonnaru-wewel	C	N	NT
Cucurbitaceae	*Mukia maderaspatana*	Gon kekiri	C	N	NT
Dioscoreaceae	*Dioscorea oppositifolia*	Hiritala	C	N	NT
Poaceae	*Hygroryza aristata*	Go-jabba	G	N	NT
Araceae	*Typhonium roxburghii*	Polong-ala	H	N	NT
Asperagaceae	*Sansevieria zeylanica*	Maha niyanda	H	N	NT
Pontederiaceae	*Monochoria hastata*	Jabara	H	N	NT
Asperagaceae	*Dracaena thwaitesii*	Wedikoka Gas	S	N	NT
Combretaceae	*Combretum albidum*	Kaduru-ketiya wel	S	N	NT
Cornaceae	*Alangium salviifolium*	Ruk anguna	S	N	NT
Erythroxylaceae	*Erythroxylum moonii*	Bata-Kirilla	S	N	NT
Malvaceae	*Wissadula periplocifolia*	Kiri-Kaju	S	N	NT
Malvaceae	*Helicteras isora*	Liniya	S	N	NT
Melastomataceae	*Osbeckia aspera*	Bowitiya	S	N	NT
Olacaceae	*Olax imbricata*	Telatiya	S	N	NT
Pandanaceae	*Pandanus thwaitesii*	Dumu-Keyiya	S	N	NT
Rhamnaceae	*Ziziphus rugosa*	Maha-Eraminia	S	N	NT
Annonaceae	*Mitrephora heyneana*	Kanu	T	N	NT
Apocynaceae	*Hunteria zeylanica*	Mediya	T	N	NT
Fabaceae	*Albizia lebbeck*	Suriyamara	T	N	NT
Fabaceae	*Erythrina fusca*	Yak-Earabadu	T	N	NT
Icacinaceae	*Nothapodytes nimmoniana*	Gonda-Pana	T	N	NT
Lamiaceae	*Gmelina arborea*	At-demata	T	N	NT
Lamiaceae	*Vitex altissima*	Milla	T	N	NT
Lauraceae	*Cryptocarya wightiana*	Gulu-mora	T	N	NT
Lythraceae	*Lagerstroemia speciosa*	Muruta	T	N	NT
Moraceae	*Antiaris toxicaria*	Riti	T	N	NT
Rhizophoraceae	*Carallia brachiata*	Dawata	T	N	NT
Sapotaceae	*Madhuca longifolia*	Mi	T	N	NT
Sapotaceae	*Mimusops elengi*	Munamal	T	N	NT
Apocynaceae	***Petchia ceylanica****	Wasa-Kaduru	S	E	NT
Dipterocarpaceae	***Dipterocarpus zeylanicus***	Hora	T	E	NT
Poaceae	*Eragrostis zeylanica*	Mal etora thana	G	N	DD
Lamiaceae	*Orthosiphon aristatus*		H	N	DD
Rubiaceae	*Spermacoce pusilla*		H	N	DD

Note : Habit - T - Tree, S - Shrub, C- Creeper (including liana) H - Herbs, G- Grass, Or-Orchid, ep- epiphyte, Taxonomic Status - N-Native, E - Endemic, NCS = National Conservation Status CR(PE) - Critically Endangered(Possibly Extinct) , CR- Critically Endangered , EN Endangered, Vu – Vulnerable, NT- Near Threaten, LC- Least Concern, DD - Data Deficient

Table 3.18: List of protected flora species (under Flora and Fauna Protection Ordinance - 2009) recorded in the project area

Family Name	Scientific Name	Common Name (S)	Habit	Taxonomic Status	NCS 2012
Annonaceae	*Artabotrys hexapetalus**	Yakada-wel	C	N	VU
Annonaceae	***Goniothalamus gardneri****	Kalu-kera	T	E	VU
Apocynaceae	***Petchia ceylanica****	Wasa-Kaduru	S	E	NT
Araceae	***Lagenandra praetermissa****	Ketala	H	E	LC
Calophyllaceae	***Calophyllum calaba****	Gurukina	T	E	LC
Celastraceae	*Salacia reticulata**	Kotala-himbutu	C	N	EN
Clusiaceae	***Garcinia terpnophylla****	Kokatiya	T	E	EN
Clusiaceae	***Garcinia zeylanica****	Ela Goraka	T	E	EN
Dioscoreaceae	*Trichopodium zeylanicum**	Bim-pol	H	N	VU
Euphorbiaceae	*Cleidion javanicum **	Okuru	T	N	VU
Fabaceae	*Pericopsis mooniana**	Nadun	T	N	VU
Myrtaceae	***Cleistocalyx operculatus****	Bata-damba	T	E	LC
Orchidaceae	*Tropidia thwaitesii**		Or	N	EN
Orchidaceae	*Cymbidium bicolor**	Visa Duli	Or	N	LC
Orchidaceae	*Vanda tessellata**	Rassana	Or	N	VU
Santalaceae	*Santalum album**	Sudu handun	T	Ex	

Note : Habit - T - Tree, S - Shrub, C- Creeper (including liana) H - Herbs, Or-Orchid, Taxonomic Status - N-Native, E - Endemic, NCS = National Conservation Status EN Endangered, Vu – Vulnerable, NT- Near Threaten, LC- Least Concern, Ex - Exotics

3.3.4.2. Faunal Diversity

A total of 309 fauna species were recorded during the field survey, belonging to 117 families. Thirty one species are endemic to Sri Lanka and 38 are listed as threatened species according to the National Red List 2012. A summary of the fauna species recorded during the field investigations is shown in Table 3.19 and a description of each fauna group recorded is presented below.

- **Birds**

There 496 recorded bird species in Sri Lanka, 240 are resident birds and 27 of them are endemic and 6 are proposed endemic.

The greatest diversity was observed among the avifauna with as many as 113 species belonging to 54 families being recorded during the survey. Among them The Critically Endangered Blue-tailed Bee-eater (*Merops philippinus*), five endemic species and five proposed endemic species were observed during field surveys. Endemic species were Sri Lanka Hanging-parrot (*Loricus beryllinus*), Sri Lanka Browncapped Babbler (*Pellorneum fuscocapillum*), Sri Lanka Grey hornbill (*Ocyceros gingalensis*), Sri Lanka Junglefowl (*Gallus lafayetii*), and Proposed endemic species were Pompadour Green-pigeon (*Treron pompadora*), Greater flameback (Chrysocolaptes lucidus), Black crested bulbul (*Pycnonotus melanicterus*), Common wood shrike (*Tephrodornis pondicerianus*) and Red-rumped Swallow (*Hirundo hyperythra*).

Black-Winged Kite (*Elanus caeruleus*), Yellow Bittern (*Ixobrychus sinensis*), Oriental Honey-Buzzard (*Pernis ptilorhyncus*) and Sri Lanka Emerald-Collared Parakeet (*Psittacula calthropae*) are classified as a NT species. As expected, the forests (both natural and forest plantations) and aquatic habitats supported the richest complement of species. Birds were also plentiful in plantations. The paddy cultivations and

aquatic habitats which are normally apart of the broader landscape supported many species of aquatic birds, predators and other smaller species such as the munias, weavers and sparrows. Some of the habitats also supported a few migrant species e.g. *Pitta brachyuran,* (Indian Pitta) and the *Terpsiphone paradise (*Asian Paradise Flycatcher).
Most of the birds were observed in marshy lands and paddy lands. Two trees which used as breading areas of birds were observed near Ganegoda Railway Station. The detailed species list is provided in Annex 3.3.2

- **Butterflies**

There are 245 butterfly species recorded species according to the National Red List 2012 while 26 are endemic to country.

A total of 55 species were recorded belongs to 5 families. The vulnerable Dark Palmdart (*Telicotabambuse Moore*) and Blue Glassy Tiger (*Ideopsis similis*) were the only threatened species among the recoded species. The most abundant were the butterflies of the Family Nymphalidae with 20 species. The preferable habitats of the butterflies were forest edges. Among the most common were the Crimson Rose (*Pachliopta hector*), Common Tiger (*Danaus genutia*) and Psyche (*Leptosia nina*). Most of species of butterflies are categorised as 'Least Concerned' and are not threatened. The detailed species list of butterflies is provided in Annex 3.3.2

- **Dragonflies and Damselflies**

A total of 118 species of dragonflies and damselflies have been recorded in Sri Lanka, with 47 species being endemic to the country. During the field survey, 37 species of dragonflies and damselflies were recorded along the project corridor, belonging to 8 families. These represent the highest threatened species percentage (35.13%) when compared with the other faunal groups recorded during the study. The endangered Green's Gem (*Libellago greeni*), vulnerable Adam's Gem (*Libellago adami*), Painted Waxtail (*Ceriagrion cerinorubellum*), Oriental Greenwing (*Neurobasis chinensis*), Black-tipped Flashwing (*Vestalis apicalis*), and Dark-glittering Threadtail (*Elattoneura centralis*) and seven near threatened species were found among the recorded species.

The scarcity of the latter (and the absence of damselflies) is very likely because the water bodies which are their preferable habitats had depleted owing to the drought.

- **Reptiles**

Total hundred and nine reptile species have been recorded in Sri Lanka, with 125 being endemic to the country.

A total of 38 species of reptiles including 3 lizards, 3 geckos, 22 snakes, 4 skinks, 2 monitors and 4 chelonians (terrapins and tortoises) were observed during field surveys. These included 10 endemic species as Sri Lankan Kangaroo Lizard (*Otocryptis weigmanni*), Barnes's cat snake (*Boiga barnesii*), Boie's roughside (*Aspidura brachyorrhos*), Dwarf day gecko (*Cnemaspis podihuna*), Flapshell turtle (*Lissemys ceylonensis*), Green pit viper (Trimeresurus trigonocephalus), Sri Lanka Keelback (*Xenochrophis asperrimus*), Sri Lanka krait (*Bungarus ceylonicus*), The checkered keelback (*Xenochrophi asperrimus*) and Common lankaskink (*Lankascincus fallax*) There were one exotic species the Red-eared Slider (*Trachemys scripta*), five vulnerable and one near threatened reptile species among the species recorded.

In contrast to other fauna groups reptiles were as numerous in man-made habitats like coconut plantations and home gardens as in the forests. Overall, the most common were *Calotes versicolor* (lizard), *Mabuya carinata* (skink) and the *Varunus bengalensis* (land monitor) which were observed in abundance in rocky outcrops, home gardens, coconut plantations and forests.

The snakes included the cobra (one moult was also found in a home garden), vipers, vine snake, rat snake, a water snake and the beautiful ornate flying snake (*Chrysopelea ornate)* which is classified as a vulnerable species. Like the amphibians, reptiles play an important role in ecosystems by functioning as natural control agents of pest species. The detailed species list is provided in Annex 3.3.2.

- **Amphibians**

The Sri Lankan Wood Frog (*Hylarana gracilis*), Corrugated water frog (Lankanectis corrigatus) and Common hourglass tree frog (Polypedates cruciger) were the only endemic species recorded during the field survey while only 10 species belonging to 5 families were recorded during the field study.

A significant portion of the Sections alignment traverses paddy fields which make ideal habitats for amphibians at times when water in the paddy fields are retained. Also, the brimming tanks (those that had water), canals and the stream and river network provided refuge sites for these species. Species such as *Euphlyctis cyanophlyctis, E. hexadactylus* and *Fejervarya limnocharis* were found in plenty in the waterholes within coconut plantations and in depleted tanks, whilst the Foam Nesting Frog (*Polypedates maculates*) was observed in forests, home gardens, and agricultural lands and in riparian habitats. *Duttaphrynus melanostictus* was found in several habitats. Nevertheless, as in the case of the other taxa, many other species of amphibians have been recorded in the broader project area during previous surveys. Thus there is a great potential for such species to occur in the area directly affected by the proposed expressway. Amphibians consume a large biomass of insects and they play a vital role as natural control agents of pests in both human settlements and agricultural landscapes. Hence they should be conserved. The detailed species list is provided in Annex 3.3.2.

- **Mammals**

The vulnerable species Otter (*Lutra lutra*), endangered and endemic Sri Lanka Purple-faced Langur (*Semnopithecus vetulus*) and endemic species Sri Lanka Toque Monkey (*Macaca sinica*) were found among the 27 mammal species which belongs to 18 families recorded during the study. Anyway there may be some more mammals' species around the project area.

A total of 19 indigenous non-flying and flying mammals represented by 15 families were recorded along the route. Among them were 5 endemic and 6 threatened mammals. Consideration of a large impacted area is necessary for mammals (particularly the primates, cervids, civets and cats) as they are mobile and they cover large distances during the course of their daily or seasonal activities.

The primates in particular are known to move between forests during certain times of the year making the quality of the surrounding areas critical. The presence of some mammals was inferred from signs. Otter signs (scat) were observed near the Deduru Oya and a tributary of the Mirisgonia Oya.

Paddy fields and ~~t~~anks are also suitable habitats for these species. The macaque is considered a pest particularly in coconut estates because of the economic damage they cause. Although classified as globally threatened, one of the most common species recorded across most of the terrestrial habitats with a reasonable canopy is the Giant Squirrel (*Ratufa macroura*). A few mammals such as the mongoose species, palm civet, giant squirrel and the palm squirrels were more frequently observed in the home gardens. These are species that benefit from human settlements due to the availability of fruit trees and other food sources. Paddy fields are also important for the rats and mice, porcupine, mongoose and civets. The detailed species list is provided in Annex 3.3.2.b.

Although not recorded in the limited field visits made during the present field work campaign, many other species of all taxonomic groups have been observed within one kilometre of the Section 4 CEP alignment ROW during the past two years, and they are very likely to be present in the project area. These details have not been included in this report due to their extensive nature but such information could be provided on request.

- **Freshwater Fishes**

The proposed roadway intercepts several perennial streams and rivers in terms of the amount of water even during the height of the dry season when the survey was conducted. It should be emphasized that a survey during the wet season would yield a much greater diversity and abundance of the fish. The overhanging reeds and rushes and the tall trees that make up the riparian strip provides ideal refuges for fish.

Freshwater fish were sampled in the water bodies along the proposed project area. Twenty nine freshwater species were recorded which belongs to 15 families which included five endemic species and 6 exotic species. Sri Lanka Walking Catfish (*Clarias brachysoma*), Sri Lanka Cumming's Barb (*Puntius cumingii*), Sri Lanka Kamalica's Barb (*Puntius kamalika*), and Smooth Breasted Snakehead (*Channa orientails*) species were both endemic and threatened. Sri Lanka filamented barb (*Dawkinsia singhala*), the former is also a threatened species and the near threatened species Freshwater Gar Fish (*Xenentodon cancila*) were also recorded.

Richness of fish was the highest in Dambulu Oya (9 species) whilst the Deduru Oya stream also had fairly large populations of around 5 species. The species included barbs, gobies, catfish, tilapia and a gourami. The six introduced species were *Tilapia spp, Trichogaster* sp, *Gambusia spp*, *Poecilia reticulate*, *Trichogaster pectoralis* and *Pterygoplichthys multiradiatus.* The most commonly harvested species were Murrel (*Channa striata*), Stinging Cat Fish (*Heteropneustes fossilis*), Green Chromide (*Etroplus suratensis*) and the Tipalia species. The detailed species list is provided in Annex 3.3.2.

Table 3.19: Summary of faunal species recorded in the project area

Animal Group	Families	Species	Endemics	Exotic	Native	NCS 2012					
						CR	EN	VU	NT	LC	NE
Butterflies	5	55	0 (0%)	0 (0%)	55 (100%)	0 (0%)	0 (0%)	2 (4%)	0 (0%)	53 (96%)	0 (0%)
Dragonflies	8	37	3 (8%)	0 (0%)	34 (92%)	0 (0%)	1 (3%)	5 (14%)	7 (19%)	24 (65%)	0 (0%)
Fishes	15	29	5 (17%)	6 (21%)	18 (62%)	0 (0%)	2 (7%)	1 (3%)	2 (7%)	18 (62%)	6 (21%)
Amphibians	5	10	3 (30%)	0 (0%)	7 (70%)	0 (0%)	0 (0%)	1 (10%)	0 (0%)	9 (90%)	0 (0%)
Reptiles	12	38	10 (26%)	1 (3%)	27 (71%)	0 (0%)	0 (0%)	5 (13%)	1 (3%)	31 (82%)	1 (3%)
Birds	54	113	5 (4%) (5PE)	0 (0%)	96 (85%)	1 (1%)	0 (0%)	0 (0%)	4 (4%)	101 (89%)	7 (6%)
Mammals	18	27	5 (19%)	2 (7%)	21 (78%)	0 (0%)	3 (7%)	1 (4%)	2 (7%)	19 (70%)	2 (7%)
Total	**117**	**309**	**31**	**9**	**257**	**1**	**6**	**15**	**16**	**255**	**16**
						38					
						309					
%			**10.0**	**2.9**	**83.0**	**0.3**	**1.9**	**4.9**	**5.2**	**82.5**	**5.2**

A noteworthy point is that the naturalised forest plantation supported a richer assemblage of fauna (as seen in Figure 3.17). The most frequently observed creatures were the birds with as many as 18 species being recorded during one field session in a single forest (e.g. Kiridigolla Ch ≈ 90 +200). A few species of lizards, butterflies and signs of mammals (e.g. bats, porcupines, wildboar, and hare) were encountered within these forests.

The coconut and paddy cultivations (even after harvest) were also conducive to many species of animals such as birds and butterflies as they consisted of frequent open vegetation with thick undergrowth consisting of weeds and other herbaceous plants.

These results were obtained in the height of the dry season and diversity in these habitats could be expected to be markedly higher in the rainy season. Furthermore, many species, particularly the more mobile ones such as the butterflies, birds and mammals, do rapid assessments such as the present survey. Home gardens are also important for biota with a relatively high percentage of species being recorded. As seen in Figure 3.17, aquatic habitats are also extremely diverse in terms of species composition and support a community different from the other ecosystems.

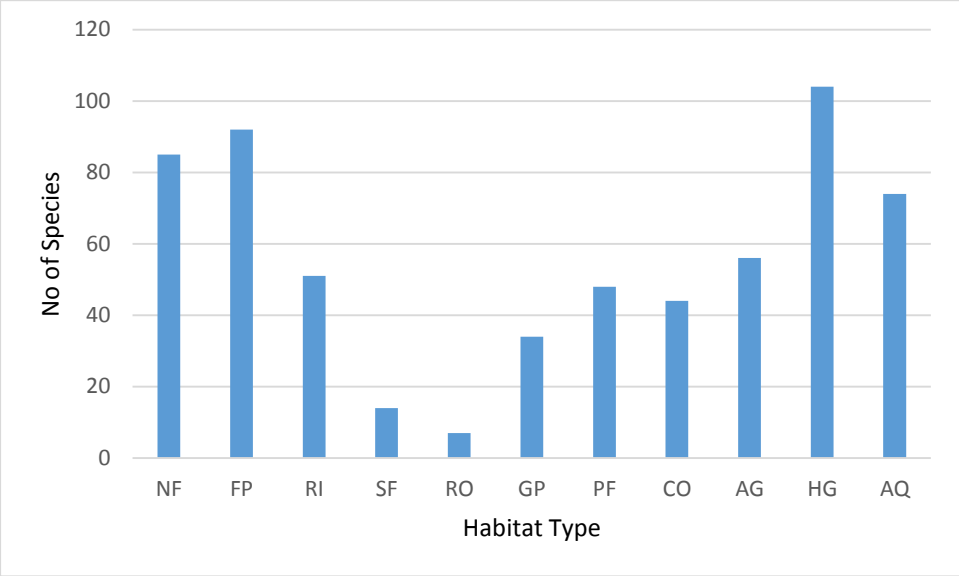


Figure 3.18: The species richness

(Among the terrestrial and aquatic fauna within the proposed project site observed during field work)

(NF – Natural Forest, FP – Forest Plantation, Riparian Strips, SF – Sparse Forest, RO – Rock Outcrops, GP – Grassy Plains, PF – Paddy Fields, CO – Coconut Plantations, AG – Agricultural Plantations (other than paddy and coconut) , HG – Home Gardens, AQ – Aquatic Habitats)

3.3.5. Migratory or movement routes of wild animals

There were no permanent terrestrial animal movement pathways observed in the project area of fauna of conservation significance. Occasional elephant movements across the existing Ambepussa – Dambulla road, closer to Dambulla and Galewela have been recorded, but the proposed highway route does not interfere with any well-recognized elephant movement path. However, as the proposed highway route can obstruct movement paths of local faunal populations, there may be some localized impacts.

3.4. Socio-cultural environment

3.4.1 Existing settlements in and around the project area

The sections 1, 2 and 4 of the proposed central expressway traverse through four administrative districts Gampaha in Western Province, Kegalle in Sabaragamuwa Province, Kurunegala in North Western province and Matale in Central Province in the country. It runs through 163 GN divisions in 18 DS divisions in those districts. 6 DS divisions in Gampaha district, Mahara, Gampaha, Minuwangoda, Attanagalla, Mirigama and Divulapitiya and the Warakapola DS in Kegalle might be affected. 9 DS divisions in Kurunegala district, Alawwa, Narammala, Weerambugedara, Polgahawela, Kurunegala, Mallawapitiya, Mawathagama, Ibbagamuwa and Ridigama and 2 DS divisions Galewela and Dambulla in Matale district come under the influence of the project.

All the 4 districts have human settlements which can be classified as urban, semi-urban and rural. Being a district highly exposed to industrialization, urbanization and economic development and been a centre of migration, the district of Gampaha has more urban and semi-urban settlements than others. Its' population in 2012 was recorded as 2,294,641, representing 11% of the total population of Sri Lanka, and has a population density of 1654 per km^2. The Kurunegala district has also been undergoing rapid urbanization during the recent past while increasing the population density up to 334 per km^2. However, the population density of Kegalle is only 494 per km^2 and it is higher than that of Kurunegala and Matale. Among these four districts, Matale records the lowest population density of 254 per km^2. All the 163 GN divisions are human settlements with different rates of population distribution. According to the latest statistics the total population residing in the 18 DS divisions is 1,919,592 and 56% of that population live in the Gampaha district. Accordingly majority of project affected persons from the proposed Central Expressway is anticipated to be from the said 6 DS divisions in Gampaha district. The 9 DS divisions in Kurunegala district account for 30.6% of the total population with the second majority of PAPs. The DS divisions in Kegalle and Matale districts represent only 5.8% and 7.6% of the population of all the DS divisions to be directly affected by the central expressway respectively. (Department of Census and Statistics 2012)

The settlements under the influence of the proposed project are not homogenous in terms of ethnic and religious characteristics, even though Sinhalese and Buddhist population represent the majority. Over 92% of the total population of the18 DS divisions is Sinhalese. Sri Lankan and Indian Tamils represent 1.5% whereas Sri Lankan moor accounts for 5.6% of the population. Over 87% of the people are Buddhists and Hindus represent 1.1%. The religion of Islam is observed by 6% and the Roman Catholic and Christian population represent 4.6% and 0.8% respectively. (Department of Census and Statistics 2012)

The survey of households in the project area has shown that over 65% of the people in the section 1 and 2 falls into the age category of 15-19 years whereas the same age group in the section 4 represents 58% of the population. Even the population below age 14 in section 4 remains relatively at a lower rate of 13% compared to 19% of people in the sections 1 and 2. Accordingly the section 4 has a higher percentage of aging people compared to other sections. Over 29% are over the age of 60 in the section 4 and in the sections 1 and 2 the same age category represent over 15% and 18% respectively (Table 3.20). This distribution of people in the affected areas is of great importance in planning the migratory measures of project impacts. The capacity of adapting to the socio economic and geographical change in the area and resettlement requirements varies according to the age of the people. The limited time period available for the aging people for adapting to a new environment deserves special attention of the project.

Table 3.20.: Distribution of sample household members by age

Project stage	Age group (Years)							
	0-14		15-59		Above 60		Total	
	Male	Female	Male	Female	Male	Female	Male	Female
Section 1	706 *(9.67%)*	699 *(9.58%)*	2374 *(32.53%)*	2396 *(32.82%)*	536 *(7.35%)*	588 *(8.05%)*	**3616** ***(49.54%)***	**3683** ***(50.46%)***
Section 2	444 *(8.92%)*	469 *(9.96%)*	1396 *(30.89%)*	1455 *(31.62%)*	365 *(9.19%)*	403 *(9.42%)*	**2205** ***(48.65%)***	**2327** ***(51.35%)***
Section 4	136 *(6.51%)*	134 *(6.41%)*	593 *(28.37%)*	611 *(29.23%)*	312 *(14.93%)*	304 *(14.55%)*	**1041** ***(49.81%)***	**1049** ***(50.19%)***
Total	**1286** ***(9.24%)***	**1302** ***(9.35%)***	**4363** ***(31.34%)***	**4462** ***(32.05%)***	**1213** ***(8.71%)***	**1295** ***(9.30%)***	**6862** ***(49.29%)***	**7059** ***(50.71%)***

Source: Sample Household survey of the project area

3.4.2 Socio Economic status of Populations (Population, income generating activities, agriculture, industry, business and service)

The nature of residential ownership is of great importance in understanding the social status of people. According to the recorded statistics, nearly 89% of households belong to residents in the house. Areas highly exposed to urbanization and accompanied social changes, such as Mahara, Gampaha, Minuwangoda and Kurunegala show less percentage of ownership of households compared to others. Over 5% of shelters is possessed by private owners who have rented out or leased them to present residents, whereas 1.3% of housing units have been rented out or leased by the government to present residents. Nearly 0.9% of residential properties have been encroached by the people. According to these information regarding the ownership of households, the project is going to influence more people living in their own residential facilities than others without proper ownership.

Education of the people in any society indicates another aspect of people and sufficient knowledge of the educational level of the affected people is important in dealing with negative impacts of the proposed project. Table 3.21 shows the levels of educational attainments of the three sections of the project. The percentage of people without school education remains at a very low rate of below 0.7% in the sections 1 and 2 whereas it is below 1.4% in the section 4. Those waiting for schooling remain below 7% in all the sections. It is evident from the statistics of educational achievements that the people of sections 1 and 2 possess higher levels of formal education than the people of section 4. However, where higher education is concerned, there is no considerable difference in the three sections.

Table 3.21: Distribution of household members by educational attainment

Project Stage		Section 1		Section 2		Section 4		Total	
		Count	%	Count	%	Count	%	Count	%
Level of education	**Illiterate**	40	0.55	52	1.15	42	2.0	**134**	**0.96**
	Can place signature	48	0.66	32	0.71	30	1.4	**110**	**0.79**
	Waiting for schooling	430	5.89	292	6.44	149	7.1	**871**	**6.26**
	Grade 1-5	761	10.43	570	12.58	350	16.7	**1681**	**12.08**
	Grade 6-O/L	2064	28.28	1169	25.79	754	36.0	**3987**	**28.64**
	G.C.E O/L Pass	2018	27.65	1348	29.74	425	20.3	**3791**	**27.23**
	G.C.E. A/L Pass	1582	21.67	878	19.37	265	12.7	**2725**	**19.57**
	Undergraduate, Graduate	287	3.93	161	3.55	64	3.1	**512**	**3.68**
	Post graduate	25	0.34	4	0.09	6	0.3	**35**	**0.25**
	Other	44	0.60	26	0.57	8	0.4	**78**	**0.56**
		7299	**100**	**4532**	**100**	**2090**	**100**	**13921**	**100.00**

Source: Sample House Hold survey of the project area

The quality of social life of people in the area under consideration is partly evident from their housing facilities and other basic needs. As the quality of housing units is concerned 60.4% of them have been built with bricks whereas 28.2% have been constructed with cement blocks and stones. Wattle and daub houses account for 6.8% and soil brick houses account for 2.15%. Walls made up of Cadjan, Palmyrah, planks and metal sheets are found in 1.35% of housing units. Where the materials of roof construction are concerned, 63.13% of housing units are covered with roof tiles whereas 26% are covered with asbestos. Concrete slabs are found in 2.5% of the houses. Nearly 6% of houses have roofs of metal sheets. Over 1.6% of shelters have Cadjan, Palmyrah and straw as their roofs. Building materials used for the walls, roofs and floors of the housing units indicate the quality of them. The floors of 70.45% of houses have been constructed with cement and only 14.43% are with granite. Just concrete floors are found in 9.59% of the houses whereas the rest are natural mud floors. As those families with permanent and well-constructed housing facilities have spent a considerable portion of their income for decades, their housing units remain a valuable asset of social security.

3.4.3. Principle economic activities

According to the statistics of 2012, 525,388 hectares of paddy had been cultivated in the "Maha" season and 13.6% of (71,731) them had been cultivated in Kurunegala district. Paddy cultivations in the Kurunegala district supply a considerable portion of the rice demand of the country. The Matale, Gampaha and Kegalle districts account for 3%, 1.2% and 1.6% of the extent of paddy cultivation. (Department of Census and Statistics 2012).

Principle economic activation in the affected areas represent the major industrial, agricultural and services conducted at different rates in the four districts under consideration. One third (33.4%) of the total industrial institutions with five or more employment in the country is found in the four districts Gampaha, Kurunegala, Matale and Kegalle. Among them, Gampaha district and Kurunegala district account for 16.6% and 11.5% of total industrial institutions respectively. Matale (2.2%) and Kegalle (3.1%) seemed less industrialized in terms of economic activities. 25.6% of the total industrial employment in the country is from the district of Gampaha. Over 8% has been employed in the Kurunegala district industries. 30.5% of the total cultivation of Rubber (116,477 Hectares) in the country is grown in the Kegalle district and 33.8% of the total coconut cultivation (394,836 Hectares) is grown in Kurunegala district. Gampaha district accounts for 11% of coconut cultivation in the country. The three types of commercial crop cultivation in the other districts remain at a rate less than 4%. The economic characteristics are well evident from the project affected areas in all the districts. Paddy cultivations in the Kurunegala district account for 10.4% of 774,380 Hectares of paddy land cultivated at least in the main season in the country. Gampaha, Matale and Kegalle districts grow less than 3% of the total extent of paddy lands. (Department of Census and Statistics 2012)

Even though an economic development is well evident from the sample studies, a considerable portion of population in the four districts under consideration suffer from poverty. The percentage of Samurdhi recipients in the DS of four districts ranges between 17 and 35. Poor households are recorded as 18.4% and 12.9% in Kegalle and Kurunegala districts respectively. Poverty headcount in Matale, Kurunegala and Kegalle districts are 19%, 15% and 21% respectively whereas Gampaha reports 9% compared to the island figure of 15.2%. Matale and Kegalle have higher level of poverty (Department of Census and Statistics 2012).

Average monthly income of householders is shown in the Table 3.22. Accordingly nearly 30% of households get an income over Rs. 50,000 per month. The monthly income of over 63% of householders ranged between Rs. 15,000 and 49,000. Being very poor over 7% of householders live on an income less than Rs. 15,000 per month. (Table 3.22).

Table 3.22: Distribution of Households by monthly income (Average income)

Project stage	Average monthly income (SLR)									
	Less than 5,000		5,001 – 14,999		15,000 – 49,999		More than 50,000		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
Section 1	50	2.71	68	3.69	1144	62.02	583	31.58	**1845**	**100.00**
Section 2	30	2.58	70	6.02	737	63.43	325	27.97	**1162**	**100.00**
Section 4	4	0.78	37	7.25	338	66.27	131	25.69	**510**	**100.00**
Total	**84**	**2.39**	**175**	**4.97**	**2220**	**63.10**	**1039**	**29.53**	**3517**	**100.00**

Source: Sample Household survey of the project area

When the average monthly income is compared with the average expenditure, the real economic condition of the people is well apparent. As shown in the table 3.23 households of all the sections of the project areas spend more than they earn per month. In filling this gap most people have become indebted.

Table 3.23: Distribution of households by monthly expenditure (Average)

Project stage	Average monthly expenditure (SLR)									
	Less than 5,000		5,001 – 15,000		15,001 – 50,000		More than 50,000		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
Section 1	40	2.17	121	6.56	1421	77.01	263	14.26	**1845**	**100.00**
Section 2	27	2.32	135	11.62	869	74.78	131	11.28	**1162**	**100.00**
Section 4	8	1.57	45	8.82	384	75.29	73	14.31	**510**	**100.00**
Total	**75**	**2.13**	**301**	**8.54**	**2674**	**76.02**	**467**	**13.29**	**3517**	**100.00**

Source: Sample Household survey of the project area

Distribution of the heads of households in the sample population by principle occupation is shown in the Table 3.24. Accordingly occupations with skilled labor are held by over 15% of households in the sections 1 and 2 while the rate is 7.8% in the section 4. Householders who cultivate their own lands as a means of sustenance account for 31.2% in the section 4 and 15.4% in the section 2. In the section 1 only 8.7% live by cultivating their lands. Compared to the other sections there is a higher percentage of 6.7% of the households who live on house tenure. These findings need to be specially taken into account as the proposed route of the expressway traverses through lands used for agricultural purposes for a considerable length of it. Farmers of the section 2 and 4 may be seriously affected as they depend on agriculture. Nearly 14% in the section 1and 2 and 11% of the section 4 are employed in the state sector. The private sector has employed only 8% of households in the section 1, 5.5% in the section 2 and 4.8% in the section 4. Unemployment rate seemed to remains at a considerable level in the sections 1 and 2 compared to section 4. Over 15.3% and 13.7% are unemployed households in the section 1 and 2. Section 4 has 9.1% of unemployed households. In summary over 60% of households depends on irregular means of income affected by various factors (Table 3.24).

Table 3.24: Distribution of heads of household by Occupation

Project Stage		Section 1		Section 2		Section 4		Total	
		Count	%	Count	%	Count	%	Count	%
Occupation /Economic Activity	Cultivation of own land	161	8.72	179	15.40	159	31.20	**499**	**14.19**
	Land tenure	13	0.68	14	1.20	34	6.70	**61**	**1.73**
	Skilled labour	285	15.46	178	15.32	40	7.80	**503**	**14.30**

Project Stage		Section 1		Section 2		Section 4		Total	
		Count	%	Count	%	Count	%	Count	%
	Unskilled labour	123	6.68	91	7.83	35	6.90	**249**	**7.08**
	Fishing	6	0.34	2	0.17	0	0.00	**8**	**0.23**
	Weaving	4	0.23	9	0.77	2	0.30	**15**	**0.43**
	Animal husbandry	2	0.11	4	0.34	1	0.20	**7**	**0.20**
	Trade	79	4.3	54	4.65	45	8.80	**178**	**5.06**
	Vendor	88	4.76	52	4.48	5	1.00	**145**	**4.12**
	Government service/Executive	43	2.32	20	1.72	5	0.90	**68**	**1.93**
	Government service/ Other grades	115	6.23	74	6.37	28	5.50	**217**	**6.17**
	Private sector/ Executive	24	1.3	14	1.20	4	0.70	**42**	**1.19**
	Private sector/ Other grades	123	6.68	51	4.39	21	4.10	**195**	**5.54**
	Security forces	43	2.32	46	3.96	15	2.90	**104**	**2.96**
	Police, Home guards/ other guards	40	2.15	15	1.29	8	1.50	**63**	**1.79**
	Housewife	100	5.44	68	5.85	24	4.70	**192**	**5.46**
	Retired Person	313	16.99	132	11.36	39	7.70	**484**	**13.76**
	Unemployed and Other	283	15.34	159	13.68	45	9.10	**487**	**13.85**
	Total	**1845**	**100.00**	**1162**	**100.00**	**510**	**100.00**	**3517**	**100.00**

Source: Sample Household survey of the project area

3.4.4. Planned development activities

The four districts under consideration have been undergoing a considerable change due to number of national, provincial, district, divisional secretariat divisions and pradeshiya sabha (local authority) based development projects. In all the 18 divisional secretariat divisions (DSDs) there are hundreds of development projects planned with the objective of solving infrastructure and other issues. All the local authorities have their development plans addressing variety of issues affecting the communities in those divisions. Where infrastructure projects are concerned, the Ambepussa- Trincomalee road (A006), the Dambadeniya- Rambukkana road (B475), the Kuliyapitiya- Kurunegala road (B087) and Rambukkana-Mawathagama road (B310) have been identified for development. The Kurunegala-Illukwela road (C060) is being developed by the provincial government. In addition to these, the following projects have been planned in the districts under consideration.

Railway

-Upgrading of railway line to Kurunegala.
-Electrification of the railway line between Veyangoda and Kalutara.
-New railway line from Kurunegala to Habarana.
-Proposed container yard in Veyangoda.

Disaster Management

- Gampaha- Canal development and flood mitigation project
- Kurunegala- Drought assessment and flood mitigation in Kurunegala
- Kegalle- Landslide slope stabilization project
- Minuwangoda DS division housing project under the assistance of Oman government
- Mahara DSD- Development of water flow paths

Board of Investment

Mirigama DSD Loluwagoda export zone and water intake of the zone in Wandurupitiya (Proposed trace is in between water intake and the zone)

DSD based other development activities

- Gampaha DSD- Road development project and water supply project
- Divulapitiya DSD- "Poor family project". The project is to select 50 families and develop their economic level

Local authority based development projects

- Gampaha PS- "Nelum Pokuna" tourism development project in galahitiyawa

Coconut development board

- Coconut nursery in Wennoruwa
- Coconut development project with subsidy and credit programmes

Health Ministry

- Accident and emergency service project (2014-2017)
  Medical officer of Health (MOH) Attanagalle
- New clinic for MOH premises at Veyangoda (to be opened)

Ministry of irrigation and water resource management

Galewela DSD "NWP" Canal project. The proposed NWP canal crosses the proposed expressway at the chainage 119+250 Km of the section 4 of CEP. The canal is from Dambulu oya to Galgamuwa area.

Urban development authority

The greater Dambulla urban development project comes under the ministry of provincial councils and local government along with the Urban Development Authority.

3.4.5 Availability of Infrastructure facilities

Social status of the people is further evident from the availability of modern communication, mass media and the information technology facilities for their daily use. Transport requirement of people and institutions in the project area under consideration are facilitated by a good network of national roads, provincial roads and roads maintained by local government bodies and private roads. The table 3.25 shows the types of such facilities and their distribution by the sections of the project route. Over 43% of the section one and 37% in the section are on land phones. Only 34% of the section four has land phone facilities. Being the most popular means of communication, mobile phones are available for 85.57% and 83.8% of households in sections one and two respectively. The section four records 89.3% of households with mobile phones. Television sets are available for over 91% of households in all the sections. Radio sets were recorded to be use in all the sections. However their number remained less than 75% of households. (Table 3.25). Availability of the communication and media equipment indicate the increasing quality of social life of people and efficiency of social interactions. Majority of the people in the three sections of the road are frequently connected by those facilities. On the other hand availability and regular use of such facilities keep the people informed and educated of most of natural and social phenomena in the country and the world. Accordingly the average people of the project area have sufficient access required for being aware of any change in the society and the capacity of mobilizing for any purpose. The Table 3.25 shows the types of such facilities and their distribution by the sections of the project route.

