PROPOSED CENTRAL EXPRESSWAY PROJECT

from Pothuhera to Galagedara (Section 03)

Final Environmental Impact Assessment Report

Volume I - Main Report

October 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.

PROPOSED CENTRAL EXPRESSWAY PROJECT

from Pothuhera to Galagedara (Section 03)

Final Environmental Impact Assessment Report

Volume I - Main Report

October 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
Gangodawila, Nugegoda
Sri Lanka

Table of Contents

List of Tables

List of Figures

List of Abbreviations

AWDT – Average Weekday Daily Traffic

BCR – Benefit Cost Ratio

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

COD - Chemical Oxygen Demand

CR – Critically Endangered

CS – Cross Section

CSC - Construction Supervision Consultant

DO - Dissolved Oxygen

DS – Divisional Secretariat

ECBA - Extended cost-benefit analysis

EIA - Environmental Impact Assessment

EMMP - Environmental Management and Monitoring Plan

EMoP – Environment Monitoring Plan

EMP - Environmental Management Plan

EMU – Environment Management Unit

EN - Endangered

EO - Environmental Officer

ESCM - Environmental Safeguards Compliance Manual

ESDD - Environmental and Social Development Division

ESIA - Environment and Social Impact Assessment

FHWA – Federal Highway Association Positioning System

GIS – Geographic Information System

GN – Grama Niladari

GPS – Global positioning System

GRC – Grievance Redress Committees

GSMB - Geological Surveys and Mines Bureau

HFL – High Flood Level

IAS - Invasive Alien Species

IRR - Internal Rates of Return

LAA – Land Acquisition Act

MC – Municipal Council

MSW – Municipal Solid Waste

NBRO - National Building and Research Organization

NCS - National Conservation Status

NE - Not Evaluated

NEA - National Environmental Act

NETSM – Northern Expressway Strategic Transport Model

NIRP - National Involuntary Resettlement Policy

NPV - Net Present Value

NT – Near Threatened

NWP - North Western Province

NWP-EA - North Western Province –Environment Authority

NWS&DB - National Water Supply and Drainage Board

OP – Over Passes

PMU - Project Management Unit

PPE – Personal Protective Equipment

PS – Pradeshiya Sabha

RAP - Rehabilitation Action Plan

RDA – Road Development Authority

ROW – Right of Way

SAIRC-Social Assessment and Involuntary Resettlement Compliance

SIA - Social Impact Analysis

SLLRDC - Sri Lanka Land Reclamation and Development Corporation

SLS – Sri Lanka Standard

SLT – Sri Lanka Telecom

SMEC - Snowy Mountains Engineering Corporation

STD – Sexually Transmitted Diseases

TIN - Triangulated Irregular Network

TN – Total Nitrogen

TOR - Terms of Reference

TP - Total Phosphorus

TRL – Transport research Laboratory

TS – Taxonomic Status

TSS - Total Suspended Solids

UC – Urban Council

UP – Under Passes

VOC - Vehicle operating costs

VOT – Value of Time

VU - Vulnerable

WBS - Work Breakdown Structure

WHO – World Health Organization

List of Annexes

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 Mirigama, length of approximately 37.0 km
- Section 2 – Mirigama to Kurunegala, length of approximately 39.7km
  Mirigama 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 Section 3 – Pothuhera to Galagedara stretch of 32.5 km. An Environmental Impact Assessment Report has been prepared for Sections 1, 2 and 4 of CEP Kadawatha to Dambulla stretch. The scope of this EIA covers the proposed expressway corridor from Pothuhera to Galagedara. 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.

Section 3 of the CEP starts at Ch 0+000 at Pothuhera, and ends at Galagedera (A10 Road) Ch 32+487covering an approximate length of 32.5km. The expressway will be a four lane carriageway with an operating speed of 100km/hr from Pothuhera to Galagedera. It consists of four interchanges at Porhuhera (Ch 0+000), Polgahawela Interchange (Ch 4+700), Rambukkana (Ch 13+900) and Galagedera (Ch 32+487). There are twelve (12) main bridges, and seventeen (17) viaducts across the floodplains of three major rivers; Rambukkan Oya, Kuda Oya and Kospothu Oya. There are also 106 culverts across medium/minor streams and irrigation canals, (23) twenty three underpasses, 14 overpasses across local roads and three (3) tunnels. Some of these structures could be used by pedestrians to cross the expressway. The 3 tunnel sections, Tunnel 1 (Ch 15+120 - 15+410 – 290m), Tunnel 2 (Ch 23+430 - 23+630 – 200m) and Tunnel 3 (Ch 27+490 - 27+725 – 235m) act as twin tunnels with two lanes for each.
The total cut length is approximately 9.6km whereas the total fill length is approximately 17.4km.

The alignment generally traverses through lands which are privately owned with a few exceptions of government owned lands and institutions. The RDA has identified the 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 Section 3 will be around 94.7 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 1km from the ROW, were subjected to assessment.

The proposed expressway goes through the wet zone and intermediate zone. It is located in an area which consists of urban settlements (Pothuhera and Galagedera), peri-urban settlements and rural areas, sparse forests, riparian vegetation, rock outcrops, paddy fields, coconut and other cultivations, home gardens, drainage entities such as rivers, streams, and irrigation canals. In addition it crosses a number of streams and canals or runs close to them including Rambukkan Oya, Kuda Oya and Kospothu Oya. 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. Most of the baseline parameters measured at selected locations on the trace of the expressway segment such as air quality, noise levels and vibration levels are within the CEA standards.

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 3 administrative districts; Kurunegala, Kegalle, and Kandy. It runs through 38 GN divisions in 4 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 the population suffers from poverty.

Anticipated Impacts and Measures for Mitigation

Through an impact identification matrix it was identified that the most affected aspects would be Geotechnical or Earth Resources, Hydrological aspects, 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.

Since certain sections of the proposed road runs through steep mountain slopes the impact on land form and stability can be considered as significant. Unless proper mitigatory measures are taken the project can increase the possibility of land slides along the road cuts and possible land subsidence.

This will be considered in the design stage itself and stable slopes will be designed. In the construction stage guidance will be sought from the National Building Research Organization throughout the project. Road cuts will be done under proper supervision and slope stability techniques will be implemented where necessary. Measures such as relief drains, cascades, grouting, reinforcements and rock bolting will be taken and localities prone to natural landslide will be stabilized. There will be frequent monitoring of slope stability around the road during and after construction.

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 impacts numerous mitigatory measures will be undertaken through design. It will also be ensured that construction will take place in the dry period. Flood impacts are anticipated in the floodplains of Rambukkan Oya, Kuda Oya and Kospothu Oya. Most of the paddy areas of minor irrigation schemes will be impacted and there will be loss of some paddy lands falling within the ROW. There could also be temporary issues regarding irrigation water allocation to isolated paddy fields.

Most of the hydrological or drainage impacts will be mitigated by designing viaducts, large box culverts and other methods to minimise backwater impacts. Paddy cultivation could be continued on either sides of the expressway. Impacts on irrigation water issues could be mitigated by providing additional site specific openings.

There is expected to be a significant impact on the livelihood of the surrounding community as a result of land acquisition and displacement. Most of the social impacts related to construction are temporary. Resettlement impacts on livelihood of people could be both positive and negative. 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. There will be access issues caused by human habitat fragmentation where villagers may not be able to cross the expressway at some locations. Serious anti-expressway sentiments are not evident for Section 3 of the CEP as people are willing to provide their land and undergo impacts for the sake of regional and national development. There could be temporary psychological impacts on some members of the community who will be relocated.

After land acquisition, people expect resettlement at their own remaining premises or at a place proximal to their original residence without disturbing their familiar simple livelihood pattern. Payment of cash compensation and providing suitable resettlement sites (for the parties who are willing to resettle) according to the current policies adopted by RDA in similar projects will be the main mitigation measure that will be implemented to mitigate social impacts. Suitable lands for resettlement sites have been tentatively identified in the relevant DS divisions.

Siyambalangamuwa forest reserve complex is likely to be indirectly influenced resulting in disturbance to fauna by affecting their home ranges and exposing them to the danger of road kills. The potential indirect impacts on Siyamblangamuwa forest could be mitigated through the proposed underpasses for terrestrial fauna, and canopy bridges and mesh enclosures for arboreal fauna to cross the expressway and go from one forest patch to another.

Although the trace traverses close to sensitive recipients such as schools and temples, there is no adverse impact to such sites except for the hospital, courts and schools at Galagedera which will be susceptible to noise. Because of this a noise barrier will be put up for the Galagedera area. Noise barriers to certain other selected places will be put up during the operational phase (e.g. after 2020) because of high traffic noise levels.

Groundwater levels of some dug wells in the vicinity of ROW could be affected during construction because of deep cuts. Precautionary measures will be taken to minimise this impact.

The Benefit Cost Ratio (BCR) values of Section 3 of the CEP for scenarios which include Section 1, 2 and 4 of the CEP are greater than 1.9 which signifies the overall project feasibility. Considering the overall findings of the EIA, implementation of the project is recommended subject to mitigation measures, the Resettlement Action Plan (RAP) and the Environmental Monitoring and Management Plans. The Environmental Management Plan will be updated and included in contract documents.

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

Number	Environmental Aspects	Impact	Proposed mitigation measures
1	Geo-Technical Aspects / Earth Resources		
1.1	Soil Erosion	Soil erosion, sedimentation and compaction. Higher level of turbidity in the surface water bodies	- Excavation activities will be minimized during the rainy season. - During the dry season wind erosion will be 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
1.2	Impact on Land Form and Stability	Natural landslides, landslides along the road cuts and possible land subsidence	- Guidance of National Building Research Organization will be sought throughout the project - Design will include stable slopes - Road cuts will be done under proper supervision. - Slope stability techniques will be implemented where necessary. - Measures such as relief drains, cascades, grouting, reinforcements and rock bolting will be provided - Material transportation will be done along the available road network in order to prevent soil compaction - Stabilisation of natural landslide localities - Frequent monitoring of slope stability around the road during and after construction will be done.
2	**Hydrological Impacts**		
2.1	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. - Measures such as soil covers, silt traps, temporary drains and silt fences will be used. - Unstabilized soil stockpiles will not be left
2.2	Impacts on issue of irrigation water and drainage at the paddy fields	Issue of irrigation water and drainage of paddy fields can be disturbed if no proper invert levels	- During the detailed design stage, every irrigation canal and drainage canal will be positioned and designed to avoid any

Number	Environmental Aspects	Impact	Proposed mitigation measures
		are maintained through the culverts.	disturbance to irrigation supply or paddy field drainage. - Temporary openings at site-specific locations will be provided and they will be upgraded to permanent openings. This will be done with the consent of the relevant irrigation engineer, agrarian officer and/or the relevant farm organization.
2.3	Impacts on the existing drainage pattern	Disturbances to the existing drainage pattern due to improper placement and orientation of bridges and viaducts and tunneling	- 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.
2.4	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.
2.5	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
2.6	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.
2.7	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.
3	**Socio – Cultural impacts**		-
3.1	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.

Number	Environmental Aspects	Impact	Proposed mitigation measures
			- Resettlement of affected parties as close as possible to their original location.
3.2	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 - Human underpasses will be provided at appropriate locations. Allow culvert openings as underpasses during non-flood periods
3.3	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 will be done in compliance with the legal provisions and the Grievance redress mechanism. Compensation will be paid before acquisition. - Temporary acquisition will be done only after formal agreement on conditions of use - Prevailing market rates will be used for the calculation of compensations
3.4	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 - Will employ affected parties for project activities
3.5	Impact on infrastructure facilities.	Normal functioning of public utilities and other infrastructure will be disrupted.	- Possible locations of breakdowns will be identified and adopt remedial measures will be provided
3.6	Impacts on public safety and health	Construction activities including tunneling and worker camps may cause accidents and health hazards.	- Project activities will be controlled in terms of clearly stipulated security guidelines and contractors and work forces will be made aware of them. - Special attention will be paid to prevent HIV/AIDS and other infectious diseases.
3.7	Impact on traffic	Traffic diversions and transport of construction material will disrupt normal traffic in the area	- Will identify all the locations of possible traffic issues in advance and adopt appropriate measures to manage them. - Will provide warning signs, detours, pedestrian crossings and flag men. A Traffic Management Plan will be prepared for locations of overpasses, underpasses and interchanges.

Number	Environmental Aspects	Impact	Proposed mitigation measures
			- Adjustments will be made in the work schedules and traffic diversions
3.8	Impact on traffic	Traffic diversions and transport of construction material will disrupt normal traffic in the area	- All the locations of possible traffic issues in advance will be identified and appropriate measures to manage them will be adopted. - Will provide warning signs, detours, pedestrian crossings and flag men. Will prepare a Traffic Management Plan for locations of overpasses, underpasses and interchanges. - Adjustments will be done in the work schedules and traffic diversions
4	**Ecological**		
4.1	Impacts on terrestrial Natural Habitats	Expressway construction will result in loss, degradation and fragmentation of natural habitats Forest reserves are likely to be indirectly affected (e.g. Siyambalagamuwa forest) causing disturbance to fauna by affecting their home ranges.	- Ecologically sensitive habitats are identified and avoided to the extent 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 - Workers and contractors will be made aware of adopting engineering best practices
4.2	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	- Contractors and workers will be made aware on environmental safeguard measures and appropriate guidelines and conditions will be incorporated into contractor documents - Enrichment planting - Green belts will be established as noise and dust barriers - Irradiation of Invasive Alien Species (IAS) will be incorporated to landscape maintenance plan
4.3	Impacts on terrestrial fauna	Habitat loss, degradation and fragmentation, disturbances due to noise,	- 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

Number	Environmental Aspects	Impact	Proposed mitigation measures
		Road kills in operation phase	- Green belts will be established 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 - Movement of fauna will be monitored and useful facts will be extracted from existing studies on the Southern Expressway. - Meshed enclosures, canopy bridges and fences over ecoducts will be monitored at regular intervals.
4.4		Aquatic Habitat loss and degradation, Obstructions to the movement of aquatic organisms, pollution	- Habitat degradation due to soil erosion and sedimentation will be controlled by adopting construction best practices - Solid waste disposal sites will be located away from waterways. - Placement of culverts and drainage structures, their proper maintenance
5	**Water**		
5.1	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 - Periodic desiltation of streams including lead in and lead way canals. - Proper monitoring of water quality and timely action initiated to prevent pollution
5.2	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 will be adopted to collect, treat and disposal of waste from rest area - Sediment traps will be installed at locations at sensitive receivers; erosion control plans will be established by establishment of stable native vegetation along the embankment slopes. - Prevention of contaminants entering water bodies during maintenance work of road surfaces

Number	Environmental Aspects	Impact	Proposed mitigation measures
6	**Air Quality**		
6.1	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.
6.2	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 will 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 will be carried out to arrest dust and airborne pollutants
7	**Noise and Vibration**		-
7.1	Noise impacts to nearby settlements and habitats during construction	High noise levels, if higher than the stipulated limits during construction works, will significantly disturb the neighbourhood. High noise and vibration will be caused due to tunneling activities Noise impacts to sensitive recipients especially for Galgedera area during the operation of the expressway	- All machinery and equipment to be used for the construction phase will be regularly well maintained - All vehicles and equipment would be ensured to 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

Number	Environmental Aspects	Impact	Proposed mitigation measures
			drills and rock breakers would not be used during the night time - Demolition of structures would 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. - Will construct a noise barrier

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 which owns a land area of about 65,000 km^2 and with 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 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 have 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 a link expressway from 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) has to be prepared.

Central Expressway Project (CEP) has been divided into four (4) Sections as follows:

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)	9.3
Section 3	Pothuhera to Galagedara	32.5
Section 4	Kurunegala to Dambulla	60.3

This Environmental Impact Assessment (EIA) has been prepared to assess Section 3 of the Central Expressway Project. EIA for Section 1, 2 and 4 are conducted as separate studies. Figure 1.1 presents the general area of Central Expressway Project.

The Road Development Authority 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 to prepare the Environmental Impact Assessment for Section 3 in accordance with the TOR issued by CEA.

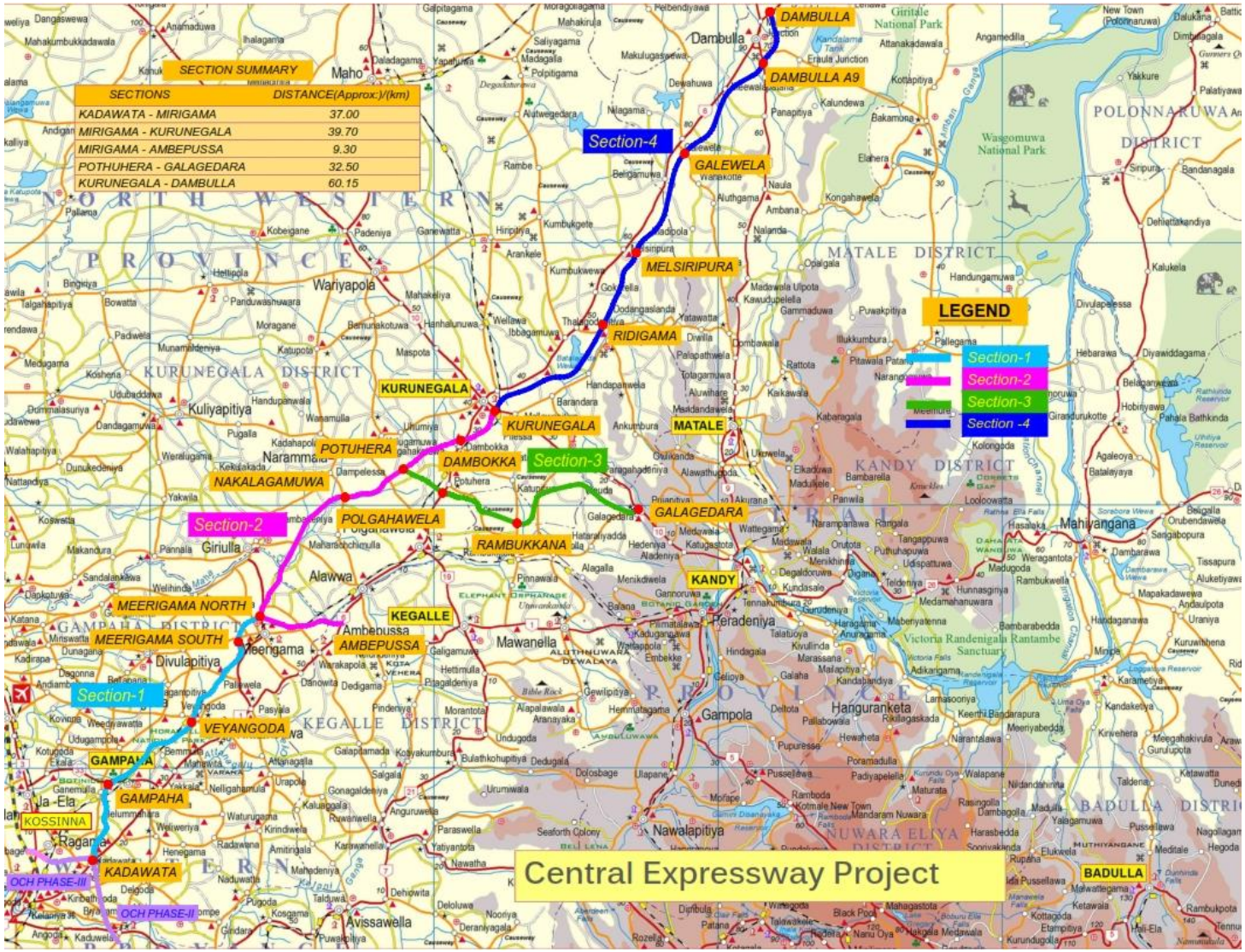


Figure 1.1 : Proposed Central Expressway

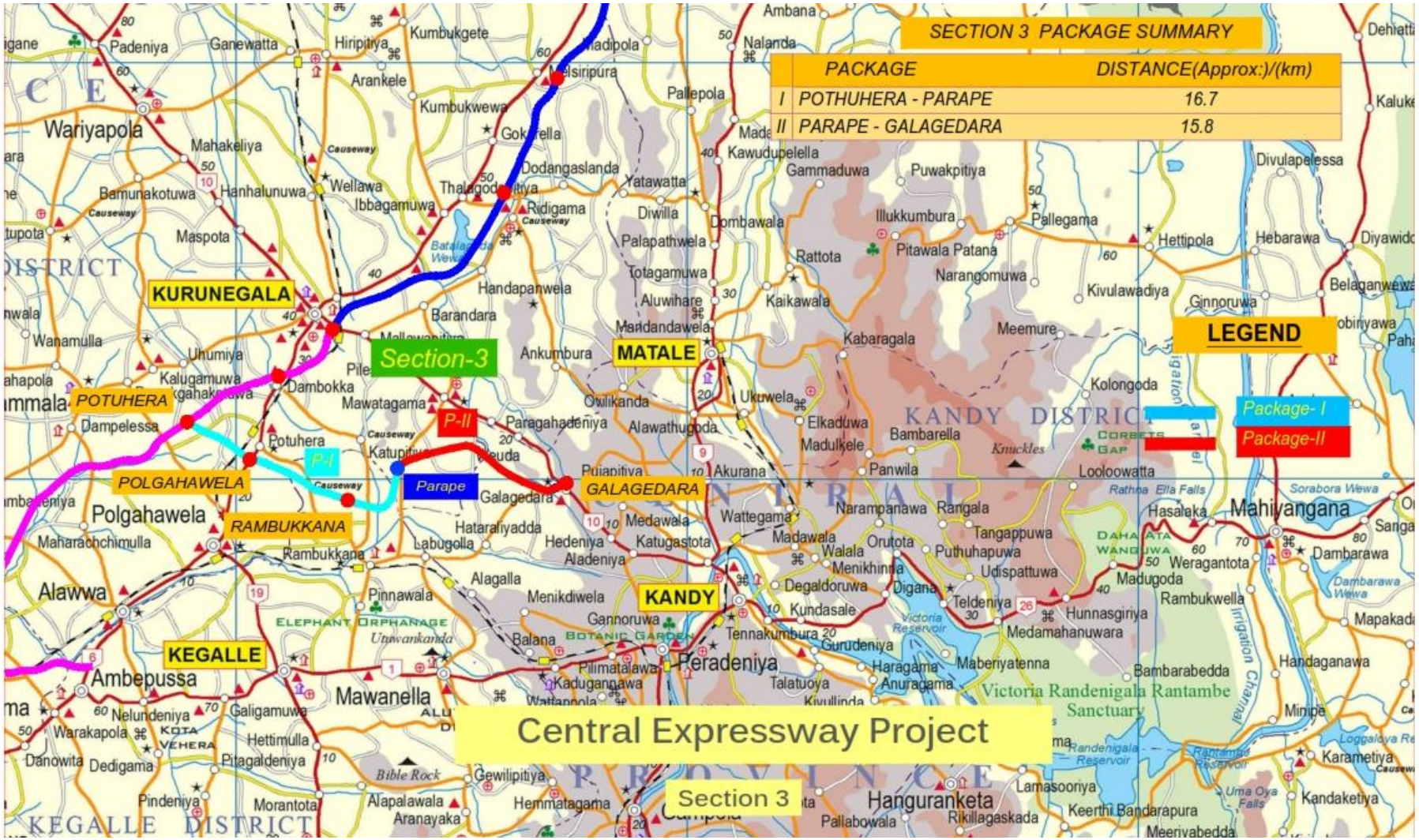


Figure 1.2: Section 3 of Proposed Central Expressway (Pothuhera to Galagedara)

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 the 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 have easy/quick access to central and northern parts of the country in order to expedite development plans in the Country,
- Facilitate the needs of industrial and social development of the areas located along the expressway corridor,
- Improve connectivity between key growth centres 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 the environmental conservation,
- Establish an economically feasible expressway network system,
- Achieve sustainable development in and around the areas of service.

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

- Availability of an efficient transportation system to the Northern, Eastern 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 the 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.
- Time saving due to reduction of travel time from Colombo to Kandy

Hence the overall CEP Project which includes Pothuhera Galagedra expressway link is justified.

Specific Objectives of Section 3 CEP

The main specific objective of Section 3 of the CEP is to provide quick access to Kandy and Rambukkana from Colombo via Pothuhera and Galagedera.

1.3. Objective of the EIA report

This Environmental Impact Assessment (EIA) Report pertaining to the development of a 32.5 km expressway from Pothuhera to Galagedara 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 mitigatory measures to minimize such impacts. A monitoring plan is proposed to ensure that the recommended mitigatory 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 for project monitoring during construction and operational stages enabling any unanticipated impacts to be determined through monitoring.

Since the project is located in 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 (Note: the ToR has been attached as Annex 1.1).

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.

Topographical survey maps of CEP Section 03 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 Pothuhera to Galagedara including the Pothuhera System Interchange.

Initially existing literature related to the proposed trace was 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

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
- Preliminary Designs for Section 3 of Proposed Central Expressway Project prepared by Road Development Authority (2016)
- Statistical Handbooks of Gampaha, Kegalla, Kurunegala and Mathale districts, Department of Census and Statistics, 2010
- Hazard Profile of Sri Lanka - Disaster Management Centre, Ministry of Disaster Management, December, 2012

- Hydrological Study of the Central Expressway Section 3 from Pothuhera to Galagedara, Sri Lanka Land Reclamation and Development Corporation, 2016

1.4.4. Field Investigations

Field Studies were carried out to gather new information, and to verify and update the existing information on the proposed alignment from September, 2015 to January, 2016. During the field studies ecological and social surveys were conducted in detail.

1.4.5. Ecological Component

- Information available in the ecological assessments of the previous studies were used as secondary data. The data were reviewed to determine their adequacy, and identify possible information gaps as well as to identify ecologically sensitive locations that need special consideration.
- Validation of information at pre-identified ecologically sensitive locations was done during the present study.

The methods used to gather missing information were:

Major habitats / 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 the protected areas in close proximity to the study area was observed 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 habitats 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 employed in the fauna survey

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

1.4.6. Methodology for existing 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 the 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 study was done mainly for the recommended buffer zones. According to the RDA recommendation, 60 m right of the way (ROW) from center line of the proposed expressway (total width of 120 m) and 100 m reservation area from the edge of the ROW (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 in Pothuhera-Galagedara, Section is located across the complicated terrain with significantly higher elevations covered by the steep and gentle slopes.
- Therefore, topography along the proposed road was studied in terms of elevation, contour, slope, aspect and land uses. In general, methodology used for the detailed land use analyses 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. 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. A 60 m right of the way (ROW) from the center line of the proposed expressway (total width of 120 m) and 100 m reservation area from the edge of the ROW (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 incorporated for the EIA. Using those information 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 soils around the proposed project where necessary.
- Especially, the geology and soil investigations for the EIA were carried out by field investigations and analyses of 1:10,000 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 therefore several folds and shear zones were analyzed.
- Soil along the proposed central expressway was further discussed in terms of possible compaction and erosion in especially the sections along the working paddy filed in Kurunagala, Kandy and Kegalle districts. Soil aspects was studied for the possible issues on infiltration capacity and nutrient losses as well. In addition, investigations 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. Investigation of Pothuhera - Galagedara stretch was done for possible natural landslide locations as well. Especially, analyses were done of the area crossing isolated rock outcrops along the proposed road. Further, investigations of possible land subsidence were done based on geology, soil and geotechnical reports. Geology and structures were mainly investigated and discussed around the interchanging locations and system interchange. Structural geology along the proposed expressway project was investigated 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 past reports of RDA which had been prepared for the previously proposed Northern Expressway. At certain places where flooding generally occurs, information available in reports were verified by 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 prepared for the previously proposed Northern Expressway Project. Information collection and compilation was carried out covering different stretches of the road.

Relevant details of Pothuhera to Galagedara section of the proposed expressway is taken from the Hydrological Study of the Central Expressway Section 3 from Pothuhera to Galagedara, Sri Lanka Land Reclamation and Development Corporation, 2016.

1.4.10. Socio-economic investigations

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 communities under consideration. Furthermore, relevant Urban Councils, Pradesiya Sabhas, Divisional Secretariat Offices, Divisional Engineer's Offices, 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 lands in the project area was also prepared.

Socio economic surveys conducted for the selected trace 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. Data from the comprehensive Resettlement Action Plan done for the proposed expressway 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 impact of the proposed project on those people and institutions and social processes were researched.

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

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 in 2014 were used considering their relevance to the areas coming under the proposed project. Information pertaining to new routes of the project which have 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 to be affected by the project were also identified in terms of the information gathered in terms of a separate Questionnaire prescribed by the SAIRC of the RDA.

Sub task 4. Focus group discussions.

Peoples' perceptions, ideas and attitudes of 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 socio-economic profile of the project affected area and public opinions and perception of the proposed project.

1.4.11. Cultural, Historical and Archaeology Heritage

The methodology for the Cultural, Historical and Archaeology Heritage Component of the Environment and Social Impact Assessment (ESIA) has been accomplished, 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 was extended to assess the heritage properties under the range of (a) Cultural properties and attributes, which cover by any cultural structures and their functions from present to past; (b) Historical properties and attributes are 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 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 or prior to excavating. Broad Desktop studies, Surface survey, Geophysical or geochemical survey and Aerial survey were to be conducted but due to lack of resources/ techniques only the Desktop study and Surface survey 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 required information and data, in 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.

1.5. Conformity with government policies and plans

Under the manifesto of current government the Central Expressway has been identified as a major road sector development project. With this expressway section which connects Kadawatha to Dambulla Section at Pothuhera, the travel time from Kandy to Kadawatha will be reduced up to one and half hours. The CEP also connects to the OCH at Kadawatha System Interchange which allows the users a clear path to Colombo Katunayake Expressway (with Phase III of OCH), Southern Expressway 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 – 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 Northern Line near Pothuhera. Discussions with Sri Lanka Railways have been ongoing during the design development process. Concurrence of Sri Lanka Railways will be required for the proposed railway overpasses on the project.

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.

Initial parts 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	Ceylon Electricity Board (CEB) /Sri Lanka Telecom (SLT) /National Water	As the alignment will intersect/affect transmission lines/ water supply networks and telecommunication networks that may need shifting	Detail design to be done together

No	Institution/Department	Reasons for Required Approvals	Status of Concern
	Supply & Drainage Board (NWS&DB)		
3	Sri Lanka Railway Department	The alignment trace is crossing the existing railway line at pothuhera	Addressed in the report
4	Forest Department	The alignment passes along few forest areas	No Forest areas within the proposed route
5	Department of Wildlife Conservation	To obtain the clearance due to the alignment along the forest patches etc.	No Wildlife areas within the proposed route
6	Department of Archaeology	The proposed trace may cut across unexplored archaeological sites if any.	Archaeological Impact Assessment Completed

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

2.1.1. No Action Alternative

The No Action Alternative means there would be no expressway link built between Pothuhera and Kandy. This alternative is not suitable as there is heavy traffic flow on the A001 Road between Ambepussa and Kandy. Kandy is a city of prominent importance which has many commercial, educational and tourism related activities. Many other important cities such as Mahiyangana, Ampara, and Matale can be reached through Kandy. While several routes were considered for the Colombo to Kandy expressway, none of these routes were feasible for a variety of reasons. The Colombo to Kandy Expressway has finally materialised as an expressway from Colombo to Kurunegala (Sections 1 and 2) and Section 3 from Pothuhera to Galagedera (Section 3, which is the scope of this report). Therefore, Section 3 is an essential component of the Colombo to Kandy expressway (as a link to Central Expressway).

As traffic volumes increase on existing roads, there is expected to be increased traffic congestion, travel times, fuel waste and negative economic impacts. The proposed CEP will ease traffic congestion on the A001 (from Colombo to Kandy) which is the only direct link between Colombo and Kandy. With the proposed Section 3 of the CEP, most of direct traffic from Colombo to Kandy would be able to use the proposed CEP via Pothuhera. Therefore, Section 3 of the expressway cannot be considered in isolation from Sections 1 and 2.

Hence No Action Alternative is not a suitable alternative.

2.1.2. Route Alternatives

Several route alternatives were considered for the section 3. The topography of the western portion of the alternative routes is in a flat to rolling terrain and the eastern portion of the alternatives lies within extremely difficult terrain. Particularly, around 15 to 20 km west of Kandy there lies a steep escarpment rising from approximately 200 m to 250 m elevation to around 600 m elevation over a distance of around 2 km in places. The construction of an expressway to the desired design standard to negotiate this escarpment will be expensive, requiring excessive earthworks or tunnels at steep grades to negotiate this feature. Providing a solution to this problem which meets the desired outcome whilst providing a cost-effective solution has been a major focus on route selection in section 3, and has resulted in the examination of numerous routes to determine the most acceptable solution. In particular, extensive efforts have been made to eliminate any requirements for tunnels due to their high initial construction and ongoing maintenance costs.

In addition to alternative corridors, various combinations of design and operating speeds were assessed to allow the use of lower geometric standards to attempt to minimize cost and environmental impacts in sections of particularly difficult terrain.

Initial corridors studied for the Section 3 (Kandy link) are illustrated in Figure 2.1.

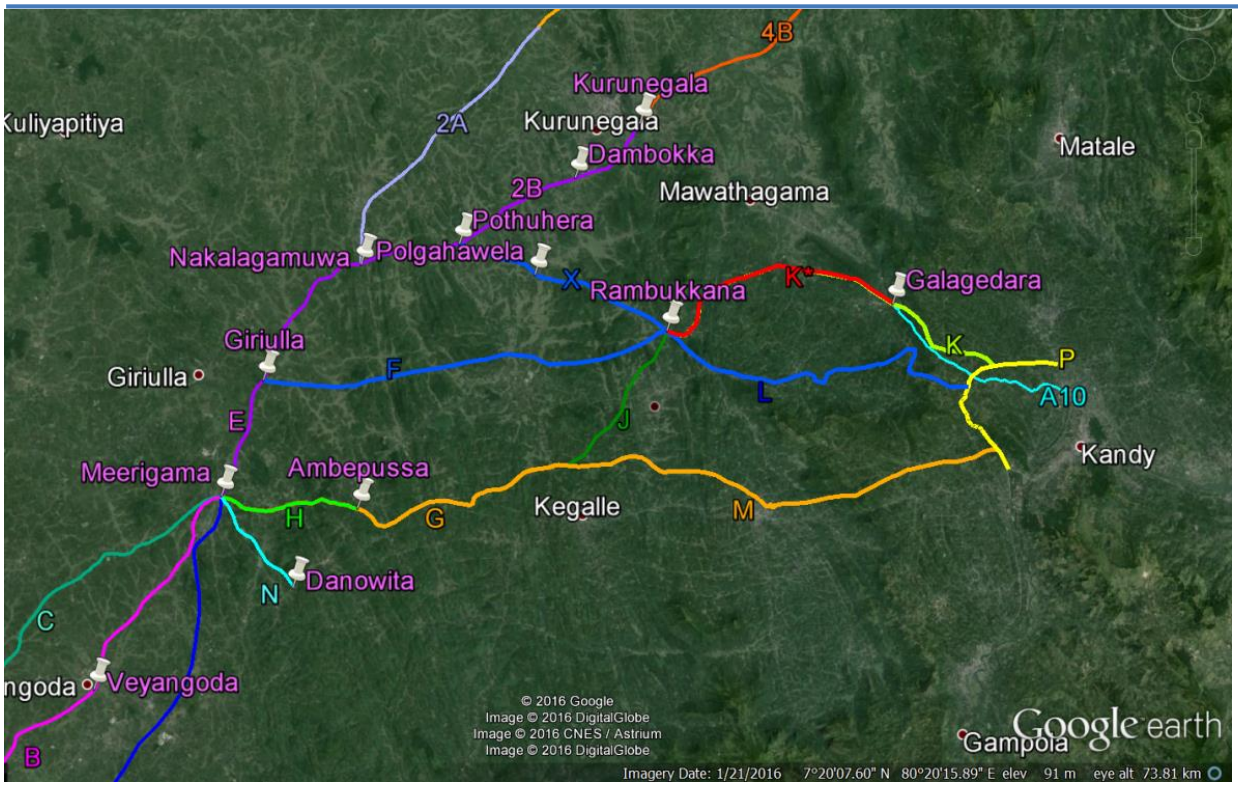


Figure 2.1 Route Alternatives for Section 3

Note that Figure 2.1 also indicates an additional link, option 'P'. This was identified during the course of the study and acts as a Kandy bypass between the A9 and A1, thereby alleviating traffic congestion in the city. This link was common to the first 5 alternatives (option 1-4) considered for section 3 and the option 5 connect to the A10 at Galagedara and widened the existing A10 to expressway standards.

Following alternatives were considered in the initial stage of the study:

- **Option 1:** F-L: Start from section 2 near Giriulla to Kandy by pass link (P) through Polgahawella and Rambukkana
- **Option 2:** G-M: Alternative trace to the south of Option 1, negotiating the escarpment approximately 1 km north of the existing A1 at Kadugannawa
- **Option 3:** G-J-L: Alternative commencing at Mirigama, heading northwards in the vicinity of Pinnawela towards Rambukkana then continuing on same corridor as Option 1
- **Option 4:** G-J-K: Alternative commencing at Mirigama, heading northwards in the vicinity of Pinnawela towards Rambukkana then heading north to approach Kandy close to the alignment of the existing A10.
- **Option 5:** F-K: Option commencing on same corridor as Option 1 and then heading north to approach Kandy close to the alignment of the existing A10
- **Option 6:** X-K: Alternative commencing from Pothuhera in Section 2B towards Rambukkana passing Polgahawela and then heading north to connect A10 at Galagedara.

However, The Kandy Ring Road concept was also dropped from the CEP because of value for money considerations at this. Link M, L and later part of K (Galagedara to Kandy ring road) was dropped from the above options. Upon further study, it became evident that the negotiation of the escarpment on Link 'L' and Link M would prove to be expensive and technically difficult, with either a lower standard of geometry resulting in reduced design speed and therefore increased journey times or lengthy tunnels. Therefore,

following options were considered up to Galagedara in the selection of preferred alternative for the section 3. Figure 2.2 illustrates the selected options for the section 3.

(1) Option F-K*
(2) Option X-K*
(3) Option G-J-K*

Note: K* indicate the link from Ramukkana to Galagedara via link K

Route alternative analysis of the section 3 is described in following sections.

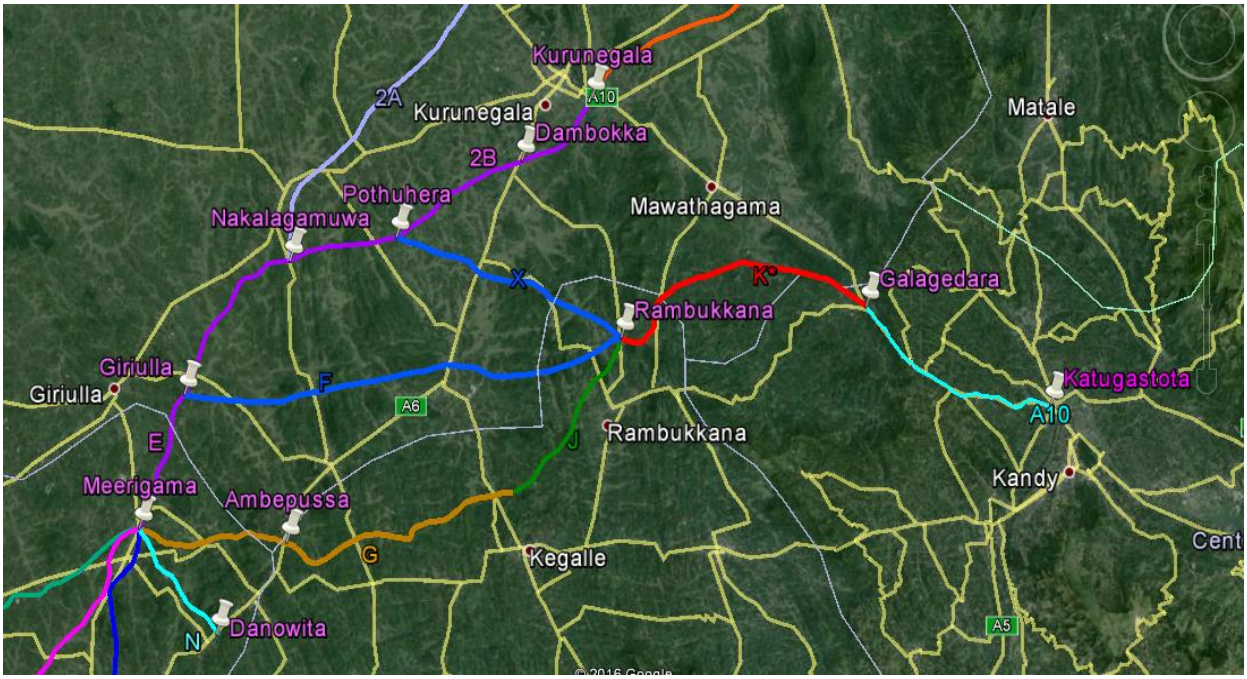


Figure 2.2 Selected options for Detail Analysis

Assessment of all of the alternatives was undertaken, taking account of such factors as:

- Potential design standards
- Geotechnical aspects
- Structural elements, particularly bridges and tunnels
- Resettlement
- Environmental issues
- Construction cost
- Journey times
- Impact on traffic on the remainder of the CEP
- Impact on traffic on the existing road network
- Economics.

It was concluded that the corridor X-K* (option 2 in the final selected 3 options) resulted in the most appropriate alignment. Assessment summary of the 3 options are shown in Table 2.1.

Table 2.1 Assessment Summary of the options.

Alternative Corridors	Length (km)	Relative benefits	Relative disbenefits
F-K*	43.5	• Potentially opens areas for development • 80 kmph design speed achieved to negotiate escarpment. • Lower social and environmental impacts	Moderately lower distance to Colombo than X-K*
X-K*	32.5	• Potentially opens areas for development • 80 -100 kmph design speed achieved to negotiate escarpment. • Lowest construction cost • Lowest social and environmental impacts • Extension of Section 2 to Ambepussa allows easy access and egress to the expressway	Although shortest alignment, results in longest route from Kandy to Colombo.
G-J-K*	52.5	• Passes close to A1 and A6,allowing easy access and egress to the expressway • 80 kmph design speed achieved to negotiate escarpment. • High social and Environmental impacts	Shorter distance to Colombo Alignment of G more winding than that of F and X as topography is more challenging.

Due to the heavy population density within the city of Kandy itself, it would prove impossible to link the expressway directly into the centre of Kandy without having a huge detrimental effect on the city and its residents. Therefore, the link from Galagedara to Kandy was dropped and the improvement of A10 road from Galagedara to Katugasthota is proposed.