Table 3.25: A summary of communication, media and IT facilities (Values are in multiple answers)

Project stage	Section 1		Section 2		Section 4		Total	
Type of asset	Count	%	Count	%	Count	%	Count	%
Telephone	795	43.08	435	37.44	175	34.1	**1405**	**39.95**
Mobile Phone	1579	85.57	974	83.82	458	89.3	**3011**	**85.61**
Internet	294	15.94	92	7.92	48	9.4	**434**	**12.34**
Computer	504	27.29	211	18.16	92	17.9	**807**	**22.95**
Television	1706	92.46	1046	90.02	455	88.7	**3207**	**91.19**
Radio	1137	61.62	833	71.69	384	74.9	**2354**	**66.93**
Satellite/ Cable TV	62	3.38	50	4.30	57	11.1	**169**	**4.81**
DVD Player	732	39.65	417	35.89	166	32.4	**1315**	**37.39**
Play Station	19	1.04	5	0.43	5	1	**29**	**0.82**
Email	132	7.16	28	2.41	24	4.7	**184**	**5.23**
News papers	574	31.11	395	33.99	182	35.5	**1151**	**32.73**
Magazines	122	6.59	88	7.57	46	9	**256**	**7.28**
Hifi Setup	28	1.53	24	2.07	13	2.5	**65**	**1.85**
Home theater systems	45	2.46	74	6.37	7	1.4	**126**	**3.58**
Postal Service	1399	75.8	660	56.80	365	71.2	**2424**	**68.92**

Source: Sample Household survey of the project area

As the sources of energy is concerned, electricity supplied by the national grid, solar power and power generators is available for nearly 98% of households. In the section one and two 98.1% and 96.3% are connected to the national grid respectively. Nearly 94% of households are benefitted by the national grid

in the section four. The domestic use of kerosene oil remains at a very low level in all the sections. Only in the section four 4.7% of households uses kerosene oil whereas the percentages of other sections are recorded below 3% (Table 3.26). The availability of electricity for almost all the households is an important indicator of the development of social life and economic conditions of people in the area under consideration. Electricity is mainly used for the illumination and other domestic purposes and use of information technology and communication facilities. The connection between the availability of electricity and the use of television, radio and other equipment of entertainment was well evident in the field studies. As the use of television and other equipment have been currently institutionalized in the social life of people and they depend on them for information and entertainment, regular supply of electricity remains as essential requirement.

Table 3.26: Availability of electricity

Project stage	Source of electricity									
	National grid		Solar power		Power Generators		Kerosene Oil		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
Section 1	1810	98.10	2	0.11	5	0.27	28	1.52	**1845**	**100.00**
Section 2	1122	96.33	2	0.16	4	0.64	34	2.87	**1162**	**100.00**
Section 4	479	93.92	2	0.39	5	0.98	24	4.71	**510**	**100.00**
Total	**3411**	**96.98**	**6**	**0.17**	**14**	**0.40**	**86**	**2.45**	**3517**	**100.00**

Source: Sample Household survey of the project area

Water supply in the three sections is as apparent from the table 3.27. Accordingly pipe born water supplied by the national Water Supply and Drainage Board is available for 23.2% and 23.1% of households in the sections one and four respectively. In the section two only 14.2% enjoys the water service rendered by the National Water Supply and Drainage Board. It is interesting to report a higher dependence on well water in the three sections. Over 83% of households in the section two get water from wells and tube wells. In the section one and four over 75.6% and 73.9% depend on wells and tube wells for water requirements respectively. The water of public wells is enjoyed by less than 2% of households.

Table 3.27: Source of water

Project stage	Source of water											
	NSW & DB		Well/ tube well		Public Well		Natural water flows		Irrigation streams		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%	Count	%
Section 1	429	23.25	1396	75.66	13	0.73	5	0.26	2	0.10	**1845**	**100.00**
Section 2	165	14.20	973	83.73	18	1.55	5	0.43	1	0.09	**1162**	**100.00**
Section 4	118	23.14	377	73.92	13	2.55	0	0	2	0.39	**510**	**100.00**
	712	**20.24**	**2746**	**78.08**	**44**	**1.26**	**10**	**0**	**5**	**0.14**	**3517**	**100.00**

Source: Sample Household survey of the project area

3.4.6 Existing environment on cultural, historical and archaeological heritage properties

The environment where the expressway is proposed to be constructed is important in cultural, historical and archaeological heritage aspects. As per the archaeological department there are 150 archeologically important monuments registered in the Gampaha district, 294 in the Kurunegala district and 44 in the Matale district. Further, there are many unregistered archeologically important monuments/ artefacts/ remains distributed in the above districts. Compared to the Gampaha district Kurunegala district and Matale district are rich in pre-historical, proto-historical and historical archaeological properties, as well as cultural properties established up to recent past.

There are some culturally, historically and archaeologically important heritage properties (physically) identified along the 120 m wide road corridor and on 500 m on either side of the planned expressway design. Further due to pre-historical, proto-historical and historical nature of the area it is possible to find

more archaeological remains located on surface and in underground strata in the 120 m wide road corridor which can be considered under the direct risk of construction and 500 m either side comes as vulnerable due to the construction. Due to human settlements occupied in the post-colonization and modern periods urban areas exhibit an already disturbed and utilized built environment and geomorphology which may have low tendency to find archaeological remains. However, during excavation and construction processes some archaeological remains may be unearthed. There is a possibility to find mirco-lithic stone (geometric) and other tools and assembles belonging to Mesolithic period; pottery, metal, glass and fossil implements belonging to proto-historic period and damaged and buried structures belonging to historical period.

The assessment identified 48 properties/ places during the study which are located on either side of the 120 m road corridor, and extended 500 m + on either side. Among those 37 are temples and Buddhist related properties, 5 are mosques 2 are churches, 2 are a shrines and 1 is an archaeological monument. Properties observed with cultural value are 46, with historical value are 25 and with archaeological value are 11. The properties reflecting "cultural value" only are 22, and properties reflecting "cultural-historical value" are 15, properties reflecting "historical-archaeological value" is 01 and properties reflecting "cultural-historical-archaeological value" are only 11.

Table 3.29: Heritage Properties

Title/ Name	Type of Heritage Property	GPS Coordinates	Category
Sri Jayasumanaramaya	Temple	7° 4'6.80"N 79°56'48.14"E	Cultural Historical Archaeological
Yatawatta Purana Viharaya	Temple	7° 5'19.08"N 79°59'10.90"E	Cultural Historical Archaeological
Sri Bhodi Sanwardana Samithiya	Temple	7° 5'54.35"N 79°59'30.97"E	Cultural
Sri Mangalarama Temple	Temple	7° 5'59.26"N 79°59'27.17"E	Cultural
Purwarama Purana Viharaya	Temple	7° 6'12.44"N 80° 0'25.37"E	Cultural Historical
Sri Wardana Piriven Mulamaha Viharaya	Temple	7° 7'30.84"N 80° 1'43.60"E	Cultural
Kandoluwawa Bauddha Sanscruthika Madyastanaya	Temple	7° 7'31.30"N 80° 2'10.40"E	Cultural
Magalegoda Purana Viharaya	Temple	7° 8'0.70"N 80° 2'11.50"E	Cultural Historical
Sumiththa Sri Sunandarama /Dadagamuwa Rajamaha Viharaya	Temple	7° 8'11.60"N 80° 3'6.60"E	Cultural Historical Archaeological
Sri Janaraja Viharaya - Danvilana	Temple	7° 8'56.96"N 80° 3'35.99"E	Cultural Historical
Sri Jayasundara Vidarshanarama Purana Rajamaha Viharaya	Temple	7°10'35.28"N 80° 4'7.27"E	Cultural Historical Archaeological

Title/ Name	Type of Heritage Property	GPS Coordinates	Category
Somaramaya Aramaya	Temple (Aramaya)	7°12'41.50"N 80° 6'19.80"E	Cultural
Khemaramaya Aramaya	Temple (Aramaya)	7°13'18.10"N 80° 6'39.19"E	Cultural
Sri Munindaramaya	Temple	7°14'42.85"N 80° 6'41.22"E	Cultural
Hakurukumbara Purana Viharaya	Temple	7°15'19.70"N 80° 7'26.10"E	Cultural Historical
Sri Purana Paththini Dewalaya	Shrine	7°16'7.30"N 80° 8'10.20"E	Cultural Historical
Sri Shailarama Galdeniya Temple	Temple		Cultural Historical
Sri Gangarama Temple	Temple	7°22'27.95"N 80°11'49.44"E	Cultural Historical
Sri Shailarama Purana Rajamaha Temple	Temple	7°22'57.85"N 80°12'16.74"E	Cultural Historical Archeological
Malpitiya St. Sebastian Church	Church	7°26'31.34"N 80°20'24.46"E	Cultural Historical
Thalagama Rajamaha Viharaya	Temple	7°15'2.91"N 80°10'53.27"E	Cultural Historical Archaeological
Botale Waluwa at Ambepussa Link	Monument		Archaeological
Digampitiya Purana Viharaya Temple	Temple	7°29'26.74"N 80°24'53.38"E	Cultural Historical
Walasgala Rajamaha Viharaya Temple	Temple	7°30'8.33"N 80°24'44.49"E	Cultural Historical Archaeological
Kongaswala Sri Nandaramaya Temple	Temple	7°30'35.26"N 80°25'16.00"E	Cultural Historical
Bolagama Kubalanga Purana Temple	Temple		Cultural Historical
Kongahagedara Sri Darmavijeyaramaya	Temple	7°31'2.57"N 80°27'37.10"E	Cultural Historical
Ranaviru Village Temple	Temple	7°31'25.20"N 80°27'46.90"E	Cultural
Shrine Tree Place	Shrine	7°31'37.90"N 80°27'56.70"E	Cultural Historical
Nebilikumbura Galviharaya Temple	Temple	7°31'54.70"N 80°27'54.00"E	Cultural
Al Masjidur Jumma Mosque	Mosque	7°32'11.10"N 80°28'12.10"E	Cultural
Dethilianga Sri Jinarathanaramaya Temple	Temple	7°32'11.90"N 80°28'35.40"E	Cultural
Nida-ul-islamJumma Mosque	Mosque	7°32'29.83"N 80°29'6.77"E	Cultural
Kirindigolla Megagiri Historical Temple	Temple	7°33'25.31"N	Cultural

Title/ Name	Type of Heritage Property	GPS Coordinates	Category
		80°27'50.74"E	Historical
Al Fridous Mosque	Mosque	7°32'56.49"N 80°29'25.52"E	Cultural
Temple	Temple	7°34'42.50"N 80°29'13.10"E	Cultural Historical
Gopallawa Purana Gallen Temple	Temple	7°35'42.90"N 80°29'41.70"E	Cultural Historical Archaeological
Sri Sumanarama Temple	Temple	7°36'1.90"N 80°30'57.60"E	Cultural
Gangamuwa Rajama haViharaya	Temple	7°36'31.64"N 80°29'47.30"E	Cultural Historical Archaeological
Sri Jinendraramaya Temple	Temple	7°37'7.80"N 80°30'48.30"E	Cultural
Humbulugala Aranya Temple	Temple	7°39'43.10"N 80°31'56.00"E	Cultural
Bambawa Rajamaha Viharaya Temple	Temple	7°44'44.65"N 80°34'20.89"E	Cultural Historical Archaeological
St Jude Church	Church	7°45'2.20"N 80°33'47.13"E	Cultural
Masjidul Hudha Jumma Mosque	Mosque	7°45'19.12"N 80°34'0.57"E	Cultural
Namadagahawaththa Jumma Mosque	Mosque	7°45'59.04"N 80°34'50.04"E	Cultural
Ashokaramaya	Temple	7°48'12.41"N 80°36'53.66"E	Cultural
Dambulu Rajamaha Viharaya	Temple	7°51'21.27"N 80°39'7.11"E	Cultural Historical Archaeological
Sri Bodhirukkarama Viharaya	Temple	7°51'49.28"N 80°40'4.20"E	Cultural

CHAPTER 4: ANTICIPATED ENVIRONMENTAL IMPACTS OF PROPOSED PROJECT

Impact Identification Matrix

After preliminary investigations an impact matrix was constructed to identify the significant impacts that might result from project related activities. Under project activities all activities during the three project phases, Pre Construction (Planning), Construction and Post Construction (Operation) were considerd. Environmental aspects relevant to the study area were categorized into the main groups of environment as Physical, Ecological and Socio Economic aspects. In the impact matrix project activities are given in one axis whereas the environmental parameters are given in the other axis. A sign of "+" was placed to indicate beneficial impacts and a symbol of "-" to indicate negative impacts. The significance of the impact is indicated by allocating a numerical value 1, 2 and 3 to indicate low, medium or high impacts respectively. The medium and high impacts were then further investigated for the impact assessment and mitigatory measures are proposed for activities causing such impacts. The impact matrix filled for scoping purposes is given in Table 4.1.

A list of potential significant impacts (with a numerical assignment of 3) and moderated impacts (with a numerical assignment of 2) are given below for each project phase.

Potential impacts during the Pre Construction or Planning Phase of the Project

The most significant impacts which might occur are;

Socio Cultural Aspects

- Negative Impact on social interactions due to negotiations with land owners, land acquisition and resettlements

The moderate level impacts which might occur are ;

Earth Resources

- Negative impacts on soil erosion and land form due to securing of access

Human Interest

- Negative impacts on social interactions during the collection of ownership records, appraisal of property values and securing access
- Negative Impacts on life styles and health and safety due to land acquisition, resettlements and securing of access
- Negative impact on education of children due to land acquisition and resettlements

Economic

- Positive impacts on land value (of nearby properties which are not in the ROW) due to appraisal of land values, land acquisition and resettlements
- Negative impacts on livelihood of people due to land acquisition and resettlements
- Negative impacts on local and regional economies due to resettlements

During the Construction Phase of the Project

The most significant impacts which might occur are;

Hydrology

- Negative impact on the drainage pattern in the area due to land clearing activities and reclamation of land
- Negative impact on flooding due to reclamation of land
- Negative impact on drainage pattern due to excavations and dredging
- Negative impact on flooding and drainage pattern due to compaction
- Negative impact on flooding and drainage pattern due to embankment and retaining walls

The moderate impacts expected are ;

Hydrology

- Negative impact on flooding, stream flow, ground water level and ground water recharge due to land clearing activities
- Negative impact on drainage pattern due to demolition
- Negative impact on stream flow, ground water flow and ground water recharge due to reclamation of land
- Negative impact on ground water level and stream flow due to excavations and dredging
- Negative impact on stream flow, ground water flow and ground water recharge due to compaction
- Negative impact on flooding, stream flow and drainage pattern due to fencing and barriers and soil stabilization
- Negative impact on flooding, ground water levels, recharge and drainage patterns due to deep foundations and piles
- Negative impact on flooding, stream flow and drainage pattern due to culverts and bridges
- Negative impact on ground water levels, recharge and drainage pattern due to underground structures
- Negative impact on flooding, stream flow and drainage pattern due to construction of storm water outlets, canals and pipes
- Negative impact on flooding, stream flow and drainage pattern due to waste disposal and landscaping

Earth

- Negative impacts on soil erosion, land form and stability due to land clearing activities, excavation, blasting and drilling, dredging and deep foundations and piling activities
- Positive impacts on soil erosion and land form due to soil stabilization and landscaping
- Positive impacts on soil stability, and consolidation and settling due to soil compaction
- Negative impact on consolidation and settling due to underground structures
- Positive impacts on consolidation and settling due to compaction

Water

- Negative impact on ground water quality due to underground structures

Air

- Negative impact on air quality due to noise and vibration and dust from demolition, excavation and blasting and drilling activities
- Negative impact on air quality doe to noise and vibration due to blasting and drilling activities

Fauna and Flora

- Negative impacts on species diversity and endangered flora and fauna species in the terrestrial environment due to land clearing activities and land reclamation
- Negative impact on and habitats (Terrestrial and aquatic)due to land clearing, blasting and drilling and waste disposal
- Negative impact on animal corridors due to embankments and retaining walls
- Negative impacts on species diversity, endangered flora and fauna species, habitats (Terrestrial and aquatic), natural vegetation and terrestrial crops and recreational uses due to land clearing, reclamation of land and waste disposal
- Negative impact on food chains in aquatic media due to waste disposal

Land uses

- Negative impacts on residential and commercial land uses due to land clearing, demolition, blasting and drilling, barriers and fencing, traffic diversion and waste disposal
- Negative impacts on agricultural land and wetlands due to land clearing, reclamation of lands and landscaping
- Negative impacts on recreational uses due to waste disposal

Aesthetics

- Negative impacts on aesthetic qualities, open space qualities and landscape due to worker camps, land clearing and waste disposal

Human Interest

- Negative impact on housing and social interactions due to demolition, blasting and drilling and barriers and fencing activities
- Negative impact on life styles of people due to worker camps, demolition and traffic diversion
- Negative impact on health and safety due to migration of workers, worker camps, demolition, blasting and drilling, transport of construction material and traffic diversion
- Negative impact on utility networks due to blasting and drilling
- Negative impact on historical and archeological sites due to demolition and blasting and drilling,
- Negative impact on education due to demolition of buildings

Economics

- Positive impact on land values due to land reclamation

- Positive impact on employment opportunities and local income due to migration of workers, worker camps, deep foundation and piling, construction of embankments and retaining walls and landscaping

Transportation

- Negative impact on transportation, accessibility and movement and existing transport system due to, barriers and fencing and traffic diversions

During the Post Construction or Operational Phase of the Project

The most significant impacts that might occur are:

Land Uses

- Positive impact on land uses (residential, commercial and industrial) , utility net works and education due to provision of power, lighting and other utilities
  Economics
- Positive impacts on land values, employment opportunities and livelihoods due to secondary developments, changes in accessibility, secondary developments and changes in accessibility
- Positive impact on local income, local economic condition and regional economic condition due to secondary developments and change in accessibility

Transportation

- Positive impact on transportation due to changes in accessibility and traffic management
- Positive impact on existing transportation system due to changes in accessibility
- Positive impact on parking facilities due to changes in accessibility and traffic management
- Positive impact on traffic hazards due to traffic management activities

The moderate impacts expected are:

Hydrology

- Negative impact on stream flow and drainage patterns due to underground structures

Land Uses

- Positive impacts on land uses (residential and commercial) due to secondary developments and change in accessibility

Socio Cultural

- Positive impact on social interactions and agricultural and industrial land uses due to secondary developments and change in accessibility
- Positive impact on health and safety, population density due to secondary developments and change in accessibility
- Negative impact on uses of water due to spills during maintenance

Transportation

- Positive impact on parking facilities due to traffic management activities
- Positive impact on traffic hazards due to traffic management activities
- Negative impact on traffic hazards due to secondary developments

According to the impact matrix it appears that impacts on Hydrology is the most adversely affected by the proposed project, followed by Human Interest impacts, Land Uses and Fauna and Flora.

The impacts thus identified as significant through the matrix analysis were then further studied. A discussion of the impacts found to be causing significant negative impacts are discussed below in order of priority, Hydrological impacts, impacts on Socio Cultural aspects (human interest, Land Use, Economics, Aesthetics and traffic aspects), impacts on Ecological aspects, Water, Earth and Air

Table 4.1: Impact Matrix

Impact	Pre Construction Phase									Construction Phase																										Post Construction Phase								Impact Value
Activities -> / Parameters	Feasibility studies	Site Surveying	Collection of Ownership records	Appraisal of real Property	Negotiations with land owners	Land acquisition	Resettlement	Securing Access	Soil Investigations	Migration of workers	Worker Camps	Land Clearing	Demolition	Reclamation of land	Excavation	Blasting & Drilling	Dredging	Transport of construction material	Compaction	Barriers - Fencing	Soil stabilization	Traffic diversion	Deep foundations and piles	Culverts & bridges	Underground structures	Embankments & retaining walls	Storm water outlets, cannels, pipes	Lighting	Waste disposal	Landscaping	Provision of power, lighting and other Utilities	Underground structures	Spills	Road maintenance	Secondary developments by the roadway	Changes in accessibility	Traffic management activities		
Earth																																									***Earth***
Soil erosion								-2				-2	-1	-1	-2	-2	-2		1		2		-2	-1	-2	-1	-1		-1	2							-15	
Land form								-2				-2	-1	1	-2	-2	-2		1		2		-2	-1	-2	-1	-1		-1	2		-1					-14	
Deposition												-1	-1										-1	-1	-1	-1	-1		-1	1							-7	
Stability												-2	-1	1	-2	-2	-2		2		1		-1		-1	-1											-8	
Consolidation & settling												-1	-1	1	-1	-1			2		1			-1	-2					1							-2	
																																								-46	**-46**
Water																																								***Water***
BOD											-1																		-1					-1			-3	
Fecal coliform											-1																							-1			-2	
Turbidity												-1	-1		-1	-1	-1				-1			-1	-1	-1	-1		-1	-1			-1	-1	-1			-15	
Color												-1	-1		-1		-1							-1		-1	-1		-1				-1	-1	-1			-11	
Toxic substances													-1																-1				-1	-1	-1			-5	
Floating materials													-1				-1												-1					-1			-4	
Odor																																	-1		-1			-2	
Ground water quality											-1				-1		-1								-2		-1							-1				-7	
																																								-49	**-49**
Air																																								***Air***
Particulate matter and dust												-2	-2		-2	-2		-1	-1		-1		-1	-1	-1		-1		-1	-1				-1	-1		-1	-20	
Hydrocarbons																																								0	
Sulfur oxides																																								0	
Nitrogen oxides																																								0	
Noise and vibrations								-1	-1	-1	-1	-1	-2	-1	-1	-2		-1					-2													-1	-1	-16	
Micro climate												-1	-1																									-2	
Odour																													-1									-1	
																																							-39	-39

Impact	Pre Construction Phase									Construction Phase																								Post Construction Phase								Impact Value
Activities -> / Parameters	Feasibility studies	Site Surveying	Collection of Ownership records	Appraisal of real Property	Negotiations with land owners	Land acquisition	Resettlement	Securing Access	Soil Investigations	Migration of workers	Worker Camps	Land Clearing	Demolition	Reclamation of land	Excavation	Blasting & Drilling	Dredging	Transport of construction material	Compaction	Barriers - Fencing	Soil stabilization	Traffic diversion	Deep foundations and piles	Culverts & bridges	Underground structures	Embankments & retaining walls	Storm water outlets, cannels, pipes	Lighting	Waste disposal	Landscaping	Provision of power, lighting and other Utilities	Underground structures	Spills	Road maintenance	Secondary developments by the roadway	Changes in accessibility	Traffic management activities		
Hydrology																																							***Hydrology***
Flooding												-2		-3	-2		-2		-3	-2	-2		-2	-2		-3	-2		-2	-2					-1			-30	
Ground water levels												-2		-2	-2		-2		-2				-2		-2													-14	
Stream flow												-2		-2	-2		-2		-2	-2	-2			-2		-1	-2		-2	-2		-2						-25	
Recharge												-2		-2	-1		-1		-2				-2		-2	-1												-13	
Drainage patterns								-1			-1	-3	-2	-3	-3		-3		-3	-2	-2		-2	-2	-2	-3	-2		-2	-2		-2			-1			-41	
																																						-123	
																																						123	
Fauna-Terrestrial																																							***Fauna-Terrestrial***
Species diversity												-2		-1	-1	-1								-1					-1	-1					-1	-1		-10	
Rare & endangered species												-2		-1	-1	-1								-1					-1	-1					-1	-1		-10	
Habitats								-1				-2		-1	-1	-2							-1	-1	-1		-1		-2	-1				-1	-1	-1		-17	
Migration patterns														-1	-1	-1							-1	-1	-1		-1	-1		-1					-1	-1		-11	
Food chains												-1		-1	-1								-1							-1					-1	-1		-7	
Corridors												-1		-1	-1	-1							-1			-2	-1			-1					-1	-1		-11	
																																						-66	-66
Fauna - Aquatic																																							***Fauna - Aquatic***
Species Diversiity												-2		-1	-1		-1						-1	-1					-2	-1					-1	-1		-12	
Rare & Endangedred												-1		-1	-1		-1							-1	-1			-1	-1	-1					-1	-1		-11	
Commercial fisheries																																							0	
Food chains												-1		-1	-1									-1				-1	-2	-1					-1	-1		-10	
Habitats											-1	-1		-1	-1	-1	-1						-1	-1			-1		-2	-1			-1	-1	-1	-1		-16	
Migration Pattern												-1		-1	-1	-1							-1	-1	-1	-1	-1	-1							-1	-1		-12	
																																						-61	***-61***
Flora-Terrestrial																																						0	***Flora-Terrestrial***

Impact	Pre Construction Phase									Construction Phase																						Post Construction Phase								Impact Value
Activities -> / Parameters	Feasibility studies	Site Surveying	Collection of Ownership records	Appraisal of real Property	Negotiations with land owners	Land acquisition	Resettlement	Securing Access	Soil Investigations	Migration of workers	Worker Camps	Land Clearing	Demolition	Reclamation of land	Excavation	Blasting & Drilling	Dredging	Transport of construction material	Compaction	Barriers - Fencing	Soil stabilization	Traffic diversion	Deep foundations and piles	Culverts & bridges	Underground structures	Embankments & retaining walls	Storm water outlets, cannels, pipes	Lighting	Waste disposal	Landscaping	Provision of power, lighting and other Utilities	Underground structures	Spills	Road maintenance	Secondary developments by the roadway	Changes in accessibility	Traffic management activities		
Species diversity												-2		-2	-1									-1			-1		-2	-1					-1	-1		-12	
Rare & Endangered												-2		-2	-1									-1			-1		-2	-1					-1	-1		-12	
Natural vegetation								-1			-1	-2		-2	-1								-1	-1	-1		-1		-2	-1					-1	-1		-16	
Crops								-1			-1	-2		-2	-1								-1	-1	-1		-1		-2	-1			-1		-1	-1		-17	
																																					-57	-57
Flora - Aquatic																																						***Flora - Aquatic***
Species diversity												-2		-2	-1		-1							-1			-1		-2	-1					-1	-1		-13	
Rare & Enadangered												-1		-2	-1		-1							-1			-1		-2	-1					-1	-1		-12	
Natural Vegetation												-2		-2	-1									-1			-1		-2	-1			-1	-1	-1	-1		-14	
																																					-39	-39
Land Use																																						***Land Use***
Residential									-1	-1	-1	-2	-2		-1	-2		-1		-2		-2	-1	-1	-1	-1	-1	1	-2		3	-1	-1	-1	2	2	1	-16	
Commercial											-1	-2	-2		-1	-2		-1		-2		-2	-1	-1		-1	-1	1	-2		3	-1		-1	2	2	1	-12	
Agricultural									-1			-2	-1	-2	-1	-1		-1	-1	-1	-1		-1	-1	-1	-1	-1		-1	-2	1	-1	-1	-1	-1	2		-21	
Wetlands												-2		-2	-1	-1			-1				-1				-1	-1	-1	-2		-1	-1					-15	
Industry												-1	-1		-1	-1				-1		-1		-1		-1		1	-1		3	-1		-1		2		-5	
Recreational uses											-1	-1	-1		-1	-1				-1		-1		-1		-1		1	-2	-1	3			-1	1			-8	
																																					-77	-77
Aesthetics																																						***Aesthetics***
Scenic views & sites										-1	-1	-2	1		-1	-1		-1		-1			-1	-1	-1	-1	-1	1	-2	2	2			1	-1			-9	
Open space qualities											-2	-2	1		-1	-1		-1		-1			-1	-1	-1	-1	-1	-1	-2	1	1			1	-1			-13	
Landscape design											-2	-2	1		-1					-1	1		-1	-1	-1	-1	-1		-2	1								-10	
Unique physical features												-2	-2																	-1								-5	
Monuments												-1	-1		-1																							-3	
Appearance of water											-1	-1	-1		-1	-1													-1			-1						-7	

Impact	Pre Construction Phase									Construction Phase																							Post Construction Phase								Impact Value
Activities -> / Parameters	Feasibility studies	Site Surveying	Collection of Ownership records	Appraisal of real Property	Negotiations with land owners	Land acquisition	Resettlement	Securing Access	Soil Investigations	Migration of workers	Worker Camps	Land Clearing	Demolition	Reclamation of land	Excavation	Blasting & Drilling	Dredging	Transport of construction material	Compaction	Barriers - Fencing	Soil stabilization	Traffic diversion	Deep foundations and piles	Culverts & bridges	Underground structures	Embankments & retaining walls	Storm water outlets, cannels, pipes	Lighting	Waste disposal	Landscaping	Provision of power, lighting and other Utilities	Underground structures	Spills	Road maintenance	Secondary developments by the roadway	Changes in accessibility	Traffic management activities		
Topographic character													-1		-1	-1			-1		1		-1							-1								-5	
																																						-52	-52
Human Interest																																						0	***Human Interest***
Housing											-1	-1	-2		-1	-2				-2		-1	-1		-1		-1	-1	-1		1				2	2		-10	
Social interactions	-1	-1	-2	-2	-3	-3	-3	-2	-1	-1	-1	-1	-2		-1	-2		-1		-2		-1				-1		1			1				2	2		-25	
Cultural patterns/life styles	-1	-1	-1	-1		-2	-2	-1	-1	-1	-2	-1	-2		-1	-1				-1		-2				-1		1	-1		1				2	2		-17	
Health and safety						-2	-2			-2	-2	-1	-2		-1	-2		-2		-1		-2	-1	-1	-1	-1		1	-2		1	-1	1	-1	2	2	2	-18	
Population density										-1	-1																								2	1		1	
Utility networks													-1		-1	-2							-1		-1			1			3			-1	1	1		-1	
Water uses										-1	-1		-1		-1	-1												1			1		-2	-1	1	1		-4	
Historical/ religious/ archeological sites												-1	-2		-1	-2							-1		-1													-8	
Education						-2	-2						-2		-1	-1						-1									3					1		-5	
																																						-87	-87
Economic																																							***Economic***
Land values	-1	-1	-1	-1		-1	-1	-1	-1			1	-1	2		-1				-1	1		-1		-1	-1		1	-1		2				3	3	1	-1	
Employment opportunities										2	2	1	-1	1	1	-1	1	1	1		1	1	2	1	-1	2				2	1	-2		2	3	3		23	
Livelihood						-1	-1			1	1	1			1	-1				-1				1											3	3		7	
Local income levels						-1	-2			2	2	1		1	1	-1	1	1	1	-1		1	2	1		2		1		2	2				3	2		21	
Tourism																																				1		1	
Local economic conditions						-1	-2			1	1	1						1		-1				1				1			2				3	3		10	

Impact	Pre Construction Phase									Construction Phase																					Post Construction Phase								Impact Value
Activities -> / Parameters	Feasibility studies	Site Surveying	Collection of Ownership records	Appraisal of real Property	Negotiations with land owners	Land acquisition	Resettlement	Securing Access	Soil Investigations	Migration of workers	Worker Camps	Land Clearing	Demolition	Reclamation of land	Excavation	Blasting & Drilling	Dredging	Transport of construction material	Compaction	Barriers - Fencing	Soil stabilization	Traffic diversion	Deep foundations and piles	Culverts & bridges	Underground structures	Embankments & retaining walls	Storm water outlets, cannels, pipes	Lighting	Waste disposal	Landscaping	Provision of power, lighting and other Utilities	Underground structures	Spills	Road maintenance	Secondary developments by the roadway	Changes in accessibility	Traffic management activities		
Regional economic conditions							-2																											3	3		4	
National economic conditions																																			3		3	
																																				68	68
Transportation																																					***Transportation***
Transportation / accessibility/ movement							-2	-1	-1			-1	-1	-1	-1	-1		-1		-2		-2	-1	-1	-1	-1							-1	-1		3	3	-14	
Existing transportation systems								-1										-1		-2		-2	-1	-1	-1										3		-6	
Existing parking facilities																				-1														-1	3	3	4	
Traffic hazards																		-1		-1		-1	-1	-1	-1					2		-1		-2	2	3	-2	
																																				-18	-18

4.1. Hydrological impacts

4.1.1. During Construction Stage

Section 1

Proposed alignment from 4+000 km to 32+000 km is highly vulnerable to flooding during the construction stage. Historically almost annually, at least a section of this stretch has experienced a flood. These floods can last a few days (in the worst case scenario) and may damage partially built structures and disrupt construction activities. Unprotected embankments and fill material stock piles can erode and washed off materials can deposit at irrigation structures, paddy fields and streams and the recovery will be very costly. This is critical at Idalwala, Galwana, Ketawala, Doranagoda, Bemmulla, Maowita, Panugala, Kachcheri Amuna, Mole Amuna, Kubaloluwa and Pallewela Anicuts as the washed away materials can deposit at the anicuts where the flow velocities are at their lowest along the stream. Almost 75% of the 3800 Acers of paddy land in the Attanagalu Oya irrigation scheme will be directly or indirectly affected if a major wash off occurs during construction.

During the construction, due to the pilot road and other temporary works, existing flow pattern can be disturbed. This is prominent at locations where the culverts are not provided as there is no flow when it is not raining. Passage of surface runoff is discontinued resulting in water logging on the upstream side. Further, existing sheet flow conditions will be converted into concentrated flow through culverts and bridges in the pilot roads. Due to the high flow velocities at culverts, erosion can take place at soft grounds especially if the culverts are located at paddy fields. Washed off materials can also deposit at paddy fields and other low lying areas where the flow velocities are retarded. If the pilot road is constructed on an embankment in an area where flooding can occur, reduced retention area due to embankment can raise the flood levels. At the sections, 23+300 - 25+100, 27+800 - 28+500 and 30+600 - 34+000, flood plains are only about 100 - 200m wide and the reduction of retention area will be significant.

Irrigation water supplies can be disturbed if the continuity of the canals is not maintained through the pilot road by providing culverts with adequate sizes and proper invert levels. Irrigation drainage at paddy fields will be disturbed resulting in water logging if they are not allowed to cross the road through properly placed and aligned culverts. Table 4.2 shows the list of locations where there is a potential for some impacts during construction stage.

Table 4.2: Locations in Section 1 where surface water hydrology can be affected during construction stage

Hydrologically vulnerable sections	Most sensitive locations	Anticipated adverse impacts
0+000 - 1+700		Disturbance to paddy field drainage canals if no culverts are provided in pilot road
2+800 - 3+500		Disturbance to paddy field drainage canals if no culverts are provided in pilot road
3+900 - 4+100		Disturbance to paddy field drainage canals if no culverts are provided in pilot road
4+400 - 7+300		Disturbance to paddy field drainage canals if no culverts are provided in pilot road
7+700 - 8+700	8+500	Free flow of Uruwal Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
9+000 - 13+900	13+800	Free flow of Attanagalu Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
14+100 - 18+550	15+500	Free flow of Deeli Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road
	17+700	Free flow of Deeli Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road
18+750 - 18+850	18+200 - 18+450	Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit at Bemmulla Anicut and at downstream reaches.
18+950 - 19+650	19+000, 19+600	Free flow of Deeli Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
19+900 - 20+050	19+900 - 20+000	Deeli Oya has to be diverted for a length of 100m but there will be no adverse impacts due to the vast extent of flood plain. Loose materials in the embankment may erode if flooding occur during construction and washed away sediments can deposit along the downstream reaches.

Hydrologically vulnerable sections	Most sensitive locations	Anticipated adverse impacts
20+300 - 20+450	20+300 - 20+450	Deeli Oya has to be diverted for a length of 150m but there will be no adverse impacts due to the vast extent of flood plain. Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit along the downstream reaches.
20+650 - 20+750	20+650 - 20+750	Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can along the downstream reaches.
20+900 - 21+650	21+000	Free flow of Deeli Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
	21+100	Some paddy fields at high elevations may not be able to be supplied if correct levels of irrigation canal bed are not maintained through the pilot road culvert.
	21+250	Some paddy fields may not be able to be drained if correct levels are not maintained through the pilot road culvert.
	21+250 - 21+650	Drainage pattern will be changed and low elevated areas may not be able to drain properly if the stream is not properly diverted.
	21+625	Paddy fields at low elevations may not be able to be drained if correct levels are not maintained through the pilot road culvert.
21+700 - 22+200		Disturbance to irrigation and drainage canals if no culverts are provided in the pilot road
	22+200	Spillway discharge and the diverted canal flow will be disturbed at Kachcheri Amuna (Anicut) during the construction as an edge of an exit ramp of Veyangoda interchange is on the Anicut spillway.
22+450 - 22+750	22+550	Free flow of Deeli Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
	22+600	Loose materials in the embankment may erode if flooding occurs during construction and washed away sediments can deposit at Mole Amuna (Anicut) and along the downstream reaches.
22+800 - 25+450	23+050	Some paddy fields at low elevations may not be able to be drained if correct levels are not maintained through the pilot road culvert.
	23+100	Free flow of the stream will be disturbed if a bridge with adequate opening size is not provided in pilot road.
	23+100 - 23+300	Stream has to be diverted for a length of 200m but there will be no adverse impacts due to the wide flood plain. Loose materials in the embankment may erode if flooding occurs during construction and washed away sediments can deposit along the downstream reaches.
	23+300 - 25+100	Pilot road embankment will reduce the retention area and that can raise flood levels.
	23+900 - 24+700	Drainage pattern will be changed and some areas may not be able to drain properly if the canal is not properly diverted. Pilot road embankment will reduce the retention area and that can raise flood levels.
	24+900	Some paddy fields at low elevations may not be able to be drained if correct levels are not maintained through the pilot road culvert.
	25+050	Some paddy fields at high elevations may not be able to be supplied if correct levels are not maintained through the pilot road culvert.
25+700 - 26+150	25+850	Some paddy fields at high elevations may not be able to be supplied if correct levels are not maintained through the pilot road culvert.
	25+925	Free flow of Deeli Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
	25+500 - 25+900	Some paddy fields at high elevations may not be able to be supplied if correct levels are not maintained through the diversion.
26+300 - 27+600	26+900	Free flow of Deeli Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
	26+900 - 27+300	Stream has to be diverted for a length of 200m but there will be no adverse impacts due to the wide flood plain. Loose materials in the embankment may erode if flooding occurs during construction and washed away sediments can deposit at Kubaloluwa Anicut. Bifurcation point of Deeli Oya and Palu Oya is also at this stretch and the discharge of Palu Oya will be disturbed if the pilot road is constructed on the left bank of Deeli Oya.
27+800 - 28+500	27+800 - 28+500	Pilot road and construction activities will occupy a major portion of the narrow flood plain. However, no significant adverse impacts are anticipated due to very small flood discharges.
29+125 - 29+250		Disturbance to irrigation and drainage canals if no proper culverts are provided at the pilot road.
29+500 - 34+000	29+550	Some paddy fields at higher elevations may not be able to be supplied if correct levels are not maintained through the pilot road culvert.
	29+900	Some paddy fields at low elevations may not be able to be drained if correct levels are not maintained through the pilot road culvert.
	30+000	Some paddy fields at low elevations may not be able to be drained if correct levels are not maintained through the pilot road culvert.
	30+600 - 34+000	Up to about 25% of the 100 to 200m wide flood plain will be occupied by the pilot road and the construction activities. However, due to the small flood discharge no significant adverse impacts are anticipated.
	31+600, 31+750,	Some paddy fields at low elevations may not be able to be drained if correct levels are not maintained through the pilot road culvert.