2.1.3. Proposed Design Alternatives

However further work has been undertaken subsequent to that conclusion to determine the most appropriate corridor. This is discussed further below. Design alternatives for the selected Corridor to optimize the benefit of the selected trace are discussed below.

The section of the alignment from its intersection with Stage 2B (i.e. Pothuhera) to the bottom of the escarpment (at Galagedara) passes through a terrain which does not pose many engineering difficulties. Also, population densities are relatively low and therefore its effect on existing settlements is relatively low. This section from Pothuhera to Galagedara is, for the purposes of this report, termed Section 3A & 3B. However to achieve the stated aim of reaching Kandy, the route must negotiate the escarpment, and rise approximately 300 m to 400 m. Due to the heavy population density within the city of Kandy itself, it would prove impossible to link the expressway directly into the centre of Kandy without having a huge detrimental effect on the city and its residents. Therefore the expressway will terminate at Galagedara and merge to A10 road.

2.1.4. Proposed Tunnel sections

The initial design of the Expressway was revised and three tunnel sections were included in to the Section 3 of CEP to increase the slope protection of the cut areas where the cut is more than 20m in height. The tunnels are constructed as twin tunnels. Table 2.2 Summarizes the details of tunnels.

Table 2.2: Summary of Tunnel Details

Tunnel No	Main Alignment	RHS Alignment	Cost (LKR)
1	Main Alignment 15+120 - 15+410 - 290 m	RHS Alignment 15+120 - 15+410 - 290 m	2.639 Bn
2	Main Alignment 23+430 - 23+630 -200 m	RHS Alignment 23+430- 23+630 - 200 m	1.878 Bn
3	Main Alignment 27+490 - 27+725 - 235 m	RHS Alignment 27+495- 27+665 - 170 m	1.762 Bn

Comparisons of tunnel and cut options are given in below Table 2.3.

Table 2.3: Comparisons of tunnel and cut options

	Cut Option	Tunnel Option
Length	0.7m	0.7m
Cost	3 Bn. LKR (Approximately)	6.279 Bn. LKR
Social Impact	Higher impact (need to resettle the families, the expressway will bisect the area)	Less impact
Impact on Ground Water	Higher Impact	Moderate Impact
Impact on Wildlife/Animals	Higher Due to habitat fragmentation	No/lesser impact
Vibration Impacts	Lesser Impact	Higher Impact
Possible earth slips	Higher Possibility	Lesser Possibility
Maintenance cost	Less	Higher

Even if the construction cost of the tunnel option is higher than the cut option, tunnel option was selected for final design due to less impacts.

2.2.5. Route Adjustments

The route selected for the section 3 was adjusted to minimize the impacts and increase the benefits when finalizing the X-K* route.

The route selected was deviated to the North Eastern side from Ch8+300 to Ch10+800 to minimize the impacts on social life of the area. The deviation will minimize more than 60% of the impacts on households. Re- alignment of the route is indicated in the Figure 2.3.

Figure 2.3 Route Deviation from Ch 8+300 to Ch 10+800

The Galagedara Junction was shifted towards the Southeastern side to connect the CEP directly with the Katugastota-Kurunegala-Puttalam Highway (A10). This will further reduce the expected traffic in the

Galagedara Town. Proposed Galagedara roundabout will manage the traffic in and out traffic from the proposed expressway. Route deviation at Galagedara is indicated in the Figure 2.4.

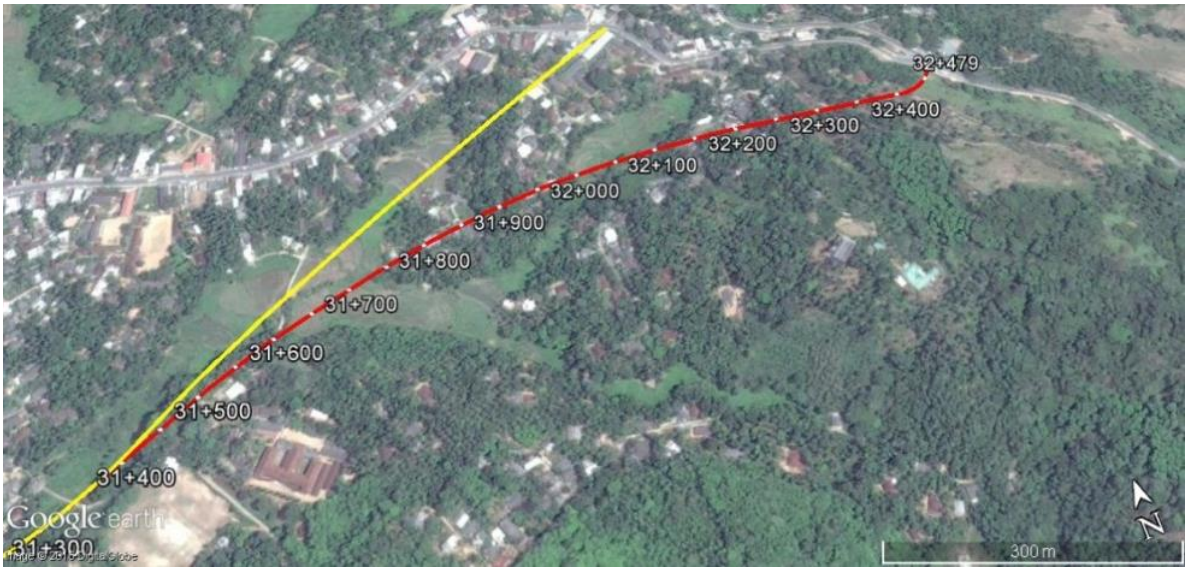


Figure 2.4 Route Deviation at Galagadara

2.2 Description of proposed project

The Central Expressway Links the Western Province to Northern and Central regions. The Section 3 of the CEP is located within the North Western and Central Provinces of Sri Lanka.

2.2.1. Project location

Within the above provinces Section 3 will pass through the Kurunegala, Kegalle and Kandy districts. The summary of affected District Secretariat (DS) Divisions, Local councils and number of Grama Niladari (GN) divisions are presented in the Table 2.4. Map of affected administrative divisions is shown in Annex 2.1

Table 2.4: Administrative divisions affected in Section 3 of CEP

Section	Province	District	DS Division	MC, UC or PS	No of GN Divisions affected
Section 3 – Pothuhera to Galagedara	North Western Province	Kurunegala	Polgahawela	Polgahawela PS	13
			Mawathagama	Mawathagama PS	7
	Sabaragamuwa Province	Kegalle	Rambukkana	Rambukkana PS	9
	Central Province	Kandy	Thumpane	Thumpane PS	9
Total	**3**	**3**	**4**	**4**	**38**

PS - Pradeshiya Sabha

2.2.2. Project layout plan

The EIAR of CEP Section 3 has a total length of 32.5km (from Pothuhera to Galagedara). There will be 4 interchanges within the expressway section, including 1 system interchange (Pothuhera) and 3 Service interchanges including Galagedara Junction. Details of the each interchange are described in Table 2.5.

Table 2.5: Details of interchanges within Section 3 of CEP

Location of interchange	Distance from Kadawatha (0.000 km)	Distance from Pothuhera	Type of interchange	Description
Pothuhera	62.8	0.00	System IC	System IC with stage 3 of CEP (expressway link to Kandy)
Polgahawela	67.5	4.7	Service IC	Ampepussa – Kurunegala Road (A 06)
Rambukkana	76.7	13.9	Service IC	Rambukkana – Katupitiya Road (B384 Road)
Galagedara	95.3	32.5	Service IC (Junction)	Katugastota – Kurunagala – Puttalam Road (A 010 Road)

2.2.3. Ownership of project site

The Section 3 of the CEP 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 property acquisition will be completed before the commencement of the project. Therefore, when the land acquisition is completed the land within the proposed corridor will be vested upon RDA.

2.2.4. Design details of all project components

The PMU has already finalized the designs of the proposed expressway section. The typical cross sections are presented in Annex 2.5 and interchange designs are presented in Annex 2.6. Land acquisitions will be carried out along a wide corridor which allows for 4 lanes (6 lanes for Tunnel sections).

The expressway will be constructed as an elevated structure using viaducts, bridges, culverts and earth fill embankments. The initial viaduct length was increased up to 4 km to minimize the potential impacts. The summary of design details are presented in Table 2.6. There will be three tunnels within this expressway Section. Schedule of Structure is given in Annex 2.4.

Table 2.6: Design details of all project components

Item	Design detail	Section 3
1	Length of trace (km)	32.5
2	Viaduct length (km)	4.0
3	Tunnel Length (km)	0.7
4	Cut length (km)	9.6
5	Fill length (km)	17.4

Item	Design detail		Section 3
6	Height of embankment (m)		09
7	Width of ROW* (m)		80
8	No. of lanes	Initial	04
		Ultimate	04
9	No. of interchanges	System	01*
		Service	01
		Junction	01
10	No. of underpasses		23
11	No. of over bridges		14
12	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.
13	Service areas		None

*Pothuhera System Interchange

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 equipment such as pontoon mounted equipment may be used especially when working in areas crossing rivers (Rambukkana Oya, Kuda Oya and Kospothu Oya). There will also be some manual activity, 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 will 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 on 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

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

construction. Separate approvals may be necessary for some new quarries. Necessary approvals will be obtained from GSMB, Pradesheeya Sabhas, DS and NWP-EA and/or CEA. Refer Annex 2.7 for details of available quarry sites.

Table 2.7: Estimated quantities of materials required for Section 3 of CEP

	Length Km	Earth m3	Aggregate m3	Cement Mt	Sand m3	Reinforcement Mt
Section 3 **Pothuhera-Galagedara** (0+000-32+500)	32.5	1,461,443.92	794,652.71	124,648.74	180,933.14	29,665.28

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 need during operation period

Maintenance of the expressway is the primary way in which the EMU of RDA carries out its goal of providing a safe, efficient, 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.

A maintenance manual will be prepared. The manual would 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 provided.

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

The comprehensive Resettlement Plan has been prepared for the Section 3 of CEP, the Land acquisition, rehabilitation/ relocation of communities, compensation will be made according to the applicable government rules and 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 thirty months. Civil works of the section 3 of the CEP from Pothuhera to Galagedara is anticipated to commence in the third quarter of 2016. Civil Works of the CEP will be carried out as two packages and both packages are to be commenced at the same time. The Table 2.8 shows the Schedule of Construction Activities and Table 2.9 shows Section 3 – Package Summary.

Table 2.8: Schedule of Construction Activities

Section	Activity/ Year	2016				2017				2018			
	Quarter of year	1	2	3	4	1	2	3	4	1	2	3	4
Section3 Pothuhera to Galagedara	Awarding of contract												
	Civil works												

Table 2.9: Section 3 – Package Summary

Contract package	Section	Length km
Section 3 - A	Pothuhara - Parape	16.7
Section 3 - B	Parape - Galagedara	15.8

2.2.10. Future expansions

The expressway connects to the Kadawatha Dambulla Section of the CEP at Pothuhera System Interchange. The existing Katugasthota – Kurunegala – Puttalam highway (A 10) will be upgraded to a 4 lane road from Galagedara to Katugastohota to facilitate the traffic coming from the expressway. It will further connect to the proposed Kandy ring road at Katugasthota which will connect Peradeniya and Gannoruwa. In addition to the above following road improvements will be carriedout in Kandy area,

Table 2.10: Expressway Connectivity roads in Kandy area

	Road	Length (km)	Present Condition	Proposed Improvement
1.0	Widening & Improving of Katugasthota Kurunagala Putlam Road (CH 0+000 - CH 13+000) **(A-10)**	13.00	2 lane	4 lane
2.0	Widening & Improving of Aladeniya – Eriyagama **(B 005)**	10.00	Road width 3.5 – 4.0 m	2 lane
3.0	Widening & Improving of Ambatenna-Bokkawala – Arambekade **(B 015)**	2.50	Road width 5.5m	2 lane
4.0	Widening & Improving of Peradeniya – Haloluwa – Katugasthota Road (Ch 3+000- Ch 10+500) **(B 365)**	7.50	2 lane	2 lane
5.0	Widening & Improving of Alawathugoda – Pujapititiya (Road **B-377** from Ch 0+000 Km to Ch 7+500km & **B-204** from (CH 7+500 km TO CH 8+100km)	8.10	Road width 3.5 – 4.0 m	2 lane
6.0	Widening & Improving of Aniwatte Road George E Da Silva Mawatha from Ch 0+000 Km to Ch 1+100km , from 1+650 To 2+350 and Aniwaththa Road from (CH 1+100 km tO CH 1+650km)	2.35	Road width 3.5 – 4.0 m	2 lane
7.0	Widening & Improving of Barigama – Haloluwa Road , B-537 (FROM CH 0+000 kmTO CH 5+750km	5.75	Road width 3.5 – 4.0 m	2 lane
8.0	Widening & Improving of Deveni Rajasinghe Mawatha from Ch 0+000 km To Ch 2+000km and Kudarawathwatta Road (FROM 2+000km TO 2+500km)	2.50	Road width 3.5 – 4.0 m	2 lane
9.0	Widening & Improving of Sri Pushpadana Mawatha Aniwaththa Road from Ch 0+000 km to Ch 1+500km	1.90	Road width 3.5 – 4.0 m	2 lane

	Road	Length (km)	Present Condition	Proposed Improvement
	and Sri Pushpadana Mawatha (FROM CH 1+500km TO CH 1+900km)			
10.0	Widening & Improving of Srimath Kudarathwatta Mawatha (FROM CH 0+000km – CH 4+500km)	4.50	Road width 3.5 – 4.0 m	2 lane
11.0	Widening & Improving of Wataranthenna Mawatha (FROM CH 0+000km – CH 0+400km)	0.40	Road width 3.5 – 4.0 m	2 lane

2.2.11. Project cost, investment and funding sources

The total project cost of the CEP Section 3 from Pothuhera to Galagedara will be around 94.66 billion LKR without Vat (652million US$). Total Project Cost for the CEP (for all sections) will be around 445.3 billion LKR (Without Vat) (3071.03 million US$). The Table 2.11 shows the summary of costs for the Section 3 of CEP. The total cost of the project is to be funded by the Government of Sri Lanka through the local banks.

Table 2.11: The summary of costs for Section 3 of CEP from Pothuhera to Galagedara

Contract package	Section	Length km	Cost Rs. Bn (Without Vat)	Cost Rs. Bn (With Vat)
Section 3 - A	Pothuhara - Parape	18.5	55.10	62.00
Section 3 - B	Parape - Galagedara	14.0	39.56	44.51
Total for Section 3		**32.5**	**94.66**	**106.51**

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 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 Pothuhera (0+000) to Galagedera (32+487) via Rambukkana.

Special emphasis was given to the affected areas at three interchanges located in Pothuhera (System Interchange), Polgahawela (Service), Rambukkana (Service Interchange) and Galagedara (Junction). 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 during the months of April and May of 2014 and additional field surveys were conducted during the October 2015 to January 2016 to verify/update the existing data.

3.2. Physical environment

3.2.1. Topography

Topography

(a) Terrain

Topography along Kandy link of the proposed Central Expressway can be described in terms of contour, terrain, slope and land use. Contour and terrain maps along the road clearly show complicated geomorphology from Pothuhera to Galagedara (Annex 3.2.1). Many sections are moving along valleys and mountain slopes. Ground elevation from Pothuhera to Galagedara gradually increases along the proposed road and it is approximately 100m around Pothuhera system interchange and 330m around the Galagedara exit point. The section length is around 32km and hence this elevation difference is quite significant in terms of topographical influences on proposed expressway. According to the terrain and contour analyses in the initial 7.5kilometers of the proposed Central Expressway ground elevation increases up to 150m. This stretch is having very few surface undulations with small hillocks and hence the possibility of landslides can be ruled out. However, road cut and fills are necessary along that stretch.

In the road segment from 7.5km to 10km, the ground elevation increases by about 50 m, however no significant impact is envisaged on possible landslides. According to geology, this 2.5 km stretch can be considered as a fold zone. A few faults are also present around them (Annex 3.2.3). Therefore, this area can be considered as a geologically weak zone. Terrain analyses further reveals that the stretch from 10km to 14.5km also has lower ground elevations. In general, the area is covering 100m - 115m elevation difference from MSL. Hence, there is no threat from possible landslides. According to the terrain study, the 14.5km to 16km stretch is moving mainly along a very narrow valley and on either side of the valley there are steep slope mountains (Annex 3.2.1). Hence, there is a possibility of occurrence of landslides along that slope after the possible road cut. After that the proposed road is moving along a terrain of lower ground elevation (around 100m from MSL) on a narrow valley up to 20.5km post. Therefore, either sides of the stretch are having mountains which can trigger landslides after possible road cuts. The stretch from 20.5km to 26km is having significant surface undulations. Especially on the 23 - 24.5km stretch the proposed road is crossing mountains which need significant level of road cut. After the 24.5km point the proposed road is

moving along a high slope area with ground elevation ranging from 200m to 330m. Along this stretch there are possible slope cuts along the southern margin of the proposed road.

(b) Slope

In short, slope angle is an important factor for the terrain analyses of the proposed development project. According to the slope angle analyses around the project, slopes range from 0 to 90 degrees (Annex 3.2.1). However, chainage of the road is mainly designed along the lower elevation and on a relatively flat terrain. Significantly higher slope angles are present around the proposed expressway (Annex 3.2.1).

(b) Land use

The proposed road is running through different lad use patterns. Land use maps for 1:10,000 scale is given in the Annex 3.2.2. The right of the way (50m from center line) and reservation area (100m from the center line) are also marked on the maps. The major land use type present from Pothuhera to Galagedara is paddy fields. However, the first 16 kms is dominant with coconut cultivations rather than paddy. According to land use analyses, in the stretch between 16km to 32km the dominant land use types are paddy fields and home gardens. In addition, rubber cultivations and scrub forest are also present. There are no known forests present across the proposed road.

3.2.2. Climate and meteorological features

3.2.2.1 Climate

The climate of the project location could be predominantly characterised as tropical, with distinct wet and dry weather patterns. Rainfall pattern in the project area is a bi-model where rainfall peaks occur in the months of April (Intermediate Monsoon) and November (North East Monsoon).

An examination of long-term rainfall records of the rainfall stations close to the proposed Section 3 of Central Expressway revealed that only two rainfall stations (Patheragalla Estate and Egodagama Ela) have reliable long-term 3-decade averages. Long-term average monthly rainfall figures of these two stations are given in Table 3.1 and data are illustrated in **Figure 3.1**.

Table 3.1 : Long-term average monthly rainfall in the project area

Rainfall Station	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Patheragalla Estate (1960-1990)	56.4	66.5	144.5	308.1	206.4	183.9	142	123.6	190.6	365.2	347.6	133.9
Egodagama Ela (1960-1990)	71.7	81.8	138.4	269.9	190.3	179.7	133.4	114.9	169.5	363.8	358.2	147.4

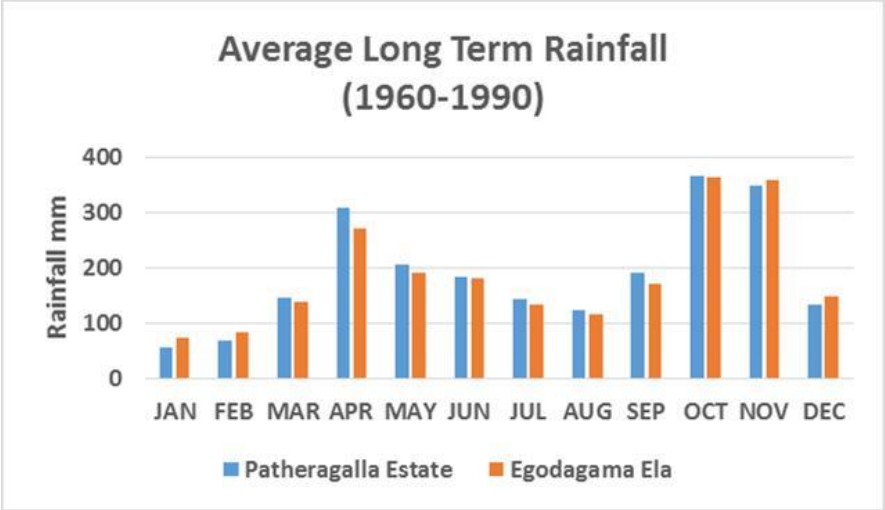


Figure 3.1 : Long-term average monthly rainfall in the project area

Recent monthly rainfall data for the rainfall stations close to the proposed CEP are given in Table 3.2 and average rainfall is illustrated in Figure 3.2.