Hydrologically vulnerable sections	Most sensitive locations	Anticipated adverse impacts
	32+150, 32+550, 32+650, 33+600, 33+900	
34+000 - 34+750		Disturbance to irrigation and drainage canals if no proper culverts are constructed at pilot road
35+700 - 37+600		Disturbance to irrigation and drainage canals if no proper culverts are constructed at pilot road
37+600 - 38+200		Disturbance to irrigation and drainage canals if no proper culverts are constructed at pilot road

Section 2

Proposed alignment (44+000 - 59+000) along Kuda Oya basin is vulnerable to flooding during the construction stage. These floods can last about a day (in the worst case scenario) and may damage partially built structures and disrupt the construction activities. Unprotected embankments and fill material stock piles can erode and washed off materials can deposit at paddy fields and streams.

In addition, in Ambepussa link, at 6+900 to 7+200 km Maha Oya is only about 100 m away from the centre line of the proposed road which is on a cut section of a steep ground. Construction materials can roll/wash into Maha Oya if precautions are not taken during construction stage.

During the construction, due to the pilot road and other temporary works, existing flow pattern can be disturbed. This is prominent at locations where the culverts are not provided as there is no flow when it is not raining. Passage of surface runoff is discontinued resulting in water logging on the upstream side. Further, existing sheet flow conditions will be converted into concentrated flow through culverts and bridges in the pilot roads. Due to the high flow velocities at culverts, erosion can take place at soft grounds especially if the culverts are located at paddy fields. Washed off materials can also deposit at paddy fields and other low lying areas where the flow velocities are retarded. If the pilot road is constructed on an embankment in an area where flooding can occur, reduced retention area due to embankment can raise the flood levels.

Several temporary stream diversions may be necessary in the construction stage especially at Kuda Oya from 44+000 km to 59+000 km. This may change the flow pattern immediately upstream and downstream of diversion and the stream will readjust to the new situation by slightly realigning the original path.

Irrigation water supplies can be disturbed if the continuity of the canals is not maintained through the pilot road by providing culverts with adequate sizes and proper invert levels. Irrigation drainage at paddy fields will be disturbed resulting in water logging if they are not allowed to cross the road through properly placed and aligned culverts. Table 4.3 and 4.4 shows the list of locations where there is a potential for some adverse impacts during construction stage.

Table 4.3: Locations in Section 2 where surface water hydrology can be affected during construction stage

Hydrologically vulnerable sections	Most sensitive locations	Anticipated adverse impacts during construction
38+400 - 41+450	39+950 - 40+300	Pilot road embankment can disturb the drainage canals in paddy fields. Some will be diverted. Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit in the paddy fields downstream.
	40+600	
	40+750 - 41+100	
	41+100	
	41+350 - 41+400	
41+650 - 41+900		
42+350		Free flow of Maha Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
42+900 - 43+450		Loose materials at the unprotected embankment may erode if floods occur during

43+750 - 44+050		construction and washed away sediments can deposit in Kuda Oya and in the paddy fields downstream.
44+050 - 44+300		
44+300 - 46+850		
	44+800	
	45+700	Free flow of Kuda Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road. Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit in Kuda Oya and in the paddy fields downstream.
	46+000	
	45+100 - 45+400	
	45+550 - 45+750	
47+100		
47+150 - 47+500		
47+800 - 49+900	48+000 - 48+450	
	48+450	
	49+600	
50+100		Free flow of the stream will be disturbed if a bridge with adequate opening size is not provided in pilot road.
50+300 - 50+550		Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit in the paddy fields downstream.
50+700 - 50+900		
51+050 - 51+150		
51+250 - 52+250	51+400	
	51+500	
	52+050	
	52+150	Free flow of Kuda Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road. Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit in Kuda Oya and in the paddy fields downstream.
52+450		
52+750 - 53+100		
53+250		
54+250 - 54+500	54+400	
55+050 - 55+650		Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit in the paddy fields downstream.
55+650 - 56+750		
56+750 - 57+650	57+450	
57+650 - 59+200		
	57+870	Free flow of Kuda Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road. Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit in Kuda Oya and in the paddy fields downstream.
	57+950	
	59+050 - 59+100	
60+000 - 60+250	60+220	Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
60+650 - 61+250		
62+050 - 62+850	62+350	
	62+600 - 62+700	
63+420 - 64+150	63+600	
64+430 - 64+820		
64+900 - 65+120		
65+720 - 65+820		
66+650 - 67+700	66+930	
	67+100	
68+800 - 69+350	69+300	Free flow of Maguru Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
69+450 - 69+650		
70+350 - 70+520		
70+650 - 72+300		Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
74+020 - 75+520	74+400 - 75+000	
	75+170	
	75+350	Free flow of spill canal will be disturbed if a bridge with adequate opening size is not provided in pilot road.
75+700 - 76+250		Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.

Table 4.4: Locations in Ambepussa Link in Section 2 where surface water hydrology can be affected during construction stage

Hydrologically vulnerable sections	Most sensitive locations	Anticipated adverse impacts
2+200 to 3+900		Disturbance to irrigation and drainage canals if no proper culverts are constructed at pilot road
4+900 to 5+600		Disturbance to irrigation and drainage canals if no proper culverts are constructed at pilot road
6+100 to 6+200		Disturbance to irrigation and drainage canals if no proper culverts are constructed at pilot road
6+900 to 7+200		Cut materials can fall into Maha Oya if they are not properly handled
8+500 to 9+000	8+950	Free flow of Kuda Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.

Section 4

Proposed alignment at Deduru Oya is vulnerable to flooding during the construction stage. A flow velocity at Deduru Oya is very high and may damage partially built structures and disrupt the construction activities. Unprotected embankments and fill material stock piles can erode and washed off materials can deposit at downstream reaches.

During the construction, due to the pilot road and other temporary works, existing flow pattern can be disturbed. This is prominent at locations where the culverts are not provided as there is no flow when it is not raining. Passage of surface runoff is discontinued resulting in water logging on the upstream side. Further, existing sheet flow conditions will be converted into concentrated flow through culverts and bridges in the pilot roads. Due to the high flow velocities at culverts, erosion can take place at soft grounds especially if the culverts are located in paddy fields. Washed off materials can also deposit at paddy fields and other low lying areas where the flow velocities are retarded. If the pilot road is constructed on an embankment in an area where flooding can occur, reduced retention area due to embankment can raise the flood levels.

Irrigation water supplies can be disturbed if the continuity of the canals is not maintained through the pilot road by providing culverts with adequate sizes and proper invert levels. Irrigation drainage at paddy fields will be disturbed resulting in water logging if they are not allowed to cross the road through properly placed and aligned culverts. Table 4.5 shows the list of locations where there is a potential for some adverse impacts during construction stage.

Table 4.5: Locations where surface water hydrology can be affected during construction stage at Section 4

Hydrologically vulnerable stretches	Most sensitive locations	Anticipated adverse impacts during construction
76+700 - 78+350	77+950	Pilot road embankment can disturb the drainage canals in paddy fields. Some will be diverted. Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit in the paddy fields downstream.
78+830 - 79+270	79+000	
80+550 - 80+650	80+600	
81+250 - 81+500		
81+900 - 82+100	82+050, 82+100	
82+450 - 82+550		
83+150 - 83+600	83+420	
83+600 - 83+700		Free flow of Deduru Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
83+700 - 84+830		Washed away soil can reach Deduru Oya. There is a drinking water intake about 1400m downstream.
84+830 - 86+400	84+950	Pilot road embankment can disturb the drainage canals in paddy fields. Some will be diverted. Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit in the paddy fields downstream.
	85+800	
	86+120	Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
	86+360	Free flow of Ibbagamuwa tank intake canal will be disturbed if a bridge with adequate opening size is not provided in pilot road.
86+700 - 87+620	86+700	
	87+400	
87+950 - 88+300		Drainage paths of paddy fields can be blocked and water loging can occur if no adequate culverts are provided in the pilot road.
89+350 -o 89+550		
89+730 - 89+820		
90+500 - 90+900		Washed away soil can reach Deduru Oya. That can block the Ibbagamuwa intake Anicut.

91+600 - 91+800		Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
92+050 - 92+400	92+200	
92+500 - 93+000		Washed away soil can reach Deduru Oya. That can block Ibbagamuwa intake Anicut.
93+600 - 95+500	94+850	Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit at the stream and the paddy fields downstream.
96+100 - 97+400	97+200	Loose materials at the unprotected embankment may erode if floods occur during construction and washed away sediments can deposit at the stream and the paddy fields downstream.
98+200 - 98+350		Washed away soil can reach the tank.
98+450 - 98+600		
99+100 - 99+200		Washed away soil can reach the tank at the downstream.
100+000 -o 100+200		Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
101+150 - 101+900		
102+750 - 103+050	102+800 - 102+900	Washed away soil can reach the tank at the downstream.
104+030		Free flow of Kimbulwana Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
112+200		Free flow of the creek will be disturbed if a bridge with adequate opening size is not provided in pilot road.
112+700 - 113+000		Drainage paths of farmlands can be blocked and waterlogging can occur if no adequate culverts are provided in the pilot road.
114+900 - 116+000		
116+000 - 116+350		Surface runoff towards the tank may be disturbed if adequate culverts are not provided at the pilot road. Washed away soil can reach the tank at the downstream.
117+250 - 119+000	18+400	There is a cascade tank system at the immediate downstream. Surface runoff towards the tanks may be disturbed if adequate culverts are not provided at the pilot road. Washed away soil can reach the tanks at the downstream. Bund of the tank at 118+400 is very close and can be affected due to vibration.
119+900 - 120+150		Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
120+150		Piers of the pilot road can disturb the flow.
120+150 - 121+100		Surface runoff towards the tank may be disturbed if adequate culverts are not provided in the pilot road. Washed away soil can reach the tank at the downstream.
121+100 - 122+100		Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
122+100		Free flow of the Stream will be disturbed if a bridge with adequate opening size is not provided in pilot road.
122+100 -o 122+700	122+150	Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
123+500		Free flow of the Stream will be disturbed if a bridge with adequate opening size is not provided in pilot road.
123+500 - 124+000		Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
124+050		Free flow of the Stream will be disturbed if a bridge with adequate opening size is not provided in pilot road.
124+100 - 124+550		Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
125+200 - 127+200	125+250	There is a cascade tank system upstream and downstream of the proposed road. Surface runoff towards the tanks may be disturbed if adequate culverts are not provided at the pilot road. Washed away soil can reach the tanks at the downstream.
127+800 - 128+700	126+750	Surface runoff towards the stream may be disturbed if adequate culverts are not provided at the pilot road. Washed away soil can reach the stream.
128+700		Free flow of Dambulu Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road. Washed away materials from the construction site can reach Ibbankatuwa Tank through Dambulu Oya.
128+700 - 129+600		Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
130+300		Free flow of the Stream will be disturbed if a bridge with adequate opening size is not provided in pilot road.
130+300 - 131+800	131+000	Free flow of the Stream will be disturbed if a bridge with adequate opening size is not provided in pilot road.
	131+450	
	131+600	
	131+640	

	131+700	
	131+800	Storage of the tank will be significantly reduced due to the pilot road.
134+250 - 137+456	134+400	Free flow of the Stream will be disturbed if a bridge with adequate opening size is not provided in pilot road.
	134+950 - 135+200	
	135+650	
	136+300	Free flow of Mirisgoniya Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
	136+350 - 136+550	Drainage paths of paddy fields can be blocked and water logging can occur if no adequate culverts are provided in the pilot road.
	136+580	
	136+700	
	137+080	
	137+180	

4.1.2. During Operational Stage

Section 1

In areas where the proposed highway crosses streams or water paths, if adequate openings at proper levels have not been provided, existing flow pattern will be changed and water logging or flooding can occur in the upstream side of the road. Culvert and bridge opening sizes given in the Preliminary Design Report - Stage 1 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014) and Hydrological Study Report of North East Expressway (Colombo- Kandy Alternative Highway) Project, prepared by SLLRDC (2011), were compared against the design discharges and found to be adequate. However, their usage, in terms of providing an uninterrupted passage for catchment discharge will reduce if they are not placed at the correct position or not aligned properly. Though, there are no invert levels of the waterway structures provided in the details given in the Preliminary Design Report - Stage 3 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), it has been recommended that the detailed designers need to match them with existing ground levels and therefore no adverse impacts are anticipated. Further, if the irrigation supply canals and drainage canals are not allowed to keep the continuity through the road, some paddy fields will not be able to be fed and drained. Table 4.6 is a list of locations with possible impacts on the hydrological landscape during the operational stage of the project.

Table 4.6: Locations and relevant impacts on surface water hydrology during operational stage in Section 1

Chainage	Most vulnerable locations	Possible impacts at the operational stage
0+000 - 1+700	0+600, 1+100, 1+450	Proposed road is on an embankment with box culverts for waterways. If the inverts of box culverts are not matched with the bed levels of drainage canals then some low elevated areas may not be able to be drained properly.
2+800 - 3+300	1+650, 2+900, 3+050	
3+300 - 3+630	3+550 - 3+630	Expressway is on a Viaduct. No adverse impacts are anticipated.
3+900 - 4+050	3+950 - 4+050	Expressway is on a Viaduct from 3+860 to 4+010. However, there is a stream at 4+050 km and it will be blocked by the expressway embankment.
4+400 - 4+500	4+450	Expressway is on a Viaduct. No adverse impacts are anticipated.
4+900 - 5+000	4+950	Expressway is on a 90m long Viaduct. No adverse impacts are anticipated.
5+100 - 5+800	5+300, 5+450	Expressway is on a 240 m long Viaduct. No adverse impacts are anticipated.
6+100 - 6+400	6+300, 6+400	Expressway is on a 240 m long Viaduct. No adverse impacts are anticipated.
6+800 - 7+350	7+100	Expressway is on a 570 m long Viaduct. No adverse impacts are anticipated.
7+700 - 8+700	8+500	Expressway is on two viaducts (580 m+ 180m) , however it is not continuing past the stream at 8+150 km. It will have to be diverted through the Viaduct. No impact on Uruwal Oya flow is anticipated as the 180 m Viaduct across it is adequate.

Chainage	Most vulnerable locations	Possible impacts at the operational stage
9+000 - 13+600	9+100 - 11+800, 13+050 - 13+500	Expressway is on a 2740m long Viaduct from 9+060 to 11+800km. From 13+050 to 13+500 km, expressway runoff can flow into Ketawala Anicut if no proper precautions are taken. No flood level increase is anticipated as the most critical section is passed through a Viaduct.
13+600 - 15+200	13+800, 14+300, 14+500 14+856	From 13+666 to 14+666 km expressway is on a 1000m long Viaduct. This is enough to pass Attanagalu Oya flood flow and as such no flood level increase is anticipated. The 40m bridge at 14+856 km will help to drain east to west during dry weather and will equalise the flood levels on either sides of the embankment. Therefore no adverse impacts are anticipated.
15+200 - 16+200	15+500	From 15+090 to 16+190 km the expressway is on a 1100m long Viaduct. This is enough to pass Deeli Oya flood flow and as such no flood level increase is anticipated.
16+200 - 16+800	16+200 - 16+800	River training is proposed. No adverse impacts are anticipated as the main channel of the Deeli Oya is not intercepted.
16+800 - 19+100	17+400, 17+400 - 17+700 18+300- 19+100	Viaduct is provided from 16+800 to 18+560 km. Therefore there are no adverse impacts in that section. Flood water over flowing around 20+200 km into the vast flood places on the south of the expressway can flow back into the main Deeli Oya from 18+300 to 19+100 km. Expressway embankment can impede this flow from 18+560 to 18+940km which will increase the inundation in the surrounding villages. 100m viaduct provided from 18+940 to 19+040 km is enough for Deeli Oya flow at that location, but not enough to provide a passage for floods reaching the section 18+560 to 18+940 km.
19+100 - 19+650	19+600	125m viaduct provided from 19+508 to 19+633 is enough for Deeli Oya flow and no adverse impacts are anticipated.
19+900 - 20+050	19+900 - 20+000	Deeli Oya diversion will have no adverse impact due to vast extent of the flood plain. Viaduct is enough for the Deeli Oya flow from 19+803 to 20+028 and no adverse impacts are anticipated.
20+300 - 20+450	20+300 - 20+450	Deeli Oya diversion will have no adverse impacts due to vast extent of flood plain.
20+650 - 20+750	20+650 - 20+750	Stream diversion and the culvert will have no adverse impacts
20+900 - 21+650	21+000	200m Viaduct provided at 20+930 to 21+130 km is enough for this location and no adverse impacts are anticipated
	21+200- 21+600	From 21+200 to 21+600 river training is required and some paddy fields may not be able to be drained if culverts are not provided.
21+700 - 22+200	21+200	Operation of Kachcheri Amuna will be disturbed if its spillway is blocked.
22+450 - 22+750	22+550	Expressway is on a Viaduct from 22+330 to 22+680 and no adverse impacts are anticipated.
22+800 - 25+450	23+050, 23+100, 23+200, 23+950, 24+800, 25+100	Provided bridge openings are adequate for the conveyance of flood. However, the expressway embankment occupies up to about 25% of the flood plain and that can raise the flood levels. Proposed flood channels can mitigate that but during dry weather conditions, the flood channels can over-drain the paddy fields.
25+700 - 26+150	25+900	Viaduct provided from 25+787 to 25+912 is not enough to cover both the irrigation canal and Deeli Oya . Flood flow of Deeli Oya will be blocked and flood levels will rise at the upstream areas.
26+300 - 27+600	26+500 - 26+900 29+900 - 27+300	Irrigation canals are to be diverted in this section. Some paddy fields may not be able to be supplied if correct levels are not maintained through the diversion. River training is required at the upstream of Kubaloluwa Anicut. Retention area of the anicut will be reduced if the present volume of retention is not provided in the trained canal. Path of the stream at immediate upstream and downstream of the diversion may readjust a little. However, the impacts will not be significant as they will confined to the flood plain. Viaduct provided at the bend of the Deeli Oya is adequate and no adverse impacts are anticipated.
27+800 - 28+500		Reduction of retention area. However, the impact will not be significant as the flood discharge is low.
29+125 - 29+250		Disturbance to irrigation and drainage canals if the invert levels are not maintained through culverts
29+500 - 34+000	29+550	Some paddy fields may not be able to be supplied if correct levels are not maintained through the culvert.
	29+900	40m bridge provided is adequate for Deeli Oya flood flow and therefore no flood level increase is anticipated
	30+200 - 31+000	Expressway is on a viaduct. No adverse impacts are anticipated.
	31+000 - 32+050	Up to 25% of the 100 to 200m wide flood plain will be occupied by the road embankment. However, due to the small flood discharge no significant adverse impacts are anticipated.
	32+050 - 32+350	Expressway is on a viaduct. No adverse impacts are anticipated.
	31+600, 31+750, 32+150, 32+550,	Proposed road is on an embankment. Provided culverts and bridge spans are adequate. No adverse impacts are expected.

Chainage	Most vulnerable locations	Possible impacts at the operational stage
	32+650, 33+900	
34+000 - 34+750		Close to the upstream boundary of Deeli Oya watershed. Flood discharges are very low. Therefore no adverse impacts are expected.
35+700 - 37+600		Flood discharges are very low. Therefore no adverse impacts are expected.
37+600 - 38+200		Flood discharges are very low. Therefore no adverse impacts are expected.
Ambepussa Link		
Chainage	Important locations	Possible impacts at the operational stage
2+200 - 3+900		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some paddy areas may not be able to be fed and some areas may not be able to be drained properly.
4+900 - 5+600		
6+100 - 6+200		
6+900 - 7+200		No impact as the road does not interfere with Maha Oya.
8+500 - 9+000	8+950	Free flow of Kuda Oya will be disturbed if the proposed viaduct/bridge is not properly aligned with the flow direction or large enough for the flood discharge. Road embankment will be flooded if it is not high enough.

Section 2

In areas where the proposed highway crosses streams or water paths, if adequate openings have not been provided at proper levels, existing flow pattern will be changed and water logging or flooding can occur on the upstream side of the road. Culvert and bridge opening sizes given in the Preliminary Design Report - Stage 2 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014) was compared against the design discharges and found to be adequate. However, their usage, in terms of providing an uninterrupted passage for catchment discharge will cease if they are not placed at the correct position or is not aligned properly. Though, there are no invert levels of the waterway structures provided in the details given in Preliminary Design Report - Stage 2 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), it has recommended the detailed designers to match them with existing ground levels and therefore no adverse impacts are anticipated.

At Maha Oya, a 180m long viaduct is provided which is enough for the 100 year flood flow and therefore no flood level change is expected. According to the preliminary design drawings of RDA (01/03/2016), between 44+000 km and 59+000 km, Kuda Oya crosses the proposed alignment several times. Where, the proposed road encroaches within the banks of the stream, it will be on viaducts and as such no change in the flooding scenario is expected. There are several stream training works which will have no significant impact on the flood levels, if the diversion canals are properly designed. However, the alignment of the stream, at immediate neighbourhood of the diversion will readjust especially if the banks are on soft grounds. Therefore, a certain amount of bank erosion and sediment deposition at some other places are expected. Further, though culverts are provided across the diverted section of Kuda Oya, there may be local areas which are not draining into those culverts. Water logging can takes place at those locations.

Further, if the bed levels of irrigation supply canals and drainage canals are not allowed to keep the continuity through the road, some paddy fields will not be able to be fed and drained. Table 4.7 is a list of locations with possible impacts on the hydrological landscape during operational stage of the project.

Table 4.7: Locations and relevant impacts on surface water hydrology during operational stage at Section 2

Hydrologically vulnerable stretches	Most sensitive locations	Anticipated adverse impacts during operation stage
38+400 - 41+450	39+950 - 40+300,	Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some paddy areas at high elevations may

Hydrologically vulnerable stretches	Most sensitive locations	Anticipated adverse impacts during operation stage
	40+600, 40+750 - 41+100, 41+350 - 41+400	not be able to be fed and some areas at low elevations may not be able to be drained properly
42+350		A 180 m viaduct provided is enough to ensure free flow conditions and no adverse impacts are anticipated
42+900 - 43+450		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some paddy areas at high elevations may not be able to be fed and some areas at low elevations may not be able to be drained properly
43+750 - 44+050		
44+050 - 44+300		Road embankment will be eroded if protective measures are not provided as the overbank flow of Kuda Oya can reach the road
44+300 - 46+850	44+800, 45+700, 46+000,	Viaducts provided at 44+730 - 44+910, 45+050 - 45+770 and 45+870 - 46+020 are enough to ensure uninterrupted passage for flood flow and therefore no adverse impacts are anticipated
47+100		Viaduct provided from 47+040 to 47+280 is enough to ensure uninterrupted passage for flood flow and therefore no adverse impacts are anticipated
47+150 - 47+500		Canal diversion will have no adverse impacts if proper levels are maintained through diversion
47+800 - 49+900	48+000 - 48+450	Road embankment will be eroded if protective measures are not provided as the overbank flow of Kuda Oya can reach the road
	48+450	The Viaduct from 48+320 to 48+500 is enough to ensure free flow conditions and no adverse impacts are anticipated
	49+050, 49+600	Stream training will have no adverse impacts. Two bridges provided are adequate for flood flow. The Anicut at 49+600 is only 100m downstream, however, the bridge is wide enough to ensure that the retention area is unchanged. Road surface run-off can reach the Anicut and that will have some adverse impacts.
50+100		Channel training will have no significant adverse impacts
50+300 - 50+550		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some paddy areas at high elevations may not be able to be fed and some areas at low elevations may not be able to be drained properly.
50+700 - 50+900		
51+050 - 51+150		
51+250 - 52+250	51+400, 51+500, 52+050	Some paddy fields at high elevations may not be able to be supplied if correct levels are not maintained through the culvert.
	52+150	Bridge is wide enough to ensure free flow conditions and no adverse impacts are expected
52+450		A 150m viaduct is wide enough to ensure free flow conditions and no adverse impacts are expected
52+750 - 53+100		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some paddy areas may not be able to be fed and some areas may not be able to be drained properly.
53+250		A 100m viaduct across Kuda Oya is wide enough to ensure free flow conditions and no adverse impacts are expected.
54+250 - 54+800	54+400	Viaduct provided from 54+340 to 54+760 is wide enough to ensure free flow conditions and no adverse impacts are expected
55+050 - 55+650		Viaduct provided from 54+900 to 55+260 is wide enough to ensure free flow conditions and no adverse impacts are expected
55+650 - 56+750		Loss of flood retention is because access ramps of the interchange can locally raise the flood levels as this is at the Kuda Oya flood plain. Road embankment will be eroded if protective measures are not provided as the overbank flow of Kuda Oya can reach the road from 55+800 to 56+700
56+750 - 57+650	56+750 - 56+900	River training for 150m section will have no adverse impacts

Hydrologically vulnerable stretches	Most sensitive locations	Anticipated adverse impacts during operation stage
57+650 - 59+200	57+850 - 58+000	A 150m viaduct section is wide enough to ensure free flow conditions and no adverse impacts are expected
	58+100 - 58+150	River training for 50m section will have no adverse impacts
	58+150- 58+600	Road embankment will be eroded if protective measures are not provided as the overbank flow of Kuda Oya can reach the road
	59+025 - 59+225	River training for 200m section will have no adverse impacts
60+000 - 61+600	60+220	Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some paddy areas may not be able to be fed and some areas may not be able to be drained properly.
61+000 - 62+850	61+000 - 62+800	Streams which are draining into the diverted section should be allowed to cross the embankment undisturbed. Culverts are provided at all major drains and streams. However, there may be locally low elevated areas which can cause water logging
63+420 - 64+150	63+800 - 63+950	Stream diversion will have no adverse impacts
64+430 - 64+820		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some high elevated paddy areas may not be able to be fed and some low elevated areas may not be able to be drained properly. Bridges at 66+930 and 67+150 are adequate for the flood flow and no adverse impacts are anticipated. No adverse impacts will occur due to the river training at 67+000 - 67+200.
64+900 - 65+120		
65+720 - 65+820		
66+650 - 67+700	66+930	
	67+000- 67+200	
68+800 - 69+350	69+230	80m bridge provided at Maguru Oya is wide enough and no adverse impacts are expected
69+450 - 69+650		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some high elevated paddy areas may not be able to be fed and some low elevated areas may not be able to be drained properly. Flood drainage channel provided from 70+500 to 71+100 can excessively drain the paddy fields during dry periods. Canal diversion proposed from 74+400 to 75+000 can disturb the drainage pattern on the downstream side of the embankment.
70+350 - 70+520		
70+650 - 72+300		
74+020 - 75+520	74+400 - 75+000	
	75+170	
	75+320	40m bridge at spill canal is enough for spill discharge and no adverse impacts are expected.
75+700 - 76+250		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some paddy areas may not be able to be fed and some areas may not be able to be drained properly.

Section 4

Culvert and bridge opening sizes given in the Preliminary Design Report - Stage 4 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014) was compared against the design discharges and found to be adequate. Design drawings of RDA dated 18/12/2015 are used to find the locations of structures and river training works. However, their usage, in terms of providing an uninterrupted passage for catchment discharge will reduce if they are not placed at the correct position or not aligned properly. Though, there are no invert levels of the waterway structures provided in the details given in Preliminary Design Report - Stage 3 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), it has recommended that the detailed designers need to match them with existing ground levels and therefore no adverse impacts are anticipated.

Further, if the irrigation supply canals and drainage canals are not allowed to keep the continuity through the road with accurate invert levels, some paddy fields will not be able to be fed and drained. Table 4.8 is a list of locations with possible impacts on the hydrological landscape during the operational stage of the project.

Inflows into the tanks will be disturbed at locations (given in Table 4.8) where the proposed road runs on the upstream side of tanks. Similarly when the road embankment is on the downstream side of the tank (locations given in Table 4.8), natural seepage from the tanks to the downstream paddy fields will be disturbed. In addition when the road embankment crosses a paddy field, the natural flow of water through the cascade is disturbed. This can happen at all the paddy areas given in Table 4.8 where the slope of the terrain is across the road trace.

Table 4.8: Locations and relevant impacts on surface water hydrology during operational stage at Section 4

Hydrologically vulnerable stretches	Most sensitive locations	Anticipated adverse impacts during operation stage
76+700 - 78+350	77+950	River training is proposed from 77+560 to 77+940 for Gettuwana Oya. However, this will have no adverse impacts as its still in the upstream most reaches and the discharges are very low. The 40m bridge provided is enough for the flood discharge. Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some paddy areas at high elevations may not be able to be fed and some at low elevations areas may not be able to be drained properly.
78+830 - 79+270	79+000	
80+550 - 80+650	80+600	
81+250 - 81+500		
81+900 - 82+100	82+050, 82+100	
82+450 - 82+550		
83+150 - 83+500	83+420	
83+500 - 83+750		A 180m viaduct provided at 83+540 - 83+720 is enough to ensure free flow of Deduru Oya and as such no adverse impacts are expected.
83+700 - 84+830		Deduru Oya is only 100m away. Run off from road surface can reach Deduru Oya where there is a water intake for drinking water supply 1.5 km downstream.
84+830 - 86+400	84+950	Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of irrigation and drainage canals then some paddy areas at high elevations may not be able to be fed and some areas at low elevations may not be able to be drained properly.
	85+800	
	86+120	Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of drainage canal then some paddy areas may not be able to be drained properly.
	86+360	Three Viaducts, 80m at 86+360 and 86+700 and 100m at 87+400 provided are enough to clear Ibbagamuwa tank intake canal and no adverse impacts are expected
86+700 - 87+620	86+700	
	87+400	
87+950 - 88+300		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of drainage canal then some paddy areas at low elevations may not be able to be drained properly.
89+350 - 89+550		
89+730 - 89+820		
90+500 - 90+900		Deduru Oya is only 70m away. Run off from road surface can reach Deduru Oya where there is a water intake for drinking water supply and intake of Ibbagamuwa wewa is within 10 km distance downstream.
91+600 - 91+800		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of drainage canal then some paddy areas at low elevations may not be able to be drained properly.
92+050 - 92+400	92+200	
92+500 - 93+000		Deduru Oya is only 100m to 200m away. Run off from road surface can reach Deduru Oya where there is a water intake for drinking water supply and intake of Ibbagamuwa wewais within 10 km distance downstream.
93+600 - 95+500	94+850	River training at 94+920 and 96+280 will make no adverse impacts as they are small streams. Proposed road is in the same general direction of a stream. Road embankment will be eroded if protective measures are not provided as the over flowing stream can reach the embankment.
96+100 - 97+400	97+200	
97+530	97+530	No bridge has been provided for Korambe Ela. Stream flow will not pass through the embankment. There is an Anicut about 25m and that also will be adversely affected.
98+200 - 98+350		Very close to the inundation area of a tank. Run off from road surface can reach the tank which is used for irrigation.
98+450 - 98+600		
99+100 - 99+200		Road runs across a tank cascade system. Run off from road surface can reach the tank which is used for irrigation.
100+000 -o 100+200		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of drainage canal then some paddy areas at low elevations may not be able to be drained properly.
101+150 - 101+900		
102+750 - 103+050	102+800 - 102+900	Within the inundation area of a tank. Run off from road surface can reach the tank which is used for irrigation and cattle farming.
104+030		75m bridge provided for Kimbuwana Oya is adequate and no flood level increase is expected.
112+200		40m bridge for Paragaha Ulpotha Ela (stream) is adequate and no adverse impacts are

Hydrologically vulnerable stretches	Most sensitive locations	Anticipated adverse impacts during operation stage
		expected
112+700 - 113+000		Proposed road is on an embankment. If the inverts of box culverts are not matched with the bed levels of drainage canal then some farmlands at low elevations may not be able to be drained properly.
114+900 - 116+000		
116+000 - 116+350	116+860	75m bridge for Kalugal Ela is enough and surface runoff towards the tank may not be disturbed. However the runoff from road surface can reach the tank which is used for irrigation.
117+250 - 119+000	118+400	Road is on the bund of Uda Wewa (tank) which is a retention tank in a cascade system. Retention capacity of the tank will be reduced. No provision for tank spill through the road embankment. Surface runoff towards the tanks may be disturbed if adequate culverts are not provided at the road embankment at other locations in this section. Run off from road surface can reach the tanks which are used for irrigation.
119+900 - 120+150		At 119+370 there is a small stream and the proposed road is on an embankment. A culvert is not provided to pass the stream to the other side of the stream.
120+150		Bridge peiers inside the canal can disturb the flow.
120+150 - 121+100		Surface runoff towards the tank may be disturbed if adequate culverts are not provided at the road embankment. Run off from road surface can reach the tank which is used for irrigation.
121+100 - 122+100	121+440	Size of the culvert is adequate for the irrigation canal. However, the location of the culvert is not suitable.
122+100 - 122+700	122+150	75m bridge is adequate and the minor river training required will have no adverse impacts
123+500 - 124+000	123+480	Viaduct provided from 123+380 to 123+705 is enough to ensure the whole Welamitiya Oya and its flood plain to drain. Therefore no flood level increase is expected.
124+050		Viaduct at 123+975 - 124+100 is enough to clear the Anicut and Dikinda Ela. Unless the piers of viaducts obstruct the Anicut and the stream flow, there will be no adverse impacts.
124+100 - 124+550		From 124+100 to 124+300 stream diversion is required. It is not included in the design drawings.
124+960		The 60 m bridge provided is adequate to cover the skewness of the stream and therefore no impacts are expected
125+200 - 127+200	125+260	Culvert provided is enough for flood discharge. There is a cascade tank system upstream and downstream of the proposed road. Surface runoff towards the tanks may be disturbed if adequate culverts are not provided at the road embankment. Run off from road surface can reach the tanks which are used for irrigation.
	125+720	No culvert is provided. May not be able to divert to the culvert at 125+620.
	126+700	The 75m bridge is enough for the flood discharge in the stream.
	126+900	Proposed road intercepts a small tank. Almost half of the water spread area of the tank is occupied by the road embankment.
128+120		Bridge is enough for flood discharge. Stream at 128+220 should be diverted through the bridge at 128+120
128+700		Viaduct from 128+625 to 128+800 ensures free flow of Dambulu Oya and no adverse impacts are expected
128+700 - 129+600		Downstream of a small tank. 20m bridge proposed for the lead away canal of the spillway of this small tank is adequate
130+300		60m bridge provided is adequate. However, the nearby Anicut will be affected due to the road embankment.
130+300 - 131+800	130+980	At 130+980 a culvert has not been provided for the stream. There is a well at 131+020 which will be inside the embankment. Bridges at 131+160 and 131+680 are adequate for those small streams and therefore no adverse impacts are expected
	131+800	Road embankment is to occupy most of the water spread area of the tank. Command area (0.6 ha) will no longer be irrigated.
133+715		Stream can be sent through the under pass bridge. No adverse impacts are expected.
134+250 - 137+456	134+020 - 134+260	River training required at Thammanna Ela.
	134+180 - 134+260	Anicut gates are cleared under the viaduct. However stream is closed at immediate upstream of the Anicut and the retention area of the Anicut is reduced.
	134+440 - 134+580 134+960 - 135+200	River training is required at Thammanna Ela.
	135+670	2.0x 2.0 culvert provided may not have enough height during a flood. Free flow through the culvert can be affected
	136+300	Viaduct from 136+205 to 136+380 is enough for Mirisgonya Oya flood discharge. No flood level rise is expected

4.2. Social - cultural impacts

The proposed central expressway has been designed to be constructed having a minimum social impact on existing human settlements and social institutions functioning in the selected Districts. The proposed route of the expressway has been carefully selected after paying special attention to achieve the prime objectives of constructing it while avoiding all the possible adverse social impacts on people and their settlements in and around the project area to the fullest extent. But, even after such scientific planning, unavoidable technical and other requirements of an expressway construction project itself have some social impacts. The magnitude of the social impacts may be perceived as low by the project proponents relative to the colossal nature of an expressway whereas the communities and their institutions tend to perceive the magnitude of the same social impact much more seriously in terms of the socio-cultural and economic importance of the properties to be acquired for the project and affected by it and the consequent issues that they have to suffer from. Therefore a team of researchers gathered information on the social impacts of the project and perception of people. The following sections discuss these.

4.2.1 Impacts during the Construction Stage

4.2.1.1 Social impacts on settlements.

The sections 1, 2 with Ambepussa link and 4 of the proposed expressway run through 163 GN Divisions located in 18 DS Divisions affecting about 8380 land owners with 5231 Acres of lands. Private land owners account for nearly 93% (7778) of them. Around 4557 building structures are to be affected requiring permanent relocation for about 75% (3438) of them.

Table 4.9: Social impacts on settlements.

Section 1 & 2

Type of Structure	Partially Affected	Fully affected but can be relocated in the same land	Fully affected need to be relocated elsewhere
Residential	326	12	1786
Trade/Business	24	14	186
Combined House Shop	07	0	17
Shed	93	0	250
Factory	2	0	3
Stores	14	0	83
Others	138	23	501
Total	**703**	**49**	**2826**

Section 4

Type of Structure	Partially Affected	Fully affected need to be relocated	Fully affected need to be relocated elsewhere
Residential	25	205	470
Trade/Business	17	18	34
Combined House Shop	1	4	7
Shed	2	118	51
Factory	0	0	4
Stores	1	13	12
Others	5	37	34
Total	**51**	**395**	**612**

Each GN Division consists of 2-3 villages. Accordingly, about 489 villages or rural communities would be affected by the project depending on their locations. As was observed in the field studies, all the settlements had deep rooted cultural and social structures evolved in those areas for a considerable period of time since

their occupation. Well grown home gardens and high grown coconut, jak and other domesticated trees stand as evidence of their long term settlements. Almost all the community needs are met by well-organized social institutions in all the areas. This particular social organization and its environmental background may undergo a drastic change with the construction and operation of the proposed expressway. This long lasting change of the area requires resettlement, re-adaptation, reintegration and relocation of affected people to restore smooth functioning of the communities with a new expressway in their vicinity or adjacent area.

4.2.1.2 Social impacts of relocation of communities.

An indispensable requirement of road construction is the acquisition of lands identified by the particular design of construction for the permanent use of the proposed project. Accordingly, the proposed expressway requires relocation of families and institutions directly affected by the acquisition of lands for the main road and all the proposed interchanges. Permanent relocation is required for the families and institutions living and working on lands to be acquired for permanent use of the project purposes. Temporary requirements of lands for the period of construction may also compel certain number of families and institutions to be relocated. In particular, families and institutions located near (1) deep cuts, (2) land filling areas, (3) rock blasting areas, (4) asphalt and concrete mixer plants, (5) metal crushers, (6) stores containing harmful materials including explosive, gas and fuel, (6) work camps, (7) temporary soil dumping sites, (8) closed access roads for project purposes, (9) areas vulnerable to project-caused inundation and families with disable members, members suffering from chronic illnesses, pregnant mothers, who should not continuously expose themselves to the dust, noise, and other negative impacts of the project activities may require temporary relocation.

Permanent and temporary relocation are compulsory requirements of the project and resettlement is one of the main concerns of the people in the project site. During public consultations with communities, members of the elderly generation were complaining over this issue of relocation on the assumption that they do not have capability of constructing new shelters and reintegrating themselves to an alien social and geographic environment. They desperately seek alternatives to the project that assure their continuous enjoyment of life in the same communities. Some have refrained from making the aging parents aware of the project as they feel that the aging parents may find it difficult to tolerate it and have a serious psychological impact. This is because of the attachment of elderly people to their home gardens and paddy fields.

The impact of relocation is felt by the communities as an uncertainty of life, developing their properties, future settlement and livelihood, education of children, care of elders, and individual capacity to face an unexpected challenge. This sense of uncertainty and anticipated repercussions are aggravated by the preliminary activities of the project such as the social and other surveys, public consultations and media reports and various rumors on the project and its locations. Being irritated and unhappy with such impacts some expressed strong opposition to the project stressing the fact that they may tolerate any impact of the project but not relocations.

4.2.1.3. Impacts of land acquisition

Land acquisition has a serious social impact on the communities and institutions in the project affected area. Depending on the land requirements of the project, land owners may lose their land fully or partially giving rise to number of issues and hardships such as landlessness for some families, decline in the profitable use of remaining portions of land, reduction in the paddy fields, issues of cultivating the remaining portions of wet and high lands and encroachment of acquired lands without proper demarcations and protection.

Acquisition of a paddy field for the proposed project may have an adverse impact on the availability of arable wetlands in the three districts as the expressway traverses through paddy lands for a considerable length of it. Even though such a selection of lands saves the high lands with human settlements, there is no way of replacing the quantity of paddy fields that produce the staple food of the nation. People of the project affected communities are highly concerned about the acquisition of paddy fields as they have been the main means of

their sustenance for centuries. A historical and ancestral value is found in some paddy lands belonging to laymen and they enjoy the possession of them as a social status. This project is also due to acquire few lands coming under the ownership and control of some Buddhist temples. They are considered as sacred properties as they had been offered to the Buddha Sasana and for exclusive use of Buddhist institutes. However some lands have been occupied by people for cultivation and residential purposes with the due permission of those temples and even making some periodical payments.

The land owners are concerned about the price that they would be given by the government and the time that they would be paid the compensation. They are afraid of getting a low value for their lands and compensations through a difficult process protracted for years and characterized with bribery and corruption.

According to the filed surveys the proposed project has some positive impacts on the use of lands by people in certain areas. In particular, less productive paddy lands were found in the Gampaha district and they remain as abandoned fields due to inundation and higher cost of cultivation. The owners are happy about the acquisition of such paddy lands at a reasonable compensation which may enable them to find productive alternative means of sustenance in lies of less productive and abandoned paddy fields. Accordingly the proposed project transforms the use of lands turning less productive and abandoned lands into economically productive while enabling the affected people to find productive livelihoods.

Positive impacts are anticipated by residents having settlements in areas frequently affected by inundations in the Gampaha district. Acquisition of such low lands with human settlements for the construction of the expressway may transform the use of lands which are not suitable for human settlements into economically productive lands providing the affected residents with safe settlements in other selected areas. People of such low lands expressed their positive response to the project route on the above anticipation of finding a solution to the issues of living in those flood affected areas.

People residing in lands that belong to temples and other laymen were also happy about the acquisition of their residential areas on the assumption that the project would resettle them with permanent property rights.

Table 4.10: Impacts of land acquisition

Section	Residential	Trade & Business	Non-Agriculturl	Agricultural	Total
Section 1 & 2	98,291	15,265	50,100	354,267	**517,923**
Section 4	87,934	2,938	16,611	211,517	**319,000**
Total	**186,225**	**18,203**	**66,711**	**565,784**	**836,923**

4.2.1.4. Impacts on livelihood.

The proposed project has a considerable social impact on the livelihood and economic activities of the communities under consideration in the period of construction and operation of it in the long run, even though it has been designed to gear up the national economic development. The national objectives of infrastructure development are to be achieved at the cost of livelihood and economic activities of a considerable portion of population to be directly and indirectly affected in 183 GN Divisions. Apart from the resettlement issue, they are highly concerned about adverse impacts on their livelihood after relocation and being unable to continue their economic activities. They will experience full and partial loss of seasonal harvest from agriculture and earnings from agricultural labor and business due to the negative impacts of the project. Even the temporary resettlement requirements will deprive them of the economic benefits of home gardens and the social support of communities. Uncertainty of project activities, prolonged periods of construction works, negligence of the negative impacts on community and bureaucratic sluggishness to address community issues within a reasonable period of time may further aggravate the issues of livelihood

and economic activities of people. The proposed expressway traverses causing a bifurcation in rural and urban communities and this rigid separation has a negative impact of the economic activities of people as they are compelled by this separation to find new access roads and means of transportation from their residences to places of work, markets and other services. Closure of easy access by the expressway may deprive people of livelihoods by reducing work and business.

The construction work in paddy lands may obstruct the irrigation systems and their regular operations disrupting the cultivation of fields connected to the work sites or affected by soil erosion, project-caused inundations, and temporary access roads and dumping of materials and soil. Closure of irrigation canals may bring about an adverse impact on the cultivations and their harvest.

4.2.1.5. Social impact on infrastructure facilities.

The project may cause temporary social nuisance as a result of its impacts in the course of construction on the existing infrastructure facilities such a road and transport, public utilities, housing and common properties. As the expressway has been designed to traverse through paddy lands, forest land and sparsely populated area for a considerable length of it, any impact on infrastructure facility remains minimal. However, when it crosses paddy lands it may disrupt the smooth operation of the irrigation systems and change the direction of drainage systems of highlands under the cultivation of coconut and other crops. It may disturb the use of public and private roads at places where the expressway runs crossing such roads or in parallel to them. The construction requirements may affect the power transmission lines, telecommunication lines, water distribution lines, use of cemeteries, public parks and play grounds and community centers. The project may also directly or indirectly affect the peaceful environment of some places where schools, temples, hospitals, hotels, religious centers, markets and bus stands are located. Construction work definitely increases the frequency of using public roads and the volume of vehicles carrying construction materials to the project sites. Consequently, public roads and all the access roads may be seriously damaged unless they are not properly maintained. In particular, transportation of soil, sand, metal and asphalt by means of heavy vehicles from remote areas causes road damages in all the roads they use regularly. Therefore, impacts on road infrastructure are not confined to the project sites but to other areas connected to the project for supplying materials.

4.2.1.6 Impacts on Land Use

Lands remain the most important resource in all the affected areas of the proposed project. Land use can be analyzed in terms of residential use, trade and commercial use, agricultural use and barren and nonagricultural lands. As was evident from the surveys conducted for the project over five thousand acres of lands are to be affected by the project. In the first and second sections of the project alone, over 3000 acres would be affected and 10% of them remain barren lands whereas 69.5% and 17.2% are used for agricultural and residential purposes respectively. Business and trade accounts for 0.3% of affected lands. In the section from Kurunegala to Dambulla over 1993 acres would be affected and only 5.2% remains barren lands. Among the rest, 66.3% and 27.6% are used for agricultural and residential purposes respectively. Business and trade account for 0.9% of affected lands. The agricultural use of lands varies according to the types of crops cultivated. As the project has been designed to have a minimum impact on human settlements, it traverses through paddy fields and other cultivations having a considerable impact on the agricultural use of them in the future.

4.2.1.7. Impacts on public safety and health

As the nature of the proposed project is concerned with reference to sites of construction and types of work to be carried out, one cannot underestimate any possible negative impact on inhabitants of 163 GN divisions as well as the work force of the project. Any development work without proper precautionary measures has the probability of causing harm on people. Use of heavy vehicles, machines, explosives, and deep cuts and land filling in hilly sites may endanger work and life in and around such areas. As the population in the 163 GN

Divisions is concerned it has to be remembered that over 30% is below 19 years and all are active in schooling and moving in the society. Construction of a new expressway is a new experience for inhabitants of the project areas and they may visit the project sites without any knowledge of possible accidents or harmful effects of work sites.

Unless due attention is paid to the protection of public health, certain project activities and sites such as work camps, dumping of materials, garbage, may cause health hazards in those areas under the influence of such issues. In particular, Dengue mosquitoes may find enough breeding ponds in work sites and unprotected places. Careless disposal of human waste, garbage and industrial waste may contaminate the ground water of wells and this factor should not be taken for granted as the majority of families get drinking water from wells.

4.2.1.8. Impacts on traffic

The proposed project requires a considerable period for construction which may be prolonged for years. In such a project any incomplete work in a traffic sensitive location may continuously hamper the smooth flow of traffic on the main roads. Construction requirements and continuous transportation of materials in rush hours of morning, school closing time and evening may cause traffic jams in all main roads providing access to work sites of the project.

4.2.1.9. Impact on Cultural, Historical, Archaeological Heritage Properties and Aesthetics

Impacts to the cultural, historical and archaeological heritage properties and their attributes were assessed mainly based on physical proximity and geo-morphological nature between the property and expressway, also access roads in the particular area considered too. Main priority given for properties those located in 120 m road corridor (direct impact), and then + 500 m either side of the centreline, in addition beyond that margin (indirect impacts).

Among the identified properties there are three (3) properties has been considered as direct impact as at least part of property crossing the 120 m road corridor due to expressway construction. Eighteen (18) properties identified as indirect high impact, eight (8) properties with indirect middle level impact and nineteen (19) properties that will have indirect low impact due to expressway construction

Table 4.11: Summary of possible impact level from Kadawatha to Dambulla

Title/ Name of the Property	Type	Distance to EW (m)	GPS Coordinates	Impact Status
Sri Jayasumanaramaya	Temple	150	7° 4'6.80"N	Indirect
			79°56'48.14"E	High
Yatawatta Purana Viharaya	Temple	400	7° 5'19.08"N	Indirect
			79°59'10.90"E	High
Sri Bhodi Sanwardana Samithiya	Temple	250	7° 5'54.35"N	Indirect
			79°59'30.97"E	Middle
Sri Mangalarama Temple	Temple	450	7° 5'59.26"N	Indirect
			79°59'27.17"E	Low
Purwarama Purana Viharaya	Temple	100	7° 6'12.44"N	Indirect
			80° 0'25.37"E	High
Sri Wardana Piriven Mulamaha Viharaya	Temple	500	7° 7'30.84"N	Indirect
			80° 1'43.60"E	Low
Kandoluwawa Bauddha Sanscruthika Madyastanay	Temple	500	7° 7'31.30"N	Indirect
			80° 2'10.40"E	Low

Title/ Name of the Property	Type	Distance to EW (m)	GPS Coordinates	Impact Status
Magalegoda Purana Viharaya	Temple	300	7° 8'0.70"N 80° 2'11.50"E	Indirect Middle
Sumiththa Sri Sunandarama / Dadagamuwa Rajamaha Viharaya	Temple	250	7° 8'11.60"N 80° 3'6.60"E	Indirect High
Sri Janaraja Viharaya - Danvilana	Temple	100	7° 8'56.96"N 80° 3'35.99"E	Indirect High
Sri Jayasundara Vidarshanarama Purana Rajamaha Viharaya	Temple	200	7°10'35.28"N 80° 4'7.27"E	Indirect High
Somaramaya Aramaya	Temple (Aramaya)	60	7°12'41.50"N 80° 6'19.80"E	Indirect Middle
Khemaramaya Aramaya	Temple (Aramaya)	175	7°13'18.10"N 80° 6'39.19"E	Indirect Middle
Sri Munindaramaya	Temple	100	7°14'42.85"N 80° 6'41.22"E	Indirect High
Hakurukumbara Purana Viharaya	Temple	200	7°15'19.70"N 80° 7'26.10"E	Indirect High
Sri Purana Paththini Dewalaya	Shrine	200	7°16'7.30"N 80° 8'10.20"E	Indirect Middle
Sri Shailarama Galdeniya Temple	Temple			Indirect High
Sri Gangarama Viharaya	Temple	100	7°22'27.95"N 80°11'49.44"E	Indirect High
Sri Shailarama Purana Rajamaha Viharaya	Temple	225	7°22'57.85"N 80°12'16.74"E	Indirect High
Malpitiya St. Sebastian Church	Church	60	7°26'31.34"N 80°20'24.46"E	Indirect High
Bothale Walauwa	Monument	150	7°14'53.57"N 80° 9'52.68"E	Indirect High
Thalagama Rajamaha Viharaya	Temple	90	7°15'2.91"N 80°10'53.27"E	Indirect High
Digampitiya Purana Viharaya Temple	Temple	800	7°29'26.74"N 80°24'53.38"E	Indirect Low
Walasgala Rajamaha Viharaya Temple	Temple	400	7°30'8.33"N 80°24'44.49"E	Indirect Middle
Kongaswala Sri Nandaramaya Temple	Temple	700	7°30'35.26"N 80°25'16.00"E	Indirect Low
Bolagama Kubalanga Purana Temple	Temple	300		Indirect Middle
Kongahagedara Sri Darmavijeyaramaya	Temple	0	7°31'2.57"N 80°27'37.10"E	Direct

Title/ Name of the Property	Type	Distance to EW (m)	GPS Coordinates	Impact Status
Ranaviru Village Temple	Temple	200	7°31'25.20"N 80°27'46.90"E	Indirect High
Shrine Tree Place	Shrine	160	7°31'37.90"N 80°27'56.70"E	Indirect High
Nebilikumbura Galviharaya Temple	Temple	450	7°31'54.70"N 80°27'54.00"E	Indirect Low
Al Masjidur Jumma Mosque	Mosque	300	7°32'11.10"N 80°28'12.10"E	Indirect High
Dethilianga Sri Jinarathanaramaya Temple	Temple	250	7°32'11.90"N 80°28'35.40"E	Indirect High
Nida-ul-islamJumma Mosque	Mosque	800	7°32'29.83"N 80°29'6.77"E	Indirect Low
Kirindigolla Megagiri Historical Temple	Temple	2000	7°33'25.31"N 80°27'50.74"E	Indirect Low
Al Fridous Mosque	Mosque		7°32'56.49"N 80°29'25.52"E	Indirect Low
Temple	Temple	700	7°34'42.50"N 80°29'13.10"E	Indirect Low
Gopallawa Purana Gallen Temple	Temple	700	7°35'42.90"N 80°29'41.70"E	Indirect Low
Sri Sumanarama Temple	Temple	1000	7°36'1.90"N 80°30'57.60"E	Indirect Low
Gangamuwa Rajamaha Viharaya	Temple	1100	7°36'31.64"N 80°29'47.30"E	Indirect Low
Sri Jinendraramaya Temple	Temple	300	7°37'7.80"N 80°30'48.30"E	Indirect Middle
Humbulugala Aranya Temple	Temple	500	7°39'43.10"N 80°31'56.00"E	Indirect Low
Bambawa Rajamaha Viharaya Temple	Temple	0	7°44'44.65"N 80°34'20.89"E	Direct
St Jude Church	Church	1250	7°45'2.20"N 80°33'47.13"E	Indirect Low
Masjidul Hudha Jumma Mosque	Mosque	1350	7°45'19.12"N 80°34'0.57"E	Indirect Low
Namadagahawaththa Jumma Mosque	Mosque	1500	7°45'59.04"N 80°34'50.04"E	Indirect Low
Ashokaramaya	Temple	700	7°48'12.41"N 80°36'53.66"E	Indirect Low
Dambulu Rajamaha Viharaya	Temple	1800	7°51'21.27"N 80°39'7.11"E	Indirect Low
Sri Bodhirukkarama Viharaya	Temple	0	7°51'49.28"N 80°40'4.20"E	Direct

Kongahagedara Sri Darmavijeyaramaya

The recently developed temple established based on an ancient Bhodi Tree which is nearly 200 years old, located along with the village road. A surrounded wall (Bhodi Prakaraya) is well developed with Buddha statues. A previously developed old small building is not in use and a small scale Image House, Sangawasaya and couple of other properties being constructed. Couple of programmes and services being conducted by the temple.

Small scale Image House, Sangawasaya and couple of other properties partially laid on proposed Expressway corridor (55 m) and therefore this temple can be considered under the direct impact and if the same road design will be implemented above properties will be demolished. The Ancient Bhodhi Tree and surrounded wall located around 80 m away from the centerline of expressway (L) and due to construction very high impacts can be projected. There is no geo-morphological barrier between expressway and the temple. Most of construction impacts such as noise, vibrations, dust, gas, particles, air and water pollution, water stagnation…etc can be projected. Impacts and damages from construction material aggregates can be expected. Access road can be completely blocked and community will lose their religious rights.

Bambawa RajamahaViharaya Temple

The area is known for pre-historical value and established before the Buddhism in the country, said linked to Kuveni's father's period. (Before 500 BC). Archaeological and historical remains exhibit well-developed establishments occupied in the area before construction of the present temple. Even though information not available for having pre-historical evidences likes stone tools and assemblages, there is likelihood to find the same. Rock cave with inscriptions, rock implements having extraordinary carvings, engravings, designs and formations…etc and other attributes exhibit Anuradhapura and cascade period's occupation. Many attributes including Bhodi Tree, Image Houses, Dagaba/Chaitya, Sangawasya/ Office, Dharmashalawa, Shines…etc can be seen. A lake located left side and surrounding area belonged to temple has added great value to the temple.

Expressway will runs through left side of the temple and around 300 – 100 m away from main heritage attributes. But the lake which is belonged to the temple and lake left boundary and couple of other attributes will be included to 120 m expressway corridor. Therefore this temple can be considered under the direct impact and if the same design will implement above attribute will be destroyed. Pre and historical attributes of the temple located nearly 200 – 300 m closeness to expressway construction centre line will be faced very high construction impacts. Most of construction impacts such as noise, vibrations, dust, gas, particles, air and water pollution, water stagnation…etc can be projected. Impacts and damages from construction material aggregates can be expected. Access road can be blocked and community will lose their religious rights. Due to labour camps in the area, there can be inconveniences to temple and may be occurred to regular programmes of the temple. Temporary floods may be expected if lack areas get blocked during rainy season. If any archaeologically important remains/ artefacts exist in surrounded area may be damaged.

Sri Bodhirukkarama Viharaya

The temple does not reflect historical background. A completed temple with all attributes like Image House, Chaitya/Dagaba with surrounded wall, Office, Sangawasaya, Dharmashalawa, Bhodhi Tree and other buildings.

Expressway corridor of 120m running through a part of the temple premises and couple of attributes will be demolished and damaged if the present design will be implemented. There is no geo-morphological barrier between expressway and the temple. Most of construction impacts such as noise, vibrations, dust, gas, particles, air pollution…etc can be projected. Impacts and damages from construction material aggregates can be expected. Access road can be blocked and community will lose their religious rights. If any labour camps occurred in surrounded area there can be inconveniences to temple and regular programmes of the temple.

4.3. Ecological Impacts

This section identifies primary activities that have the potential to cause significant ecological impacts during the construction and operational phases of the proposed CEP – Sections 1, 2 and 4. Potential significant ecological impacts are discussed with reference to terrestrial and aquatic ecosystems.

4.3.1. Ecological impacts during the Construction phase

Construction phase of the project involves vegetation clearance along the main trace and material supply roads, erecting storage yards and worker camps, ground excavation, cutting, filling, rock blasting, piling and other civil works typically involved in road construction projects. These can potentially have serious ecological repercussions and most of these impacts are location-specific.

Ecological impacts on Terrestrial Habitats

4.3.1.1. Loss of Natural Habitats and Habitat Fragmentation

A larger proportion of the proposed CEP is located on heavily or moderately modified habitats by humans (mainly agricultural ecosystems and home-gardens). Most of the sensitive natural habitats have been avoided during the initial design of the expressway. Yet, there is a substantial loss of natural terrestrial habitats due to the proposed project. Loss and fragmentation of natural habitats will occur due to the required clearing of a corridor for the ROW and a larger area at the interchange sites. Additional clearance can be anticipated due to the broadening of access routes, sites for temporary/permanent structures for storage of construction material, burrowing sites and quarry sites. The impact will be most severe in areas where forests (naturalized plantation forests, hill tops) are required to be cleared.

Landscape connectivity is the degree to which the landscape facilitates animal movement and other ecological flows. High levels of landscape connectivity occur when the area between core habitats in the landscape comprise relatively benign types of habitats without barriers, thus allowing wildlife to move freely through them in meeting their biological needs. Landscape connectivity is important for two reasons:

- Many animals regularly move through the landscape to different habitats to meet their daily, seasonal and basic biological needs.
- Connectivity allows areas to be recolonized, for dispersal, for maintaining regional meta-populations and minimizing risks of inbreeding within populations.

Reduced landscape connectivity and limited movements due to roads may result in higher wildlife mortality, lower reproduction rates, ultimately smaller populations and overall lower population viability.
Construction of the highway involves cut and fill operations. In places where filling operations are required, the highway goes on earth-filled embankment. Such earth-filled embankments act as strong barriers for animal movement. In places where cutting operations are involved, the fragmentation effect of roads occurs as animals become reluctant to move across roads as they perceive moving vehicles as a risk or because they have to cross over a widely open area to preferred habitats on the other side.

A. Mirigama Kos Kele Forest

The section between Ch 6+540 and 6+840 of Ambepussa link road traverses through "Mirigama Kos Kele" forest which is a naturalized plantation forest. An extent of approximately 0.67 ha (with an average ROW of 30 m) will be lost permanently from the 57.9 ha forest. The proposed link road will bisect this plantation forest in to two parts with extents of approximately 30 and 27 ha. Hence, the proposed highway will act as a barrier that fragments the entire forest, affecting on the floral and faunal communities negatively (Figure 4.1).

The faunal species living in the forest (especially the mammals, reptiles and amphibians) will be affected as the expressway blocks their free movement between the forest and Maha Oya to the South of the forest. This may be a significant source of water for fauna inhabiting the forest. Blocking of the access to the main water

source can lead to unforeseen human-wildlife conflict as animals may move towards human settlements in search of alternative water sources.

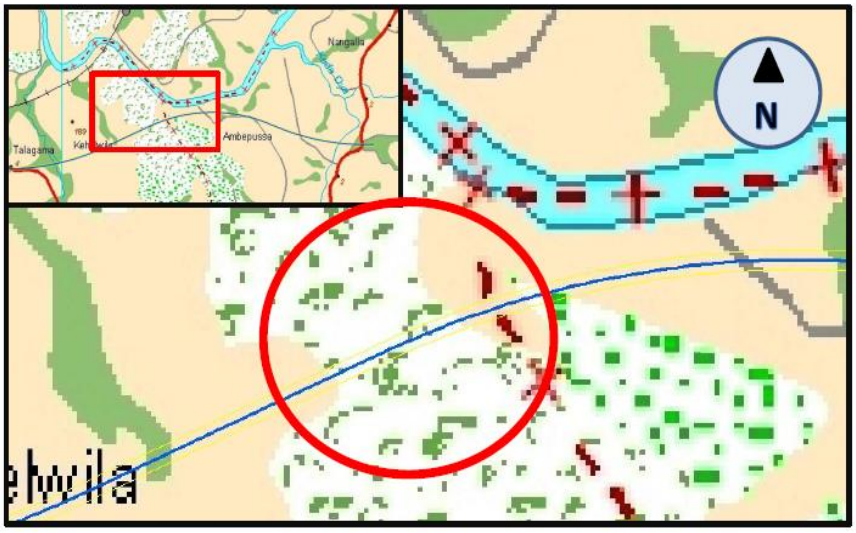


Figure 4.1: Habitat loss and fragmentation of Mirigama Kos Kele Forest (Ch 6+540 to 6+840)

B. Horakela forest

A Horakela forest reserve, which is a small patch of naturalized forest will be bisected by the Ambepussa link road at Ch ≈ 1+970 to 2+170. An area of approximately 0.46 ha (with an average ROW of 30 m) will be lost permanently from the Horakela forest respectively, and this will result in two smaller forest fragments of 7.3ha to the north and 3.5ha to the south. As such, the proposed highway will act as a barrier that fragments the entire forest, affecting on the floral and faunal communities negatively (Figure 4.2). However, the surrounding area of the forest is increasingly subjected to human pressure.

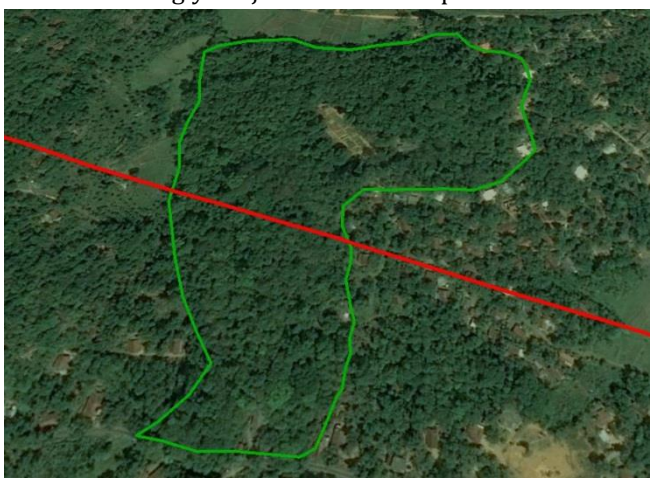


Figure 4.2: Habitat loss and fragmentation of Horakela forest

C. Weragalakanda Forest

Due to construction of the expressway, an extent of about 1.5 ha will be loss (for an average ROW of 60 m) from the total extent of the 164 ha in Weragalakanda forest. The proposed expressway will be passing along the southern edge of the scrub forest. There will be no fragmentation of the forest area, but the construction of expressway may act as a barrier for faunal communities to freely move between different habitat patches (Figure 4.3). The faunal species living in the forest (especially the mammals, reptiles and amphibians) will be affected as the expressway blocks their free movement between the scrub forest and Kuda Oya. Kuda Oya is possibly the main source of water for a variety of fauna inhabiting the forest. Blocking of the access to the

main water source can lead to unforeseen human-wildlife conflicts as animals may move towards human settlements in search of alternative water sources.

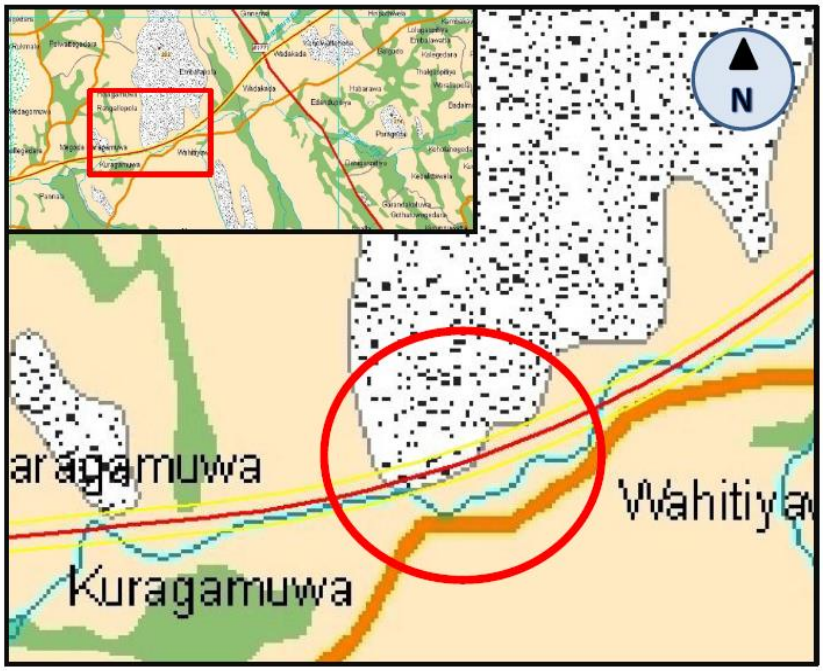


Figure 4.3: Habitat loss and fragmentation in Weragalakanda Forest (Ch 58+550)

D. Kiridigolla Forest

This Jak-Mahogony naturalized forest is bordered by the Nikamada estate and the DeduruOya. The stream edge comprises riparian vegetation. The river (Deduru Oya) serves as a source of water for the animals inhabiting the forest. The proposed CEP will pass through the forest close to the edge of the river around Ch ≈ 16 +500, and a narrow strip of forest will be lost. The forest will be cut-off from the river by the roadway by a distance of approximately 310 m (From Ch≈90+020 to Ch ≈ 90 +340). This will affect the faunal species living in the forest as the expressway will block their free movement between the forest and Deduru Oya (Figure 4.4).

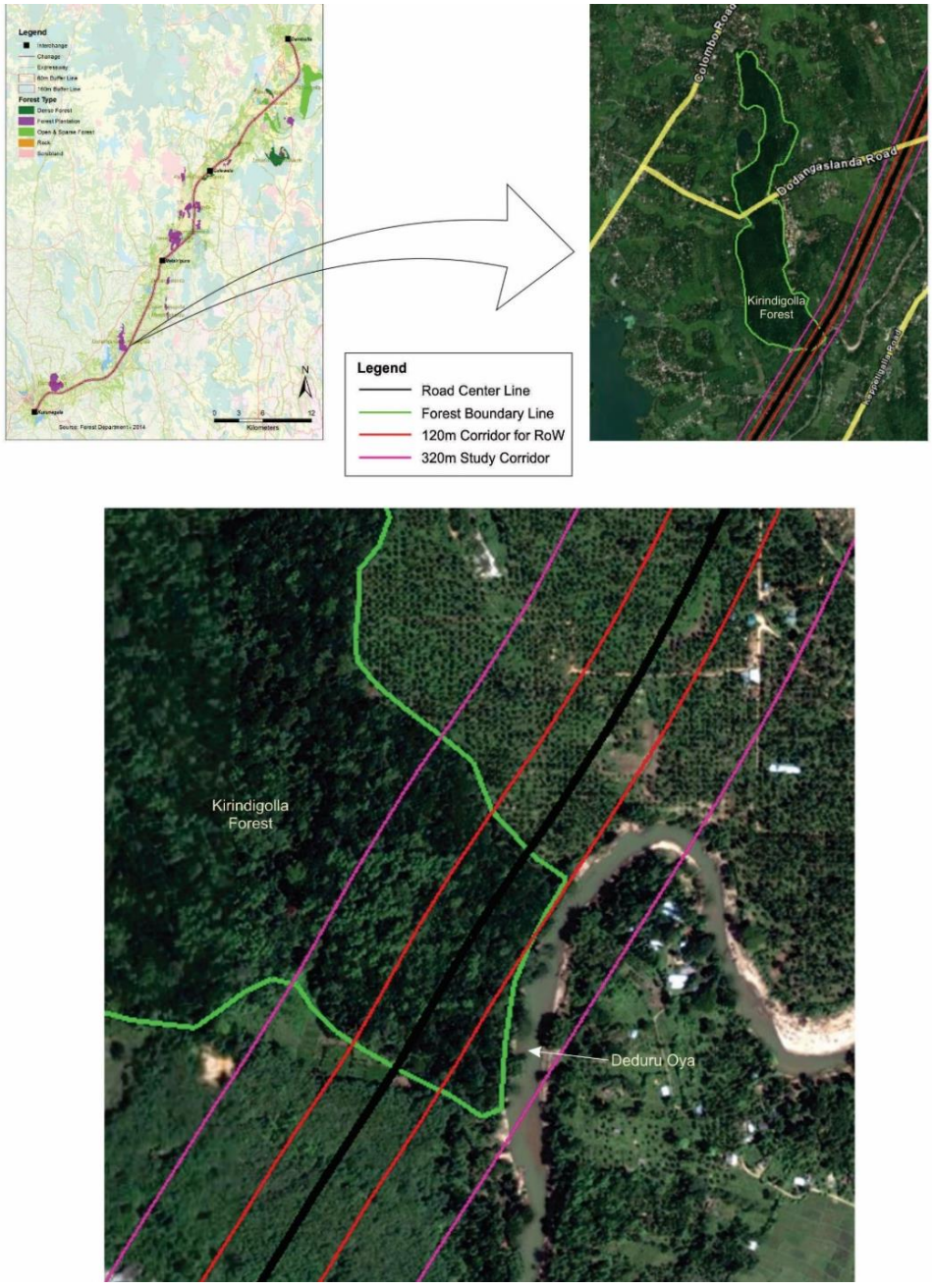


Figure 4.4: Habitat loss and fragmentation at Kiridigolla Forest (Ch 90+020)

E. Henagederalanda Forest

The proposed CEP will traverse the forest's edge at two locations around (Ch≈103+750 to Ch ≈ 105 +000) causing permanent loss of habitats. Further, it will also obstruct access to the adjoining stream which is very likely the water source of the animals in the forest.

F. Hevanethenna Forest Reserve

This forest comprises natural and plantation segments and is declared as a reserve by the Forest Department. This is one of the few healthy natural and naturalized forests found in the Kurunegala area and species such as barking deer, spotted deer and civets are recorded here. This will be fragmented (Figure 4.5) by the expressway in sections Ch≈106+100 to Ch ≈ 106 +500 (≈400m), Ch≈106+800 to Ch ≈ 107+220 (≈420m) and Ch≈107+400 to Ch ≈ 108 +000 (≈600m).

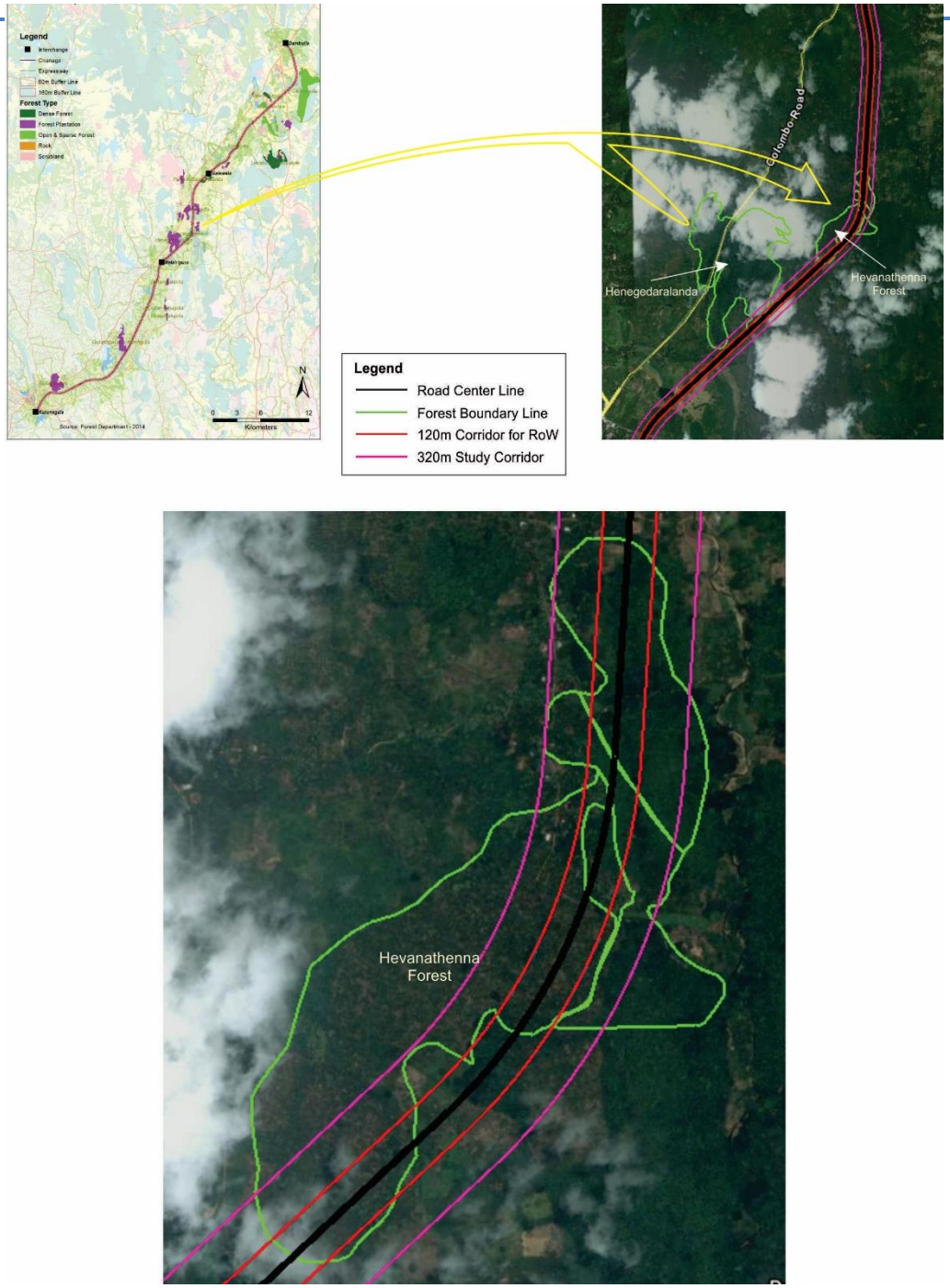


Figure 4.5 : Habitat loss and fragmentation at Hevanathenna Forest (Ch 106+100)

G. Omaragolla Forest

The Omaragolla Forest comprising of planted and natural forests consists of three blocks. A substantial area of the centre block will be lost while the entire forest complex is being bisected by the proposed expressway (around Ch ≈ 110 + 350). The forest is home to a variety of birds and other smaller vertebrates. Their movement between forest patches will be hindered by the road.