Table 3.2 : Monthly Rainfall of the Stations Close to Expressway

Kurunegala												
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2004	30	43	86.1	290	183.8	121.5	95	52.1	235.3	423.9	290.1	147.5
2005	49	59.3	214.7	160.2	101.5	105	115.4	8	52.6	562.7	478.6	99
2006	133.9	17.1	160.6	71.5	156.1	104.3	40	173.9	27.6	703.3	671.1	56.7
2007	32	24.4	55.1	170.2	53	191.3	95.9	79	185.6	339.4	211.6	180.9
2008	80.5	137.6	522.4	330.2	126.1	85	316.2	62.9	50.1	514.8	131.5	47.5
2009	21.2	4.8	369.4	160.2	172	95.2	76.3	255.8	179.8	130.8	268	317.3
2010	85.7	1.5	160.9	332.2	142.5	162	93.8	99	207.4	275.8	550.5	323
2011	177.5	154.4	86.8	634.1	223	64.7	36.5	87	142.5	155.7	124	71.8
2012	11.9	143.4	105.2	239	8.3	128.9	66.6	103.3	26.7	356.9	208.2	563.5
2013	194.8	52.9	160.3	132.4	242.9	183.4	65.6	24.5	229.3	297.4	190.1	31.8
Average	81.7	63.8	192.1	252	140.9	124.1	100.1	94.6	133.7	376.1	312.4	183.9
Godagama Ela												
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2004	6.2	0	96.5	178	149.4	8.7	61.6	56.7	193.3	306.6	176.2	44.8
2005	4.9	0	13.8	94.3	19.5	69.1	77.9	36	15.2	485.8	178.3	33.7
2006	9.9	0.3	108.2	62.4	92.5	55.5	4.9	178.4	3.3	619.9	715.2	0.5
2007	0	0.4	0	178.1	0	182.4	2.7	50.1	135.4	221.3	266.2	250.5
2008	0	9.9	207.9	468.2	35	2.6	114.9	6.2	59.7	406	78.6	4.4
2009	0	0.1	177.4	173.8	94.5	41.6	25.5	80.9	150.4	87.6	205.8	186
2010	74.7	0	47.4	214.9	144.3	23.2	74.2	23.8	123.1	290.5	379.1	311.1
2011	160.6	93.5	89	389.2	81	13	3	35	89	223	79	44
2012	2	NA	263	278	2	116	71	79.9	6	248.5	148	NA
2013	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	183.3	NA
Average	28.7	13	111.5	226.3	68.7	56.9	48.4	60.8	86.2	321	241	109.4

Polgolla												
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2004	48.5	35.5	139.6	102.1	104.8	121.2	121.9	60.6	109.7	171.6	122.4	312.5
2005	9.9	64	165.3	125	115.8	107.2	106.8	46.8	91.5	213.9	422.4	152.8
2006	190.8	62	303.4	141.5	151.2	217.2	84.1	61.1	50.1	397.6	404.9	170.9
2007	89	100.4	100.4	334.1	60.4	167.6	104	31.9	196	207.2	172.4	298.7
2008	114.1	96.6	308.8	253	1.1	52.5	94.9	69.7	44.9	287.1	206	69.6
2009	6.1	10.3	198.5	104.9	215.1	56	43.8	67.1	98.3	250.6	318.4	276.6
2010	86.6	25.5	105.8	237.8	100.9	146.8	207.8	165.9	81.2	177.9	454.7	388.3
2011	390.3	234.2	83.6	163.8	65.3	41.7	38.2	31	108.1	312.6	153.9	79.7
2012	21.1	105.5	71.6	174.7	0.2	42.8	134.1	57.6	18.4	513.1	306.8	409.7
2013	269.6	119	71.2	163.1	144	284.7	96.8	129.8	145.9	288.3	111.9	84.2
Average	1226	853	1548.2	1800	958.8	1237.7	1032.4	721.5	944.1	2819.9	2673.8	2243
Weuda												
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
2004	58.5	9.5	107.2	199.5	131.8	104.7	52	0	132.4	266.7	205	210.8
2005	0	0	46.9	162.9	76.9	63.3	41	0	96.2	423.8	367.5	199.4
2006	215.4	0	176.2	116	103	98.5	43.5	75.8	32	548	674	124
2007	59	15	0	236	38.5	286.6	-9.9M	52.1	217.2	230.6	307.4	264.8
2008	158.3	91.6	254.3	286.7	8.3	50.8	228.6	38.6	84.2	399.5	245.9	110.3
2009	0	0	47.8	45.3	21.8	0	32	164	240	176	452.5	200.6
2010	49.5	0	-9.9	394.1	89.4	-9.9M	246.3	11.2	-9.9M	-9.9M	-9.9M	-9.9M
Average	540.7	116.1	622.5	1440.5	469.7	603.9	643.4	341.7	802	2044.6	2252.3	1110

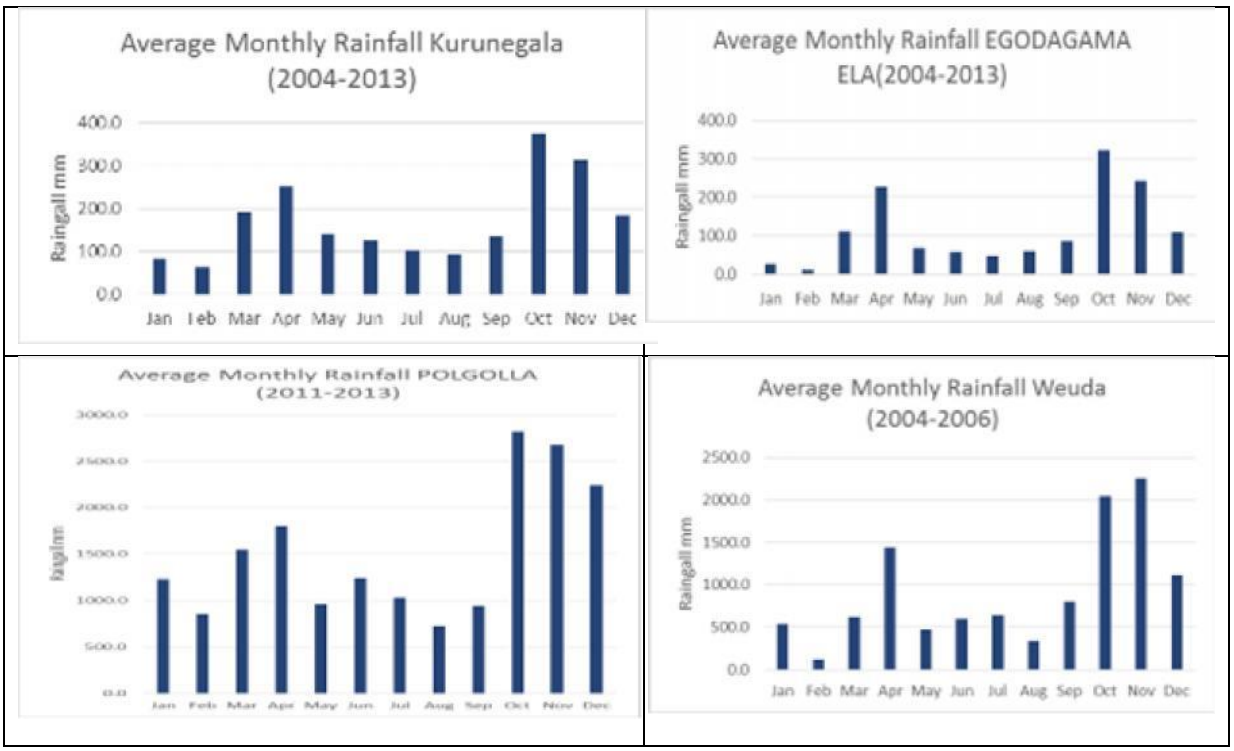


Figure 3.2 Monthly Rainfall of the Stations close to Expressway

3.2.2.2 Meteorology

The closest meteorological station with reliable meteorological data available is Kurunegala and reliable long term three decade data on temperature and relative humidity are available for 1961- 1990 period which are presented below in Table 3.3 & Table 3.4.

Table 3.3 : Climate data for Kurunegala meteorological station

Climate data for Kurunegala, Sri Lanka (1961-1990)													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Record high °C (°F)	35.6 (96.1)	37.6 (99.7)	39.2 (102.6)	39.0 (102.2)	37.7 (99.9)	35.5 (95.9)	35.3 (95.5)	35.7 (96.3)	37.2 (99)	36.7 (98.1)	34.0 (93.2)	39.0 (102.2)	39.2 (102.6)
Average high °C (°F)	30.8 (87.4)	33.1 (91.6)	34.5 (94.1)	33.5 (92.3)	32.2 (90)	31.0 (87.8)	30.8 (87.4)	31.1 (88)	31.5 (88.7)	31.3 (88.3)	30.9 (87.6)	30.1 (86.2)	31.7 (89.1)
Daily mean °C (°F)	25.7 (78.3)	27.0 (80.6)	28.4 (83.1)	28.6 (83.5)	28.3 (82.9)	27.6 (81.7)	27.3 (81.1)	27.4 (81.3)	27.5 (81.5)	27.0 (80.6)	26.5 (79.7)	25.9 (78.6)	27.3 (81.1)
Average low °C (°F)	20.7 (69.3)	20.9 (69.6)	22.4 (72.3)	23.6 (74.5)	24.4 (75.9)	24.2 (75.6)	23.9 (75)	23.8 (74.8)	23.5 (74.3)	22.8 (73)	22.1 (71.8)	21.7 (71.1)	22.8 (73)
Record low °C (°F)	14.6 (58.3)	14.7 (58.5)	16.2 (61.2)	20.4 (68.7)	20.3 (68.5)	20.8 (69.4)	20.2 (68.4)	19.4 (66.9)	19.2 (66.6)	18.3 (64.9)	15.7 (60.3)	14.8 (58.6)	14.6 (58.3)
% humidity - Day	65	59	60	69	73	74	73	71	71	74	74	72	69.6

Source: Department of Meteorology

Table 3.4 : Climate data for Kandy meteorological station

Climate data for Kandy Sri Lanka (1961-1990)													
Month	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Year**
Average high °C (°F)	27 (81)	28 (82)	30 (86)	30 (86)	29 (84)	28 (82)	27 (81)	28 (82)	28 (82)	28 (82)	27 (81)	27 (81)	28.1 (82.5)
Daily mean °C (°F)	23.1 (73.6)	24.1 (75.4)	25.4 (77.7)	25.9 (78.6)	25.6 (78.1)	24.8 (76.6)	24.3 (75.7)	24.4 (75.9)	24.3 (75.7)	24.3 (75.7)	24 (75)	23.7 (74.7)	24.49 (76.06)
Average low °C (°F)	18 (64)	18 (64)	18 (64)	20 (68)	20 (68)	20 (68)	20 (68)	19 (66)	19 (66)	19 (66)	19 (66)	18 (64)	19 (66)
% humidity -Day	70	64	63	71	72	73	73	72	71	74	75	74	71

Source: Department of Meteorology

3.2.3. Geology and Soil of the area together with vulnerability for landslides, erosion

(a) General geology

Baseline geology along the proposed road was studied for the 2km buffer zone on either sides from the road due to lack of rock outcrops. Investigations were done using both field studies and 1:100 000 maps developed by the Geological Surveys and Mines Bureau. In general, most of 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),

- Charnockite gneiss (undifferentiated)
- Charnockite gneiss
- Granite gneiss
- Hornblende biotite gneiss
- Biotite hornblende gneiss
- Garnet sillimanite biotite gneiss
- Quartzite
- Impure quartzite
- Quartzo-feldspathic gneiss

Undifferentiated charnockite - The undifferentiated charnockite mainly reflect the limited availability of rock outcrops 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 charnockite looking grey gneisses. Mineral hypersthenes are scattered and are often available as ridge forming outcrops. Lack of outcrops further implies that there is 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 often ridge forming are typically course grained with characteristic green greasy lustre. They may lack hypersthenes, and include patchy in-situ charnockite and are partially retrogressed. The rate of weathering and geotechnical properties of the rocks seems to be stronger than that of 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 quartz > 20% and a few percentage of mica. Geotechnical prosperities of the granitic gneisses are somewhat similar to the charnockitic gneisses. However, the rate of weathering can be different with respect to the amount of feldspar present in the rock. Rock strengthening characteristics can be significantly different.

Hornblende biotite gneiss and Biotite hornblende gneiss - Massive to compositionally layered grey gneiss with quartz > 20% and plagioclase <10% + garnet. 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.

Garnet sillimanite biotite gneiss -

Usually known as "Khondalite". Meta-sedimentary rock with high weathering intensity, coarse grained red color garnet are abundant. 30 % of mineral graphite is present (1-3 cm). Main source for sillimanite is available in alluvial sand deposit in the area.

Quartzite and Impure quartzite - Pure course grained ridge-forming quartzite <5% of sillimanite, kaolinised feldspar or biotite is also present. Quartzite is also a geotechnically weaker 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 for any construction.

Quartzo-feldspathic gneiss - Quartz and feldspar rich rock. Due to availability of higher amount of feldspar this rock has higher weathering intensity than the other rock types. Therefore, this rock can create a weak platform for any engineering construction.

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 Annex 3.2.3. The general trend directions of the rock layers are from north to south and dipping usually towards the west and east directions (see the structures in the Annex 3.2.3). Field and laboratory studies further imply that most of the rock layers are extended across the proposed road. Therefore, during the constructions lateral variation of the basement rocks and structures will be seen. According to field observations and literature review, rocks are usually massive and hence joint and fracture densities are relatively low. This results in low potential of groundwater accumulation and movement in the aquifers. The proposed expressway is located on a sound basement rock. However, a number of several weak zones (shear zones) can be identified. In

addition, most of the rock boundaries are present across the proposed road and they are considered as geologically and structurally weak margins (refer to geology map in the Annex 3.2.3).

Land subsidence and other natural disasters -

Land subsidence and landslide are the critical environmental issues recorded with rapid development projects. However, geological investigations of the proposed expressway indicate the lower significant threats from land subsidence. Geological and structural conditions of the terrain are quite stable and there are no kast topographical conditions in which subsidence generally takes place.

(b) General description of soil - The major soil type available along the proposed expressway is red yellow podzolic which represents 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 soils with variable drainage and texture are occasionally present. Bog and half-bog soils are only observed 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 between 25 cm to 40 cm. However, the layer is very thin in cultivated lands. Soil is acidic and it is not easily subjected to erosion.

Red yellow podzolic soil - This is commonly known as 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, 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 have shown that the lateritic soils could be used in numerous engineering applications including road works, earth embankment and as building materials. 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 enhance the engineering properties.

Along the proposed expressway both granitic and amphibolite rocks are alternatively present. Hence, considerable variation of engineering properties of the laterite soils can be seen along the proposed line. The Fe-rich laterite is abundant in the area and they are usually harder at surface level due to exposure to the air and consists 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 specially in Al-rich areas. It will result in weak foundations and thus proper soil compaction need to be done prior to any civil engineering construction.

Landslides

The natural process of harder laterite formation in Fe-rich soil helps to prevent possible earth slips (landslides) along the road cuts during the construction of proposed project. Moreover, excess road cut materials (laterite) can be used for earth embankments in other areas of the road construction since the laterite consists of suitable physico-chemical properties for land filling materials in civil engineering.

Areas where landslides may occur are presented in annex 3.3.3 and the plan and profile of the Major cut areas along the trace are presented in annex 4.2.

3.2.3.1 Tunnels

According to map analyses and the field investigation of the proposed Kandy link tunnel constructions will be done under following surface geological conditions.

Proposed tunnel 1 - (15+120 - 15+410) - Undifferentiated gneiss and highly weathered granitic gneiss

Proposed tunnel 2 - (23+ 430 - 23+630) - Weathered hornblende biotite gneiss

Proposed tunnel 3 - (27+490 - 27+725) - Weathered quartzo feldspathic gneiss

Bore hole tests have been done during feasibility studies near tunnel locations. However, it is necessary to conduct further studies on geological and soil conditions around the proposed tunnels prior to implementation. In general, according to geological field observations following conditions were recognized,

- In all areas of proposed tunnels human settlements are present
- Under surface conditions rocks are highly weathered and there are no sound basement rock outcrops.
- Groundwater is the major water resource for all three tunnels and groundwater table is very shallow especially in the area around the proposed tunnel 1. Therefore proposed tunneling can significantly affect groundwater around them.
- It can be noted that the partially and highly weathered soil layers are dominant around the proposed tunneling site, hence tunnels need to be basically constructed through the weathered soil layers.
- Some section of morphology around the proposed tunnel 1 can be seen as paleo-landslide deposits with the boulders which can be unstable during tunnel construction.
- Proposed tunnel 3 will be constructed along a saddle morphology which can affect groundwater movement along the valleys.
- In general, all the tunneling sites are having weak geological conditions in terms of rock weathering, groundwater stability and slope stability.

Plan and profle of the tunnel areas are presented in annex 4.2.

3.2.4. Surface and groundwater hydrology and drainage

3.2.4.1 Salient Features of Hydrological Landscape

A total of 7.6 km length out of 32.5 km of the proposed road is on paddy fields. However, unlike in the sections 1 and 2 of the same project, most of the paddy fields are at high grounds and therefore, there is no threat of flooding. Rambukkana Oya (stream), Kuda Oya (stream) at Parape and the Kospothu Oya (stream) are the main rivers encountered by the proposed road.

A. Rambukkan Oya (stream) - From 15+600 km to 16+000 km, expressway goes across Rambukkan Oya at a sharp bend where the flow bypasses the bend during high flood and the ROW is on flooding area. Peak discharges for 100 year return period at 15+860 km in Rambukkan Oya has been reported to be about 920 m^3/s.

B. Kuda Oya (a tributory of Rambukkan Oya) - From 16+000 km to 21+000km at Parape, proposed road alignment is in the general direction of a tributary of Rambukkan Oya (Parape Kuda Oya). It is a long but very narrow valley with only 100 to 200 m width at the level of the proposed road. In the valley, there is a paddy field, Rambukkana-Mawathagama B281 road and the stream. Proposed road crosses (with highly skewed bridges) and goes over the stream at several places. Due to the steep slope of this stream, flooding is not a major issue and over bank flow has taken place only at few places according to the residents.

Preliminary Design Report - Stage 3 - Volume 3 - Hydrology and Drainage, prepared by SMEC (2014), estimates a 100 year peak discharge of 370 m^3/s at 19+080 km.

C. Kospothu Oya (stream) - Proposed expressway crosses Kospothu Oya at 25+800 km, 26+550 km, 27+800 km and at 31+000. At 26+200 km, where there is a sharp bend in the stream, it is very close to the ROW. During high floods, swelling stream can encroach into the ROW. According to Hydrology Study Report of Central Expressway - Stage 3 - From Pothuhera to Galagedara, prepared by SLLRDC (2016), the peak discharge for 100 year return period in Kospothu Oya at 25+800 km is about 254 m^3/s

3.2.4.2 Minor Drainages

Hydrology Study Report of Central Expressway - Stage 3 - From Pothuhera to Galagedara, prepared by SLLRDC (2016), identified 106 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. Annexes 2 and 3, of the same report gives the catchment areas, peak discharges and other relevant information at these locations.

3.2.4.3 Retention Areas and Retention Times

Generally, low lying areas act as retention areas during high floods. However, throughout the proposed trace, from Pothuhera to Galagedara, there is hardly any low lying areas. Though there are paddy fields close to the streams, they do not act as retention areas due to the steepness of the terrain. Therefore, the retention time is not more than a few hours depending on the location resulting generally in flash floods.

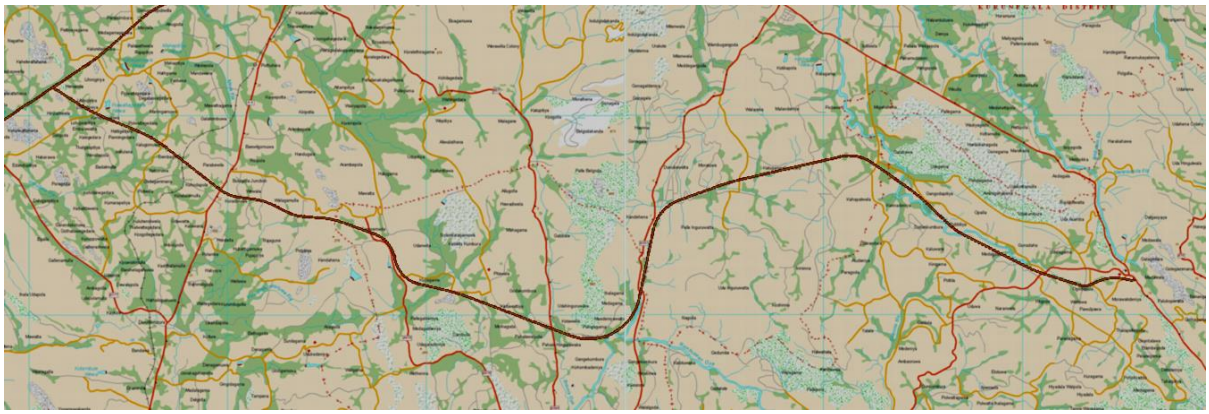
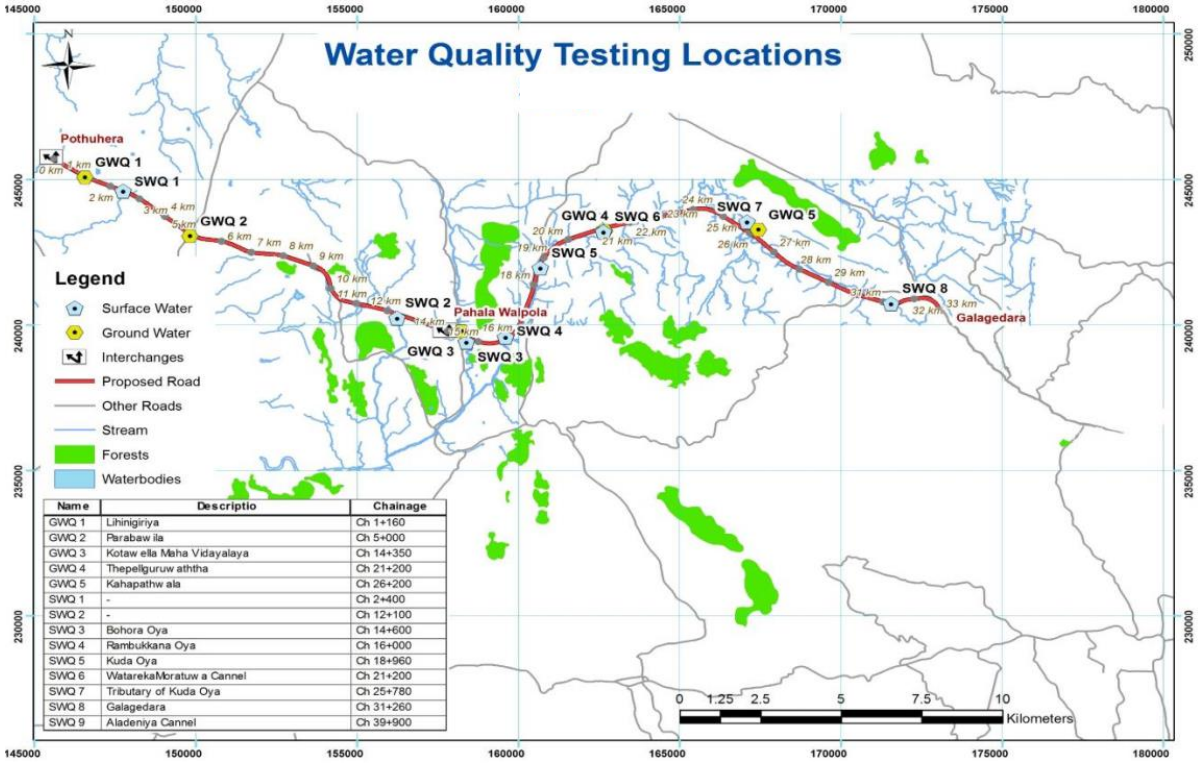


Figure 3.3: General Drainage Pattern of the Project Area

3.2.5. Water quality and sources of water pollution

Figure 3.4 indicates the locations where surface water and groundwater samples were obtained to assess the baseline conditions.



Name	Descriptio	Chainage
GWQ 1	Lihinigiriya	Ch 1+160
GWQ 2	Parabaw ila	Ch 5+000
GWQ 3	Kotaw ella Maha Vidyalaya	Ch 14+350
GWQ 4	Thepelguruw aththa	Ch 21+200
GWQ 5	Kahapathw ala	Ch 26+200
SWQ 1	-	Ch 2+400
SWQ 2	-	Ch 12+100
SWQ 3	Bohora Oya	Ch 14+600
SWQ 4	Rambukkana Oya	Ch 16+000
SWQ 5	Kuda Oya	Ch 18+960
SWQ 6	WatarekaMoratuw a Cannel	Ch 21+200
SWQ 7	Tributary of Kuda Oya	Ch 25+780
SWQ 8	Galagedara	Ch 31+260
SWQ 9	Aladeniya Cannel	Ch 39+900

Figure 3.4 : Water Quality Sampling Location Map of the project area

Annex 3.1.1 shows the results of ambient surface and groundwater quality recorded for selected waterways.

A water quality analysis of the project area revealed that organic pollution is not significant at present as both Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand $(BOD)_5$ levels have not exceeded the CEA proposed ambient water quality standards. However, the analysis report indicates the presence of faecal contamination (higher e-coli count). Considering the relationship between water quality and DO levels, it could be inferred that all the waterways seem to be relatively less polluted as DO levels are between 6-8 mg/L, survival of most fish is possible if DO levels are greater or equal to 2 mg/L. pH is within the range of 6-9 for most locations except at Kuda Oya (SWQ7) where the pH was slightly acidic compared with other locations. This shows the congeniality for the existence of most biological life.

Rambukkana Oya (SWQ4), Kuda Oya (SWQ5), Wataraka Moratuwa (SWQ6) and Galagedara (SWQ8) showed the occurrence of high levels of oil and grease with levels greater than 10 µg/L (CEA proposed ambient water quality standards for Class II Waters: Category 4 –Fish and aquatic life protection). Possible sources of oil may be tractors (washed oil) and the townships of Galagedera (urban runoff and disposal of kitchen effluents from eating outlets).

Groundwater within the project area seems to be moderately to highly polluted considering the relationship between DO and water quality alone[1]. Furthermore, pH was not within the range of 7-8.5 (maximum desirable levels - SLS 614 (Part I drinking water guidelines 1983) and 6.5-9 (maximum permissible levels - SLS 614 (Part I drinking water guidelines 1983).

Significant levels of Iron (Fe) were detected at Lihinigiriya (GWQ1). Taking into consideration the WHO and SLS 614 (Part I Drinking Water Guidelines (levels greater than 0.3 mg/L). NO_3 level at GWQ3 (at Kotawella Maha Vidyalaya) is greater than 10 mg/L (maximum permissible levels under SLS 614; 1983 – Part 1 drinking water quality limits) possibly due to leaching of agricultural pollutants from the

[1] According to Ileperuma (2000) if DO levels are < 4.5 mg/L and between 4.5 mg/L and 6 mg/L, then the water is said to be highly polluted and moderately polluted, respectively

neighbouring paddy fields and at GWQ1 NO_2 levels had slightly exceeded 0.01 mg/L (maximum permissible levels under SLS 614; 1983 – Part 1 drinking water quality limits).

At locations GWQ1, GWQ2 and GWQ5 the groundwater samples appeared to be moderately hard (as total hardness is between 75 mg/L and 150 mg/L) and it seems that there is non-carbonate hardness too as total alkalinity is less than the total hardness. In addition, faecal pollution is evident in the project area possibly due to the percolation of soakage pit effluents.

3.2.5.1. Surface water quality

Water quality analysis of the project area revealed that organic pollution may not be significant at present as both COD and BOD_5 levels measured at selected locations have not exceeded the CEA proposed ambient water quality standards (i.e., 4 BOD_5 mg/L and 15 COD mg/L considering Class II Waters; Category 4; Fish and aquatic life), though some faecal pollution is evident. Generally, quality of the water can be considered degraded if BOD is 5 mg/L and furthermore such waterways are regarded to be polluted when BOD is ≥ 10 mg/L (Nahallage and Piyasiri, 1997 - Ref-53).

All the waterways showed some contamination with total and faecal coliform matter possibly due to runoff containing faecal matter, cattle bathing, etc. pH is within the range of 6-9 (except at one location i.e. SWQ7 in Figure 3-17. where the water was slightly acidic compared with other locations) and measured values of pH show suitability for the existence of most biological life. pH levels are also within the range of 6.5-8.0 (CEA proposed Ambient Water Quality Standards; Class II Waters – Category 4; Fish and Aquatic Life Protection).

3.2.5.2. Ground water quality

Ground deposits change the quality of the water depending on the water chemistry of the area. Solubility of iron in such areas enriches the groundwater with various ions and changes could take place in accordance with toxic and anoxic conditions prevailing in such areas. Significant Fe levels were not detected in the groundwater (measured levels are less than 0.3 mg/L with reference to WHO and SLS 614; 1983 - Part I drinking water guidelines). pH levels were also acceptable with reference to WHO and SLS 614; 1983 - Part I drinking water guidelines (pH levels measured are within the range of 7-8.5). However, all the groundwater sources were contaminated with faecal matter according to the measured values. This could be due to the usage of inappropriate pits to dispose black water (Refer Annex 3.1.1).

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 (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 (Annex 3.1.1.).

3.2.5.3. Sources of water pollution

There are two major waterways within the Project Area, namely Rambukkana Oya and Kuda Oya, which are crucial for irrigation of agricultural lands, for bathing, and washing and domestic uses by the locals. Rambukkana Oya and Kuda Oya are often encountered by the trace at several locations as tributaries. The Section 3 of CEP is likely to be constructed as a flyover / bridge at several locations including Ch 2+400 km, Ch 12+100 km, Ch 14+600 km (Bohora Oya), Ch 16+000 km (Rambukkana Oya), Ch 21+860 km and Ch 31+275 km crossing waterways. None of the above waterways exhibited signs of cultural eutrophication (inferred through visual inspections) or significant growth of aquatic weeds due to the flowing nature of the streams. Water quality results did not reveal the occurrence of high nutrient levels exceeding the CEA proposed limits for ambient water quality. However, there is a great likelihood that these waterways are possible recipients of agricultural runoff (rich in TN and TP largely due to excessive application of chemical fertilisers during the cultivation seasons) during and following the rainy seasons due to close proximity to agricultural lands (especially paddy fields) in many locations.

Discussions with the locals (for example, at Ch 14+600 km, Ch 21+200 km and Ch 31+275 km) revealed that they do not use water for drinking due to the possible occurrence of agricultural pollutants.

The canal located downhill of the A10 Rambukkana-Kandy Road and parallel to this road is often subjected to pollution caused by Municipal Solid Waste (MSW) dumped by the road commuters and possibly TSS laden urban runoff during the rainy periods (Figure 3.5).

Figure 3.5: Potential diffuse sources of pollution in most of the waterways are agricultural runoff

Rambukkana Oya (SWQ4), Kuda Oya (SWQ5), Wataraka Moratuwa Canal (SWQ6), and Galagedara (SWQ8) showed the occurrence of high levels of oil and grease with levels > 10 µg/L (CEA proposed ambient water quality standards for Class II Waters : Category 4 – Fish and aquatic life protection).

Oil and grease levels are also greater than 200 µg /L (CEA proposed ambient water quality standards for Class II Waters: Category 3 – Bathing). Possible sources of oil may be from surface runoff and due to washing of agricultural machinery such as tractors.

Erosion is not significant along the waterways, except at Rambukkana Oya especially in areas where the river curves / bends due to heavy flow induced erosion during the peak rainy seasons and illegal sand mining activities. Household level sand mining carried out by the locals was also evident in certain areas of the Bohora Oya (Figure 3.6).

 Sand mining on the left bank of the Rambukkan Oya (downstream of the proposed trace with the waters appearing to be relatively turbid (visual inspections) with some siltation	 Significant erosion of the right bank (downstream of the Rambukkan Oya)

Downstream of Bohora Oya

A pile of river sand in one of the home gardens located on the left bank of the Bohora Oya

Figure 3.6: Close views of the Rambukkana Oya and Bohora Oya

3.2.6. Ambient air quality

Previous studies had revealed that the Rambukkana area is not polluted with reference to the ambient air quality standards enacted under the National Environmental (Ambient Air Quality) Regulations, 1994 (Extraordinary Gazette No. No. 1562/22 – August 15th, 2008) with SPM, SO_2 and NO_x (8 hour averages) values of 78 g/m^3, 41 g/m^3 and 23 g/m^3, respectively (RDA, 2001).

However, data collected for the Stage 3 NEP in late June 2014 (under windy, cloudy and light rain conditions) has indicated that 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 stipulated by the Ministry of Environment and Natural Resources of Sri Lanka (Extraordinary Gazette No. 1562/22, August 15th, 2008). The sampling locations are shown in Figure 3.7. Refer to Air Quality measurement details from previous studies in Annex-3.1.2.

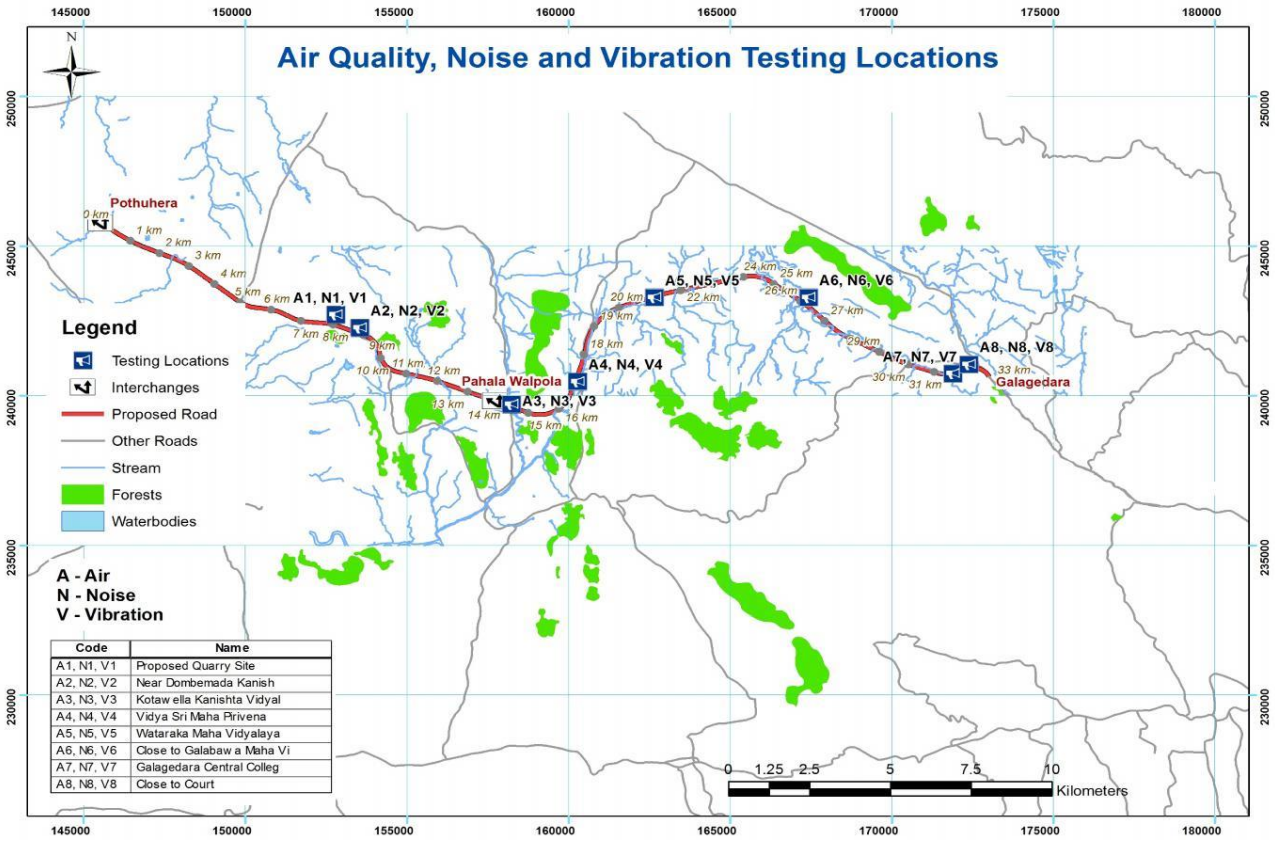


Figure 3.7: Ambient air quality, noise and vibration measurement locations

Table 3.5 : Air Quality along the Proposed Expressway Section

Location	Location description	GPS coordinates	NO_2 (µg/m³)	SO_2 (µg/m³)	SPM (µg/m³)	PM_{10} (µg/m³)	$PM_{2.5}$ (µg/m³)
L1	Possible Quarry site at Ch 7 + 600	N- 07° 23'12.3" E-080°20'46.1"	-	-	16	7	4
L2	R.S.J.Rathnayake	N- 07° 22'58.1" E-080°21'10.4"	11	5	31	15	8
L3	Kotawela Kanishta Vidyalaya	N- 07°21'35.0' E- 080°23'43.6"	12	6	18	11	4
L4	Vidya Siri Maha Piriwena	N- 07°21'59.8" E- 080°24'50.1"	12	5	17	9	5
L5	Watareka Maha Vidyalaya	N- 07°23'31.4" E- 080°26'7.4"	8	6	25	12	7
L6	Galabaawa Maha Vidyalaya	N- 07°23'31.6" E- 080°28'43.2"	9	6	21	10	5
L7	Galageda Central College	N- 07°22'08.8" E- 080°31'08.5"	7	4	32	17	9
L8	Rathnayake Home	N- 07°22'19.0" E- 080°31'24.7"	9	6	16	6	4

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

Table 3.6 shows the residual noise levels recorded in the Rambukkana area for an EIA study undertaken for the alternate highway between Colombo and Kandy (RDA, 2001).

Table 3.6 : Noise levels in the Rambukkana area

Date of Sampling	L_{10}	L_{90}	Leq	Max	Start time	Run time
28/11/2001	51.7	41.5	50.0	74.8	10.36 am	15 min

(Source: RDA, 2001)

The residual noise and baseline vibration levels of the project trace were identified through field measurements (refer to Figures 3-20 for locations); the results of residual noise and vibration level assessments carried out by the NBRO are summarized in Tables 3.6, Table 3.7 and Table 3.8 respectively. It is noted that the baseline noise levels are relatively high in high traffic road areas and low in rural areas within the proposed project area. However, the baseline noise levels seem to be not exceeding the noise levels stipulated under schedule 1 of the National Environmental (Noise Control) Regulations No.1 of 1996.

Peak particle velocities (PPVs) were less than the interim standards on vibration for Category / Type 2 structures (4 mm/sec and 8 mm/sec for continuous and intermittent vibration, respectively when the frequency of vibration is 10-50 Hz) and Category / Type 3 structures (2 mm/sec and 4 mm/sec for continuous and intermittent vibration, respectively when the frequency of vibration is 10-50 Hz) with reference to the operation of machinery, construction activities and vehicle movement.

Table 3.7 : Noise level results – 24 hour measurements

Location	Location description	Morning (06.00 am-09.00 am)			Afternoon (11.00 am - 13.00 pm)			Evening (17.00 pm-22.00 pm)			Night (22.00pm-24.00pm)		
		Leq	L50	L90	Leq	L50	L90	Leq	L50	L90	Leq	L50	L90
N1	Quarry site at Ch 7+940 km (an active quarry site during the past, but it is likely to be further used for the NEP too. The site is located in the vicinity of some houses)	57	49	43	47	44	43	46	44	42	47	45	43
N2	R.S.J. Rathanyake	56	46	41	53	45	39	49	46	41	51	48	42
N3	Kotawela Kanishta Vidyalaya	49	47	44	49	47	44	48	46	44	48	46	44
N4	Vidya Siri Maha Piriwena	49	45	42	51	48	44	52	46	41	51	44	43
N5	Watareka Maha Vidyalaya	50	48	46	51	48	47	49	47	46	49	43	44
N6	Galabaawa Maha Vidyalaya	55	49	45	49	44	39	52	49	42	45	43	40
N7	Galageda Central College	52	48	45	51	47	43	50	46	43	48	45	41
N8	Rathnayake Home	50	48	46	52	47	43	49	46	42	47	45	42

(Source: NBRO, 2014)

A measuring time of 5 minutes was selected to focus on baseline noise levels (to evaluate construction impacts) as per the schedule VII of the National Environmental (Noise Control) Regulations No.1 1996. This represent baseline noise levels for operation period as well as when taking noise measurements several times a day. As per the noise regulation, "Day time: is defined as from 06:00 hours to 18:00 hours, expect for the third schedule and sixth schedule (for construction activities), where it means from 06:00 hours to 21:00 hours." Therefore, measuring time intervals have been selected to represent residual noise levels of a day which could be used during construction as well as in operation period (of which could be used to assess construction impact or operational impact by measuring construction or operational noise in any time of day)

Table 3.8 : Vibration levels

Location	Location description	Run Time (min)	Morning (06.00 am-09.00 am)		Afternoon (11.00am - 13.00 pm)		Evening (17.00 pm- 22.00 pm)		Night (22.00 pm-24.00 pm)	
			Frequency Range (Hz)	Vibration in ppv (mm/sec)	Frequency Range (Hz)	Vibration in ppv (mm/sec)	Frequency Range (Hz)	Vibration in ppv (mm/sec)	Frequency Range (Hz)	Vibration in ppv (mm/sec)
V1	Quarry site at Ch 7+600 km	15	10-50	0.08	10-50	0.31	10-50	0.08	10-50	0.09
V2	R.S.J. Rathnayake	15	10-15	0.14	10-50	0.08	10-50	0.09	10-50	0.12
V3	Kotawela Kanishta Vidyalaya	15	10-50	0.57	10-50	0.13	10-50	0.09	10-50	0.08
V4	Vidya Siri Maha Piriwena	15	10-50	0.3	10-50	0.2	10-50	0.16	10-50	0.15
V5	Watareka Maha Vidyalaya	15	10-50	0.17	10-50	0.18	10-50	0.21	10-50	0.13
V6	Galabaawa Central College	15	10-50	0.24	10-50	0.17	10-50	0.13	10-50	0.11
V7	Galageda Central College	15	10-50	0.08	10-50	0.09	10-50	0.17	10-50	0.11
V8	Rathnayake Home	15	10-50	0.08	10-50	0.08	10-50	0.09	10-50	0.09

3.3. Biological environment

3.3.1. Project Area

The Section 3 of the proposed CEP traverses through the administrative districts Kurunegala, Kegalle and Kandy. Hence, the project falls within the Intermediate Zone (Kurunegala) and Wet Zone (Kegalle and Kandy) of the country. The annual rainfall varies greatly along the route, with the proximal section in the intermediate zone receiving around 1,750 to 2,500 mm with a short and less prominent dry season, and the latter half in the wet zone receiving around 2500 – 4000 mm. In the entire project area, the average maximum temperature ranges from 28 to 33^{0}C with highest values being recorded during the period of late March to early May. The day time relative humidity generally ranges from 55 to 75 percent whereas nighttime values are generally around 75 to 85 per cent. Owing to prevailing climatic conditions, the initial stage of the CEP supports the intermediate zone vegetation which is a mix of what is found in wet evergreen and dry monsoon forests, whilst the latter section supports vegetation typical of the wet zone.