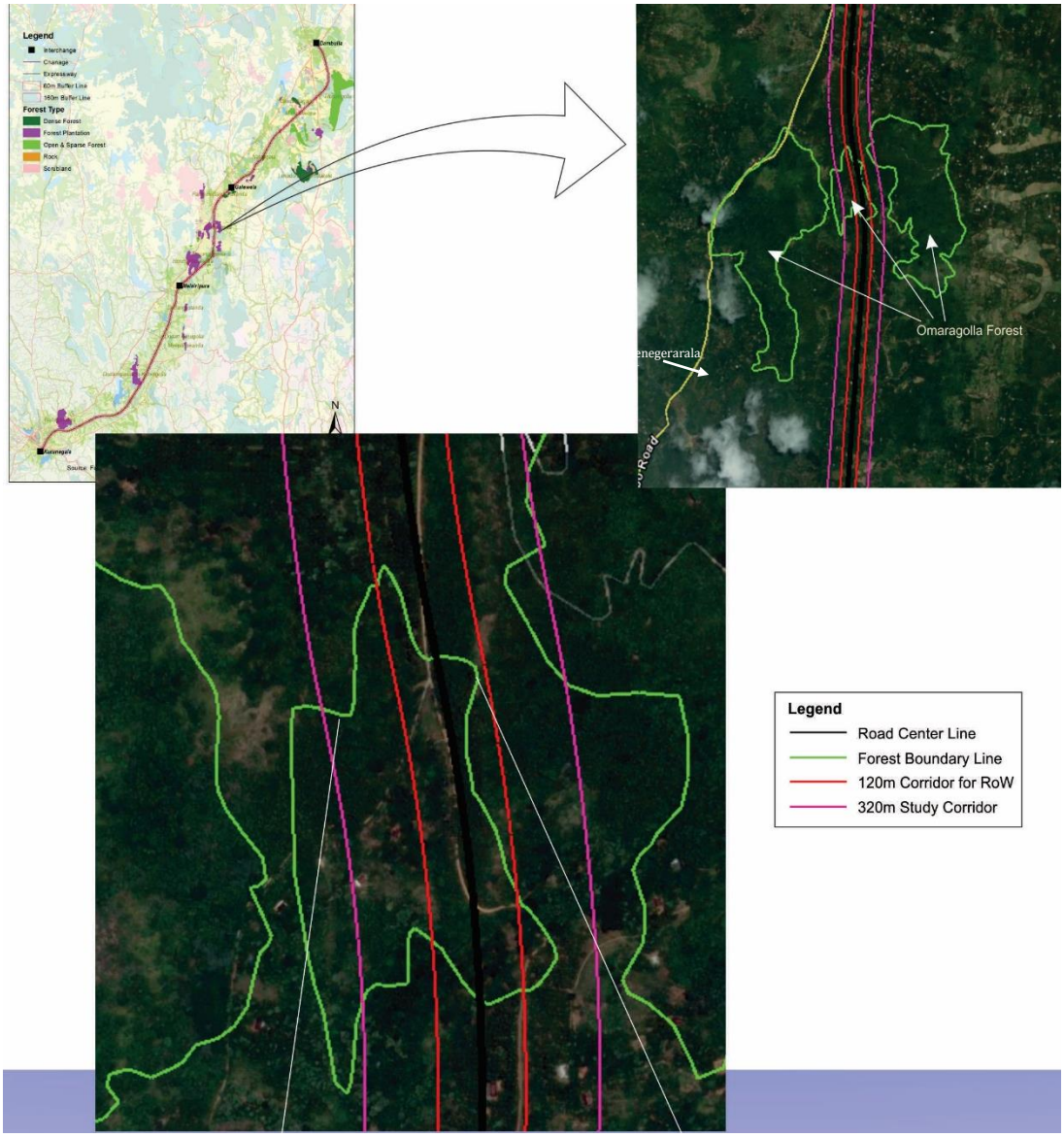
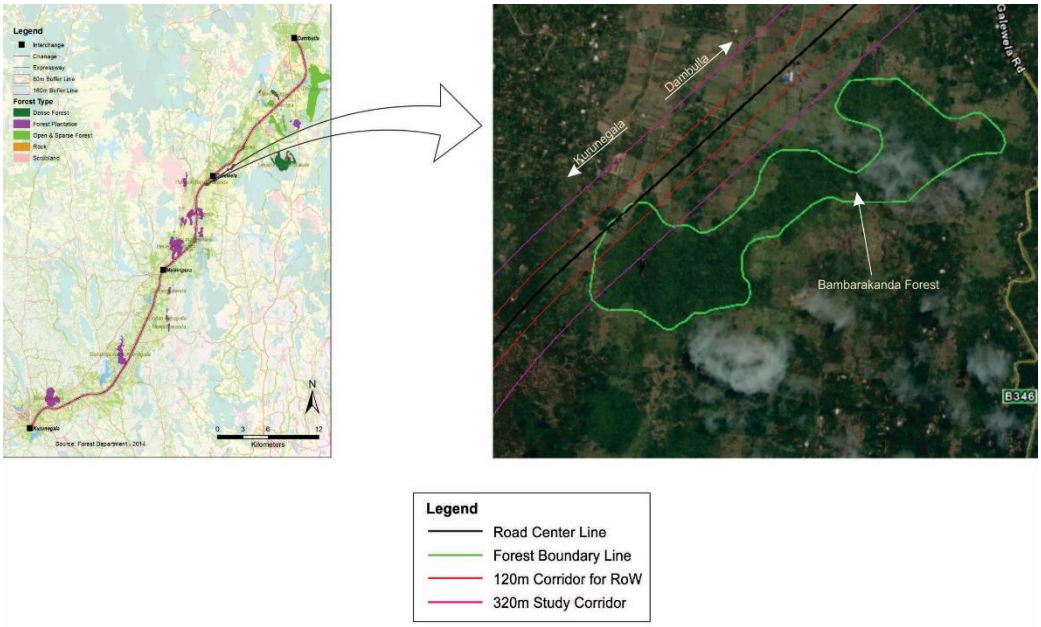


Figure 4.6: Habitat loss and fragmentation at Omaragolla forest Ch ≈ 110 + 350)

H. Bamarakanda forest reserve

The roadway will traverse through this rock-outcrop dominated forest, and a narrow strip of forest will be lost (Figure 4.7).



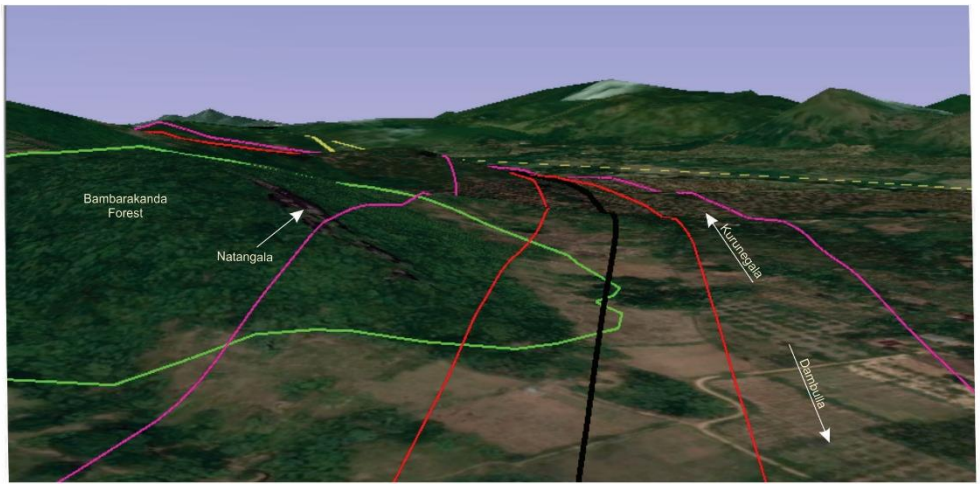


Figure 4.7: Location of the Bambarakanda forest with Natangala hillock

I. Kethiganakanda

Although not declared as a forest reserve, part of this rock outcrop dominated natural habitat will be lost due to the construction of the proposed CEP. The proposed CEP would pass through this forest obstructing access to the Kethigana wewa which is close to this natural forest patch (Ch≈120+450 to Ch ≈ 120+810 ≈360m). The tank and the water canal may be vital as a water source for the animals inhabiting the forest.

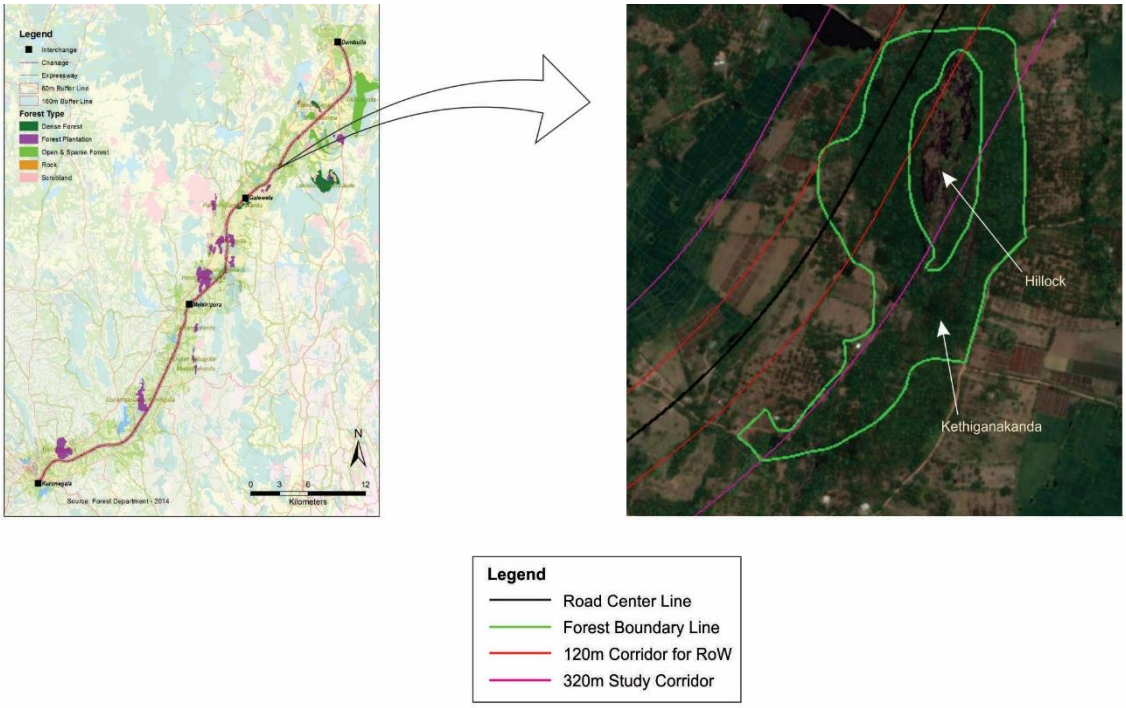


Figure 4.8: Kathigana Kanda Forest

4.3.1.2. Loss and Fragmentation of Manmade Habitats

A larger proportion of the proposed CEP is located on heavily or moderately modified habitats by humans (mainly agricultural ecosystems and home-gardens). Large stretches of paddy fields, coconut plantations, plantations of other minor crops (e.g. papaya, banana) and home gardens which provide key habitats for native flora and fauna will be lost. Field investigations recorded a variety of native and endemic birds inhabiting densely vegetated home-gardens. These home-gardens provide foraging, resting and breeding cover for birds. For many mammals (civets, mongoose, giant squirrels, monkeys and small mammals such as mice and shrews), reptiles and amphibians that co-exist in human modified habitats, the earth-fill

embankments of the road will be a significant barrier, hindering their movement. Alteration of the microclimates in these habitats will further take place, causing long term irreversible impacts on native biodiversity.

4.3.1.3. Ecological impacts due to inappropriate disposal of removed vegetation and soil/debris

Careless dumping of waste/debris on to natural habitats may further cause habitat loss and degradation. The significance and persistence of this impact can vary based on the magnitude, and is highly site specific.

4.3.1.4. Ecological disturbances by workers and their camp operations

Several adverse impacts such as dumping of refuse, sanitary waste and sewage into waterways, clearance of vegetation for worker camp sites, hunting of animal species and collection of fire wood from forests may be particularly intense at camp sites. This may cause pollution of waterways. Open dumping of garbage at these sites could also increase threats of mosquitoes, flies and the spread of rats and crows. Such garbage dumps can attract wild fauna, posing some threats to both humans and wildlife. The nature of impact by workers and their camp operations is moderate and restricted to the construction phase only.

4.3.1.5. Ecological disturbances by construction vehicles and their operations

The proposed project will employ heavy machinery and construction vehicles during the construction phase. Careless operation of such vehicles in sensitive habitats such as forests and near aquatic /wetland habitats can potentially cause severe destructions to native plants, animals and habitats. Soil compaction and disturbances can damage soil seedbank and make it difficult for seedlings to germinate. Oil spills at vehicle parking and maintenance areas may also contaminate soil and water bodies, causing negative ecological impacts. Nature of the impact can be moderate to significant and it is mostly confined to the construction phase.

4.3.1.6. Disturbance due to noise, vibration and dust

Noise, vibration and dust due to large machinery, blasting and excavation have the potential to disturb faunal species inhabiting forests, agricultural lands and home gardens. Noise during civil works, excavations and movement of construction vehicles can potentially interfere with normal animal behaviour. Reported animal reactions include a cessation of feeding, resting, socializing and an onset of alertness or avoidance. As a large stretch of the project affected area is already subjected to substantial human influences, most terrestrial faunal species are already habituated to common human disturbances. But persistent disturbances may cause certain animal species (especially forest dwelling species) to permanently avoid such habitats. Furthermore, deposition of dust and mud on vegetation can interfere with physiological functions of trees. Disturbance due to noise, vibration and dust is a moderate impact, but it can have short to long term impacts depending on the location, nature and scale.

4.3.1.7. Spread of invasive species

The opening of habitats due to partial disturbance and total clearance may assist the spread of invasive species which may not be restricted to the cleared areas but may subsequently penetrate into natural forests. These invasive species (plants or animals) may in turn displace native species. Invasive plant species could also spread from construction equipment. Habitat fragmentation and resulting increase of the habitat edges may encourage domestic animals and urban species to stray into natural forests and possibly pray on wild animals/nests or compete for same resources. This is a moderately significant irreversible impact where the time horizon of the impact may be short and long term.

4.3.1.8. Impacts on Animal Movement Paths

There were no permanent terrestrial animal movement pathways observed in the project area. Occasional elephant movements across the existing Ambepussa – Dambulla road, closer to Dambulla and Galewela have been recorded, but the proposed highway route has not been recognized as a frequent elephant movement path. The faunal species living in the forest patches identified above, will be affected due to the construction of expressway as it acts as a barrier and bisects the movement path between adjacent habitat patches/different resource areas such as water bodies/streams (some case-specific examples have been discussed above).

Especially the mammals, reptiles and amphibians will be affected due to this separation. If any under/over passes is not provided to allow the free movements of wild animals living in forest patches mentioned above, unforeseen human wildlife conflicts may occur.

4.3.1.9. Added threats to flora and fauna

Excavation and borrowing will result in temporary pits or trenches being created which may expose animals to danger of falling. Hunting may increase as the displaced animals leave forests that are cleared or disturbed and fall prey to hunters. Mosquito menace may increase if such pits are filled with rain water. Clearing up forests and opening them may also facilitate the infiltration of feral predators. This is a medium short term irreversible impact.

Ecological impacts on Aquatic Habitats

4.3.1.10. Aquatic Habitat loss and degradation

Large extents of the expressway will traverse through low-lying areas and paddy fields. Hence, construction will require filling of such areas. This will affect the general hydrology of the entire area affecting the biotic community in affected aquatic ecosystems. Change of hydrology may also occur where the proposed roadway travels across rivers, streams and canals. Diversion of Kuda Oya near Ch 20+900 to Ch 21+500 will make negative impacts on the faunal species and riverine habitats along the diversion area. Such changes in the habitat conditions can potentially displace the original biotic community.

4.3.1.11. Impacts due to inappropriate disposal of soil, debris, solid waste and sanitary waste

Careless dumping of waste may cause the blockage of streams and canals affecting the hydrology of the area. This is critical since many of the streams are interconnected with larger rivers which together provide habitats for fish and other aquatic fauna that migrate along them. Thus any change in drainage and flow patterns may affect the entire stream network adversely affecting the fauna in the environs. The nature of this impact can be significant and, short term. It may be irreversible but it depends on site and scale.

4.3.1.12. Obstructions to the movement of aquatic organisms

Many of the streams and rivers are interconnected, forming networks. Fish and other aquatic fauna move across the different streams and rivers because of this connectivity. Any obstruction due to filling or construction of bridges in one of the streams may affect flora and fauna not only at the site of construction but also downstream. This may affect migration of fish along the network of streams leading to local extinction.

4.3.2. Ecological impacts during the Operational phase

4.3.2.1. Road kills

Road kills are one of the most frequently observed adverse effects of expressways. Some of the most vulnerable groups are mammals, (monkeys, mongoose, deer, civets and small cats) and reptiles (snakes, monitor lizards). However, experience with road kills associated with highways elsewhere suggests that, road kills tend to decline with time (Brown & Brown 2013). This may be due to animals learning to avoid risk or individuals ranging in the area being killed due to road accidents.

During the early operational period, it is likely to have an increase in animal road kills caused by high speed vehicles, representing an adverse impact on both domestic and wild animals. Road kills of domestic animals (dogs in particular) is a concern. This is a short term and mostly reversible impact through the implementation of mitigation measures.

4.3.2.2. Animal movements across fragmented habitats

This would continue to be a problem for the animals whose habitats are fragmented by the expressway unless suitable connectivity is provided using the proposed mitigation measures such as eco-ducts, canopy walkways etc. This would particularly affect large mammals such as monkeys, deer, fishing cats, who require sufficiently large home ranges for survival. The nature of this impact is significant, short and long term, and it is irreversible.

4.3.2.3. Loss of vegetation and habitats in the vicinity because of future development

The development of settlements and access roads facilitating human activities are expected to escalate in the vicinity of the proposed CEP, particularly at the locations of the interchanges. This may result in further habitat loss and fragmentation, pollution and erosion. Other impacts that could be anticipated are the illegal felling of trees and hunting owing to the easier access provided by the development of the CEP near vegetated areas. The nature of this impact is high, long term and irreversible.

4.3.2.4. Noise and vibration pollution

Vehicular traffic along the expressway will generate noise and vibration which some animals may not tolerate. Hence, such impacts will cause them to permanently avoid nearby habitats. Some forest birds are especially sensitive to noise disturbances and this will be a considerable impact in places where the CEP traverses forests. The nature of this impact is moderate, long term and irreversible.

4.3.2.5. Ecological Impacts due to pollution

Pollutants found within surface water runoff from the CEP may enter aquatic habitats and affect the quality of the habitat for aquatic flora and fauna. Pollution might also occur due to oil leaks, dust, particles from wear and tear of tyres, and carbon monoxide emissions from vehicles.

4.3.2.6. Spread of invasive species

As a wide strip of vegetation will be cleared on reservations of both sides of the road, such areas will become vulnerable to invasive plants. These species may then spread into natural or anthropogenic habitats beyond the reservation zone. The nature of this impact is moderate, mid to long term, and reversible/irreversible depending on the circumstances.

4.3.2.7. Impacts on aesthetic value

Due to site clearing, cut and fill operations, changes to landscape with artificial structures, shading effect on water bodies under bridges and laying of other concrete structures, the aesthetic value will be impaired in the project area. This impact may be more severe in forested areas.

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4.4. Surface water and groundwater pollution

Section 1 & 2

During construction stage of project

Uruwal Oya, Attanagalu Oya, Diyaelleoya, Ambepussa Kuda Oya, Maha Oya , Kuda Oya, Maguru Oya, Deduru Oya, Kimbulwana Oya, Welamitiya Oya, Dambulu Oya and Mirisgoniya Oya are the main surface water bodies located within the Section 1, 2 and 4 of project area. Irrigation canals and drainage canals could also be observed in the project area.

The proposed construction of highway, interchanges and related facilities, material and machinery yards and storage-related facilities involve activities such as land clearing, extensive cut and fill operations, excavations, blasting and drilling, soil disposal and soil stabilization, construction of access roads and landscaping which would invariably result in surface water quality deterioration mainly as a result of high turbidity and colour, especially during the rainy season. The proposed highway will be constructed on elevated embankments, which demands very large amounts of soil, which has to be transported to the project area. Construction of piers on the river bed will temporarily increase the turbidity of the water and may also affect the flow regime

which will be a permanent impact. This will even lead to high rates of erosion in the area where borrow pits are located and also in sections where there are significant amounts of filling, (Erosion can be expected from freshly placed earth fills and borrow areas until the soil layers are stabilized). Surface runoff from such areas will carry substantial amounts of eroded soil particles, which will cause severe turbidity and colour problems in rivers and streams. Washed off soil and debris from construction sites (during earth operations) flowing in to these water bodies would cause sedimentation which is a major impact on surface water. The sediments may well flow on to nearby paddy fields causing siltation in these fields and affect the yield of such fields. In the Western and North-western Provinces, 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) and north-east monsoon (December-February) periods, respectively.

Considering the huge quantities of soils to be conveyed to the project area from borrow areas located elsewhere, dust and soil spills may also contribute to high sediment loads in road-side drainage, which will then be carried to nearby streams or low-lying areas. Shallow wells located close to access roads, borrow areas and project area may receive considerable loads of wind-borne dust particles. Improper storage of fill material will also be a possible source contributing to high silt loads.

In addition, construction activities such as land clearing, blasting and drilling, dredging etc., could also cause substantial amounts of topsoil to be washed away with runoff. Construction of bridges, culverts and canal systems will occasionally need dredging and bank stabilization, which will increase turbidity in water and also lead to colour problems. Disposal of dredged material may cause impacts similar to, but potentially more severe than, those associated with dredging operation.

A large fleet of construction vehicles, mainly for transportation of earth and other construction material is expected. Washing and cleaning of these vehicles will also contribute substantial amounts of solids to water bodies. Oil spills, fuel and lubricant leakages from vehicles and construction machinery and equipment will contaminate both surface and groundwater. Improper storage of construction material and waste and debris can be a potential source of pollution of both surface and groundwater. Accidental spills/leaks of chemicals used for the construction of pavement, oil and fuel may flow into surface and ground water bodies after mixing with storm water or waste water discharged from worker camps, yards and vehicle service and repair stations. Such a situation would also deteriorate the surface and ground water quality of the project area.

The proposed highway crosses (or passes adjacent to) several rivers, numerous streams, irrigation tanks and low-lying areas. At locations where the highway passes through paddy fields or above water bodies, the impacts of water quality deterioration will be relatively more significant during construction stage than operational stage. Locations such as Bathalagoda, Uda Thuttiri wewa, Meddeketiya wewa, numerous irrigation canals, and major river basins (Attanagalu and Deduru oya and their tributaries) where the highway passes adjacent to these tanks, streams and canals are more vulnerable to siltation from surface runoff.

Another potential impact on water quality can be sewage and municipal solid waste produced by the work force. Unless these are disposed with proper care, inadequate waste handling will cause high levels of BOD, nutrients and pathogens in water. Fairly large quantities of concrete that are required for construction, wash water arising during the cleaning of the machines involved in concrete plant operations or batching plants could cause color and turbidity problems in water bodies and 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. 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.

The project area also contains peat especially in the Gampaha District. Therefore, improper handling and storing of unearthed peat material in storm-water drainage areas can cause solubilization of certain minerals such as gypsum, calcite, halite, dolomite, pyrite, etc. This can result in excess amounts of cations that may

dissolve in run-off and cause hardness problems in nearby water bodies. Furthermore, disposal of the excavated peat material in substantial quantities into nearby waterways could result in acidification of the waters.

Table 4.12 presents a summary of the anticipated impacts during construction phase for some of the activities.

Table 4.12: Anticipated impacts during construction

Activity	Factors Affecting Impacts	Remarks
Construction material, exploitation, handling and storage	Improper handling and storage of construction material; e.g. cement, earth, gravel	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 are 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 are 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	Number of persons employed and displaced due to 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

Human wastes arising from worker camps (during construction), that are not properly treated and are disposed at the point of origin can contaminate groundwater sources and pose a risk of parasitic infections (through direct contact with fecal matter), hepatitis and various gastrointestinal diseases including cholera and typhoid.

Solid and liquid waste disposal from worker camps, storage yards and kitchens and other biologically degradable wastes will produce leachates that demand high amounts of oxygen or undergo anaerobic decomposition. Such wastes can contaminate shallow groundwater, but the conditions will not be long lasting. Seepage from solid waste containing dissolved solids can be attenuated by soil through processes such as precipitation, adsorption and ion exchange mechanisms. Under favourable hydraulic conditions,

contaminated seepage (leachate) from solid waste can pass through the unsaturated soil beneath the solid waste deposit and enter and contaminate groundwater.

Most of the people living in the project area depend on ground water (through wells) for their domestic needs. It has the potential to become a significant social impact during construction of the expressway.

During operational stage of project

During operational stages, with road transportation, there will be spillage of oil, grease and other petroleum products, wear and tear of tyres, which if washed away with surface water, will contaminate surface waters. This will contribute hydrocarbons, oils and trace metals such as Pb and Zn into surface run-off. Bowsers and trucks filled with fuel and other chemicals will move along the expressway. The potential for accidental spills or leaks from such vehicles cannot be ruled out. Such spilled fuel or chemicals may flow into storm water drains and contaminate the surface water in the area. The extent of contamination will depend on many factors such as the type, quantity and concentration of material spilled, and prevailing weather conditions.

Pollution due to improper disposal of wastewater and solid waste generated at transit stations, interchanges, service areas and related facilities can be regarded as one of the potential impacts. Litter thrown away by road users will contribute to pollution of road-side environment. Uncollected refuse clogs open drains and sewers, thereby leading to overflow of wastewater and contaminating the surrounding area. Surface water (and occasionally groundwater) can be polluted when it receives surface runoff that has been contaminated with leachate from landfill areas. Untreated sewage disposed from toilets in the trains has the potential to contaminate surface waters.

Section 4

Surface water and groundwater pollution
The following major waterways will be subjected to water quality degradation.

- Irrigation canal / Pahalagattuwana
- Denagamuwa Ela Irrigation Canal
- Deduru Oya
- Canal linking Bathalagoda Wewa
- Kimbulwana Oya
- Bambawa Temple Wewa
- Large irrigation canal km
- Ketigana Wewa-close to the Walaswewa blasting area
- Uda Tuttiri Wewa
- Welametiya Oya - intersected twice
- Dambulu Oya
- Wewa
- Mirisgoni Oya
- Wewa at Melsiripura Farm
- Meddeketiya Wewa
- Kalugala Ela
- Epitawewa
- Gokarella stream

During the construction phase, material acquired from borrow areas and quarry sites, site clearing, cut and fill operations, land reclamation, excavating drains, spoil disposal, asphalt and concrete plant operations, and construction of bridges and culverts could pollute nearby surface water bodies. Surface run-off from the

cut and fill areas, borrow areas, and spoil disposal sites, have the potential to affect the quality of water. Accidental spills also would potentially cause water quality degradation.

Construction material exploration and exploitation seem to be a major activity of a project of this nature. For the proposed expressway it is anticipated that a substantial amount of the construction material is to be found from quarry sites. These activities could pose significant water quality issues in both surface water bodies and groundwater wells.

Deduru Oya is used by the nearby community for bathing and washing of clothes. High levels of turbidity could cause a nuisance to bathers (Fig. 4.8). During the construction phase, the chances of other pollutants through surface runoff may occur at Deduru Oya but chances are very low.

Figure 4.9: Deduru Oya

Spoil and land clearing debris containing vegetation and solid / rock debris are construction and demolition (CD) wastes which are likely to be generated in large quantities during the construction process. This waste consists of soft inert material (e.g. spoil), hard inert material (e.g. concrete debris, glass material, building material from houses, rocks/rubble) and non-inert material (e.g. metals, timber, plastic and packaging wastes). Improper disposal of such waste may cause sedimentation and siltation of streams, and water and soil pollution.

Improper storage and disposal of chemicals and oils during construction (e.g. lubricating oils, fuel, vehicle/equipment washing effluents) has the potential to enter and contaminate surrounding areas such as productive lands, construction worker camp areas and nearby waterways.

4.5. Geology /Soil Impacts

The proposed expressway is going on along a flat terrain with isolated hillocks. There are some direct impacts in terms of slope stability after the possible road cuts. Therefore, prior to detail designs it is necessary to consider slope stability in such locations with the proper guidance of geologist. In general, rock types, structural features and rate of weathering are necessary to study along the possible road cuts. During road cuts along the mountainous area, there will be a problem on groundwater discharge through the cut slopes. It can affect groundwater stability of the upper slope areas. Such locations should be identified prior to detailed design with the help of the hydro-geologist. For instance, cement grouting should be applied along such slopes in order to maintain groundwater stability.

In addition, rock slides can be expected when road cuts are happening across the escarpment slope of the mountain. Those locations should be studied by the geologist and necessary slope stability techniques such as rock bolting should be applied in such locations.

In general, it should seriously consider the landslide hazard zonation locations given by the National Building Research Organization (NBRO). Potential high risk natural landslide areas should be strongly stabilized prior to the construction with the help of suitable stability methods suggested by the NBRO.

During the road cuts and filling of the embankment, soil erosion and sedimentation in adjacent water bodies will be a severe problem. For instance, during excavation of soil, air quality will be changed due to transport of soil particles by wind. In addition excavated soils can accumulate in the drainage system and surrounding surface water bodies during runoff. Thus the drainage network can be blocked and silting of the surrounding surface water bodies can be expected.

4.5.1.Impacts due to extraction and transportation of material and disposal of soil

Available road network can be effectively utilized for construction activities of the proposed road. Hence, a temporary road network around the area is not necessary. After finalizing the proposed road stretch, it can be used as a road for material transportation. Therefore, there is no significant impact on soil compaction during the transportation of construction material. In general, road slope cut soils can be used as materials for filling of the embankment.

4.5.2. Contamination of soil and ground subsidence

Soil around the proposed road stretch can be directly contaminated by the cement materials to be used for the constructions. Especially when the proposed construction is going on in paddy fields the contaminants can easily mobilize to soil layers due to higher fracture density in paddy lands. According to the general geology of the area, there is no possibility of land subsidence along the proposed stretch.

4.6. Impacts on Air Quality, Noise and Vibaration

4.6.1. Noise impacts on nearby settlements and habitats

Section 1 & 2

During construction stage of project

Due to a project of this nature it is anticipated that there will be a heavy flow of construction vehicular traffic. Therefore, high noise from machinery, equipment and engines (see Table 4.13) and irritating noise emanating from beeping horns and vibration effects of the heavy flow of construction vehicles will cause inconvenience to nearby schools, religious places and residential areas close to the project area. Moreover traffic noise would also have a disturbing effect on the fauna in sensitive ecosystems such as marshy areas.

The proposed trace is located mainly through large tracts of paddy fields, water bodies, lands with other plantations (coconut, rubber) and home gardens. The proposed alignment of Section 1, the final stretches of Section 2 and initial stretches of Section 4 of the CEP are located within urbanized land areas. Noise emissions and vibrations from vehicles and factories are the main sources of existing back ground noise and vibration levels as presented in Section 3.2.7 “Noise and vibration levels”.

With commencement of construction work, the noise levels will increase due to the operation of machinery for various construction activities. The level of noise generated by an equipment will greatly depend on factors such as type of equipment, the specific model, the operation being performed and condition of equipment. The equivalent sound level (L_{eq}) of the construction activity also depends on the fraction of time the equipment is operated over the time period of construction. Table 4.13 presents typical noise levels created by different equipments at approximately 15 m from the source.

Table 4.13: Construction equipment noise emission levels

Equipment	Typical noise level (dB(A)) at 15m from source
Air compressor	81
Backhoe	80
Ballast equalizer	82
Ballast tamper	83
Compactor	82
Concrete mixer	85
Concrete pump	82
Concrete vibrator	76
Crane, Derrick	88
Crane, mobile	83
Dozer	85
Generator	81
Grader	85
Impact wrench	85
Jack hammer	88
Loader	85
Paver	89
Pile driver (impact)	101
Pile driver (Sonic)	96
Pneumatic tool	85
Pump	76
Rail saw	90
Rock drill	98
Roller	74
Saw	76
Scarifier	83
Scraper	89
Shovel	82
Spike driver	77
Truck	88

Source: US EPA, Noise from construction equipment, operations, building equipment and home appliances (Note: these values may vary with site conditions)

Construction processes connected with extraction, handling and material transportation may also cause increased noise levels. Blasting of rocks could result in producing disturbing effects to neighboring residential areas, etc. In the quarry sites crushing plants are also a significant noise source. Noise from crushers can be high especially from high capacity plants (i.e., crushers having a higher ability to crush more tons or kgs of material per hour). Furthermore, generators, electrical drills, saws, backhoes, air compressed jack hammers, rock breakers and tippers coming to the quarry sites also contribute to significant noise. Therefore, it is highly recommended that quarry sites are not located in the vicinity of noise and vibration sensitive areas especially residential areas and even religious and archeologically important places.

Equipment involved in cut and fill operations and mechanical compaction such as compactors are known to generate high noise. The total Sound Pressure Levels (SPL) will be high when several equipment and machinery are used. Similarly, jack hammers that are used in breaking concrete columns and beams of properties (that are to be destroyed or demolished) and breaking of rock boulders and equipment used for clearing of sites such as JCB backhoes also generate significant noise levels. Concrete mixing and batching plants also could cause some undue noise and vibration.

Therefore, in view of the values given in Table 4.13, noise levels generated from the machinery involved in construction works could drastically disturb nearby communities since the noise levels generated tend to exceed the permissible day time (defined from 6 am to 9 pm) limit of 75 dB(A) stipulated in Sri Lanka for construction activities.

Any significant increase of noise levels during construction will be temporary, for the duration of the construction stage. But the impact of noise could have a long term effect if residents near construction areas and workers are constantly exposed to very high noise levels for a prolonged time period. Complaints on noise typically arise from interference with community activities, especially when the community has no clear understanding of the extent or duration of the construction. Misunderstandings can arise when the contractor considers being insensitive by the community even though he believes that he is in compliance with national regulations.

This situation highlights the need of early identification and assessment of noise sensitive receivers near the construction sites. Compared to the road where the construction will move progressively and high noise levels generated by heavy equipment will recede to low levels the interchange areas will experience higher noise levels during construction stage and even during operational stage. This is due to the reason that vehicle acceleration and deceleration will be significant within the interchange areas. Therefore noise mapping was carried out considering the construction stage of interchange areas of Section 1 & 2 of CEP.

High frequency and continuous noise levels during construction will also have an adverse impact on terrestrial and avian fauna. Disturbance to resting and foraging habits of several avifaunal, mammalian and reptile species could occur especially in the remaining natural habitats and near Henerathgoda Botanical Gardens.

During operational stage of project

Noise levels generated by moving vehicles (at speeds above 80 kmph) along the expressway will be at a higher level compared to the baseline condition. As per information available in literature, the vehicle noise levels may be in the magnitude of 70 to 80 dB (A). Prolonged exposure to such noise levels will be a nuisance to public in the settlement areas as well as fauna in the habitats close to the ROW. Therefore this impact could be considered as a long term permanent impact which needs to consider as significant.

Section 4

Noise and vibration nuisance to nearby settlements and habitats

There could be significant noise and vibration induced damage to nearby infrastructure (direct adverse impacts) because of the large fleet of construction machinery and equipment that would be used on the project. Excavators and tippers could become significant sources of noise to the community around the locations where sensitive recipients occur.

The Kurunegala and Melsiripura interchanges are close to sensitive recipients (compared with the other 2 interchanges) that will be subjected to high dust / PM_{10}, noise and vibration.

Other sensitive recipients are houses on the left bank of Deduru Oya (Ch 83+250 km), the A9 crossing area at Kapuwatte (Ch 129 + 650 km), Kuda Kowana (Ch 81 + 200 km), the location at Ch 123+750 km, houses on the left bank of Mirisgoni Oya (Ch 135+900 km)and Udamvita Maha Vidyalaya at Ch 100 + 050 km.

Sensitive recipients such as Bambawa Temple (Bambawa Purana Raja Maha Viharaya in the Galewala DS Division) and the tank within the Galewala-Dambulla interchange (Ch 115+800 km) are archaeological sites that may be subjected to dust, noise and vibration. Although construction-related noise is intermittent in general (not continuous) and confined to the construction phase, noise levels are

expected to cause disturbance to nearby communities. Noise levels generated by machinery would exceed specified standard noise levels. The highest expected noise levels will be generated when land clearing, cut and fill, pilie driving and excavations are in progress.

Constant exposure to very high noise levels can often cause hearing deficiencies and machine operators who are directly involved in such activities are at high risk.

Impulsive noises and vibration

Rock blasting in quarry sites and pile driving activities undertaken when constructing bridge piers using drop hammer pile driving equipment would produce impulsive noise (sudden high-pitched or high-intensity noise with a lifetime of < a second) of around 110-140 dB. These impacts would be temporary and short-term.

Blasting using detonators and charging drilled holes with dynamite/gelignite cartridges may cause damage to nearby houses (due to higher peak article velocities and air blast overpressure levels). The projectiles could pose a physical hazard to workers, nearby houses and the residents. The few houses in the Walaswewa / Ketigana area at Ch 47+040 km is not expected to be greatly impacted by high noise and vibration due to attenuation with distance. However, they may be subjected to some fine / powdery dust after blasting if blasting is undertaken in hot and windy conditions. Some nearby tank bunds (which are in a dilapidated condition at present) would be subjected to further damages due to higher PPVs (see Figure 4.10).