Biogeographically, the entire route falls under two floristic zones; the III: Northern Intermediate Lowlands (within the intermediate zone) and the V: Northern Wet Lowlands (within the wet zone) (Ashton and Gunatilleke, 1987). 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 belongs to the bioclimatic regions Nothern Intermediate Zone and Sub-montane Zone (Wijesinghe et al., 1993).

An ecological survey has been conducted along a 100m wide corridor of the entire proposed Section 3 route 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. According to latest statistics, the impacted districts have relatively limited forest cover i.e. Kurunegala (4.5 %), Kegalle (9.1 %) and Kandy (19.3 %) (Edirisinghe et al., 2012). However, only two forests which are under the jurisdiction of the Forest Department have been observed to be directly or indirectly affected by the proposed Scetion 3 of the CEP.

Agro-ecosystems and home gardens are the two major land-use types that will be affected by the proposed project. The section 3 of the CEP that falls within the intermediate zone (Kurunegala District) is laid through paddy fields whilst some of the areas traverse through home gardens and coconut cultivations. The section of the highway that falls within the wet zone mainly traverses through rubber plantations and home gardens. Despite being human modified habitats, wet zone home gardens were observed to be rich in floral and faunal diversity and hence, of high conservation value as they serve as critical habitat links between isolated fragments of natural forests.

The project affected area is drained by network of streams which are permanent sources of water and inhabited by fish and other aquatic invertebrates. These streams also supported irrigation activities in the area. The riparian habitats bordering the streams have been impacted by human activities to a certain degree, in most places, yet they harbor numerous native flora and fauna.

3.3.2. Major Habitat Types recorded along the Proposed Route

A detailed ecological study has been carried out along the proposed route using 89 transects in 2014 to get an overview of the habitat types as well as to study the floral and faunal composition in each habitat type. These locations were randomly revisited during the period of November to December 2015 to validate the information in EIA study report conducted for the same route in 2014. In addition, pre-identified ecologically sensitive locations were specifically examined. Figures 3-21 and Figure 3-22 indicate the locations and geo-references (chainage and description) of the points through which the survey transects were aligned during 2014 ecological assessment.

The proposed route spans over a variety of natural and man-made vegetation/habitat types including terrestrial, aquatic and semi-aquatic systems in 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: Naturalized Forest Plantations, Riparian Vegetation, Rock outcrops
II. Anthropogenic terrestrial habitats: Home Gardens, Coconut plantations, Rubber plantations, Road-side vegetation
III. Natural aquatic/wetland habitats: Streams/rivers, ponds
IV. Anthropogenic aquatic/wetland habitats: Paddy fields

Short descriptions of each habitat type are provided herein.

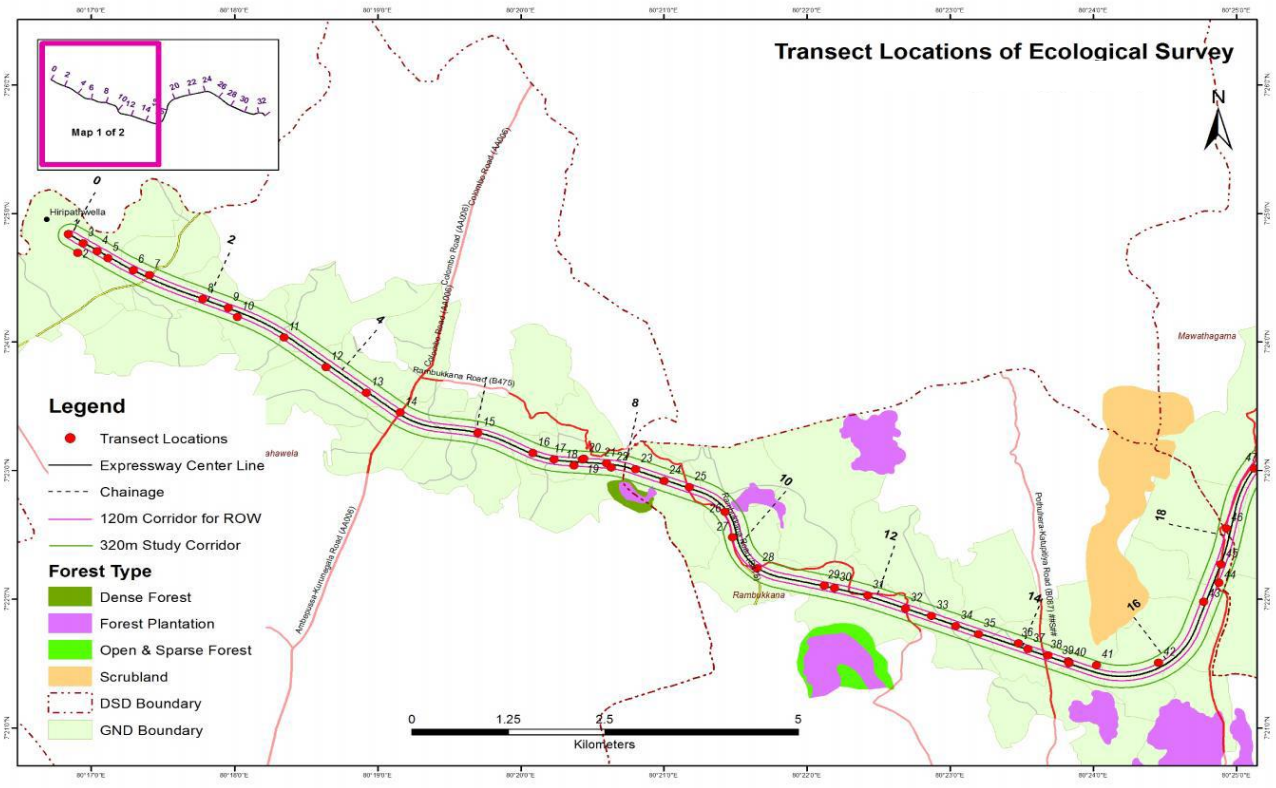


Figure 3.8 a : Map of the study area showing the points through which transects were aligned.

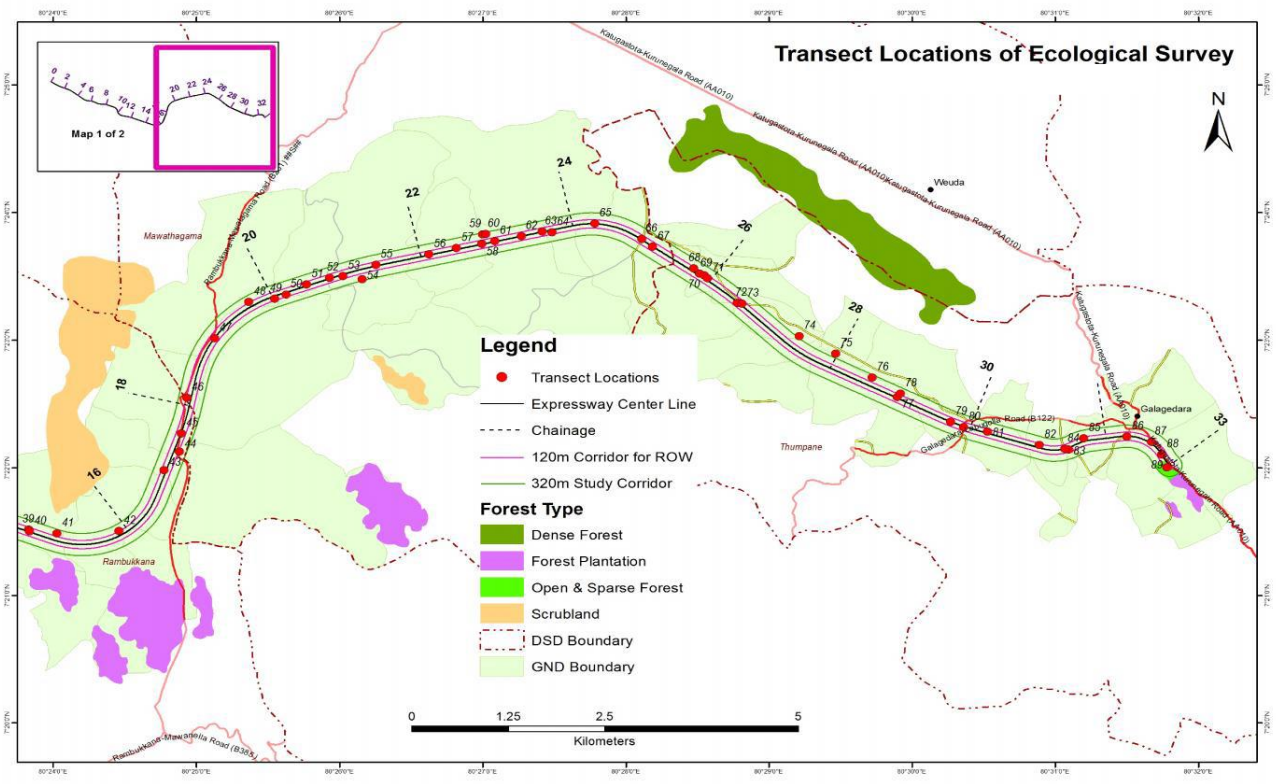


Figure 3.8 b : Map of the study area showing the points through which transects were aligned.

3.3.2.1. Natural terrestrial habitats

A. Naturalized Forest Plantations

Naturalized plantation forests are the major forested habitats encountered closest to the study corridor. Although these plantations have been initially established by the Forest Department for the purpose of timber extraction, they've 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. However, no state-owned forest patches seem to be affected due to the proposed project. Some areas of privately owned lands (e.g. the large estate adjacent in Dombemada (Ch = 7+900) near Korossakanda resembles the characteristics of a naturalized forest plantation (Figure 3.9). The floral and faunal communities of such forest patches are more or less similar to that of forest reserves in the area.

Figure 3.9 : A naturalized Forest Plantation near Korossakanda (Ch ≈ 7+900)

These forest patched bear similarities in species composition to both the tropical lowland wet evergreen forests and the tropical dry mixed evergreen forests. Some of the species of flora found in such forest patches are *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), *Leea indica* (Gurulla), *Lantana camara* (Gandapana), *Eupatorium odoratum* (Podisinnamaran), *Alstonia scholaris* (Ruk Attana), *Pagiantha dichotoma* (Divi Kaduru), *Pothos scandens* (Pota Wel), *Caryota urens* (Kitul) and *Helicteres isora* (Lihiniya).

Five endemic plant species *Semecarpus nigro-viridis* (Badulla), *Litsea longifolia* (Rat Keliya), *Aporusa lanceolata* (Heen Kebella), *Cissus lonchiphylla*, *Derris parviflora* (Kala Wel), one vulnerable (VU) plant species, *Gyrinops walla* (Walla Patta) and five near threatened (NT) plant species, *Ziziphus rugosa* (Maha Eraminiya), *Vitex altissima* (Milla), *Helicteres isora* (Lihiniya), *Carallia brachiata* (Dawata) and *Cissus lonchiphylla* are among plant species associated with secondary vegetation. A comprehensive list is given in Annex-3.3.1.

With regard to fauna, the presence of several species of animals was verified from direct observations of the animals, indirect signs and through interviews with residents bordering the forest. This revealed that the forests comprise an invaluable assemblage of fauna. Some of the species that were recorded were the

primates (Loris and macaque), fishing cat (scat), mouse deer and barking deer and several rodents (porcupines, rats and mice, jungle squirrel).

B. Riparian vegetation

The proposed CEP Section 3 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, 03 such places where riparian vegetation would be severely affected were identified. For instance, the proposed route crosses the Rabukan Oya at two locations (Ch ≈15+750 to 15+930), affecting the riverine vegetation. However, riparian vegetation consisting of well-established trees is present only the left bank. In contrast, the more heavily used bank bordered by paddy fields, consists mainly of shrubs (Figure 3.10)

Figure 3.10: Riparian vegetation on the banks of Rambukkan Oya (Ch ≈15+750)

The proposed route goes parallel to Kuda Oya for about 4km and the 60m ROW corridor of the highway includes Kuda Oya (Ch ≈16+400 to 20+300). It further goes across Kuda Oya at approximately (Ch ≈17+100). This stretch of Kuda Oya comprises relatively less disturbed narrow strip of riverine vegetation, especially on the left bank.

Figure 3.11: Riparian vegetation along Kuda Oya (Ch ≈16+700)

At approximately Ch ≈25+800, the proposed route crosses Kospothu Oya. Despite agricultural land uses along both banks, the narrow strip of riverine vegetation consists of well-established large trees and shrubs. In places where the vegetation is absent, the banks have been subjected to erosion.

The riparian vegetation affected by the proposed highway at locations identified above show more or less similar floral composition as they are located within the same floristic zone V: Northern Wet Lowlands. Some of the floral species found in riparian areas include *Lagenandra* sp. (Kethala), *Pandanus ceylanicus* (O Keyiya), *Colocasia esculenta* (Gahala), *Barringtonia racemosa* (Diya Midella), *Terminalia arjuna* (Kumbuk), *Pongamia pinnata* (Magul Karanda), *Bambusa vulgaris* (Kaha Una), *Acacia caesia* (Hinguru Wel), *Lagerstroemia speciosa* (Murutha), *Saccharum spontaneum* (Wal Uk), *Dillenia indica* (Honda para), *Erythrina fusca* (Yak Erabadu), P*othos scandens* (Pota Wel), *Areca catechu* (Puwak), *Caryota urens* (Kitul), *Hydnocarpus venenata* (Makulu), *Anamirta cocculus* (Titta Wel), *Ficus hispida* (Kota Dimbula), *Ficus racemosa* (Attikka), *Streblus asper* (Netul), *Streblus taxoides* (Gon Gotu), and *Piper sylvestre* (Wal Gam Miris Wel).

Figure 3.12: Riparian vegetation on the banks of Kospothu Oya (Ch ≈25+800)

Nine endemic plant species, Semecarpus nigro-viridis (Badulla), Garcinia quaesita (Rat Goraka), Hydnocarpus venenata (Makulu), Artocarpus nobilis (Bedi Del), Pandanus ceylanicus (O Keyiya), Aporusa lanceolata (Heen Kebella), Litsea longifolia (Rat Keliya), Cissus lonchiphylla, Horsfieldia iryaghedhi (Ruk) Six vulnerable (VU) plant species, Calamus thwaitesii (Ma Wewel), Margaritaria indicus (Karavu), Hugonia ferruginea, Pandanus ceylanicus (O Keyiya), Gyrinops walla (Walla Patta) Horsfieldia iryaghedhi (Ruk) and six near threatened (NT) plant species, Erythrina fusca (Yak Erabadu), Lagerstroemia speciosa (Murutha), Olax imbricata (Telatiya), Ziziphus rugosa (Maha Eraminiya) and Vitex altissima (Milla), Cissus lonchiphylla were among plants associated with streams.

Raparian habitats are home to a range of terrestrial birds, amphibians and insects (dragonflies and butterflies). Amphibians of particular interest are the Corrugated Frog (*Lankanectes corrugatus*) and *Rana aurantiaca* which was observed here. The detailed plant and animal species recorded in riparian strips during the field ecological study are listed in Annex-3.3.1 and Annex-3.3.2 respectively.

***C.* Rocky 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 segment of Pothuhera to Nugawela. The extent of vegetation cover and the elevation of rocks vary greatly. Some outcrops are sparsely vegetated while others have patches of relatively thick vegetation. Some extensive rock outcrops are found at the beginning (Ch ≈0+100 - 0+300) of the proposed route at Pothuhera (Figure 3.11). The stratification is less evident in these vegetation formations with trees hardly exceeding 10m height forming a discontinuous canopy, while a shrub layer of 3-4 m and a ground layer consisting of herbaceous plants less than 1m in height make up rest of the vegetation structure. Dry litter fall can be observed during the dry season. The vegetation also tends to differ based on the ground surface features of rocky structures and bare ground. Plants can be observed growing among the boulders and rock crevices of these areas, as well as on soil/bare ground among rocks.

Figure 3.13: Rocky outcrop vegetation on Avarigala (Ch ≈0+100)

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), *Hiptage benghalensis* (Puwak Gediya Wel), *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), an endangered plant species *Cyanotis obtusa* (Maha Namba), 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. In addition, rocky outcrops provide refuge to many faunal species. A detailed list of flora and fauna recorded in rock outcrop habitats are provided in Annex – 3.3.1 and Annex-3.3.2 respectively.

3.3.2.2. 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 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 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. These home gardens supported an appreciable community of native but common species of plants (often of economic importance), animals (Annex – 3.3.1 and Annex-3.3.2).

Figure 3.14: A typical home garden with dense, stratified arrangement of vegetation

B. Coconut plantations

Section 3 of the CEP fragments several coconut plantations in the Kurunegala and Kegalle districts. Many of these plantations are quite extensive and well-established. Intercropping is practiced in some estates while in some plantations, natural vegetation has established, giving the appearance of a mixed plantation (Figure 3.15). As such, they appear to have a rich biotic community. Plant species recorded in coconut cultivated lands, during the field ecological study are listed in Annex – 3.3.1.

Figure 3.15: Mixed and intercropped coconut plantations

C. Rubber plantations

Many of the rubber plantations that will be affected by the proposed expressway were well managed and hence contained rubber as a monoculture. However, access roads and specific locations within some rubber plantations were seen to be highly disturbed and were invaded by herbaceous plants which in turn were conducive for many invertebrates and herpetofauna. Plant and animal species found in such habitats are given in Annex – 3.3.1 and Annex-3.3.2

Figure 3.16: Two Rubber Plantations that will be bisect by the expressway

3.3.2.3. Natural aquatic/wetland habitats:

A. Streams

Kospothu Oya, Rambukkan Oya, Kuda Oya and Bohora Oya are the major stream networks which will be affected by the proposed expressway project. These streams are perennial and they carry a large quantity of water throughout the year, although a temporary reduction in the flow takes place during the dry season. They are ecologically important as they support thick strips of riparian vegetation and harbour many species of aquatic plants and animals. These waterways are also important because they are used for

irrigating paddy fields while also being used by locals. In addition to the terrestrial faunal species which use the riparian habitats, several aquatic species were also observed in stream systems. The streams also hold a rich community of fish. No fishery activities were observed in any of the streams during the survey. The faunal species recorded in rivers and streams during the field study are listed in Annex 3.3.2

B. Ponds

A naturalized rock pond can be observed on the Avarigala rock at the start of the route (Figure 3.17). Possibly man-made, this pond at present has been invaded by a number of native aquatic flora and fauna. This pond is thought to be of archaeological significance, possibly associated with a temple.

Figure 3.17 : Pond on the top of Avarigala

3.3.2.4.. Anthropogenic wetland habitats

A. Paddy fields

Paddy is one of the major cultivations that will be impacted by the Section 3 of the CEP because much of the route traverses paddy lands. 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. Also, because sampling was preceded by rainy weather, dragon flies, damsel flies and amphibians were observed. The detailed animal species recorded in this habitat are given in Annex 3.3.2.

Figure 3.18: Paddy fields that will be affected by the Section 3 of the CEP

Habitats at the start and end points of the Section 3 proposed CEP

Section 3 of the CEP commences at Avarigala in Thulhiriya, which is a rocky outcrop. At present a quarry is in operation and a significant portion of the rock has already been blasted. The ROW of the Section 3 CEP is proposed to end at Galagedera (Ch 32+487).

(a) At the start: Avarigala rock **(b) Quarry operating on Avarigala**

Figure 3.19 : Habitats observed at the start (Pothuhera) of the Stage 3 CEP

3.3.2.5 Floral composition of the Project Area

A total of 355 plant species including 16 endemic species, a nationally critical endangered (CR) species, two endangered (EN), 13 vulnerable (including four endemic) and 11 near threatened (NT) plant species were recorded during the ecological survey within the study area (Table 3.10). Majority of the plant species recorded were trees (130) followed by shrubs (76) herbaceous species (65), climbers or creepers (39), Grass and grass-like (37), two aquatics and one epiphyte. Further, about 34.6 % of the recorded flora is exotic to the country and about 65.4 % are flora is native (including endemics). All recorded plant species are not unique or restricted to the project area. The Critically Endangered *Ailanthus triphysa* was recorded in abundance from home grdens and roadsides. Plant species recorded during the field study are listed in Annex-3.3..1.