Bridges / flyovers would be required at the following locations where sensitive recipients are found. These areas would be subjected to impulsive noises and high vibration especially during pile driving works. This process is likely to cause disturbance to nearby residents. These locations are:

- Deduru Oya; Ch 83+250 km; The bed comprises unweathered rocky outcrops Ch 129 + 520 km; A9 crossing area at Kapuwatte
- Ch 81 + 200 km at Kuda Kowana
- Ch 123+750 km
- Mirisgoni Oya (Ch 135+290 km) where the left bank has some houses
- Udanvita Maha Vidyalaya at Ch 100 + 050 km

Some rock blasting is likely to occur in the Deduru Oya area for the construction of piers (Ch 83+250 km/ E162123 and N 256022) since the bed comprises unweathered rocky outcrops. Furthermore, use of pneumatic and tandem rollers while compacting soil on embankment would create vibration.

Figure 4.10: The houses located opposite / parallel to the blasting site

Note: Recipients of some wind-blown dust during and after rock blasting works (left photograph). The tank bund is in a dilapidated condition (right photograph).

4.6.2. Impacts due to vibration on settlements and habitats

During construction stage of project

Construction activities will result in varying degrees of ground vibration depending on the equipment and methods employed. Operation of construction equipment causes ground vibration which spreads through the ground and diminishes in strength with distance.

Buildings founded on the soil in the vicinity of the construction site respond to these vibrations with varying results from no perceptible effects at the lowest levels, low rumbling sounds and vibrations at moderate levels and damage to structure at the highest levels.

Construction activities that typically generate the most severe vibrations are blasting and impact pile driving. Use of pneumatic and tandem rollers during compaction of embankment soil also generates some amount of vibration. Ground vibration created during construction could be considered as a temporary short term impact. Vibration levels generated by some construction equipment are presented in Table 4.14.

Table 4.14: Vibration source levels for selected construction equipment

Equipment		PPV at 7.5m (cm/sec)
Pile driving (impact)	Upper range	3.856
	Lower range	1.636
Bulldozer	Large	0.226
	Small	0.007
Loaded trucks		0.193

Source: US EPA, Noise from construction equipment, operations, building equipment and home appliances (Note: these values may vary with site conditions)

Exposure to ground vibration will have an impact on terrestrial and avian fauna by causing a disturbance at resting and foraging habits of several avifauna, mammal and reptile species that could occur near the alignment, especially in the remaining natural habitats of Kalu Oya, Uruwal Oya, Attanagalu Oya, Diyaella Oya, Maha Oya and Kuda Oya floodplains where most of the pile driving activities and embankment construction will take place.

The exploitation of rock which involves blasting operations is likely to produce very high noise levels which could cause adverse impacts on nearby communities, though the effects may be sporadic and temporary in nature. In addition, potential vibrations and shocks arising from blasting activities could result in severe damages to nearby properties such as archaeological, religious and culturally important sites. In this respect properties or houses having weak building or civil structures would be at risk from substantial damage or even from total collapse (especially old structures such as Purana Viharayas which may have an archaeological significance).

It should be noted that archaeological structures are sensitive to vibrations and the ground induced vibrations and shocks can cause severe damages to nearby properties when ground vibrations are exceeding well over 5 mm/sec (vibration standards for Type 3 structures – 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) and over 7 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) during blasting activities.

Moreover vibrations from heavy traffic flow in the quarry sites and the proposed railway areas could harm nearby properties (for example, shattering of glass windows) and even cause discomfort to people living in the immediate vicinity.

During operational stage of project

Vehicle movements along the expressway will not create a significant level of vibration that could have an impact to nearby structures. Levels of vibration may occur when large vehicles such as semi-trucks move along the highway. However, this will be a short term impact.

4.6.3 Air quality impacts on nearby settlements and habitats

At present the project area in general has a good atmosphere. Only the townships of Gampaha, Veyangoda, Mirigama, Boyagane, Kurunegala and Ambepussa may have some air pollutants, mainly due to vehicle and industrial emission.

During construction stage of project

During construction, clearing and grubbing operations, blasting and quarrying operations, cut and fill operations and embankment work will release dust into the atmosphere. Out of all earth work operations clearing and grubbing operations emit large amounts of dust. With prevailing wind conditions the dust particles may flow away from the construction site over to settlement areas and cultivated lands close to construction sites. Exposure to excessive dust levels may lead to respiratory infections in the settlement areas nearby.

Removal of vegetation is likely to have an adverse impact on air quality. Trees within the ROW (including coconut and rubber trees) will be removed. Removal of ground cover and vegetation is a primary source of air pollution and could contribute to global warming.

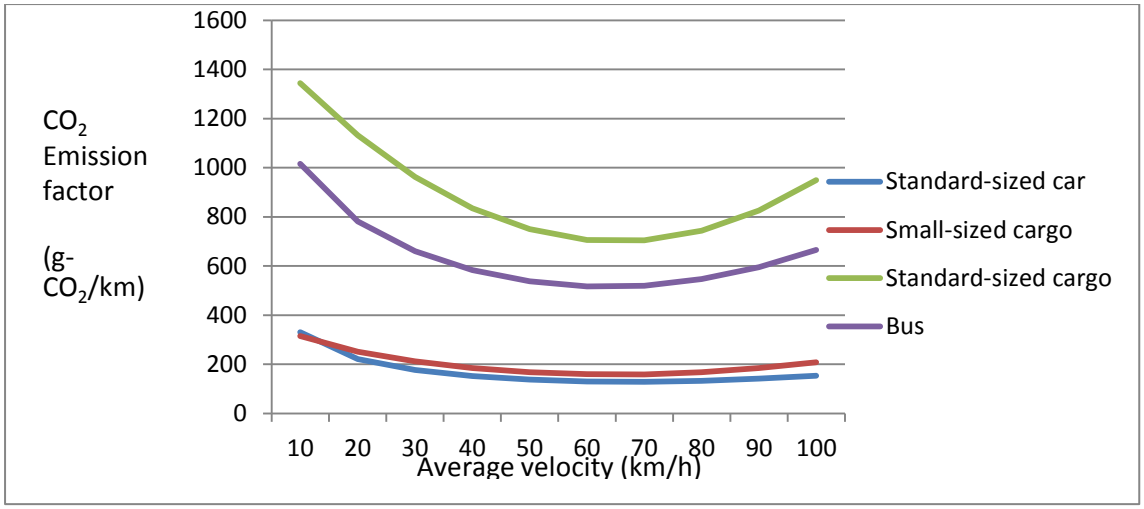
Exhaust gases containing CO, CO_2, SO_x and NO_x emitted from construction machinery may also lead to the degradation of local air quality. The quantities of emissions will vary depending on many factors such as the type of equipment, fuel source used, type and magnitude of operation carried out by the equipment, fuel consumption and combustion efficiency of the equipment which depends on the condition of equipment.

Operation of asphalt plants, concrete batch mixing plants and crusher plants will also emit dust and other fumes to the atmosphere. Burning of cement bags, waste generated in labour camps and vehicle servicing yards will also release gases, fumes and dust which could be potential source of air pollution.

During operational stage of project

The impact on air quality will remain a factor during the operational stage of the project. Emissions from vehicles travelling along the expressway will be the contributing factor to affect the air quality. During the operational phase, air pollutants due to fuel combustion will be expected from the vehicles and this will include primary pollutants such as NO_x, CO and HC and derived or secondary pollutants formed from chemical reactions in the atmosphere (such as photochemical oxidants). Also there will be SO_2 emissions. The graph below shows the CO_2 emission levels of different types of vehicles at various speed levels.

With an increase of vehicle numbers it is apparent that more quantities of such gases will be released to the atmosphere. This will be a long term impact requiring long term effective mitigation measures.



Source: EIA for improvement of traffic around new Kelani Bridge

Figure 4.11: CO_2 emission levels at different speeds of vehicles

Section 4

Air quality impacts on nearby settlements and habitats

Significant Suspended Particulate Matter (SPM)/PM_{10} emissions are expected from borrow areas, access/haulage roads, quarry sites, crusher plants, concrete/asphalt plants and construction sites along the alignment. The Kurunegala interchange and Melsiripura interchange have many recipients that will be subjected to high dust/PM_{10}. Other sensitive recipients occur at;

- Deduru Oya area (Ch 83+250 km) where the left bank has some houses,
- The A9 crossing area at Kapuwatte (Ch 129 + 650 km),
- Kuda Kowana Ch 81 + 200 km
- Ch 123+750 km,
- Mirisgoni Oya (Ch 135+900 km) where the left bank has some houses
- Udanvita Maha Vidyalaya at Ch 100 + 050 km,
- Bambawa Temple (Bambawa Purana Raja Maha Viharaya in the Galewala DS Division) and Bambawa Tank close to the temple at Ch 115 + 800 km.

4.7. Impact on Railway Line

Proposed Section 1, 2 and 4 of CEP will cross exsisting and proposed railway line (from Kurunegala to Habarana) of Sri Lanka Railways at few locations. Summary of locations are given in Table 4.15. The expressway will be designed to pass over these locations on bridge and viaduct structures except of Ambepussa link road (Section 2) where there will be a cut over the tunnel overburden.

During construction stage of project

Falling objects and construction material kept close to railway line will affect the movement of trains and safety of the trains and passengers. Trains will also be expected to move within these sections at reduced speeds which will cause delays to railway commuters. Use of heavy machinery for cutting the embankment at Ambepussa link road may unstable the tunnel roof and allow debris to fall on to the railway tracks. Such falling debris could damage the trains and affect the safety of goods and passengers. Under worse conditions such debris could block the railway line.

During operational stage of project

Although there will be no hindrance to the movement of trains across Section 1 , 2 and 4 vibrations caused by moving vehicles on Ambepussa link road may further damage the tunnel roof leading to fall of debris on to the railway tracks. Falling debris could damage the trains and will affect the movement of trains and safety of goods and passengers.

Table 4.15: Summary of locations where CEP will cross exsisting and proposed railway lines of Sri Lanka Railways

Section	Location with Chainage	Structure	Remarks
1	7+650-7+700	Viaduct	Main line of Railway Department
1	17+150 - 17+200	Viaduct	
1	32+200 - 32+300	Viaduct	
2	74+050	Rail Bridge	
2	76+400	Viaduct	
2 (Ambepussa Link)	1+260 - 1+400	Railway Tunnel	
3	3+750 - 3+800	Viaduct	
4	76+950	Viaduct	
2	76+350 - 76+450	Viaduct	Proposed Railway from Kurunegala to Habarana
4	79+748	Bridge Railway	
4	135+750	Viaduct	

CHAPTER 5: PROPOSED MITIGATION MEASURES

5.1 Proposed mitigation measures for the Hydrological impacts

5.1.1 During Construction Stage

Section 1

1. Pilot road will have temporary culverts, bridges and an embankment designed for floods with relatively lower return periods. Therefore, if backwater builds up due to an event with a higher return period, the pilot road embankment shall be breached at appropriate places to ease the flood levels. At the end of the construction phase the pilot road embankment will be removed and the fill material will be disposed properly with the consent of the relevant authorities.

2. High turbidity due to the wash off materials reaching the nearby water bodies can be mitigated by planning the earth works at those locations during dry periods, preventing running water through loose soils, covering loose soils, by selecting proper places for stockpiling and by preventing mixing up of oil, fuel, grease, bitumen, cement etc with surface runoff during rainy days. This is very important at Ketawala, Kachcheri Amuna, Mole Amuna and Kumbaloluwa Anicults as they are less than 50m from the expressway.

3. Provisions will be made available for the farmers to move their tractors and other farming equipment across the construction area where the farmlands are divided due to the road.

Section 2

1. Pilot road will have temporary culverts, bridges and an embankment designed for floods with relatively low return periods. Therefore, if backwater builds up due to an event with a higher return period, the pilot road embankment will be breached at appropriate places to ease the flood levels. At the end of the construction phase the pilot road embankment will be removed and the fill material will be disposed properly with the consent of the relevant authorities.

2. High turbidity due to the wash off materials reaching the nearby water bodies (especially at Kuda Oya flood plain 44+000 - 59+000) will be mitigated by planning the earth works at those locations during dry periods, preventing running of water through loose soils, covering loose soils, by selecting proper places for stockpiling and by preventing oil, fuel, grease, bitumen, cement etc mixing with surface runoff during rainy days.

3. Continuity of the irrigation canals and drainage paths will be maintained across the construction area where the farmlands are divided due to the road construction.

Section 4

1. Pilot road will have temporary culverts, bridges and an embankment designed for floods with relatively low return periods. Therefore, if backwater builds up due to an event with a higher return period, the pilot road embankment will be breached at appropriate places to ease the flood levels. At the end of the construction phase the pilot road embankment will be removed and the fill material will be disposed properly with the consent of the relevant authorities.

2. High turbidity due to the wash off materials reaching the nearby water bodies will be mitigated by planning the earth works at those locations during dry periods, preventing running of water through loose soils, covering loose soils, by selecting proper places for stockpiling and by preventing oil, fuel, grease, bitumen, cement etc mixing with surface runoff during rainy days. This is very important at Deduru Oya, Kimbulwana Oya, Welamitiya Oya, Dambulu Oya and Mirisgoni Oya as the water in those rivers is used for drinking and irrigation.

3. Continuity of the irrigation canals and drainage paths will be maintained across the construction area where the farmlands are divided due to the road construction.

The detail hydrological study for the CEP is being carried out by the Sri Lanka Land Reclamation & Development Corporation (SLLR&DC). Addtion to the mitigatory measured proposed in the EIA report any other findings from the detail hydrological study will be consider in details desings of the Project. Drainage improvemt work proposed by SLLR&DC with regard to the entire project shall be carried out. After completion of the construction activities, all tempory land filling in low areas and flood prone areas shall be removed & reinstate to its original state.

At Operational Stage:
Section 1

1. Improper drainage and water logging on the upstream side of the proposed road where it is on an embankment will be mitigated by the design. All the cross drainage structures (viaducts, bridges and culverts) given in the design are found to be adequate for the respective catchment flows. However, there may be local low elevated areas very close to the embankment which cannot be drained towards the respective structure due to the unevenness of the terrain. Collector drains along the toe of the embankment, properly placed and aligned culverts and lead away canals can effectively pass the flow to the downstream side of the embankment.

2. Road embankment will be high enough to clear the levels of design flood event, which will be achieved through the design. This is very important from the section 5+900 to 32+000 section as the floods are frequent.

3. Long bridges or viaducts are provided where the present flooding scenario can be significantly changed due to the embankment construction. However, some of them need to be repositioned as explained in the Table 4.1. Viaducts will be extended at 4+050, 8+150, 18+560 - 18+940 and at 25+950 to avoid flood level built up at the surrounding areas. Opening sizes of bridges and culverts will be large enough to freely pass the flood flow to the other side of the road without any additional efflux. Flood efflux due to backwater effects and water logging will be mitigated by periodically maintaining culverts and lead in and lead away canals to ensure uninterrupted passage for flow.

4. To avoid collection of water in and around the proposed road, all road surface drainage, drainage through cut slopes, drainage down the embankments, drainage from centre median drains, drainage at toe drains, drainage from overhead bridges etc will be properly connected to an existing flow path with clear downstream connections and they will be properly maintained.

5. Stream diversion will be avoided wherever possible as that is against the natural flow pattern of the location. Through erosion and deposition, the stream may readjust to the new diversion. In some cases this readjustment can cause adverse impacts to the adjacent reaches as well. Where possible the need of stream diversions will be avoided at the design stage by using bridges or via duct sections. However, the river trainings proposed at 20+300-20+500, 21+200 - 21+600, 23+100 - 24+600 and 26+900 - 27+300 do not change the flow pattern significantly and as such no adverse impacts are anticipated. Since these river trainings are at the Attanagalu Oya Irrigation system and have direct impacts on Anicuts such as Kumbaloluwa Maha Amuna, consent of the Gampaha Irrigation Engineer will be taken before finalizing the designs.

6. All irrigation canals and drainage canals in paddy fields will be allowed to continue across the proposed road with culverts having invert levels matching with the bed levels of the canals. When the width of the provided box culvert is too wide for a small irrigation canal, a narrow ditch will be made within the bed width of the box culvert for irrigation and normal drainage flows. This will avoid reduction of flow velocities due to wide culvert width and therefore will prevent siltation. Designs of culverts for the continuation of irrigation

canals will be done with the consent of the irrigation engineer, agrarian services officer and/or the relevant farmer organizations.

7. Loss of retention areas due to embankment will be avoided if that leads to an increase in flood levels. From sections, 23+300 km to 25+100 km the retention area is significantly reduced. However, according to the Preliminary Design Report - Stage 3 - Volume 3 - Hydrology and Drainage prepared by SMEC (2014), there will be flood channels constructed along the road embankment which will compensate for the reduction of retention area. Therefore there is no significant impact due to the reduction of potential retention areas. Further, from 30+600 km to 34+000 km, proposed embankment occupies a significant portion of the retention area. For about half of this stretch, it shares the potential retention area with the railway embankment. However, the flood levels will not increase as the remaining retention area is adequate for the small flood discharge.

8. Flood channels proposed (21+000 km - 25+000 km) to compensate for the loss of retention areas can lead to excess drainage in the surrounding low lying areas. This will adversely affect the paddy fields if the groundwater levels are not maintained at the flood channels during dry periods. Therefore if the flood channels cannot be avoided there will be a gated arrangement to maintain water levels to avoid the paddy fields running dry. As an alternative at the paddy fields, rather than digging a channel, a strip of land cleared of all obstructions for flood flow may be left next to the expressway. If this strip of land is maintained with only grass at its surface, a conveyance capacity enough to mitigate a flood efflux can be achieved.

9. Special precautions will be taken in the detailed design stage to avoid leading road surface runoff outlets towards the anicuts, as that can contaminate stagnated water there. This is very important at Ketawala, Kachcheri Amuna, Mole Amuna and Kumbaloluwa Anicults as they are less than 50m from the expressway.

10. Connections between the divided farmlands by the road embankment will be re-established by providing adequate amount of openings as tractors and other farming equipment are required to move. Irrigation engineer, agrarian services officer and/or the relevant farmer organizations will be consulted at the design stage to decide the most appropriate locations for these connections.

Section 2

1. Improper drainage and water logging on the upstream side of the proposed road where it is on an embankment, can be mitigated by the design. Collector drains along the toe of the embankment, properly placed and aligned culverts and lead away canals will effectively pass the flow to the downstream side of the embankment.

2. Road embankment will be high enough to clear the levels of design flood event with a high free board, at underpasses in the flood area where the local roads may need to be raised up in the future.

3. Provided viaducts, ridges and culverts are enough for the design flood events. However, they will be kept free of weed growth and debris accumulation in order to achieve the expected benefits. Flood efflux due to backwater effects and water logging will be mitigated by periodically maintaining culverts and lead in and lead away canals to ensure uninterrupted passage for flow.

4. To avoid collection of water in and around the proposed road, all road surface drainage, drainage through cut slopes, drainage down the embankments, drainage from centre median drains, drainage at toe drains, drainage from overhead bridges etc will be properly connected to an existing flow path with clear downstream connections and they will be properly maintained.

5. Stream diversions proposed at Kuda Oya will not cause adverse impacts in terms of flood levels. However, through erosion and deposition, the stream may readjust to the new diversion at some places where the stream banks are erodible. Further, through toe drains all low elevated areas will be connected to culverts to

make sure that both sides of the embankment are properly draining into the diverted stream. Locations of river training are given in the Table 4.3.

6. All irrigation canals and drainage canals in paddy fields will be allowed to continue across the proposed road through culverts having invert levels matching with the bed levels of the canals. When the width of the provided box culvert is too wide for a small irrigation canal, a narrow ditch will be made within the bed width of the box culvert for irrigation and dry weather drainage flows. This will avoid reduction of flow velocities due to wide culvert width and therefore will prevent siltation. Designs of culverts for the continuation of irrigation canals will be done with the consent of the irrigation engineer, agrarian services officer and/or the relevant farmer organizations.

7. Loss of retention areas due to embankment will be avoided if that leads to an increase in flood levels. At sections, 40+750 km to 41+100 km and 70+650 km to 72+300 km retention areas are significantly reduced. However, the flood levels will not increase as the remaining retention area is adequate for the small flood discharge.

8. Special precautions will be taken in the detailed design stage to avoid leading road surface runoff outlets towards irrigation canals as that can contaminate irrigation water. There is an anicut at 49+600 which also can be affected with contaminated water.

9. Connections between the divided farmlands by the road embankment will be re-stated by providing adequate amount of openings as tractors and other farming equipment need to go through. Irrigation engineer, agrarian services officer and/or the relevant farmer organizations will be consulted at the design stage to decide the most appropriate locations for these connections. Relevant agencies north of Maha Oya are the Irrigation Engineer, Kurunegala, Northwestern Provincial Irrigation Engineer, Kurunegala and Agrarian Services Office of Kurunegala district.

Section 4

1. Improper drainage and water logging on the upstream side of the proposed road where it is on an embankment, will be mitigated by the design. Collector drains along the toe of the embankment, properly placed and aligned culverts and lead away canals can effectively pass the flow to the downstream side of the embankment.

2. Additional culverts/bridges will be provided at 97+530, 119+370, 125+620 and at 130+980 to avoid blocking of the relevant streams due to the road embankment.

3. River training will be provided at 124+100 - 124+300 and 134+020 - 134+260 to maintain the continuity of those streams.

4. Tanks (Wewa) and anicuts are intercepted at 102+800, 118+400, 126+900, 131+800 and at 134+200. Irrigation Engineer or Agrarian officer of the corresponding area will be consulted before finalizing the road embankment design. Additional viaduct sections may have to be included to clear these anicuts and tank bunds if they cannot be relocated.

5. A pier of the viaduct at 120+150 intercepts the discharge of the trans-basin Irrigation canal at Galewela. That pier will be relocated outside the water area or the canal cross section at the pier will be enlarged. This will be done with the consent of the Mahaweli Authority.

6. Flood efflux due to backwater effects and water logging will be mitigated by periodically maintaining culverts and lead in and lead away canals to ensure uninterrupted passage for flow.

7. To avoid collection of water in and around the proposed road, all road surface drainage, drainage through cut slopes, drainage down the embankments, drainage from the centre median drains, drainage at toe drains,

drainage from overhead bridges etc will be properly connected to an existing flow path with clear downstream connections and they will be properly maintained.

8. At locations where river training have to be done, water logging on the other side of the trained canal will be avoided. By using a toe drain, water collected at low elevations will be brought to a culvert through which the water will drain into the stream.

9. All irrigation canals and drainage canals in paddy fields will be allowed to continue across the proposed road through culverts having invert levels matching with the bed levels of the canals. When the width of the provided box culvert is too wide for a small irrigation canal, a narrow ditch will be made within the bed width of the box culvert for irrigation and dry weather drainage flows. This will avoid reduction of flow velocities due to wide culvert width and therefore will prevent siltation. Designs of culverts for the continuation of irrigation canals will be done with the consent of the Irrigation Engineer, Agrarian Services Officer and/or the relevant farmer organizations.

10. At locations where groundwater inflow into the tanks can be disturbed due to soft ground treatments and soil compactions, additional culverts with low inverts will be provided.

11. Special precautions will be taken in the detailed design stage to avoid leading road surface runoff outlets towards irrigation canals as that can contaminate irrigation water.

12. Connections between the divided farmlands by the road embankment will be re-stated by providing adequate amount of openings as tractors and other farming equipment are required to move. Irrigation engineer, agrarian services officer and/or the relevant farmer organizations will be consulted at the design stage to decide the most appropriate locations for these connections.

5.2. Mitigation of Socio- cultural impacts

Mitigation of social impacts is the most important component of this project for the construction of an expressway which requires acquisition of considerable acreage of lands occupied by people and institutions. As the proposed expressway is constructed for the benefit of the nation as a whole, those national objectives will be achieved with due restoration of affected local communities, their means of sustenance and well-being. The affected communities are aware of the benefits of the project for their rural communities and for the Districts connected by it. But the adverse socio-economic impacts of the project compel them to be conscious about the way the Government is going to redress their grievances to the satisfaction of them. Being highly concerned about the current economic challenges of restoring socio-economic functions, they reiterated the importance of adopting four principles of redressing their grievances and losses; (1) a package of compensation based on the highest market value of their properties, businesses and livelihoods, (2) a package of compensation fully sufficient to resettle and restore socio-economic life in terms of modern standards irrespective of poor economic conditions, legal issues of property ownership and any discrimination they had at their original places, (3) resettlement within the geographical areas familiar to them and convenient to maintain social relations and other activities of their families and businesses and (4) a simple mechanism and institutional arrangement that make the responsible officials readily available for addressing the grievances of PAPs and carrying out the mitigations tasks as agreed upon with them. It is with due recognition of peoples' perception of the impacts of the project and their plight all the mitigations measures will be adopted. The proposed Entitlement matrix is available in Annex 5.1.

5.2.1. Mitigation of impacts on settlements.

With reference to the adverse impacts on settlements, people responded suggesting and exhorting to propel the route of the proposed expressway so that it may traverse avoiding their valuable shelters and other properties. In particular, the incumbents of the Buddhist temples, Ayurveda doctors with private medical centers, hoteliers, requested to reconsider the influential sections of the road design allowing them to continue their residential, religious and commercial tasks unabated. In response the questionable sections of the proposed expressway were reconsidered and thereby adverse impacts were mitigated to the fullest

possible extent. Such alterations in the road design as well as difficulties of addressing such requirements would be properly convinced to the relevant people to avoid public misunderstandings.. As was apparent in the field surveys, people had shared rumors of alterations in the road destination in response to desires of influential politicians. Such public misunderstandings indicate the significance of making the communities fully aware of the rational, logical, scientific and technical selection of the current route of the proposed project.

After making viable amendments to the proposed road design, measures for mitigating the inevitable negative social impacts will be adopted in compliance with the relevant legal provisions as well as the internationally agreed standards and guidelines of redressing public grievances stemming from national development projects. In particular, the Land Acquisition Act of 1950 (LAA) and subsequent Amendments and Regulations including the Gazette Notification No.1837/47 of 22 November 2013, Road Development Authority Act No.73 of 1981, the National Involuntary Resettlement Policy of Sri Lanka (NIRP), Gazette Notification No.858/14 of 23 February 1995, will be referred to assure the maximum justice for the project affected people. Where the international standards and guidelines are concerned, the project is required to adopt a mechanism to minimize, mitigate and compensate for the adverse impacts in terms of the Safeguard Policies adopted internationally. Accordingly, the Project Executing Agency- the Road Development Authority of Sri Lanka (RDA) will be held responsible for adopting a Grievance Redress Mechanism implemented through Grievance Redress Committees (GRC) comprised of relevant and prescribed stakeholders. The PMU of the RDA functions as the key agent of supervising the overall implementation of the project, evaluation and monitoring. Gender parity is specially emphasized as a universal policy of making decisions pertaining to the grievance redress mechanism of the project.

5.2.2. Mitigation of impacts of relocation of families.

Relocation of families and institutions mentioned above is the most significant component of this project as any residential and institutional change brings about a structural change in the equilibrium of the social life of the affected people and there arises a new requirement of restoring the same in a different location within a given period of time. The project requires permanent relocation of 3438 households and institutions. In compliance with the legal requirements of relocation of project affected persons and the Grievance Redress Mechanism specially adopted for this project, the RDA through its PMU shall update the available Resettlement Action Plans (RAP) for both permanent and temporary relocation of families and institutions.

Relocation measures will be adopted in terms of the consent and consensus of all members of the families as certain family members have contradictory proposals, claims, discrimination against spouse, parents, grandparents and children and even have motives of deception and conspiracies against each other to appropriate the financial compensations and ownership of new settlements and other material grants contained in a package of grievance redress. Even though one or more members of the families may appear on behalf of others and have the legal right for the ownership of the properties of family, all the dependents of the family shall be taken into account for safeguarding their future by means of the grievance redress mechanism. A family centered compensation payment system shall be adopted by the RDA for this purpose.

Cash compensation alone is not going to solve the problem as most of PAPs emphasize the importance of resettling in the same area as their communities. Therefore, resettlement lands located in or in the vicinity of the original residential places had been identified for constructing new houses and other institutions and such resettlements would facilitate continuation of existing socio-economic relations and other businesses with lower interuption. This allocation will be done in accordance with the existing regulations and in consultation with the affected parties. RDA will identify all possible sites of resettlement within the locality and take action to acquire them from the owners.

As land acquisition is a prerequisite of the proposed project, resettlement of all (permanent and temporary) shall be completed before the commencement of construction activities. The RDA will clearly inform the people of the resettlement requirement, land acquisition methods and conditions, resettlement plan, all-encompassing package of compensation, time of land evacuation, removal of properties and disconnection of

power and other supplies giving sufficient period of time and without exerting unnecessary burden on both permanent and temporary PAPs. Not only the legal agreements of land acquisition and evacuation but also the unexpected practical issues of PAPs shall be properly addressed as evacuation from properties they have enjoyed for generation after generation is a highly sensitive phenomenon. Even after compensating for all assets belonging to them, they will be allowed to make use of materials of their structures, trees and other resources they had earned and developed or inherited. Such materials may be useful for their resettlement purposes.

Temporary relocation of households and institutions shall also be addressed in the RAP with special reference to the period of such displacement in terms of the order of the construction tasks and project requirements analyzed from the perspective of public safety and the safeguarding of livelihoods. The PAPs will be informed in advance the exact period of temporary relocation, commencement of the resettlement, probability of extending the period of relocation, nature and magnitude of the project impact on the properties of PAPs, mechanism for restoring the affected properties and businesses, and redressing any other grievances. Such relocations shall not hamper the education of the children of PAPs, well-being of the people with special needs and care and the unity of the families.

Protection and well-being of women, children, elderly, disabled, widows, single parent families and other dependents shall be specially taken into account and measures shall be adopted to assure the proper accomplishments of such needs in both temporary and permanent resettlement processes. Special attention will be paid to resettlement of these categories of PAPs as some of them are not strong enough to carry out resettlement work or are not confident in their capacity of successful completion of such activities. The PMU of RDA will adopt special measures to deal with the issues of such vulnerable people as mentioned in the sections 5.3.6, and 7.

Being a long-term process, resettlement requires a proper monitoring and evaluation system and RDA will adopt such a system. Resettlement program shall assure all the PAPs a better life compared to what they had in their former residential places. Infrastructure facilities such as roads and transport, power supplied by the national grid, water supply, postal and communication, disposal of waste shall be developed in all the resettlements and maintained with due attention of the relevant authorities. Potential lands for resettlement sites identified by the PMU of RDA are presented in Annex 4.3.

5.2.3. Mitigation of Impacts of land acquisition

The residential and agricultural lands in the project affected area remain scarce, limited and invaluable property for almost all the PAPs and consequently full or partial acquisition has an adverse social impact on them. Therefore land acquisition for the permanent and temporary use of the project shall be carried out in compliance with the legal provisions including the Land Acquisition Act and the grievance redress mechanism of the RDA.

As land remains the most valuable asset of people, land acquisition shall be carried out according to a well-designed plan of land requirement of the project and only the exact quantity of land shall be acquired after proper demarcation of boundaries and a legal document of the acquired land with an approved plan shall be provided to the land owners. Furthermore, all such land owners shall be made fully aware of the new boundaries of the remaining portion of the land and structures and the future impacts on them.

Land acquisition mechanism needs to assure the protection of the remaining portions of land acquired for the project. In particular, construction work in the acquired portions of land, might cause soil erosion, land slips, inundation, sludge concentration, diversion of water streams, and unexpected disasters in the remaining portions of lands, unless precautionary measures are taken simultaneously. Such project caused problems is expected to have an adverse impact on the people living in the remaining portions of lands and the project is responsible for such damages and accidents and RDA will pay compensation for such events. The following policy principles are prescribed for granting compensations in terms of the RAP of the project.

5.2.3.1 Replacement cost

The amount of compensation required for the replacement of lost or affected lands, structures, and other properties at least in similar quantity and quality shall be paid as the cost of replacement. Replacement cost needs to be paid for all buildings irrespective of their age and the PAPs will be allowed to retain the salvaged materials. Those who had wattle and daub (Katumati) shelters or cadjan thatched huts are also entitled to a cash grant for the loss of shelters in addition to other due compensations.

5.2.3.2. Temporary use of private lands

The project requires temporary occupation of private lands in selected locations for different purposes including excavation of materials, dumping of materials, disposal of industrial waste, parking of vehicles and machines, formation of embankments etc. In such instances lands will be obtained after signing a contract of temporary occupation with the land owners by the contractors and the PMU of RDA. Stipulated in such a contract shall be (1) the period of occupancy, (2) amount and terms of compensation agreed mutually, (3) compensation for the material losses for the period of temporary occupation, (4) compensation for the other damages caused to the properties and for disturbances, (5) the frequency of compensation payment, (6) rehabilitation and restoration measures, (7) conditions of settling utility bills for the period of occupation, and (8) conditions of returning the property.

5.2.3.3. Determination of rates for properties acquired

Prevailing market rates of relevant properties shall be used for the calculation of compensations for the properties to be acquired, on the assumption that such a rate of valuation is indispensable to offset the cost of replacement of the properties acquired. The National Involuntary Resettlement Policy (NIRP), makes it mandatory to grant an amount of compensation that is sufficient to replace the lost assets of PAPs. Therefore the project needs to pay due attention to these and other guidelines of GRM in determining the relevant rates.

5.2.3.4. Special needs of vulnerable households.

As mentioned in the 5.3.2. section, the vulnerable households with special needs consists of women headed families, families with elderly persons, differently able persons, people below the poverty line and people without legal ownership for properties. They are entitled to obtain a special grant of Rs. 15,000 per household in addition to other types of compensation available for them. The PMU will support them for the successful resettlement with the assistance of special community workers with a proper training in social work. They will identify the families in need of special assistance and work for their benefit in the process of resettlement. Furthermore, the PMU will work with national level institutions at the DSD level that provide institutional support for the well-being of such PAPs.

5.2.3.5. Rights of tenant cultivators (Under the Paddy Land Act)

The proposed expressway has been designed to traverse through paddy lands in the three districts for a considerable length of it with the intention of avoiding human settlements and consequently it has an adverse impact on the paddy cultivation in those acquired areas. Paddy lands are cultivated by land owners as well as land tenants. The Paddy Land Act of 1958 safeguards the rights of tenant paddy farmers who are required to pay a prescribed share of harvest to the owners of paddy lands. As they have been living on the income earned from the tenanted paddy lands, acquisition of those lands deprive them of an important means of sustenance ensured by the particular Act of Paddy Lands. In accordance with this and other relevant laws the tenant farmers will be paid a part of the compensation.

5.2.3.6. Lands of State corporations

People who have leased lands from State Corporations for a particular period of time are entitled to get the balance of income for the remaining period after the acquisition of such lands by the project.

5.2.4. Mitigation of Impacts on livelihood.

Acquisition of farm lands, home gardens, arable lands, lands used for industries, business and services and certain construction work requirement has an adverse impact on the livelihoods of affected individuals and families. Restoration of their livelihoods is an important mitigation measure that the project will adopt with

special attention to poor families and various types of economic dependents. Food security of the affected people will be specially addressed in the Grievance Redress Mechanism of the project. As most of the people live on income earned from agriculture, acquisition of farm lands may deprive a significant number of rural peasants of their main livelihood. The project will find temporary and long lasting means of income for the PAPs.

In order to re-establish the livelihood of PAPs, Income Restoration Plan will be implemented as identified in the resettlement plan. The project will also consider recruitment of project affected persons for different capacities of employment depending on their skills and qualifications as well as economic hardships of families. Giving priority to such families will be an advantage in employing people in the construction of the expressway and the PMU will intervene in the recruitment process to assure job opportunities for local PAPs. The project creates a considerable number of employment opportunities and those employable among the PAPs will be employed as a measure of mitigating negative economic impacts of the project.

Prolonged temporary relocation may also result in permanent loss of work, business, and other sources of income for the original residents of the affected areas and such opportunities may be transferred to others. Therefore, the project will consider ways and means of protecting the livelihoods of people relocated for a particular period of time.

5.2.5. Mitigation of impact on infrastructure facilities.

Proper functioning of the infrastructure facilities such as road and transportation, telecommunication, water supply, power supply, irrigation systems and canals, and drainage systems may be affected by construction works of the project. The PMU will identify all the possible locations of breakdown in all the infrastructure systems and precautionary measures as well as remedial measures will be adopted in advance. Construction work in the paddy lands will affect the irrigation canals disturbing water for the fields fed by them. Unexpected inundation may also be caused by dumping of soil , excavation and land filling. Until irrigation canals are restored after construction of the road, temporary alternative water supply systems will be constructed in affected paddy lands and their proper functioning will be regularly maintained with the assistance of authorities legally responsible for their administration. Adverse impacts on the public roads and all the other access roads will be mitigated by regular maintenance with renovations and restorations. The project will be held responsible for any damage caused by the transport of materials and other construction works. Use of main roads and other access roads will be regulated in consultation with relevant authorities to prevent accidents and use of roads not prescribed for heavy vehicles. Where the existing roads are closed at certain points for construction purposes, safe and easy-to-travel alternative temporary access roads shall be constructed.

The project requires relocation of power transmission lines and their supportive posts located in the ROW and any power cuts caused by such relocations shall be informed to affected people in advance to avoid any negative impact on residents and other institutions. Uninterrupted power supply in the course of construction will be assured by the PMU in consultation with and with active cooperation of the National Electricity Board and its regional centers. Any prolonged interruption of electric power supply to households and institutions shall be mitigated with alternative means negotiated with the affected parties through PMU.

5.2.6. Mitigation of Impacts on public safety and health

Mitigations measures are required to assure public safety and health during both the period of the construction and the operation of the proposed expressway. Long term security measures will be adopted in all the vulnerable points and sections of the expressway including the sections running through areas with higher population density, potential areas having a higher population density in the near future, all interchanges and access roads, bridges, points of overpass and underpass, and points of crossing existing infrastructure facilities and deep cuts and excavation areas of the project. In the course of the construction, different tasks in the area of construction and related to them but operated in external areas may pose a serious threat to the public health and safety of people. Therefore, all the project activities shall be controlled in terms of clearly stipulated security guidelines prescribed by the PMU. All the contractors and work forces

will be made aware of security guidelines and supervised to assure regular application of them for the benefit of both the work force of the project as well as the people living and working in the project affected areas.

Special attention shall be paid to prevent HIV/AIDS and other types of diseases in the areas where there might be such vulnerabilities. Prevention of dengue fever shall be considered as an important responsibility of all involved in the construction works within and outside the project sites. In particular all locations related to the project shall be frequently supervised to leave no room for breeding of dengue mosquitoes. Not only the safety of people in the project sites of the expressway but also the people living in outside locations supplying materials, processing of materials and, storing of materials, shall also be assured of protection from diseases and all health hazards.