Table 3.9 : Recorded threatened plant species

NCS - National Conservation Status : CR -Critically Endangered, EN - Endangered, VU - Vulnerable, NT - Near Threatened,
TS - Taxonomic Status : N - Native, E - Endemic

H - Habit : T - Tree, H- Herbaceous, C - Climber or creeper, S- Shrub,

Family	Species	Sinhala Name	English name	TS	NCS	H
Simaroubacea	*Ailanthus triphysa*	Wal-Biling	White siris	N	CR	T
Annonaceae	*Polyalthia suberosa*	Kalati		N	EN	T
Commelinaceae	*Cyanotis obtuse*	Maha-namba		N	EN	H
Arecaceae	*Calamus thwaitesii*	Ma-wewel		N	VU	C
Fabaceae	*Saraca asoka*	Ashoka, Asoka	Ashoka	N	VU	T
Linaceae	*Hugonia ferruginea*			N	VU	S
Loganiaceae	*Strychnos nux-vomica*	Goda-Kaduru	Nux-vomica	N	VU	T
Phyllanthaceae	*Phyllanthus emblica*	Nelli	Indian gooseberry	N	VU	T
Phyllanthaceae	*Margaritaria indica*	Maha karawu		N	VU	T
Poaceae	*Coix lacryma-jobi*	Kirindi	Job's tear	N	VU	G

Family	Species	Sinhala Name	English name	TS	NCS	H
Rutaceae	*Chloroxyclon swietania*	Burutha	Satinwood	N	VU	T
Thymelaeaceae	*Gyrinops walla*	Walla patta	Sri Lankan Agarwood	N	VU	T
Lauraceae	***Cinnamomum verum***	Kurundu	Cinnamom tree	E	VU	T
Myristicaceae	***Horsfieldia iryaghedhi***	Ruk		E	VU	T
Pandanaceae	***Pandanus ceylanicus***	O-keyiya	Indian sorrl	E	VU	S
Phyllanthaceae	***Phyllanthus myrtifolius***	Gangawerella		E	VU	S
Fabaceae	*Erythrina fusca*	Yak-Earabadu	Coral Bean	N	NT	T
Lamiaceae	*Vitex altissima*	Milla		N	NT	T
Lythraceae	*Lagerstroemia speciosa*	Muruta	Queen's flower	N	NT	T
Malvaceae	*Helicteras isora*	Liniya	Screw tree	N	NT	S
Melastomataceae	*Osbeckia aspera*	Bowitiya		N	NT	S
Olacaceae	*Olax imbricate*	Telatiya		N	NT	T
Rhamnaceae	*Zizyphus rugosa*	Maha-Eraminia		N	NT	S
Rhizophoraceae	*Carallia brachiata*	Dawata		N	NT	T
Sapotaceae	*Chrysophyllum roxburghii*	Lawalu		N	NT	T
Sapotaceae	*Madhuca longifolia*	Mi	South Indian Mahua	N	NT	T
Vitaceae	***Cissus lonchiphylla***			E	NT	C

Table 3.10 : Summary of the plant species recorded during the study

Plant Type	Total	Near Threatened				Endemic	Native	Exotic
	Species	CR	EN	VU	NT			
Tree	130	1	1	8	7	10	76	54
Shrub	76	0	0	3	3	2	48	22
Herb	64	0	1	0	0	0	39	22
Epiphyte	2	0	0	0	0	0	2	0
Climbers or Creepers	39	0	0	1	1	3	22	13
Aquatic	2	0	0	0	0	0	2	0
Grasses	42	0	0	1	0	1	30	8
Total	**355**	**1**	**2**	**13**	**11**	**16**	**219**	**119**
%		**0.2**	**0.5**	**4**	**3**	**5**	**62**	**34**

EN – Endangered, **VU** – Vulnerable, **NT** – Near Threatened, No. of Endemic Plant Species Listed within the Bracket

3.3.2.6 Faunal composition of the project area

A total of 259 species belonging to seven groups (butterflies, dragonflies, fish, amphibians, reptiles, birds and mammals) were recorded during the survey. This included 26 endemics and 17 threatened species. A

summary of the total number of species in each taxonomic group observed during the survey has been provided in Table 3.11 A detailed list of the species have been provided in the Annexure 3.2.2

Table 3.11: Summary of the faunal species recorded during the study

Animal Group	Families	Species	Endemics	Exotic	Native	Data Deficient	NCS 2012					
							CR	EN	VU	NT	LC	NE
Butterflies	5	61	2 (3%)	0 (0%)	59 (97%)	0 (0%)	0 (0%)	0 (0%)	3 (5%)	4 (7%)	54 (89%)	0 (0%)
Dragonflies	5	18	1 (6%)	0 (0%)	17 (94%)	0 (0%)	0 (0%)	0 (0%)	4 (22%)	0 (0%)	14 (78%)	0 (0%)
Fishes	9	21	3 (14%)	3 (14%)	14 (67%)	1 (5%)	0 (0%)	1 (5%)	0 (0%)	0 (0%)	17 (81%)	3 (14%)
Amphibians	6	12	3 (25%)	0 (0%)	9 (75%)	0 (0%)	0 (0%)	0 (0%)	1 (8%)	0 (0%)	11 (92%)	0 (0%)
Reptiles	10	32	8 (25%)	0 (0%)	24 (75%)	0 (0%)	0 (0%)	0 (0%)	5 (16%)	0 (0%)	27 (84%)	0 (0%)
Birds	46	94	8 (9%) (4PE)	3 (3%)	83 (88%)	0 (0%)	1 (1%)	0 (0%)	0 (0%)	4 (4%)	86 (91%)	3 (3%)
Mammals	16	21	1 (5%)	0 (0%)	20 (95%)	0 (0%)	0 (0%)	1 (5%)	1 (5%)	4 (19%)	15 (71%)	0 (0%)
Total	**97**	**259**	**26**	**6**	**226**	**1**	**1**	**2**	**14**	**12**	**224**	**6**
							17					
							259					
%			**10**	**2**	**87**	**0**	**0**	**1**	**5**	**5**	**86**	**2**

CR- Critically Endangered, **EN** – Endangered, **VU** – Vulnerable, **NT** – Near Threatened

Natural forests are not affected directly by the proposed project. However, indirect impacts such as behavioral disturbances may occur. The coconut which was mainly observed as a mixed cultivation, paddy and rubber also supported many species. Home gardens in the area of the expressway, especially those in the latter half were rich in vegetation. These home gardens were major habitats of butterflies and birds. Aquatic habitats are also extremely diverse in terms of width and depth, vegetation, flow rate and substrate and hence the species community would differ somewhat depending on the location.

A description of the fauna encountered in each taxonomic group is described below in detail.

Invertebrates

The terrestrial and aquatic habitats along the route supported a rich variety of invertebrates. Special attention was given to the butterflies and dragonflies because of their importance as indicators of habitat health and due to their greater visibility in comparison to other invertebrates. A total of 59 native and 2 endemic butterflies of five families were recorded. Dragonflies were not frequently observed during the survey with only 18 species being encountered. The most abundant were the butterflies of the Family Nymphalidae with 27 species. The preferred habitats of the butterflies were edges of forests, wild patches in paddy fields and access roads within plantations which were invaded by herbaceous vegetation. Among the most common were the Common tiger (*Danausgenutia*), Glassy tiger, Psyche (*Leptosianina*) and the common crow (*Euploea core*). All species of butterflies are categorised as 'Least Concern' and not threatened. A species of spider (Tarantula species Family Theraphosidae) was recorded on the banks of Kospothu Oya whist several species of snails – e.g. *Paludomus* species in streams and *Acavus indica* in home gardens /plantations were recorded. The detailed species list of butterflies is provided in Annex 3.3.2.

Vertebrates

Fish (Class: Pisces)

The proposed Section 3 CEP alignment intercepts several healthy perennial streams with extensive strips of natural vegetation. A total of 21 species representing nine families were recorded during the survey which included three endemics, one being classified as an endangered species (*Puntius kamalika*), and three exotic species. Richness of fish was highest in Rabukkan Oya where around five species were recorded in

a single visit. One of the most common species was the endemic Sri Lankan Filamented Barb (*Dawkinsia sinhala*). Identification of the species was somewhat a difficult task due to the heavy rain that preceded the field survey. As a result some of the streams were murky and contained a large volume of water. The detailed list of the identified species is provided in Annex 3.3.2.

Toads and Frogs (Class: Amphibia)

With regard to the amphibians, twelve species belongs to six families Bufonidae, Ranidae, Dicroglossidae, Microhylidae, Nyctibatrachidae and Rhacophoridae were recorded from the Scetion 3 CEP project area. There were three endermics and one vulnerable species. They were more prevalent in streams and paddy fields. Species such *Euphlyctis cyanophlyctis, E. hexadactylus* and *Fejervarya limnocharis* was recorded from paddy fields whilst *Duttaphrynus melanostictus* and *Polypedates maculatus* were recorded from home gardens and coconut and rubber plantations.

The endemic *Lankanectes corrugates* was recorded from a shallow sandy stretch of the Rabukkan Oya. This species is categorised as a vulnerable species. Amphibians are critical for the functioning of the ecosystems as they play a dual role as prey and predators. The detailed species list is provided in Annex 3.3.2.

Reptiles (Class: Reptilia)

A total of 32 species of reptiles including three lizards, two gecko, twenty snakes, three skink, two turtles and two monitors were observed during field surveys. There were three endermic and five vulnerable species. Reptiles generally are adapted to live in anthropogenic habitats. Hence many of the reptiles recorded were found in plantations and home gardens. The two most common were *Calotes versicolor* (lizard) and *Eutropis macularia* (skink). The skinks were observed primarily in rocky outcrops while the lizard was found in many different habitats. The two monitors *Varunus bengalensis* (Land Monitor) and *V. salvator* were also recorded a few times, the latter particularly in streams. Some of the serpents recorded were the Green Vine Snake, Rat Snake, a water snake and the Ornate Flying Snake (*Chrysopelea ornate)* which is classified as a Vulnerable species. The detailed species list is provided in Annex3.3.2.

Birds (Class: Aves)

The greatest diversity was observed among the avifauna with as many as 94 species belonging to 46 families being recorded during the survey. Among them were four endemic and four proposed endemic species and also there were three exotics. Birds were also plentiful in all natural and man-made habitats. Among the birds recorded were aquatic birds, predators, munias, weavers and sparrows. The detailed species list is provided in Annex3.3.2.

Mammals (Class : Mammalia)

A total of 20 indigenous non-flying and flying mammals represented by 16 families were recorded along the route. Among them were an endemic and two threatened mammals. Since mammals are relatively mobile they tend to traverse large distances. Thus it is necessary to consider a large impacted area for these animals. Some of the species that were recorded in the Siyambalangamuwa forest were the Grey Slender Loris (*Loris lydekkerianus)*, the Macaque (*Macaca sinica*), the Mouse Deer (*Moschiola meminna*), Barking Deer (*Muntiacus muntjak*), Porcupine (*Hystrix indica)* and the Giant Squirrel (*Ratufa macroura).* Mongoose species, palm squirrels and wildboar were recorded through observations and signs. Scat of the Jackal and otter were also found close to streams in the study area. Bats of the genus *Cynopterus* were recorded from home gardens, whilst macaques were also common in many of the habitats including roadsides. The detailed species list is provided in Annex 3.3.2.

3.3.2.7. Environmentally sensitive habitats/species

Sensitive habitats

Indirect impacts from the proposed expressway on a few ecosystems could be considered as important due to the effects on two natural / semi-natural habitats which function as habitat links or because they hold a reasonable complement of biodiversity. Details of these two forests are given below. The locations of forests within the vicinity of project area are shown in Figure. 3.20.

Significance:

- Forests play a vital role in carbon fixation. Hence many areas around the world are being reforested for this specific purpose.

- In the absence of pristine intermediate forest vegetation, these forests will be important as biodiversity refuges and therefore any clearance or disturbance will be avoided.

- Siyambalagamuwa although it was a forest plantation has become naturalised and now resembles a rainforest patch. Therefore many native/endemic plants and animals now inhabit this forest.

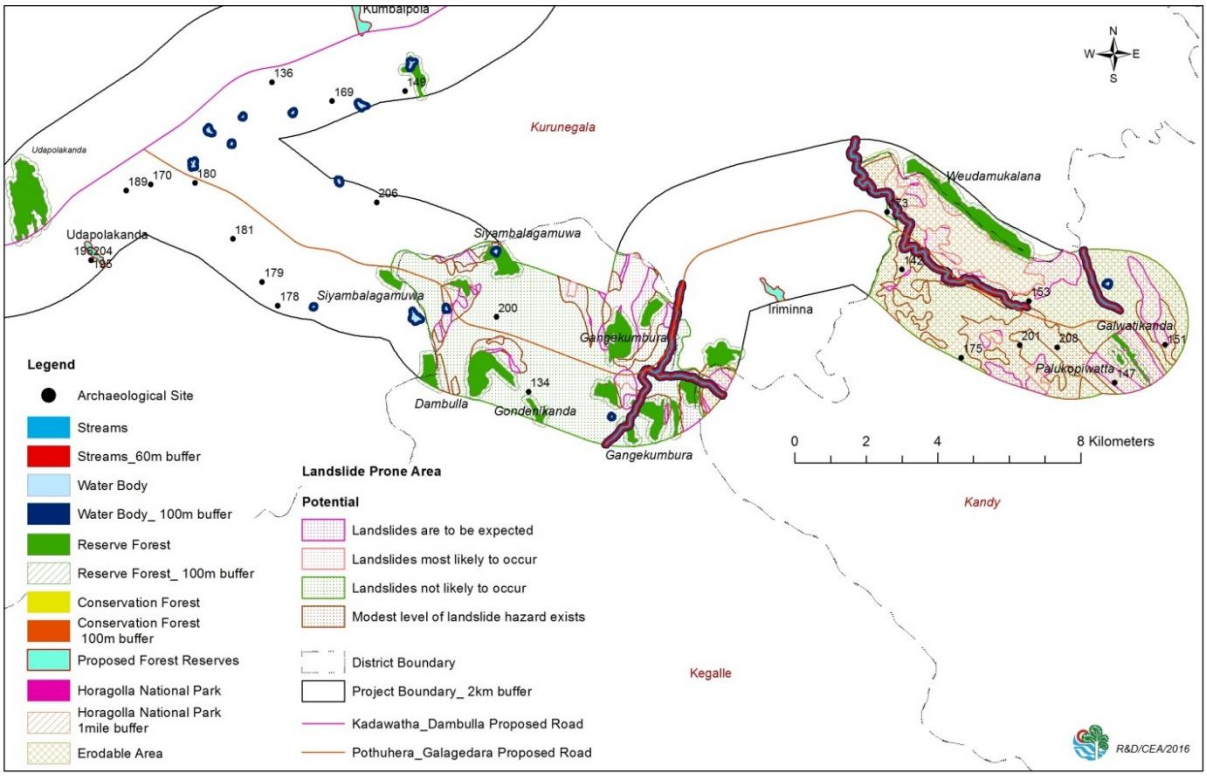


Figure 3.20: Map showing the sensitive areas of the Section 3 Central Expressway (Also Available in Annex 3.3.3.)

Siyambalagamuwa

The Siyabalangamuwa forest is a gazetted reserve (in 1925; Gazette No. 8388) and consists of three isolated patches of forests. This was originally a mahogany plantation forest, but through time, certain areas have become naturalized with the establishment of mixed vegetation forming 'open and sparse' forest. The edge of two of the three patches of this forest falls within 320 m study corridor of the Section 3 of the CEP. However, it doesn't fall within the 120m ROW. Therefore, the construction of the expressway will not affect the flora. However, the forest functions as a complex (between the three patches) where animals (particularly the larger and the more mobile species such as the lorises, monkeys, barking deer and mouse

deer) within each of the forest patches constantly move between them for their daily requirements. Thus the preservation of the intervening areas in between the patches is also vital.

Streams and canals

The three stream networks that will be directly affected by the expressway are the Kospothu Oya, Rabukkan Oya and Kuda Oya systems. In addition to these, Walagan Oya and Bohora Oya were also observed within the study corridor and will be directly or indirectly impacted. These streams were of good quality based on the vegetation, and the observed associated faunal species.

Significance: Biodiversity

- These freshwater habitats were seen to support several species of native and endemic fish, snails, dragonflies and spiders.
- Some of the natural streams and rivers support riparian strips that are important for bank stability and biodiversity.
- Most of these streams are used for bathing (including livestock) and for irrigation.
- Paddy field biota therefore indirectly benefit from these streams.

Sites of particular concern are:

- Kospothu Oya and its tributaries
- Rabukkan Oya and its tributaries
- Kuda Oya
- Walagan Oya
- Bohora Oya

(a) Kospothu Oya

(b) Rambukkan Oya

(c) Walagan Oya

(d) Bohora Oya

Figure 3.21: Showing the (a) Kospothu Oya (Ch ≈25+600), (b) Rambukkan Oya (Ch ≈32+600) (c) Walagan Oya (Ch ≈7+500) and (d) Bohora Oya (Ch ≈14+800)

Ponds

The only naturalized pond that will be affected along the Stage 3 CEP route is the tank on top of Avarigala (starting point). Conversations with quarry workers indicate that the tank exists from ancient times and is therefore maybe of archaeological value. The pond is confined by rocks but has over time been invaded by an array of aquatic and terrestrial vegetation and aquatic and semi aquatic fauna.

Figure 3.22: Tank on top of Avarigala

- **Faunal species of particular concern**

Some of the concerns with regard to particular faunal species or taxonomic groups are as follows. A rare species of fish, the Scarlet Banded Barb (*Puntius kamalika*) was observed in the Kospothu Oya. Another endemic fish, *Dawkinsia singhala,* was also observed. These species will be affected by pollution or the obstruction of waterways caused by the proposed expressway. However, both the species are not restricted to this location alone (not point endemics). The Grey Slender Loris which was recorded from the Siyabalagamuwa Forest and in adjoining privately owned forest patches will be affected due to the clearance and fragmentation of forests and riparian habitats. Since the species typically moves around on trees between forest patches they require continuous strips of vegetation for survival.

Small cats (Fishing Cat) and cervids (Barking Deer and Mouse Deer) were recorded from the forests and in the privately owned lands surrounding the area (particularly in Siyabalangamuwa).

The presence of otters was confirmed by the observation of their scat along both tributaries of the Kospothu Oya and Rabukkan Oya.

3.4. Socio-cultural environment

3.4.1. Existing settlements in and around the area.

The proposed expressway from Pothuhara to Galagedara traverses through the DS divisions of Rambukkana (in the District of Kegalle), Mawathagama and Polgahawela (in the District of Kurunagala) and Thumpane (in the District of Kandy) crossing 38 Grama Niladari Divisions mentioned in the Table 3.4.1 in Annex 3.4. All the GN Divisions are human settlements with different rates of population distribution. The primary data from the sample survey in the area and secondaty data from the census data were considered in the study. The sample survey According to the latest statistics, the total population residing in the four DS divisions is 26645 and 30.6% and 25.8% of them live in 13 GN Divisions in Polgahawela and 9 GN Divisions in Rambukkana DS Divisions respectively. Seven GN Divisions in Mawathagama and 9 GN Divisions in Thumpane account for 23.3% and 20.3% of the total population respectively. As far as Gender is concerned, the female population represents 52.9%. Women in these areas enjoy a higher percentage compared to their national rate in the total population. The population in the affected divisions remains relatively young as nearly 60% is below the age of 39 years. The age range of 0-19 years represents 30.8% and the range of 20-39 years accounts for 27.6%. Over one fourth of the population (25.6%) falls into the age category of 40-59 years and the rest 16% is over 60 years of age. (Table. 3.4.2 in Annex 3.4). This particular distribution of people in age in the affected areas requires special attention of the proposed project as over 30% below 19 years of age and 16% over 60 years (a total of 46.8%) are dependents on others for their survival.

The settlements under the influence of the proposed project are not homogeneous in terms of ethnic and religious characteristics even though Sinhalese and Buddhist population represents the majority. Nearly 90% of people in the affected areas in four DS Divisions is Sinhalese. Sri Lankan and Indian Tamils represent 2.6% whereas Sri Lankan Moor accounts for 7.4% of the population. As far as the religion is concerned, 87.4% is Buddhist and 2% is Hindu devotees. Islam is followed by 7.6%. The representation of Roman Catholic and Christian population remains at 1.3% and 1.6% respectively. (Table. 3.4.3, and Table. 3.4. 4 in Annex 3.4)

As far as the nature of settlements is concerned 92% of the GN divisions could be attributed to rural socio-cultural and economic structures whereas the rest 8% is characterized with urban and semi urban traits. The Polgahawela, Rambukkana and Galewela are under the rapid expansion of market economy predominantly based on the commercial agricultural products in those areas. The 38 GN Divisions under the direct impact of the project have 7221 housing units with the distribution of 30.3% in Polgahawela DS, 25.5% in Rambukkana DS, 24.2% in Mawathagama DS and 20% in the Thumpane DS Divisions. Over 90% of the housing units are single story and double story units account for 5.6%. (Huts and shanties remain at a very low rate of 0.6% (Table.3.4.5 in Annex 3.4).

3.4.2. Socio-economic status of populations (population, income generating activities, agriculture, industry, business and services)

Socio-economic status of people was explored in terms of number of factors such as education, shelters and quality of them, occupations, income and expenditure, communication and household appliances etc. General education and educational achievements of a community clearly indicate an important aspect the social status of people. In the GN divisions under consideration, only 2.2% of people had had no school

education whereas 3.4% was at least graduates. G.C.E Ordinary Level and Advance level education had been secured by 18.9% and 14.7% of the population respectively. It is interesting to report that 20% and 39.1% of the people have been confined to primary and secondary education respectively (Table.3.4.6 in Annex 3.4).

As far as the residential facilities are concerned possession of a house and the availability of consumer durables and household appliances play a symbolic role of social status of families. Over 90% of the total householders had permanent ownership for their housing units whereas only 1% of families are in encroached and other shelters without legal ownership. 3.7% of families were rented or leased houses (Table.3.4.7 in Annex 3.4). As far as the materials of construction of shelters are concerned, 77.7% of units had been permanently constructed with cement floors, 7.2% with Tiled floors (Table, 3.4.8 in Annex 3.4) 70% with tile roofs, 19% with Asbestos (Table3.4.9 in Annex 3.4), 84.2% with brick walls, 7.2% with cement block walls. Only 5.7% of units had wattle and daub walls (Table. 3.4.10 in Annex 3.4). According to the assessment of householders 87.2% of housing units are permanent structures whereas the rest is semi-permanent (Table 3.4.11 in Annex 3.4). As was revealed in the consultations with peoples in those divisions most of families are proud of their possession of permanent well-constructed housing units. Some had spent a whole life span for constructing good housing structures depending on their means of income.