Project caused contamination of drinking water, irrigation water, air pollution and other health hazards shall be prevented by means of carefully stipulated precautionary measures.

As most of the residents in the project areas depend on well-water for drinking and other purposes, protection of the hygienic quality of well-water shall be specially taken into account with proper precautionary measures. Drastic impacts of deep cuts of the project site and land fillings on the availability of well-water will also be mitigated with alternative means such as tube wells and pipe borne water supply. Until such measures are adopted regular water requirements of people shall be met with water carried from outside the project.

Disposal of garbage and industrial waste need to be carried out in a proper manner exclusively adopted for this purpose. The PMU is responsible for maintaining such a mechanism for the whole period of construction and thereby assuring the well-being of people.

All the project tasks with possible direct harmful impacts on people will be carried out after taking precautionary measures. People in the area or communities including the children and women at homes in particular, will be made fully aware of such vulnerable work and times of carrying them out. Felling of trees, use of explosives, and similar dangerous work shall not be done without proper communication with the people living in the areas of such project activities.

5.2.7. Mitigation of Impact on traffic

Construction activities driven traffic problems may be experienced on the main public roads and other related roads in the project sites and the PMU will identify all the locations of possible traffic issues in advance and adopt appropriate measures to manage them without serious impacts on the smooth flow of traffic. Required adjustments in the work schedules and traffic diversions may reduce the traffic congestions on the roads of project sites. Traffic Management Plan by contractor/ Approval will be obtained from the SC and Police.

5.2.8. Mitigation measures for impacts on cultural, historical and archaeological heritage properties

Proposed mitigation measures are based on the level of impact on the particular cultural, historical and archaeological property. Mitigation measures are proposed according to whether the level of impact is a “Direct Impact” or “Indirect Impact”. . If a property or attribute is within the 120 m road corridor it is been considered as a Direct Impact, and if the properties/attributes are located out of 120 m road corridor but within the zone of 500 m on either side or beyond that margin but located in access road to expressway construction area it is considered as an Indirect Impact. Further Indirect Impacts are classified as Indirect High, Indirect Middle, and Indirect Low based on proximity, geo-morphological nature and access roads between occupied between the particular property and expressway. Following regular mitigation measures are suggested according to level of impact level.

5.2.8.1. Direct Impact

A considerable distance will be kept from the boundaries of the temple properties to prevent and minimize construction related impacts. If any property is acquired, demolished or moved it will be re-established without causing harm to religious/ cultural values. All mitigation measures shall be strongly implemented to

prevent and minimize impacts from air pollution, noise, vibrations, traffic, water pollution, material transportation and stocks, labour movements etc. Prior to planning of constructions chief party of the property and village committee will be consulted to avoid and mitigate disturbances to access and programmes of the particular property. Only well maintained heavy machineries and equipment will be deployed in this area. Immediate actions will be taken if any water stagnation and floods occurr. Construction activities will not be conducted during religious days, Sundays and other special religious days. If any archaeologically important remains or artifacts are identified the procedure given in 5.2.8.5 will be followed.

5.2.8.2. Indirect High

All mitigation measures would be strongly implemented to prevent and minimize impacts from air pollution, noise, vibrations, traffic, water pollution, material transportation and stocks, labour movements etc. Prior to planning of construction activities discussions will be held with head of the property and village committee to avoid and mitigate disturbances of access and programmes. Only well maintained heavy machineries and equipment will be deployed in this area. Immediate actions will be taken if any water stagnation occurrs. It's not advisable to carrying out construction during religious and on days of special religious functions. Laborers and if any labour camps, will be properly managed during on-duty as well as off-duty periods. If any archaeologically important remains or artifacts are identified the procedure given in 5.2.8.5 will be followed.

5.2.8.3. Indirect Middle

While planning construction activities, its highly recommended to discuss and coordinate with the chief party and committee to avoid and mitigate disturbances of access and programmes of the property. Construction methods that generate minimum vibration, noise, dust, particles and gas emission in the particular area would be applied and only well maintained heavy machineries and equipment will be deployed in this area. Construction activities will not be carried out during religious days and special days of religious functions.

5.2.8.4. Indirect Low

Construction methods that generate minimum vibration, noise, dust, particles and gas emission in the particular area would be applied. Appropriate measures will be taken to divert excess water that will inundate or stagnate during rainy season. Construction activities will not be done on special days of religious functions.

5.2.8.5. Mitigations for Construction period

If any archaeological property or attribute is affected due to expressway construction following mitigation measures will be adopted.

- If any signs, hints, indicators, traces or remains identified in pre construction, construction or post constructions phases Surface Reconnaissance, Arial Reconnaissance…etc methods would be applied in order to conduct Archaeological Survey, under supervision of Director General, Archaeological Department.
- If any archaeological remains/ artifacts or similar items, are found immediately the construction or related activities would be immediately stopped and Director General, Archaeological Department would be informed.
- If archaeological property/ attributes are found to be damaged due to construction activities, methodologies such as techniques of Salvage Archaeology and Rescue Archaeology, under approval and supervision of Director General, Archaeological Department.
- There would not be any obstacles/ resistance to monitor/ report/ advise or take further actions for visiting the construction or related area/ sites by Director General or any authorized Officer of Archaeological Department and they would be well facilitated by the developer.
- If any archaeological properties, items or may be part or traces of the archaeological remains, are found they would be handed over to be kept in the government museums under approval and supervision of Director General, Archaeological Department and/or Director. National Museums.
- If any changes take place in the plans and designs or other related items, the Director General, Archaeological Department would be informed immediately.

- If any further activities need to be conducted with respect of Archaeological Assessment, Conservation or Preservation, RDA would mobilize financial resources.
- Prior approval and permission would be obtained from relevant authorities, if any soils at the site is removed to any other location and/or if any soil is brought from any other location to the present site.
- An Archaeology/ Heritage Specialist/Manager/Officer would be recruited on a part time consultancy basis.

5.3. Mitigation of Biological Impacts

5.3.1. Mitigation of Ecological impacts during the Construction phase

5.3.1.1. Loss of Natural Habitats, Habitat Fragmentation and obstructions for Animal Movement

The detail design would minimise the impact on sensitive areas as much as possible. Avoidance of sensitive habitats is the best option, but it is not feasible all the time often due to substantial increase in costs. In such cases, bio links or animal over passes, underpasses, eco-ducts shall be established. Some successful design considerations adopted from elsewhere are summarized herein (Department of Environment and Heritage of Australian Government, 2008).

1. Overpass: Allows passage of animals above the road

i. Land bridge: Also known as an eco-duct or wildlife bridge. This is typically a wide (30 – 70m) bridge that extends over the road. The bridge has soil on it, and is planted with vegetation and enhanced with other habitat features (e.g. logs, rocks, water-body etc.) (Figure 5.1)

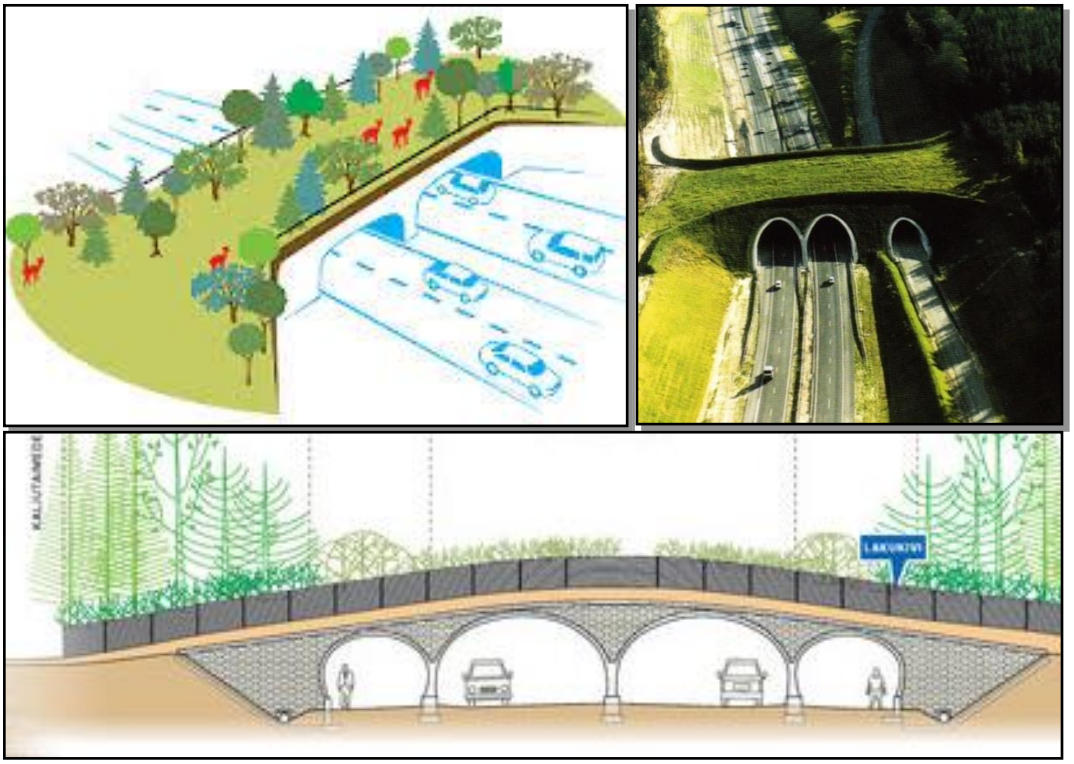


Figure 5.1: An example of a land bridges or eco-duct overpass land bridge

ii. Canopy Bridge: These can be simple structures such as ropes or poles suspended above the traffic, either from vertical poles or from trees, or meshed enclosures through which the arboreal and scansorial (climbing) animals can move on top of the mesh or through the structure. The height of the enclosures could be much less than the canopy level (Figure 5.2). In canopy bridges, meshed fence will be constructed to the level of the canopy on either side of the road to avoid arboreal

animals crossing through the roads. The exact locations and number of canopy links are subjected to change, and will be determined after consulting DWLC and FD during the detailed designing phase.

Figure 5.2: Examples of canopy bridge designs

2. Underpasses: Allows the passage of animals below the major linear infrastructure such as roads

Culverts and tunnels: Culverts are typically square, rectangular or half-circle in shape and may be purpose-built for fauna passage or water drainage, or a combination of both. They are typically precast concrete cells or arches made of steel (Figs 5.3). Tunnels or 'eco-pipes' are typically round pipes of relatively small diameter (e.g. < 1.5 meters diameter). The exact locations and number of underpasses are subjected to change, and will be determined after consulting DWLC and FD during the detailed designing phase.

Figure 5.3: Bridge underpasses and culverts designed to facilitate animal movement

A. Mirigama Kos Kele Forest

Mirigama Kos Kele forest harbours relatively a diverse faunal community. Therefore it is important to provide sufficient animals passes within the bisected forest area. It is recommended to provide 2m×2m underpasses at Ch 6+950 and Ch 7+260 of Ambepussa link road and providing land bridge/bio-link with minimum 20m width around Ch 7+060 of Ambepussa link road to facilitate the animal movement. Edges of the bio link will be fenced off to avoid animals falling on to the expressway. Some design considerations are provided in Figure 5.1. Further to that, ROW in this area will be minimised.

B. Horakela forest

Being an isolated and fragmented forest, Horakela FR is relatively less in biological diversity. However, in the landscape context, it functions as an important refuge for many faunal species including reptiles and birds. The proposed link road will act as a barrier for the free movement of terrestrial fauna. As a mitigation measure, 2m×2m underpasses are suggested at 50m intervals. The exact location and number of underpasses are subjected to change, and will be determined after discussions with DWLC and FD during the detailed designing phase.

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C. Weragalakanda Forest

Avoiding the forest will be the best option. If this is to be done, the expressway trace needs to be moved more towards the south from the existing locations. Such a shift of alignment will require the expressway to cross the existing road four times, affecting more settlements and also crossing the Kuda Oya two times resulting in further impacts. These were the same reasons to place the expressway through the current alignment (as indicated in chapter 2). Therefore, the most suitable way to reduce the impacts on animal movement will be to provide sufficient animal passes with this area. It is suggested to provide a 2m×2m underpass at Ch 59+540 of Section 2 and provide two bio links with minimum 20m width around Ch 58+700 and Ch 59+650 of Section 2. Both edges of the bio link will be fenced off to avoid any animal falling on to the expressway. The exact location and number of underpasses are subjected to change, and will be determined after discussions with DWLC and FD during the detailed designing phase. Further, the ROW in this area will be minimised in detail drawings.

D. Kiridigolla Forest

In Kiridigolla, the CEP will traverse the Deduru Oya edge of the forest. The forest will be cut-off from the river by a length of approximately 310 m of the road (From Ch≈90+020 to Ch ≈ 90 +350). The connectivity will be maintained between the river and the forest to allow free access to the river for both terrestrial and arboreal animals. As a means of providing connectivity at this location, construction of underpasses for the terrestrial animals, and an overpass (a meshed enclosure or canopy bridge) for arboreal animals are suggested. Some examples of the designs of underpasses used elsewhere are given in Figure 5.3. Appropriate design will be incorporated with the consultation of engineers. However, considering the faunal diversity, the minimum height and width of an underpass is suggested to be at least 2 x 2m.

Studies conducted elsewhere show that, when the distance between two underpasses increases, animals with smaller home ranges are less likely to reach the underpass and instead attempted to climb over or crawl under the fencing (see Manen and McCollister, 2010). Hence, it is proposed to place underpasses at every 50-75m interval (4 underpasses for the 310m stretch).

For the arboreal animals, several canopy bridges (one for every 100m for the 310m stretch) with a continuous mesh fence on either side of the road along the entire stretch or meshed enclosures (Figure 5.2) will be used. Canopy bridges will be designed to have sufficient protection to prevent animals falling on to the road.

E. Henagederalanda Forest

Since the proposed CEP at Henegederalanda will traverse through the forest at two locations close to its boundary (Intermittent fragmentation from Ch≈103+750 to Ch ≈ 105 +000), it is suggested to replant an

equivalent area of land approved by the Forest Department, with indigenous vegetation to the area. A meshed fence up to canopy level will be constructed at the forest side to prevent animals from getting onto the road.

F. Hevanethenna Forest Reserve

This is one of the few healthy natural forests found in the Kurunegala area, and harbours large mammals such as barking deer, spotted deer as well as civets. This will be fragmented by the expressway from Ch≈106+100 to Ch ≈ 106 +500 (≈400m), from Ch≈106+800 to Ch ≈ 107+220 (≈420m) and from Ch≈107+400 to Ch ≈ 108 +000 (≈600m). The deer in particular generally have a relatively large home range. As mitigation measures, it is proposed to place underpasses for at least at every 100 m intervals. For the arboreal animals, several canopy bridges (at least one for every 100m for the 310m stretch) with a continuous mesh fence on either side will be used.

G. Omaragolla Forest

This forest patch has relatively less diversity, and provides home to smaller mammals. However, it is rather rich in terms of bird diversity. Fragmentation impacts may not be so severe on fauna since the majority of the understory users such as birds and small mammals (murids and squirrels) can survive in such smaller forest fragments. Replanting with native species shall be done in selected areas adjoining the Acasia plantation. Underpasses/culverts are recommended for every 75-100m along the road stretch that bisects the remaining forest blocks of Omaragolla.

H. Bamarakanda forest reserve

Replanting with native species will be done in selected areas adjoining the forest to compensate for the loss of habitats.

I. Kethiganakanda forest

In Kathiganakanda, the route will traverse the hillock From Ch≈120+450 to Ch ≈ 120 +810 (≈360m)} which contains one of the few natural forest patches in the area. This further separates the forest from the Kathigana Wewa by the roadway through a distance of nearly 500 m preventing the animals reaching the water body. Hence, the connectivity should be maintained between the Kathigana wewa and the forest to allow both terrestrial and arboreal animal's to access water. As the height difference between the two edges of the road trace is around 35 meters, construction of an underpass would be difficult at this location. Construction of land bridges (Figure 5.1) is proposed as an option.

Other mitigation measures to compensate habitat loss and fragmentation

- As a means of compensating for unavoidable losses of forest and associated vegetation, enrichment planting shall be undertaken in degraded forests. Afforestation /reforestation on scrub lands shall be undertaken with the help of the Forest Department and local stakeholders (such as schools and CBOs). If rare and threatened plants are present, they will be removed (root balling method) and replanted in alternative sites or be used in road-side landscaping.

- Landscaping and replanting of trees shall be carried out to enhance the ecological balance and appearance of the site. Plant species selected for landscaping will in large determines the types of birds, butterflies, and other fauna, inhabiting the site (garden) after construction. In addition to enhancing the aesthetic appeal of the site, landscaping provides the means for partially restoring the site's natural elements and ecological habitats. Low-maintenance native plant species will be used wherever possible.

5.3.1.2. Loss and Fragmentation of Manmade Habitats

Loss of agricultural lands and home gardens is unavoidable. As a means of compensating for these losses, enrichment planting in home gardens will be undertaken. Landowners will be provided with native multipurpose trees and native trees with timber value (free of charge) to diversify the home gardens.

5.3.1.3. Ecological impacts due to inappropriate disposal of removed vegetation and soil/debris

Topsoil and dredged material from all working areas and access tracks will be stripped carefully and stockpiled, or used immediately to rehabilitate worked areas/filling operations. Wherever possible, stripped topsoil will be placed directly onto an area being rehabilitated or filled. This avoids stockpiling and double handling of the soil.

Pollution and solid waste disposal can degrade terrestrial and aquatic habitats. Proper and safe storage of materials will be carried out to avoid accidental spills or wash-off of chemicals/ materials with rainwater.

Proper maintenance of vehicles and machinery will be carried out to avoid oil spillages and leakages.

5.3.1.4. Ecological disturbances by workers and their camp operations

Solid waste and sanitary waste arising from labour camps and other sites will be properly collected and disposed. Under no circumstances such waste will be released untreated into the environment and water bodies. All workers and contractors will be made aware of engineering best practices and solid waste disposal guidelines. Necessary guidelines and conditions for operation will be included into contract awarding documents.

5.3.1.5. Ecological disturbances by construction vehicles and their operations

This is avoidable by following best practices. All vehicles shall operate on designated existing access roads. If additional supply roads are required, they should be established on already disturbed/degraded paths determined jointly by the monitoring committee. The contractor will be instructed to follow appropriate safeguard measures and guidelines will be included into contractor documents. The contractor will be advised to strictly adhere to the environmental management plan.

5.3.1.6. Disturbance due to noise, vibration and dust

In general, most fauna recorded along the proposed trace are capable of adapting to human disturbances and co-exist in human modified habitats. Hence no special mitigation measures are required. However, mitigation measures are required for species that are sensitive to noise disturbances during the construction phase. Construction vehicles and machinery will be well-maintained to reduce the noise and vibration disturbances. Temporary sound barriers will be erected in sensitive areas during constructions. Appropriate safeguard measures and instructions will be included into contractor documents and they will be advised to strictly adhere to the environmental management plan.

5.3.1.7. Spread of invasive species

Invasive Alien Species (IAS) exert a great threat to valuable native flora. Thus their spread should be prevented. Therefore all workers will be made aware of IAS and it is advisable to remove IAS manually at a very early stage of their emergence.

5.3.1.8. Added threats to flora and fauna

During the construction phase the excavated temporary pits and trenches should be barricaded to prevent animals from falling into them and to prevent breeding of mosquitoes. The sides of these trenches will be sloped to facilitate the escape of animals that may fall into them. No Point Endemics species were recorded during the survey. However, in view of the occurrence of threatened, endemic and valuable fauna and the provision of migratory routes, forests will be kept intact as far as possible.

Mitigation of Ecological impacts on Aquatic Habitats

5.3.1.9. Aquatic Habitat loss and degradation

Habitat degradation due to soil erosion and sedimentation can be controlled by implementing appropriate mitigation measures. Manual labor will be used in sensitive areas wherever possible. The timing of major construction activities will be adjusted to coincide with dry months of the year to minimize soil erosion and

sedimentation. Necessary guidelines and conditions for operation will be included into contract awarding documents. The contractor will be advised to strictly adhere to the environmental management plan.

5.3.1.10. Impacts due to inappropriate disposal of soil, debris, solid waste and sanitary waste

Soil, debris and solid waste shall be disposed on pre-identified sites located away from waterways. Suitable sites and methods will be selected for the disposal of waste. Accepted sanitation methods (e.g. mobile toilets) with proper sewage disposal facilities will be provided. Soakage pits will be located away from waterways. Necessary guidelines and conditions for the disposal of soil, debris, solid waste and sanitary waste will be included into contract awarding documents. The contractor will be advised to strictly adhere to the environmental management plan.

5.3.1.11. Obstructions to the movement of aquatic organisms

Most of these are short-term negligible impacts; hence no specific mitigation measures are required. However, necessary precautions will be taken during construction operations near water-bodies/streams to minimize construction waste, soil, debris and other material entering water-bodies Specific measures and construction best practices are discussed in detail elsewhere in the document. Culverts and drainage structures will be well-maintained during the operational stage to allow water flow into the natural drainage network.

5.3.2. Mitigation of Ecological impacts during the Operational phase

5.3.2.1. Road kills

Reducing animal access to roads: Meshed fences of at least 2 m height (other than in forest areas) can be used throughout to cover most of the places. At interchange points, will be taken to erect such fences so that domestic animals do not have access to these roads.

Signs to caution vehicles: Signs can be erected at the start of a sector where animals are likely to enter to the highway. A study will be carried out prior to the operational stage to identify such locations. In addition, speed limits will be implemented at certain locations.

A significant number of case of low flying birds collisions and run over by fast moving vehicles have been reported in currently operating expressway networks in Sri Lanka. In order to reduce the number of flying bird casualties, following design is suggested for the expressway trace which traverses through wetlands as neccessary. The concept is to increase the flying height of the birds and avoid vehicle collisions. This could be acheived by placing an additional fence just outside of the pavement shoulder of the expressway as presented in figure 5.4 below

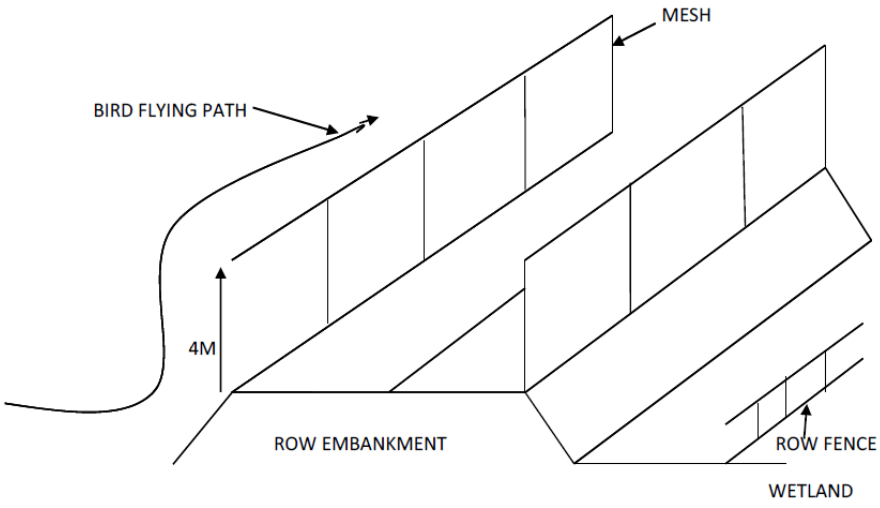

Figure 5.4: A sketch showing a bird flying pathway diversion structure

5.3.2.3. Loss of vegetation and habitats in the vicinity because of future development

It is difficult to impose any development restrictions on private lands. However, state lands and minimum reservation on either side of the road shall be kept intact.

5.3.2.4. Noise and vibration pollution

Mitigation measures are required for species that are sensitive to noise disturbances during the operational phase, especially in ecologically sensitive forested areas. Vegetation/roadside tree planting will be used as a sound barrier to reduce the impact of operating vehicles on the highway, especially in sensitive areas. Vehicle condition shall be considered in allowing vehicles through entrance points.

5.3.2.5. Ecological Impacts due to pollution

Green belts shall be established with native species to reduce the impact of dust and air pollution**.** The mechanical condition shall be considered in allowing vehicles through entrance points (traffic management policy).

5.3.2.6. Spread of invasive species

Irradiation of Invasive Alien Species (IAS) will be incorporated to landscape maintenance plan. Therefore all maintenance workers will be made aware of IAS.

5.3.2.7. Impacts on aesthetic value

Landscaping and replanting of trees will be carried out to enhance the ecological balance and appearance of the site. Plant species selected for landscaping will in large determines the types of birds, butterflies, and other fauna, inhabiting the site (garden) after construction. Low maintenance native plant species will be used wherever possible.

5.4 Mitigations for Water Quality Impacts

Section 1 & 2

Mitigation of impacts due to water pollution

Installation of appropriate drainage facilities to control runoff at the site premises will be given priority for two purposes: to control sediment loads carried by the runoff, and to prevent contamination of water by oxygen demanding waste, oils, grease and any other harmful material.

Degradation of soil cover from erosion, removal, or loss of soil during construction:

Both temporary (during construction) and permanent erosion control plans to control erosion of the cut and fill areas shall be planned to ensure that the surface water bodies are not contaminated with heavy sediment loads, thus turbidity and color in water are within acceptable limits. Cut and fill operations during construction shall be carried out, to the extent as possible, during dry days rather than on rainy days. This will avoid generation of high suspended solid loads in the surface runoff.

Temporary plans:

- Silt fencing
- Site runoff diverted through temporary silt trap basins and interceptor drains and sedimentation tanks to collect suspended solids contained in surface runoff before discharging into surface water
- Short term seedling or mulching of exposed soil areas (particularly on slopes). Exposed sloping areas will be thatched with dead or live vegetation would reduce the generation of wind-blown dust.

Permanent plans:

- Erosion control plans would be established which focuses on establishment of stable native vegetation communities, especially along the embankment slopes.

Prevention of water contamination from sources other than suspended sediments:

Proper on-site management and prevention of petroleum products, oil and grease, and other harmful material entering water bodies would be given serious consideration, both during construction and operational stages. Good housekeeping practices will be aimed at prevention of spills, and wastages, storage, sorting and segregation of wastes until properly treated before discharge. In addition, site runoff during construction would be diverted through oil and grease traps. During operational phases, oil interceptors shall be provided for surface runoff from the vehicle and machinery service yards, maintenance yards, and storage facilities. Storage facilities would be advised to refrain from stockpiling of material (construction material during construction phase), and take steps to regular monitoring of leakages. Contaminated wastewater will be properly treated using appropriate physico-chemical methods after identification of the substances present in the waste stream and discharge would conform to CEA stipulated discharge standards for inland surface waters.

Construction camps will be provided with sanitary latrines. If the workforce at one location is in the order of 100-150 persons or less, pit latrines will be used as the ground water table is relatively deep and there is no possibility of groundwater contamination. If the work force is more, sewage would receive primary-equivalent treatment before it is discharged. Wastewater generated from the service areas and interchange points (including toilets and canteens) is essentially domestic in character and would be treated before discharge (as proposed in SLS745 Part I and II).

Impacts of waste contamination of natural waters shall be carefully examined considering effects of dilution and the fate of contaminants considering the existing water quality and flow characteristics of the receiving water body. Most of petroleum-based pollutants, wash-water containing lubricants and oil and grease will not be biologically degraded in natural water sources nor will they be lost from the water phase as a result of precipitation, sedimentation or volatilization. Such pollutants will be collected on-site and properly treated before being discharged. Downstream concentration of such pollutants after discharge can be predicted considering the dilution capacity of the receiving water body (refer CEA guidelines and National Environment Act 1980) using a mass-balance approach with appropriate assumptions. Organic wastes including nutrients (especially N and P) and wastes containing bacteria will undergo biological decomposition and decay after they are being discharged to aquatic systems. Wastewater of both above categories shall be treated to reduce concentrations until dilution of wastes are acceptable, most importantly during low-flow conditions during the dry weather (e.g. minimum monthly flow in a five-year period).

Proposed measures to address ground water quality deterioration

Most of the remedial measures to prevent groundwater contamination follows the mitigations strategies described above for surface water. These include proper disposal of wastewater and solid wastes (both sanitary as well as hazardous) during construction and operational phases. For on-site disposal of human waste, and solid wastes, the selected sites would be located where soils underlying are relatively impermeable and have attenuative properties. An adequate depth would be provided between the bottom of the landfill and the top of the groundwater table. Such land disposal sites will not be located upgradient of any ground or surface water whose usage could be affected by contamination. (This does not apply to surface waters, if the dilution capacity is adequate).

If water supply during construction phase is from groundwater sources, then it will be ensured that projected use of groundwater is within the capacity of natural system to replenish itself.

Section 4

All the mitigation measures described above for Sections 1 and 2 are applicable to Section 4, as well. Specific mitigation measures are described below.

Baseline measurements of water quality should be undertaken prior to construction at the following sensitive recipients.

- 3 interchanges.
- Walas Wewa area (Ch 120+750 km).
- Deduru Oya area at Ch 83+250 km.
- Ch129 + 650 km; A9 crossing area at Kapuwatte.
- Ch 81 + 200 km at Kuda Kowana, Ch 124+100 km.
- Mirisgoni Oya (Ch 136+600 km).

5. 5. Proposed mitigation measures for Geology and Soil

Possible road cuts shall be done under the guidance of a geologist/geotechnical engineer, and slope stability techniques will be implemented where necessary.

Excavation activities shall be minimized during the rainy season to reduce soil erosion leading to sedimentation in adjoining water bodies and drainage system. Conversely, during the dry season wind erosion will be reduced by spraying water to the surface of the excavated soil.

Groundwater stability would be studied around the road cuts prior to any construction works. Cement grouting will be applied along such slopes in order to maintain groundwater stability.

In addition to road cuts, possible natural landslide areas would also be demarcated along the proposed road, and necessary slope stability methods shall be applied during the construction.

Rock sliding also can be expected along the road cuts, in order to stabilize them, rock bolting and other stability methods shall be applied.

In order to control surface runoff and thus the turbidity in surface water bodies, construction activities would be minimized during the rainy seasons.

To minimize the impacts on soil, a systematic construction procedure would be used, soil would not be dumped everywhere and would not be kept for long period of time without using.

During the construction through the dry season the surface moisture level of the soils would be increased by sprinkling water to them in order to prevent dispersion of dust and soil particles,

All the soil materials which are going to be used for the road embankment would be covered until used for the construction activities.

Soil would be transported from one place to another by covering the loaded vehicle with tarpaulin.

Material transportation would be done along the available road network in order to prevent soil compaction. Proposed road stretch will be used for the transportation of the construction materials.

Materials shall be reuse for the road construction while nonusable materils shall be disposing to the disposal sites.

Specific approvals shall be taken from GSMB for areas where the road sections which are to be oriented through rock out crops in relation with the respective road segments.

If any quarry sites are within the ROW special approval from the GSMB shall taken.

5.6 Mitigations for Noise, Vibration and Air Quality Impacts

Mitigation measures for noise and vibration impacts on nearby settlements and habitats (Section 1&2)

Noise impacts on nearby settlements and habitats

During construction stage of project

Noise levels would be carefully monitored during the construction phase. If ambient levels are far higher than the stipulated limit of 75 dB(A) for daytime construction works (defined from 6 am to 9 pm), then appropriate measures shall be taken. All workers in the vicinity of loud noise and those working with or in compaction, batching or concrete mixing operations, jack hammering, etc. shall be provided with appropriate protective gear.

All machinery and equipment to be used for the construction phase will be regularly well maintained (for example, proper lubrication of the moving parts of the machinery in contact will reduce noise due to friction) and fitted with noise reduction devices such as exhaust silencers/mufflers in accordance to manufacturer's instructions. Similarly, the vehicles will have good quality mufflers or silencers to reduce exhaust noise. However, there are some construction machinery and equipment from which it is extremely difficult to reduce undue noise. Therefore, high noise emitting machinery and equipment and all other noisy works such as concrete mixing and batching, mechanical compaction, use of saws, excavation works using excavators, jack hammers, rock drills and rock breakers will not be used during the night time (defined from 8 pm to 6 am the following day) and such works shall be done sufficiently away from sensitive receptors to the extent possible. In fact erection of temporary barriers such as GI fences (about 8-10 feet in height) round the perimeter of the construction site will be necessary to reduce noise and even dust to some extent especially when sensitive receptors are present.

The contractor will be instructed to use exhaust mufflers in all construction vehicles and equipment. The functionality of such mufflers would be monitored and if found faulty they would be replaced immediately. All heavy machinery shall be maintained in good operable conditions at all time during the construction period to avoid any unnecessary sounds generated during the operation of such equipment. Any additional fittings fitted to construction equipment that generates high and irritating noises shall not be permitted on site. Construction equipment would be placed as far away as possible from noise sensitive receptors. Construction of temporary noise barriers such as temporary walls or piles of excavated material between a site with noisy activities (e.g. pile driving site) and noise sensitive receivers will be considered where feasible to reduce the impact of noise. The use of impact pile driving will be avoided where possible, especially in noise sensitive areas. Drilled piles or the use of a vibratory pile driver will be used as quieter alternatives. All such operations would be approved by Construction Supervision Consultant (CSC) prior to commencement of construction.

Demolition of structures would be carried out using quieter methods especially near settlement areas. For example use of a backhoe to demolish a structure will generate more noise than demolishing the structure using small power tools. Even though the time taken for the activity may be greater the impact of noise nuisance to nearby public will be less.

Transport routes for trucks and heavy vehicles to the construction site would be selected to minimise the impact on residential areas where possible. Proper traffic management practices too will be implemented along with maintenance of access roads during transport of materials in order to reduce traffic noise. Heavy vehicle movements too would not be carried out during night time (8 pm to 6 am the following day) to avoid disturbances to neighbouring communities.

It is noted that a set of noisy operations could be carried out at the same time period as the total noise level produced will not be significantly greater than the level produced if the operations were performed separately.

Workers in vicinity of high noise levels and workers exposed to continuous noise such as drillers, workers working at quarry, crusher, asphalt and concrete batch mixing plants will be instructed to wear ear plugs during working hours.

Noise generating construction activities would not be undertaken on days with religious importance or at night. Operations which generate high noise levels at noise sensitive locations (e.g. near schools) will not be undertaken at given times of the day where noise becomes an issue. If the contractor wishes to carry out construction activities during the nighttime it will be ensured that such activities do not generate noise levels more than 45~55 dB (A). The contractor will make a written request to CSC and obtain approval from both CSC and CEA before executing such activity.

It is suggested that the contractor informs the public on any noisy operations that would be carried out close to settlements with details of timing and duration of such operations. It would be ensured that the contractor always listen to any complaints from public, and make necessary changes to the operations or equipment without any delay.

During detailed design, noise sensitive receptors that may be significantly affected during the operational stage will be identified and potential mitigation measures such as permanent noise barriers will be constructed.

During operational stage of project

Drastic measures are not required during the operation phase. However, it is important to emphasize the fact that all vehicles are regularly serviced and well maintained (in compliance with emission control standards) to reduce both air pollution and even engine noise. In other words enforcement of stringent laws governing maintenance aspects and periodic or random on-site monitoring of exhaust emissions and even the surrounding air quality of the project area (when the highway is relatively busy) would be of paramount importance. Furthermore, it is essential to monitor the ambient air quality of areas that are further away from the project area to be used as reference points for comparison purposes.

The noise barriers constructed to minimise noise impact would be maintained during the operational stage of the project. In addition, maintenance of a vegetation cover (forestation zone construction) or uprooting (root balling) and replantation of trees to the extent possible near the highway area would be carried out to arrest dust and airborne pollutants as well as to reduce noise.

It is also important that RDA from time to time take measurements on noise to monitor the changes in noise levels close to noise receptors.

Mitigation of impacts due to vibration to settlements and habitats

During construction stage of project

Prior to commencement of operating metal quarries, the contractor will undertake dilapidation surveys with the project proponent to identify any archaeological/historical and weak structures that are likely to collapse from high ground vibration levels or peak particle velocities (PPVs) and air blast over pressure levels (AOPB) levels.

Furthermore several test blasts would be carried out in order to determine the optimum quantity of ANFO and dynamite required per borehole, so as to ensure that ground vibration levels or peak particle velocities (PPVs) and the air blast over pressure (AOPB) levels does not exceed the limits given in Table 5.1. Therefore, to evaluate this vibration monitoring will be done at pre-determined locations.

Table 5.1: Vibration Standards for Blasting

Category of Structure	Type of Blasting	PPV (mm/sec)	AOPB dB(L)
Type 1 – Multi-story buildings of RCC or structural steel, within filling panels of block work, brick work or pre-cast units not designed to resist earthquakes	Single bore hole	8	105
	Multi bore hole with delay detonators	10	115
Type 2 – Two-storey properties constructed of reinforced block work, pre-cast units, and with reinforced floor and roof construction, or wholly of reinforced concepts or similar, not designed to resist earthquakes	Single bore hole	6	105
	Multi bore hole with delay detonators	7	115
Type 3 – Single and two-storey properties made of lighter construction, using lightweight materials such as bricks, cement bricks, etc. not designed to resist earthquakes	Single bore hole	4	105
	Multi bore hole with delay detonators	5	115
Type 4 – Structures that do not correspond to those listed above due to their sensitivity to vibration,, and are declared as archaeologically preserved structures by the Department of Archaeology	Single bore hole	0.5	95
	Multi bore hole with delay detonators	0.75	100

Blasting would be done at regular intervals and ake any people living in the vicinity of the project area would be made aware about the places, dates and times of blasting. In this respect air sirens (which can be heard more than 500 m from the quarry site) would be operated at least 3 times before blasting.

The contractor would be advised to carry out a property condition survey of all structures within a 50~75 m corridor from both edges of the proposed ROW and any existing failures of the structures would be recorded. If any structure is found susceptible to vibration the occupants of such structure would be vacated from the structure at least until the heavy vibration activities are over. The contractor would pay for any damages caused to structure due to vibration or repair the damages. The contractor would obtain a third party insurance to cover any unforeseen damage to property due to activities with heavy vibration. Reasonable compensation would also be given to any property which is damaged by blasting including for the damages that may have occurred during the test blasting events. As for other high noise generating construction works, blasting activities too would not be carried out during the night time.

During blasting operations careful continuous monitoring would be carried out of nearby building structures in order to investigate any instability or damage following blasting. In other words regular monitoring of vibration levels in nearby building structures would be carried out whenever blasting activities are carried out and whenever complaints are received. In this respect special attention would be paid to the development of cracks and crevices in nearby building structures.

As in the case of noise, impact type methods will not be used for demolition of structures. Avoiding the use of heavy vibratory rollers or packers close to sensitive areas will also reduce the impact of vibration.

Selection of transport routes for heavy loaded trucks through areas with less population will reduce the vibration nuisance created by the movement of such trucks.

Phasing off the demolition, earth moving and ground impacting operations so as not to occur in the same period of time would help in reducing the impacts of heavy vibration. The total vibration levels produced would be significantly less when vibration sources operate separately.

Activities that create vibration would be avoided during hours from 20.00 to 06.00 (night time) as the public are more aware of vibration in their homes during the hours of night time.

Impact pile driving shall be avoided where possible (especially close to vibration sensitive locations as identified during the property condition survey). Drilled piles or use of vibration/ sonic pile drivers (which use a standard frequency to drive piles) which causes lower vibration levels would be used where geotechnical conditions permit.

No special measures will be required for this impact of vibration during operational stage of project. However, all users of the expressway will be advised to avoid using any item fixed to the exhaust system of the vehicles that causes unnecessary noise and vibration levels as at higher speeds the noise and vibration levels produced by such fittings would be nuisance to public living close to the expressway and fauna.

Mitigation measures for air quality impacts on nearby settlements and habitats

During construction stage of project

Dust generating activities such as earth works, handling and transporting of soil and aggregate during times of high winds or during more stable conditions with winds directed towards adjacent residences and other facilities will be effectively managed.

All earthworks shall be covered in a manner minimizing generation of dust (e.g. placing of barricade tape over rolled embankment sections to avoid any movement of other vehicles over such sections which generate dust). Vehicles transporting construction material would be required to adequately cover the material to avoid wind induced dust and spillage. In addition, enforcing limitations to speeds of construction vehicles (about 10 km/h) carrying material is another measure that may be practiced in reducing dust emissions and therefore, it is recommended to erect sign boards. Further all construction materials such as cement brought to the site would be stockpiled carefully to avoid unnecessary dust emissions. Hence, such material would be adequately covered and stored in temporary sheds that are well protected against rain and wind or stockpiled in locations not subject to floods, heavy rains and winds. Similarly, spoil stockpiles would be located sufficiently away from sensitive receptors. In addition open areas which are frequently subject to winds would also be avoided.

It is anticipated that during the construction works dust emission scenarios would be significant and it will be minimized through measures such as frequent wetting or wet spraying of dusty surfaces and any exposed earthwork surface. Contractor shall be instructed to use a set of water trucks/ bowers to sprinkle water over all exposed areas as required for suppression of dust. The frequency and timing of sprinkling will depend on the weather conditions and availability of sensitive receptors. However the contractor shall not be allowed to use wastewater or waste oil for dust suppression. This is highly crucial in areas with laterite, clay or sandy clay soil. In this respect it is recommended to use sprinklers or to use tankers or bowzers. Use of wastewater or waste oil for dust suppression would be prohibited. In addition, steps will be taken to compact loosened soil, carry out regular manual cleaning of the construction sites (with regular removal of debris and unnecessary material) and even cover all exposed earthwork areas with material such as black polythene cover (which could be later used for other purposes), gunny bags, straw material or removed/uprooted vegetation to the extent possible.

The levels of dust generation from the crusher plant, loading of raw materials to the asphalt plant and concrete batch mixing plant shall be controlled up to the national ambient air quality standards (Gazette Notification No. 1562/22 of 15th August 2008). Crushing plants will be sited sufficiently away from sensitive receptors such as residential areas, schools, religious places and hospitals. Normally siting shall be upwind of sensitive receptors a minimum of 500 m and downwind of sensitive receptors minimum of 100 m. However,

all dust emissions from the plants would be carried out by means of covering all dust generating locations (points) of the crushers or the entire crushing plant with material such as fabric bag filters or gunny bags which would be frequently wetted.

Furthermore, wet spraying of the quarry site will be done to minimize dust emissions prior to blasting (to the extent possible) and soon after blasting so as to minimize possible spreading of the dust to considerable distances. However, when wetting the area to be blasted, care would be taken to ensure that misfires would not result. For example, when the drill holes are wet only the ANFO (safely packed on polythene tubes) can be used to prevent misfires caused by water deterioration. ANFO and the joints of connecting wires of the electric detonators would be adequately insulated.

Quarry material would be thoroughly wetted prior to loading to tippers and trucks (when using backhoes) in order to minimize dust emissions during material loading and then to cover the vehicles to avoid dust emissions and spillage.

Storage locations of gravel, metal and sand shall be located away from settlements and other sensitive receptors. Care will be taken to avoid spillage of construction material and dust emissions during unloading of such material to the project site. Care shall be taken in stockpiling construction material with adequate cover (with artificial barriers or natural vegetation) against wind and rain.

During the construction phase the vehicles and the machinery to be used would be regularly serviced and well maintained in order to avoid unpleasant diesel 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 and further amendment, 1557/14 July 2008). Vehicles and the machinery producing unpleasant diesel (black) smoke and having faulty exhaust silencers will be removed from the sites.

The contractor would be instructed to advise all truck and other construction vehicles operators on speed limits to be enforced at construction sites. All vehicles delivering material to construction sites would be covered to avoid spillage of material and emission of dust. The contractor would be advised to avoid or with tarpaulin take suitable action to prevent dirt and mud being carried to the roads (particularly following wet weather). As in the case of noise and vibration the movement of heavy vehicles and other construction vehicles through settlement areas would be avoided. If such movement is unavoidable the drivers would be instructed to travel at slow speeds, and in such a manner, that does not generate dust.

The contractor would be instructed to operate the quarries, crusher plants, asphalt plants and concrete batching plants with Environment Protection Licenses (EPL) and other regulations of local authorities. All employees used for quarrying and construction works would br supplied with nose masks and safety goggles.

Proper storage facilities would be constructed for chemicals, cement, paints and other construction material. Such storage facilities would always be adequately ventilated. Cement mixing operations and batching plants too shall be sited away from sensitive recipients and cement mixing/handing works would be avoided during heavy windy conditions.

All workers would be advised not to burn waste material at random locations. All solid waste from worker camps shall be collected and incinerated at one location.

During operational stage of project

Drastic measures will not be required during the operation phase. However, it would be emphasized that vehicles are regularly serviced and well maintained (compliance to emission Standards is important) to reduce both air pollution and even engine noise. In other words enforcement of stringent laws governing maintenance aspects and periodic or random on-site monitoring of exhaust emissions and even the surrounding air quality of the project area (that when a train is travelling) would be ensured. Furthermore,

the ambient air quality of areas that is further away from the project area would be used as reference points for comparison purposes.

The increased CO_2 emissions by vehicles would be managed by maintenance of a green belt and establishing more trees that would absorb emissions of CO_2..

Section 4

All the mitigation measures described above for Sections 1 and 2 are applicable to Section 4, as well. Specific mitigation measures are described below.

Mitigatory measures for impacts on Air quality, noise/ vibration

There would be some noise (around 50-55 dB) contributed by machinery associated with borehole drilling. However, this impact will be temporary and noise will be intermittent.

Noise impacts have been predicted near Udanwita Maha Vidyalaya as the expressway traverses within a 200 m distance from it. A noise barrier will be constructed at this place. Vibration impacts have been predicted at several places as given below. For these places dilapidation surveys (crack surveys) will be carried out before construction.

Baseline measurements of air, noise, vibration and water quality shall be undertaken prior to construction at the following sensitive recipients.

- 3 interchanges.
- Walas Wewa area (Ch 12+750 km).
- Deduru Oya area at Ch 83+250 km.
- Ch 129 + 650 km; A9 crossing area at Kapuwatte.
- Ch 81 + 200 km at Kuda Kowana, Ch 124+100 km.
- Mirisgoni Oya (Ch 136+600 km).
- Areas close to Udanvita Maha Vidyalaya at Ch 99 + 800 km and Bambawa Purana Raja Maha Viharaya at Ch 116 + 000 km.

Designing of noise barriers

- RDA shall design a 5-10 m tall noise barrier at the side of the trace facing the Udanvita Maha Vidyalaya (Ch 99+800 km)

5.7 Mitigations for the impacts on railway line

In case of the tunnel at Ambepussa link it is suggested that a concrete lining (Jacket) to be placed within the tunnel to strengthen the tunnel roof or to entirely remove the tunnel overburden and place the road on a bridge. The second option will be more viable as there are plans by Sri Lanka Railways Department to upgrade this railway line.

During construction stage of project

All construction work close to railway lines should be done in coordination with Sri Lanka Railways Department. The contractor should take every precaution to avoid even an accidental damage to the railway lines. Minimum height of 7m shall be maintained from the top of the exsisting railway line to the structures of the expressway. Nessasary structures shall be placed which allowas to construct the proposed railway line from Kurunegala to Habarana. Concerns of the department of Railways shall consider in detail design of the project.

During operational stage of project

As the railway line is placed below the expressway it is important to place a net or mesh above the railway line. Such measure will avoid any debris thrown out of the expressway falling on to therailway line which could damage the trains or affect the safety of railway commuters and goods.

CHAPTER 6: ENVIRONMENTAL MANAGEMENT AND MONITORING PROGRAMME

6.1 General

The potential pre-construction, construction and operational impacts of the project identified in Chapter 4 will be minimised by the implementation of mitigation measures that are discussed in chapter 5. The potential impacts and mitigation measures discussed in Chapters 4 and 5 will be further updated (to be more project and site-specific in terms of construction aspects, economic aspects, environmental aspects and social aspects) during the detailed design stage of the project.

The Environmental Management Plan (EMP) is presented as an annex to this Chapter (Annex 7.1).

6.2 EMP for Detailed Design Stage

The EMP will be revised during the detailed design stage and the updated EMP will form part of the contract documents. The construction contractor would be responsible for implementing the EMP during the construction period.

6.3 Monitoring Mitigation Measures

The implementation of mitigation measures outlined in the EMP would be monitored during the pre-construction, construction and post-construction stages of the project to ensure that the environmental impacts are being managed appropriately.

The Environmental Monitoring Plan (EMoP) presented in Annex 7.2 lists the environmental parameters that need to be measured during the pre-construction, construction and post-construction stages of the project.

6.4 Execution of Mitigation Measures

As stated above, the implementation of mitigation measures during the construction period is the main responsibility of the contractor. The RDA is responsible for the implementation of the mitigation measures during preconstruction and post-construction stages. The Environmental and Social Development Division (ESDD) of RDA will be responsible for monitoring the implementation of EMP as an internal monitor, while CEA/NW-PEA will be the external monitoring agency for the project. The ESDD will carry out regular inspections of the project site to monitor the compliance levels while CEA/NW-PEA could carry out inspection on a quarterly basis or as decided by them at random.

6.5 Staffing Requirements

The Contractor will recruit a dedicated Environmental Officer (EO) to advise the environmental compliance requirements of the Contractor's construction team. The Construction Supervision Consultant (CSC) will obtain the services of an Environmental Specialist to advise the contractor in implementing the EMP and EMoP during the construction period.

6.6 Reporting

Monthly reports on Environment and Social Safeguard compliance will be prepared by contractor and submitted to the PMU through CSC, who will then submit them to PMU. PMU of RDA will submit them to Environment and Social Development Division (ESDD) for checking. The ESDD will submit the reports to CEA/ NWP-EA. In addition to the monthly progress report, a biannual report with the summary of mohtly reports will be submitted to CEA/ NWP-EA.

CHAPTER 7: EXTENDED COST BENEFIT ANALYSIS

7.1. Introduction

General

In this chapter, findings of the extended cost-benefit analysis (ECBA) are presented. Extended cost-benefit analysis (ECBA) is the tool used to assess whether a project is economically justifiable when environmental and social impacts are also taken into consideration. It is carried out by extending the scope of standard cost-benefit analysis (CBA) that evaluates intended benefits of the project, against estimated costs, by incorporating environmental/social impacts either as costs or benefits measured in terms of monetary values. It is based on the analysis of discounted flow of costs and benefits. The key economic criteria used for project justification are net present value (NPV), cost-benefit ratio (CBR) and internal rates of return (IRR).

Any project has environmental and social impacts other than benefits/costs intended by the design of the project. Depending on the nature of impacts, they can either be identified as costs or benefits to the society. Usually data on such impacts is not available at the feasibility stage of the projects. Extended costs-benefit analysis (ECBA) is used to assess the economic viability of projects once the information on environmental and social impacts is acquired through environmental and social impact assessments. ECBA evaluates whether a project is still economically justifiable when environmental and social impacts also are taken into account either as costs or benefits, depending on the nature of impacts.

Key Steps of ECBA

Key steps involved in the ECBA include:

- Selecting suitable combinations of expressway stages to conduct ECBA that can appropriately cover the environmental and social impacts identified in the EIA and SIA.
- Extracting the required base data on project costs and benefits from the relevant CBA carried out in the economic and financial analysis of the project feasibility study.
- Identifying, economically measurable environmental social impacts reported from EIA and SIA and determining whether they represent net negative (cost) or net positive (benefits) impacts to the society
- Acquiring required physical data regarding the respective impacts (costs and benefits) from experts of EIA and SIA teams
- Evaluating costs and benefits of environmental and social impacts using appropriate valuation techniques
- Carrying out ECBA, incorporating extended scope of cost and benefits identified in EIA and SIA and calculation of project performance criteria—i.e. NPV, BCR and IRR
- Interpretation of ECBA results in comparison with CBA carried out for the selected combination of stages in the economic analysis of project feasibility study to assess the real impact of the project once the environmental and social impacts also are taken in to consideration

Tools used and Assumptions Made in ECBA

Identified impacts were valued using standard tools of valuation. As far as analysis is concerned the same assumptions and standards used in the CBA conducted for the economic and financial analysis were maintained. The list of assumptions and standards adopted in the analysis is given in the table 7.1.

Table 7.1: Major assumptions and standards used in the extended cost-benefit analysis

Parameter	Standard/Assumption	Remarks
Discount rate	7%	This had been decided based on the historical movement of the interest rates in the country.
Evaluation period	4 years for construction and 30 years for operation	Cost estimates for the construction were available for given number of years and consistent with the usual standards applied for similar projects.
Price year	2016 constant prices	CBA has used the same basesyear
Numeraire currency	LKR bn	Standard used in the CBA
Treatment of inflation	Constant prices excluding inflation was used	Standard practice adopted in economic analysis

Other assumptions regarding the shadow conversion factors, economic unit costs and taxation also were same as in the case of Economic Analysis of the project (University of Moratuwa, 2016).

Decision Criteria

The three decision criteria considered in the ECBA were:

- Net Present Value (NPV)
- Benefit Cost Ratio (BCR)
- Internal Rate of Return (IRR)

Net Present Value

The Net Present Value (NPV) measures the actual or real net economic benefit of the project. The NPV is calculated by subtracting the discounted costs from the discounted benefits. All projects with a positive NPV provide a net economic benefit and are economically justified. The NPV should be used when comparing mutually exclusive project options. The option with the highest NPV is the economically preferred option.

The formula applied for calculating NPV is as follows:

$$NPV = \sum_{i=1}^{n} \frac{(B_i - C_i)}{(1+r)^i}$$

B= Net annual benefits
C = Net annual costs
r = discount rate

Benefit Cost Ratio (BCR)

The Benefit Cost Ratio (BCR) is the ratio of the present value of benefits to the present value of costs and measures the relative net gain of the proposed expenditure. The BCR will be greater than 1 whenever discounted benefits exceed discounted costs. A project with a BCR above 1 provides a net economic gain and is therefore economically justified. In a budget constrained environment, projects should be prioritized according to their BCRs. The project with the higher BCR is expected to provide the greatest benefit per dollar invested and hence should receive priority in the allocation of funding. This will ensure the efficient allocation of scarce resources.

The formula applied for computing BCR is as follows:

$$BCR = \sum_{i=1}^{n} \frac{B_i}{(1+r)^i} \Big/ \sum_{i=1}^{n} \frac{C_i}{(1+r)^i}$$

Internal Rate of the Return (IRR)

Internal Rate of Return (IRR) is the discount rate at which the present value of benefits equals the present value of costs (where NPV equals zero). It measures the rate of return of benefits to costs. If the IRR is greater than the interest rate that would otherwise was the rate of returns for the funds invested in the project concerned, it is considered as a sound investment.

7.2. Costs and Benefits

7.2.1. Costs

Cost items have been identified under the following major categories.

Pre-construction costs: This includes cost items that have to be incurred before starting the construction of the CEP. Major cost items identified are cost of feasibility, detailed design and land acquisition. Information on these cost items were extracted from the costing undertaken at the feasibility study. The land acquisition cost is estimated as Rs. 54 Billion.4

Cost of construction: This includes all capital cost items estimated for construction of the CEP. It covers cost of all engineering constructions and project management costs undertaken at the construction stage of the project. Period of capital expenditure is covered within the first four years of the project life. Information on these cost items were also extracted from the costing undertaken at the feasibility study. The total project cost is Rs. 507.59 Billion and a summary of construction cost of the expressway is given in Table 7.2. Additionally there is cost for tunnels which amounts to Rs bn 8.075.

Operating costs: This includes all operating costs estimated for a period of 30 years after the construction period. Estimates cover cost concerning government management, toll collection, servicing, maintenance and rehabilitation of the road for the period concerned. Again, the source of Information is the costing undertaken at the feasibility study.

These include routine and periodic maintenance of the road, road furniture repairs, tolling station operation costs, expressway management centre operational costs; culverts, bridges and drainage maintenance costs, road lighting, CCTV operations etc. The annual operating and maintenance cost is computed in the Northern Expressway Feasibility study report and is estimated at US $ 0.34 mn/km (2013 US $). In an ADB study report6 it is estimated at US $ 0.19 mn/km. However for this study the annual operating and maintenance cost were estimated considering the cost incurred for the Southern Expressway.

The cost of routine maintenance and operating cost for the Central Expressway is estimated as Rs. 2.78 Bn per year (US $ 0.11 mn/km, at US $ 1 = Rs 143).
In addition to the annual operating and maintenance cost there is periodic costs as well such as overlays, replacement of equipment, vehicles etc. The cost estimate for periodic cost in the Northern Expressway is US $ 1.92 mn/km occurring every 10 years. For the purpose of this study periodic costs is estimated as Rs. 22.8 bn (US $ 0.89 mn/km, at US $ 1 = Rs 143) incurring every 10 years. This includes rehabilitation cost, upgrading of equipment and vehicles.

Table 7.2: summary of the construction cost

	Section	Length (km)	Cost Rs. Bn
Section 1	Kadawatha - Mirigama	36.54	143.87
Section 2	Mirigama - Potuhera - Kurunegala	39.72	97.74
	Ambeypussa link	9.30	10.80
Section 3	Potuhera-Galagedara	32.50	102.09
Section 4	Kurunegala-Dambulla	60.15	153.09

Source: Economic Feasibility Analysis for Central Expressway Project, University of Moratuwa 2016.

The construction costs are distributed during the construction period of four years. The present value of operating and maintenance cost is Rs. 33.65 Bn. Furthermore, as 25% residual value is included in the cost, since it is expected that the expressway would continue to operate beyond the analysis period and its remaining useful value of the infrastructure is included in the residual value of the asset. A residual value of 30% is used after 25 year operating period for the Southern Expressway in the STDP Completion Report, ADB.

Besides the above mentioned project related costs, following environmental/social impacts have been identified as costs in the EIA and SIA.

Opportunity cost of affected land uses: Road is going to occupy a land strip which currently has economically valuable land uses. Vegetation of these land uses sequestrates atmospheric carbon while generating agricultural income for their owners. Both the carbon sink values and agricultural incomes will be lost once the road is constructed which can be considered as opportunity costs of land released for the project.

Cost of environmental damage: Compared with the base case CEP is expected to generate large volume of additional traffic which lead to additional emissions. In addition, certain negative impacts on local environment and mitigation measures to overcome them have been identified in the EIA. ECBA incorporates the costs that can be measured and valued based on the available data.

Table 7.3 provides a summary of the nature of cost items identified under above categories and methods used to estimate these costs.

Table 7.3: Types of opportunity costs and environmental damages and methods of estimation

Cost item	Method of estimation
Opportunity cost of affected land uses and travel time	
Loss of home gardens and other agricultural land uses	Economic values of major tree crops reported in RAP & SIA surveys for the project period
Cost of environmental damage	
Impacts on biodiversity and natural vegetation	
Losses of eco-systems services due to clearance of vegetation	Carbon sink values for the types of land uses lost for the project period
Losses and disturbances to habitats of wild animals	• *Prevention cost*: Cost of structures (under passes (UP), over passes (OP) and Eco-ducts) proposed for ecological purposes • Cost of replanting
Cost of pollution	
Cost of sound, air and water pollution	*Prevention cost*: Cost of sound barriers; cost of air and water pollution mitigation measures

Main sources of data for evaluating opportunity cost of affected land uses is surveys conducted for Social Impact Analysis (SIA) and for Rehabilitation Action Plan (RAP). Cost of environmental damages is based on data provided by experts of Environmental Impact Assessment (EIA) team. Given the limited availability of data, many of the impacts identified in EIA are valued on the basis of prevention cost approach. Here the cost of prevention measures proposed to overcome various impacts has been used as proxies for cost of the impacts concerned.

The loss of carbon sequestration ability due to clearance of vegetation in expressway area was calculated using the information on areas of different vegetation types. Total area of affected land uses were assessed at 511.19 Ha.

In addition EIA team has proposed an environmental monitoring program and cost of implementation of this program has been included. Estimated levels of the cost items identified under opportunity costs and environmental damages are given Table 7.4.

Table 7.4: Cost items under opportunity costs and environmental damages and data sources

Cost item	Economic Costs (PV LKR billion)	Data sources
Opportunity cost of affected land uses		
Loss of home gardens and other agricultural land uses	138.48	RAP/SIA survey
Cost of environmental damage		
Impacts on biodiversity and natural vegetation		
Loss of carbon sink values due to clearance of natural vegetation	0.93	EIA
Cost of environmental mitigation and monitoring program		
Cost of all proposed environmental monitoring measures	1.29	EIA

7.1.1. Benefits

In the Project Feasibility Study and Economic Analysis the following transport system benefits have been identified as the key benefits of the project.

Vehicle operating cost savings: Vehicle operating costs (VOC) are the costs associated with the running of a motor vehicle such as fuel, oil, tires, repair and maintenance and depreciation costs.

Smooth vehicle running conditions in CEP, against the base case situation of existing road network, was assumed. CEP operations reduce the unit VOC offering vehicle operating cost savings to users as main economic benefit.

Travel and freight time savings: Savings in travel time is a primary economic benefit sought from undertaking transport sector projects. These savings are enjoyed by passengers as well as freight consignees. A main benefit predicted by traffic models for users of CEP is travel and freight time savings.

Savings of accident costs: Compared with situation of the existing road network (base case), reduced number of accidents is another advantage of CEP. This results in the economic benefit of accident cost savings.

Methods used to calculate the respective types of benefits can be described as follows.

Savings

Vehicle Operating Cost (VOC) savings

Vehicle Operating Cost Savings were estimated using the following formula.

$$VOC\ savings\ = Total\ VKT\ by\ vehicle\ class\ \times\ \Delta\ unit\ OC\ per\ vehicle\ km\ by\ vehicle\ class$$

VKT = Vehicle km travelled
Δ Unit OC = Difference in unit operating cost between base case and CEP

SMEC has projected VKT for traffic diverted to NEP using the Northern Expressway Strategic Transport Model (NETSM) for 5 vehicle classes under 6 economic scenarios for the assessment years 2016, 2021, 2026 and 2036. The projected figures under the 'GDP linked CV growth' economic scenario has been selected for estimation of VOC savings.

UoM (2016) notes that this scenario resembles the most probable scenario, mention that a revision was warranted based on two reasons and following changes were made.
1. The growth rate of 1.40% - 1.47% per annum for Private vehicle was underestimating the growth of private vehicles. The motor car registration growth in Sri Lanka is around 6.65% for cars and even higher for motor cycles at 9.55% and three wheelers at 15% from years 2011- 2014. Therefore the growth factor for private vehicles were updated to be 5% based on annual growth values on existing road network.

2. CV growth factor of 5.21% across all CV types were considered too high. The highest Annual growth in the national highway network is around 4% for LCV while MCV and HCV are 3.5% and 2.5% respectively. Therefore the CV growth rates were adjusted for commercial vehicles.
The relevant figures are given in Table 7. 5.

Table 7.5: Daily VKT for the stage combination 1, 2 and 4

Base case 'Do Minimum' Traffic Modelling Results

	Units	2021	2026	2036
VKT				
PV NB	km	14,564,572	19,667,544	37,647,292
PV B	km	2,126,751	3,077,440	6,108,509
LCV	km	1,202,059	1,439,661	2,046,218
MCV	km	5,427,723	6,334,658	8,500,242
HCV	km	321,800	369,574	484,208
Total	**km**	**3,642,905**	**30,888,877**	**54,786,469**
VKT				
FOR TOLLED ROADS				
PV NB	km	1,216,336	1,943,150	5,414,033
PV B	km	297,073	506,801	1,264,749
LCV	km	136,884	169,389	248,364
MCV	km	380,540	485,113	799,659
HCV	km	21,464	25,861	36,217
Sub Total	**km**	**2,052,297**	**3,130,312**	**7,763,023**

Source: Economic Feasibility Analysis for Central Expressway Project, University of Moratuwa 2016

The vehicle operating costs (VOC) used in the analysis for different vehicle types is given below which is based on the report prepared by University of Moratuwa (2016).

Table 7.6: vehicle operating costs (VOC) used in the analysis for different vehicle

Type	VOC_Expressway (Rs./km)	VOC_Highway network (Rs/km)
Private vehicle	25.9	28.8
Light commercial vehicle	25.9	28.8
Medium commercial vehicle	39.1	47.1
Heavy commercial vehicle	56.8	68.4

Source: Economic Feasibility Analysis for Central Expressway Project, University of Moratuwa 2016

The Vehicle Operating Cost and Value of Time estimates are based on the values given in the report, Assessing Public Investment in the Transport Sector, 2000, Department of National Planning. Vehicle operating cost for expressway is decreased from that for highways considering the savings on vehicle wear and tear, fuel consumption largely due to lower roughness value (IRI) of the expressway. A similar estimate was adopted in the Northern Expressway Economic Feasibility study report.

Travel Time Savings

The value of Time estimates is based on the values given in 'Assessing Public Investment in the Transport Sector', 2000, Department of National Planning.

Table 7.7: Daily VHT for base case and CEP

Base case

	Units	2021	2026	2036
VHT				
PV NB	hours	529,254	859,585	4,006,841
PV B	hours	72,979	122,327	557,533
LCV	hours	39,774	54,668	167,842
MCV	hours	181,412	243,675	719,816
HCV	hours	11,252	15,369	48,376
Total	**hours**	**834,671**	**1,295,623**	**5,500,408**

Source: Economic Feasibility Analysis for Central Expressway Project, University of Moratuwa 2016

Project case

	Units	2021	2026	2036
VHT				
PV NB	hours	511,943	824,567	3,508,220
PV B	hours	70,072	115,971	484,390
LCV	hours	38,222	51,819	144,181
MCV	hours	176,027	233,483	618,227
HCV	hours	10,845	14,557	41,076
Total	**hours**	**807,109**	**1,240,397**	**4,796,094**

Source: Economic Feasibility Analysis for Central Expressway Project, University of Moratuwa 2016

Table 7.8: Economic value of time (VOT) by vehicle type and trip purpose

Type	VOT (Rs./hr)
Private vehicle Non Business	407
Private vehicle Business	597
Light commercial vehicle	517
Medium commercial vehicle	850
Heavy commercial vehicle	1,250

Savings of Accident Costs

The accident rates reduce on expressways compared to normal highway roads (A class). The fatal accident rates for highways is 0.12 accidents/ mn veh-km and for expressways is 0.05 accidents/mn veh-km. The economic cost of a fatal accident represent the majority of the total economic cost of accidents in Sri Lanka, furthermore there are no present estimates for accident rate for other types of accidents (damage only, grievous, non-grievous) for expressways in Sri lanka, therefore consideration of reduction of fatal accidents is deemed adequate for the purpose of this analysis. The economic value of a fatal accident is given as Rs. 1.51 mn (199 Rs.) in a report published by Department of National Planning, Sri Lanka (2000). The adjusted value to represent the current value is Rs. 5.75 mn.

Accordingly savings of accident cost were estimated by using the formula given below.

$$Accident\ costs = Total\ VKT\ for\ road\ type\ \times\ \Delta\ accident\ rate\ \ per\ vehicle\ km\ by\ the\ road\ type\ \times VA$$

VKT = Vehicle km travelled
Δ Accident rate = Difference in accident rate per vehicle km between base case and CEP
VA = Value of accident

Data related to the accidents rates estimated by the University of Moratuwa (2016) were used in the study.

Projected benefits for the 30 year period under above categories are summarized in Table 7.9.

Table 7.9: Summary of the projected benefits of CEP 2019-2048

Benefits	Present Value in LKR bn
Vehicle operating cost savings	101.11
Travel time savings	568.40
Saving of accident costs	9.43
Total	**1,311,322.6**

Other Unquantified Benefits

In addition, following benefits will be resulted due to establishment of CEP stages I and II and not included in the cost benefit analysis due to lack of data for making a reliable assessment.

Table 7.10: Unquantified benefits expected from project

Benefits	Remarks
Benefits during construction period	
Employment (direct + indirect) Direct Indirect	CEP is a large scale construction project and during the construction period it is expected that a significant number of employment opportunities (direct + indirect) will be created.
Benefits after implementation of the project	
Real estate market value gains	It is expected that commissioning of CEP will bring in an upward push to real estate prices located along the road and surrounding areas.
Employment benefits Direct Indirect	CEP will generate additional employment opportunities after commissioning of the road for management and maintenance of roads.

Calculation of Benefit Cost Ratios (BCR), NPV and IRR

It is found that at the initial stage capital investment is high (project period 2014-2018), and after that the local community, general public and the Government of Sri Lanka will be benefited. BCR, NPV and IRR were calculated applying the equations mentioned in the sections of 7.3.1 and 7.3.2.

Benefit Cost Ratios were estimated for the existing situation (Baseline Scenario) and three worst case scenarios. Under the existing situation, discount rate was considered as 7% for both benefits and costs. According to the cash flow following estimates were recorded for 30 years. The estimated BCR, NPV and IRR values are given in Table 7.11.

Table 7.11: ECBA Results

Item	Discounted Value (LKR bn)
Benefits	
• Saving of Vehicle Operating Cost (VOC)	101.11
• Travel Time Cost Savings	568.40
• Saving of accident cost	9.43
Total	678.94
	Costs
• Construction costs	420.47
• Operating costs	41.11
• Acquisition cost	50.47
• Cost for loss of carbon sequestration ability	0.93
• Opportunity cost of land	138.48
• Environmental mgt. cost	1.29
Total	595.44
Decision Criteria	
BCR	1.015
NPV (LKR bn)	9.73
IRR	7.10%

Sensitivity Testing

A sensitivity testing was carried out under scenarios given below.

- Scenario 1: Benefits are reduced by 20%
- Scenario 2: Costs are increased by 20%
- Scenario 3: Costs are increased by 10% and benefits are decreased by 10%

The estimated BCR, NPV and IRR values are given in Tables 7.12a-c.

Table 7.12a: BCR, NPV and IRR values resulted in the CBA study under the scenario 1

Item	Value
BCR	0.81
NPV	-LKR bn 120.82
IRR	5.53%

Table 7.12b: BCR, NPV and IRR values resulted in the CBA study under the scenario 2

Item	Value
BCR	0.84
NPV	-LKR bn 118.88
IRR	5.82%

Table 7.12c: BCR, NPV and IRR values resulted in the CBA study under the scenario 3

Item	Value
BCR	0.83
NPV	-LKR bn 119.85
IRR	5.69%

Conclusion and Recommendation

Under the assumptions made in the base case, the project is marginally viable with a Rs billion 9.73 net present value. Tables 7.12 (a, b, c) show the predicted NPV, IRR and BCR values under proposed three worst case scenarios. It is found that under worst scenarios, the project is not viable from national economy and environmental point of view.

CHAPTER 8: CONCLUSION AND RECOMMENDATION

8.1. Conclusions

The following broad conclusions could be reached from this study.

- This Environmental Impact Assessment (EIA) has been prepared to assess the sections 1,2 and 4 of CEP Kadawatha to Dambulla stretch. The scope of the EIA covers the proposed expressway corridor from Kadawatha to Dambulla and Ambepussa Link Road, excluding Kadawatha System Interchange. The EIA has investigated environmental and social implications associated with the proposed project.
- From the baseline studies of the existing environment it is seen that a significant stretch of the proposed trace traverses through paddy fields and low lying areas and that it crosses a number of streams and canals. It is also observed that the proposed route traverses through variety of natural, semi natural and human-modified landscapes. Although the proposed expressway does not traverse through any national parks, sanctuaries or declared wetlands it sometimes goes through or very close to a few forests. The trace traverses through four administrative districts; Gampaha in Western Province, Kegalle in Sabaragamuwa Province, Kurunegala in North Western province and Matale in Central Province in the country. It runs through 163 GN divisions in 18 DS divisions in those districts some of which are densely populated.
- According to the findings of the EIA study it could be concluded that the proposed expressway alignment will cause significant adverse impacts to the physical, biological and social environment at certain locations of the trace
- The need of resettlement or physical displacement of HHs has been greatly reduced by placing the expressway trace over marshy lands, paddy fields, other agricultural lands and non residential lands.
- Still the obvious adverse project impacts are social impacts arising as a result of land acquisition, displacement of people, and resettlement. Around 4557 building structures are to be affected requiring permanent relocation for about 75% (3438) of them. About 489 villages or rural communities would be affected by the project depending on their locations. This long lasting change of the area requires resettlement, re-adaptation, reintegration and relocation of affected people to restore smooth functioning of the communities with a new expressway in their vicinity or adjacent area.
- As a consequence there would be impacts on the personal income, livelihood, psychology and well being of the directly affected parties. Although the trace traverses closer to sensitive receivers such as schools and temples, there will not be any significant adverse impacts to such sites after construction of the expressway.
- Since the alignment is going primarily through paddy fields and low lying areas and cross a number of streams, canals and drains hydrological and drainage impacts are anticipated. Most of the minor irrigation schemes will be affected and there will be loss of paddy land within the ROW. However, paddy cultivation could be continued on either side of the ROW as in the case of the other expressways in operation (e.g. Southern Expressway). There could also be temporary issues regarding the allocation of irrigation water to isolated paddy lands.
- During the construction there would be air quality, noise and vibration issues affecting settlements, sensitive recipients, archeological sites and ecological aspects. Noise impacts continue through operation phase. Surface water quality would be affected by runoff contaminated with sediments and chemicals during construction.
- A few forest patches, species and natural habitats will be affected by the alignment. The forests affected by the trace are : 1) “Mirigama Kos Kele”, a naturalized plantation forest, of which an extent of approximately 0.67 ha will be lost permanently from the 57.9 ha forest. The proposed link road will bisect this plantation forest in to two parts with extents of approximately 30 and 27 ha; 2) Weragalakanda Forest from which about 1.5 ha will be lost from the total extent of the 164 ha but

there will be no fragmentation of the forest area. , but the construction of expressway may act as a barrier for faunal communities to freely move between different habitat patches; 3) Kiridigolla Forest, a Jak-Mahogony naturalized forest bordered by the Deduru Oya which serves as a source of water for the animals inhabiting the forest. The proposed CEP will pass through the forest close to the edge of the river and a narrow strip of forest will be lost affecting the faunal species and Bamarakanda forest reserve from which a narrow strip will be lost.

- In spite of these negative impacts there are enormous regional and national level positive outcomes of the project which far outweigh the negative impacts at local level and due to this even the affected people and communities do not fully disagree with the proposed project which is expected to upgrade the life styles of all.
- Affected parties are expecting a direct and immediate involvement of RDA to compensate, resettle and restore their livelihood elsewhere in a fair and justice manner. This will be done prior to commencement of the construction activies.
- Via ducts and large box culverts have been built into the design to minimize backwater impacts and additional mitigatory measures as stated in the EIA to address drainage and hydrological impacts such as local floods will be taken.
- The detail design will be done to minimise the impact on sensitive areas as much as possible. Although avoidance of sensitive habitats is the best option, it is not feasible at all the time often due to substantial increase in costs. In such cases, bio links or animal over passes, underpasses, eco-ducts shall be established. The exact requirements will be finalised at the detailed design stage.
- It is seen that almost all the anticipated adverse impacts could be mitigated to a great extent using the proposed mitigation measures.
- In the Extended Cost Benefit Analysis (ECBA) identified impacts were valued using standard tools of valuation. Under the assumptions made in the base case, the project is viable.
- Once the entire trace of CEP is constructed the economic capital of the country will be linked with the Central, Northern and Eastern regions of the country. Thereby it will assist the sustainable development which the government intends to achieve in the coming years.
- It can be concluded from the EIA that although the proposed project is anticipated to bring about certain significant impacts these will be mitigated through adopting the mitigatory measures proposed. The EMP and EMoP proposed in the EIA will be strictly adhered to ensure that the mitigatory measures are implemented without failure. The project is continuously monitored to ensure that there are minimal environmental impacts.

8.2. Recommendations

The following recommendations are made in this study.

- All proposed mitigation measures and environmental monitoring and management actions shall be considered as recommendations.
- Special emphasis shall be paid to address mitigatory measures proposed to minimise social impacts arising from land acquisition and resettlement
- Resettlement and offer of compensation for the affected parties will be implemented without delay considering the views of stakeholders as far as possible in collaboration with all concerned line agencies especially Division Secretaries.
- Although hydrological modeling has been carried out and designs and locations of structures identified, these designs will still be reviewed during the detailed design stage with more accurate information such as river bed levels and flow regime information. Such approach will provide more accurate results in structural designs. A special emphasis will be paid to viaduct sections where a balance is required in the length and location of viaduct placement and cost of such construction

- The existing irrigation canals and drainage facilities will be properly maintained in the project area. In this respect it is important to consider requirements stipulated by Irrigation Department, Sri Lanka Land Reclamation and Development Corporation and Department of Agrarian Development in to detail designs and contract documents of the project.
- The EMP and EMoP for the project will be updated in the detail design stage and incorporated in to respective tender documents.