The socio economic status of people is well evident from the sample study conducted for project purposes. The sample consisted of 1246 members of 311 households with a gender distribution of 51% females and 49% males. The Table 3.4,12 shows 13 types of occupations of the employed householders. Accordingly 76.3% of householders are employed whereas 13.8% are retired. Majority of families (18%) live on agriculture. The second highest category of employment is skilled and unskilled nonagricultural labor that accounts for 11.6% of householders. The third category of employment refers to state sector employments accounting for 10.6%. The private sector has employed 6.1% of householders. The Table, 3.4.13 in Annex 3.4 provides details of employment and other involvements of all the 1246 members of the sample. Accordingly, 22.4% of the sample are students whereas 7.3% are below 5 years in age. Unemployed rate is 6.1% (Table. 3.4. 13 in Annex 3.4). It is also important to record the rate of employed population in the total population of 38 GN divisions. According to the available statistics, 37.4% of the total population is employed whereas 36.8% remain economically inactive (Table.3.4.14 in Annex 3.4).

The availability of communication equipment and other household appliances in the communities under consideration shows the extent of modernization they have undergone. The Table.3.4.15 in Annex 3.4 provides types of such equipment and number of families enjoying their services. Land phones and mobile phones are available for nearly 50% and 85% of households respectively. Television and radio services are enjoyed by 92.7% and 60.7% of householders respectively. DVD players are also utilized by 36.1%. Newspapers are available for 54% of families. Most of the people in the project area ownat least one type of vehicle such as motor bicycles, three wheelers, tractors, vans, cars, and lorries for their personal use. This particular possession is considered as a symbol of the material success of their life in the modern rural and urban social contexts.

3.4.3. Principle economic activities

The Tables 3.4.12 in Annex 3.4 and 3.4.13 in Annex 3.4 are furnished with the information of employment of the sample of householders and they clearly reveal the economic activities of people in the area under consideration. Commercial agriculture in the area remains the main means of sustenance for the majority of people. Commercial cultivation of coconut, vegetables, fruits, paddy, grains and plants of home gardens provide livelihood for the majority of people. As a considerable portion of their cultivations is rain fed any change in the average rain fall has an adverse impact on anticipated harvest. Apart from the cultivation of land, employment in the state and private sector industries and services support the economic well-being of families. The expansion of market economy with all of its economic organs such as banks, financial institutions etc. facilitate the agricultural, industrial and service sector economic activities. As a result of this economic change the mean income of households remains at a higher level compared to the mean

expenditure. The Table 3.4.16 in Annex 3.4 shows the mean income and expenditure rates of the three Districts of Kurunagala, Kegalle and Kandy. A detailed account of income of the sample population is provided in the Table 3.4 .17 in Annex 3.4. As is apparent from the statistics, over 25.5% of households enjoy a monthly income over Rs. 50000.00 whereas 3% lives on a meager income less than Rs.10, 000.00. The majority, 62.1%, of households has a monthly income that ranged between Rs.15000.00 and 50,000.00. The rates of expenditure of the households remain relatively lower than the income of them as is well evident from the information of expenditure of the sample presented in the Table.3.4.18 in Annex 3.4. Nearly 40% of the families spend less than Rs. 25,000.00 per month. Over 41% spends an amount that ranged between Rs 25,000.00 and 50,000.00. The rest spends over Rs. 50,000.00 per month.

Being predominantly rural communities still some subsistence economic practices and social values of generosity and sharing, are still maintained in these areas. The people have been able to keep the rate of financial expenditure at a lower rate compared to people of highly urbanized. In particular, the cultivations in home gardens and paddy fields support the daily consumption requirements of families. The economy of those rural communities is a system well interwoven with cultural values and principles of simple consumption patterns of food culture and modern values of achieving material success and saving money and properties for such purposes. The geographical locations of rural communities and accompanied resources have facilitated the institutionalization of their life styles in those communities making it a very difficult problem for them to relocate and reintegrate to a different social context. In brief, as described by rural peasant people in some communities, their domestic economy is primarily based on the products of home gardens that they have grown.

3.4.4. Planned development activities

As was revealed by the local authorities, a number of infrastructure development projects are being planned and implemented in the Divisions under consideration by the Central Government with the support of provincial governments and relevant local government bodies. In particular, several road development projects have been proposed and carried out. The Ambepussa- Tricomalee road (A 006), the Dambadeniya – Rambukkana road (B 475), the Katupitiya – Kurunagala road (B087), Rambukkana – Mawathagama road (B 310), and Galagedara – Hatharaliyadda road (B 122) have been identified for development. The Kannadeniya – Illukwela road (C 060) is being developed by the provincial government. An urban development project has also been implemented in the Rambukkana Township. This project is concerned with the improvement of the roads in the urban area, bus stand, railway station, market, street lighting, water supply and drainage systems, and the public spaces of the town. The Galagedara Township is also being developed. Both Rambukkana and Galagedara towns are to have access to the proposed expressway through proposed interchanges in those locations.

3.4.5. Availability of infrastructure facilities

Infrastructure facilities in the project affected area were surveyed by a team of field researchers and required information was gathered in addition to statistics sourced from the department of Census and Statistics.

Infrastructure of transportation

Transportation requirements of people and institutions of the project area under consideration are facilitated by a good network of national roads, provincial roads and roads maintained by the Local government Bodies and private roads and footpaths. The Table 3.4.19 in Annex 3.4 shows the types of main and access road facilities enjoyed by the members of the Sample study. Accordingly, 2.6% of 313 householders have access from public roads. Over 20% find access to their residences through footpaths with a width of less than 5 feet. Gravel roads and concreted roads provide access to 29.7% and 26.2% of households respectively. Tar roads are available for 19%. As observed in the course of field surveys, most of the rural roads remain in relatively good condition whereas some roads have not been maintained properly for years. However, 80% of the Sample population carries a positive image of the existing condition of their access roads (Table 3.4.20 in Annex 3.4). The rest are not happy with their roads. Access

roads that facilitate the use of motor vehicles are considered as an indispensable need of all communities with the increasing capacity of possessing and using of such vehicles. All the communities have experienced a rapid increase in the volume of vehicles used for agricultural, industrial, commercial, travelling and distribution of goods in the last period of one or more decades. This particular change has been conducive to a rapid transformation of rural footpaths into wide roads.

Water supply

As an infrastructure facility pipe-born water is available only for 15% of the households in the 38 GN Divisions. Over 84% of families get drinking water from various types of wells (Table 3.4. 21 in Annex 3.4). As far as the sample study is concerned, the hygienic water supplied by the NWSDB is available for only about 12% of households. 87.8% get their drinking water from wells (Table.3.4.22 in Annex 3.4)

Sources of energy

According to the official statistics, 95% of households in the 38 GN Divisions depend on firewood for meeting the energy requirement for cooking purposes. Only 3.5% of families uses liquid gas for cooking (Table. 3.4.23 in Annex 3.4).The same percentage of households use firewood for cooking is reported from the sample study (Table 3.4.24 in Annex 3.4).

Source of power for illumination

The benefits the national development of electric power supply are enjoyed by the people of the 38 GN divisions to a considerable extent. In particular domestic illumination of 91.2% of the total households of those GN divisions is powered by the National Grid and the rest of families depend on kerosene oil (Table 3.4.25 in Annex 3.4). The sample of the study reveals that 98% of households is connected to the National Grid for lighting and other purposes. Power generators provide electricity for 1.3% of households (Table 3.4.26 in Annex 3.4).

Disposal of waste

As far as the solid waste disposal is concerned, only 3% of households in the 38 GN divisions is benefited by the service of Local Government authorities for the disposal of their domestic garbage. Majority of the households either burn (49.4%) or bury (32.4%) their solid waste. Only 10.3% of households make use of solid waste by means of composting for agricultural purposes (Table 3.4.27 in Annex 3.4).

Telecommunications and postal service

People in the project area seem to have no serious problem of telecommunication and postal services as they are well connected to both services. According to the sample study, 48.9% of residents are on land phone and 85% on mobile phones. Internet facility is enjoyed by 8.9% and computers are available for 20.4% of households. E-mail access is available for 4.5%. The local post offices render a regular service catering to the postal requirements of people. Over 41% of families of the sample enjoy the postal service in their areas (Table 3.4.15 in Annex 3.4).

Health and medical services

Health and medical requirements of the people in the project area are addressed by number of state and private sector health and medical services which are available in the three districts and the adjacent districts depending on the seriousness of the illness and people' choice. Government health centers and hospitals play a vital role as most people tend to seek the consultation and treatments in those hospitals as their first choice. The state policy of providing the health and medical services free of charge assures the well-being of the people of rural areas who struggle with their meager income to meet the basic needs and are not in a position to enjoy the service of private sector health care. Among the Government hospitals, Galagedara District hospital, Kurunegala District hospital, Kandy General hospital, Peradeniya general

hospital, Pothuhara District hospital, Rambukkana District hospital, and regional hospitals render regular services for the people. The Table 3.4.28 in Annex 3.4 shows the institution that the respondents of the sample tend to use.

Religious service

Religious services are provided by the Buddhist temples, mosques, churches and other religious institutions located in and in the vicinity of different religious communities. As majority of the population are Buddhists, Buddhist temples are found in almost all village areas. The tradition of one temple for one village is clearly evident from the project area. This cultural factor has to be taken into account in the project planning as relocation of a Buddhist temple is hardly possible due to this village identity. This exclusive identity cannot be replaced in a different area as there are other temples well institutionalized in those villages. Consultations with Buddhist monks in Project affected areas close to temples revealed the above mentioned tradition and emphasized the importance of paying due attention to protect temples.

3.4.6. Culturally, historically and archeologically important places

Table 3.12 Culturally, historically and archeologically important places

No	Title	Type	Type of Heritage*	Coordinates	Chainage	Side	Distance
01	Sri Vijeya Sundarama Rajamaha Viharaya	Buddhist Temple	C H A	07⁰24'03.3" 080⁰16'37.2"	01+120	R	1.5 Km
02	Mayurawathi Rajamaha Viharaya	Buddhist Temple	C H A	07⁰24'18.3" 080⁰16'58.0"	01+340	R	700 m
03	Pothgul Viharaya, Lihinigiriya	Buddhist Temple	C H	07⁰24'26.9" 080⁰17'18.6"	01+700	R	75 m
04	Sri Aswaththarama Viharaya	Buddhist Temple	C H	07⁰23'40.7" 080⁰19'39.3"	06+500	L	670 m
05	Vivekarama Purana Viharaya	Buddhist Temple	C H	07⁰22'58.1" 080⁰19'43.1"	06+940	R	550 m
06	Sri Saranapala Road Viharaya	Buddhist Temple	C H	07⁰23'31.7" 080⁰20'09.8"	07+280	L	720 m
07	Sri Negrodarama Senasanaya	Buddhist Temple	C	07⁰22'50.8"	07+760	R	425 m

No	Title	Type	Type of Heritage*	Coordinates	Chainage	Side	Distance
				080⁰20'11.7"			
08	Sambudda Mandiraya& Ella Bodiya	Buddhist Temple	C	7°23'27.23" 80°20'27.39"	08+100	L	710 m
09	Keththarama Viharaya	Buddhist Temple	C	07⁰23'03.6" 080⁰21'03.6"	09+220	L	265 m
10	Roadside Statue 01 (Christian)	Christian Statue	C	07⁰22'36.2" 080⁰21'27.3"	10+300	R	45 m
11	Roadside Statue 02 (Christian)	Christian Statue	C	07⁰22'13.2" 080⁰21'37.9"	11+060	R	60 m
12	Church (Maha Palliya)	Christian Church	C H	7°22'4.26" 80°21'38.14"	11+200	R	285 m
13	Galadenikada Purana Viharaya	Buddhist Temple	C H	07⁰21'52.1" 080⁰21'39.1"	11+300	R	615 m
14	Dambulu Rajamaha Viharaya	Buddhist Temple	C H A	07⁰21'11.3" 080⁰21'43.9"	11+660	R	1750 m
15	Galagedara Mosque	Islamic Mosque	C	07⁰22'23.0" 080⁰30'55.1"	31+680	L	420 m

** C: Cultural, H: Historical, A: Archaeological*

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 considered. 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, according to the expert opinions. 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 ;

Human Interest

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

Geo-Technical/ Earth Resources

- Negative impact on erodability of soil and on landform due to securing of access

Transportation/ Accessibility and Movement

- Negative impacts on Transportation and Movement due to resettlements

During the Construction Phase of the Project
The most significant impacts which might occur are;

Hydrology

- Negative impact on drainage pattern due to compaction and reclamation of land
- Negative impact on flooding and drainage pattern due to embankment and retaining walls

Geo-Technical / Earth Resources

- Negative impacts on soil erosion/ landslides, land form, deposition, stability and consolidation and settling due to land clearing activities, excavation, dredging, tunneling. Blasting and drilling activities and deep foundations and piling activities
- Negative impact on land form due to underground structures

The moderate impacts expected are ;

Hydrology

- Negative impact on the flooding in the area due to land clearing activities, reclamation of land, excavations, dredging and tunneling activities
- Negative impact on drainage pattern due to land clearing activities, demolition, excavations, dredging and tunneling activities
- Negative impact on flooding and stream flow due to reclamation of land
- Negative impact on ground water level and stream flow due to excavations
- Negative impact on flooding, 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

Geo-Technical/ Earth Resources

- Negative impacts on soil erosion/ landslides, land form, deposition, stability and consolidation and settling due to demolition activities
- Negative impacts on soil erosion/ landslides due to embankments and retaining walls
- Negative impact on soil erosion/ landslides during land reclamation activities
- Positive impacts on soil erosion/ landslides 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 soil erosion/ landslides, deposition, stability, consolidation and settling due to underground structures
- Positive impacts on consolidation and settling due to compaction

Water

- Negative impact on surface water quality due to increase in turbidity
- 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, blasting and drilling and tunneling activities

Fauna and Flora

- Negative impacts on natural vegetation and crops in the terrestrial environment due to land clearing activities and land reclamation
- Negative impact on animal corridors due to excavations, dredging and embankments and retaining walls
  Negative impacts on species diversity and and habitats of terrestrial fauna due to land clearing activities.

Land uses

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

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 housing, health and safety and utility networks due to tunneling activities
- Negative impact on life styles of people due to worker camps and demolitions
- 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
- Negative impact on land values due to tunneling activities

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

Geo-Technical/ Earth Resources

- ***Negative impact on Soil Erosion/ Landslides due to road maintenance activities***

Land Uses

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

Flora and Fauna

- ***Negative impact on corridors of terrestrial fauna due to changes 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 Geotechnical Aspects or Earth resources is the most adversely affected by the proposed project, followed by impacts on Hydrological Aspects, 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, impacts on Geo-Technical aspects or Earth Resources, Hydrological impacts, impacts on Socio Cultural aspects (human interest, Land Use, Economics, Aesthetics and traffic aspects) impacts on Ecological aspects, and impacts on Water and Air.

Table 4.1: Impact Matrix

Impact	Pre Construction Phase									Construction Phase																						Post Construction Phase								Impact Value
Activities ->	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	Tunneling	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		
Parameters																																							
Earth																																						***Earth***
Soil erosion/ Landslides								-2			-1	-3	-2	-2	-3	-3	-3	-3		1		2		-3	-1	-2	-2	-1		-1	2				-2				-29	
Land form								-2			-1	-3	-2	1	-3	-3	-3	-3		1		2		-3	-1	-3	-1	-1		-1	2		-1						-25	
Deposition												-3	-2		-3	-3	-3	-3						-3	-1	-2	-1	-1		-1	1								-25	
Stability								-1				-3	-2	1	-3	-3	-3	-3		2		1		-3		-2	-1								-2				-22	
Consolidation & settling												-3	-2	1	-3	-3	-3	-3		2		1		-3	-1	-2					1								-18	
																																						-119	**-119**
Water																																							***Water***
BOD											-1																		-1						-1			-3	
Fecal coliform											-1																								-1			-2	
Turbidity												-1	-1		-1	-1	-2	-1				-1			-1	-1	-1	-1		-1	-1			-1	-1	-1			-17	
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	
																																						-51	**-51**
Air																																							***Air***
Particulate matter and dust												-1	-2		-1	-2	-2		-1	-1		-1		-1	-1	-1		-1		-1	-1				-1	-1		-1	-20	
Hydrocarbons																																							0	

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	Tunneling	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		
Sulfur oxides																																						0	
Nitrogen oxides																																						0	
Noise and vibrations								-1	-1	-1	-1	-1	-2	-1	-1	-2	-2		-1					-2													-1	-1	-18	
Micro climate												-1	-1																									-2	
Odour																													-1									-1	
																																					-41	-41
Hydrology																																							***Hydrology***
Flooding												-2		-2	-2		-1	-2		-2	-2	-2		-2	-2		-3	-2		-2	-2					-1			-29	
Ground water levels															-2			-2						-2		-2												-8	
Stream flow												-2		-2	-2			-2			-2				-2		-1	-2		-2	-2		-2						-21	
Recharge															-1									-2		-2													-5	
Drainage patterns												-2	-2	-3	-2		-2	-2		-3	-2	-2		-2	-2	-2	-3	-2		-2	-2		-2			-1			-38	
																																					-101	-101
Fauna-Terrestrial																																						0	***Fauna-Terrestrial***
Species diversity												-1		-1	-1	-1	-1													-1									-6	
Rare & endangered species												-1																											-1	
Habitats								-1				-2			-1	-1	-1											-1		-1	-1								-9	
Migration patterns															-1		-1							-1				-1									-1		-5	
Food chains																																						0	
Corridors												-1			-2			-2						-1			-2	-1			-1					-1	-2		-13	
																																					-34	-34

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	Tunneling	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	Undergroud structures	Spills	Road maintenance	Secondary developments by the roadway	Changes in accessibility	Traffic management activities		
Fauna - Aquatic																																						***Fauna - Aquatic***
Species Diversiity																								-1					-1	-1							-3	
Rare & Endangedred												-1																		-1							-2	
Commercial fisheries																																					0	
Food chains												-1																	-1	-1							-3	
Habitats											-1	-1												-1					-1	-1			-1	-1			-7	
Migration Pattern												-1												-1													-2	
																																					-17	***-17***
Flora-Terrestrial																																					0	***Flora-Terrestrial***
Species diversity												-1																		-1							-2	
Rare & Endangered												-1																									-1	
Natural vegetation								-1			-1	-2		-1	-1		-1							-1		-1		-1		-1	-1					-1	-1	-14	
Crops								-1			-1	-2		-1	-1		-1							-1		-1		-1		-1				-1		-1	-1	-14	
																																					-31	-31
Flora - Aquatic																																						***Flora - Aquatic***
Species diversity																								-1					-1								-2	
Rare & Enadangered																																					0	
Natural Vegetation																								-1					-1				-1	-1			-4	
																																					-6	-6

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	Tunneling	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		
Land Use																																						***Land Use***
Residential									-1	-1	-1	-2	-2		-1	-2	-2		-1		-2		-2	-1	-1	-1	-1	-1	1	-2		3	-1	-1	-1	2	2	1	-18	
Commercial											-1	-2	-2		-1	-2	-2		-1		-2		-2	-1	-1		-1	-1	1	-2		3	-1		-1	2	2	1	-14	
Agricultural									-1			-2	-1	-2	-1	-1	-2		-1	-1	-1	-1		-1	-1	-1	-1	-1		-1	-2	1	-1	-1	-1	-1	2		-23	
Wetlands												-1		-1	-1	-1	-1			-1				-1			-1	-1		-1	-2		-1	-1					-14	
Industry												-1	-1		-1	-1	-1				-1		-1		-1		-1		1	-1		3	-1		-1		2		-6	
Recreational uses											-1	-1	-1		-1	-1	-1				-1		-1		-1		-1		1	-1	-1	3			-1	1			-8	
																																						-83	-83
Aesthetics																																						***Aesthetics***
Scenic views & sites										-1	-1	-2	1		-1	-1	-1		-1		-1			-1	-1	-1	-1	-1	1	-2	2	2			1	-1			-10	
Open space qualities											-2	-2	1		-1	-1	-1		-1		-1			-1	-1	-1	-1	-1	-1	-2	1	1			1	-1			-14	
Landscape design											-2	-2	1		-1		-1				-1	1		-1	-1	-1	-1	-1		-2	1								-11	
Unique physical features												-2	-2				-1														-1								-6	
Monuments												-1	-1		-1																								-3	
Appearance of water											-1	-1	-1		-1	-1	-1														-1				-1				-8	
Topographic character													-1		-1	-1	-1			-1		1		-1							-1								-6	
																																						-58	-58
Human Interest																																						0	***Human Interest***
Housing											-1	-1	-2		-1	-2	-2				-2		-1	-1		-1		-1	-1	-1		1				2	2		-12	
Social interactions	-1	-1	-2	-2	-3	-3	-3	-1	-1	-1	-1	-1	-2		-1	-3	-1		-1		-2		-1				-1		1			1				2	2		-26	

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	Tunneling	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		
Cultural patterns/life styles	-1	-1	-1	-1		-2	-2	-1	-1	-1	-2	-1	-2		-1	-1	-1				-1		-1				-1		1	-1		1				2	2		-17	
Health and safety						-2	-2			-2	-2	-1	-2		-1	-2	-2		-2		-1		-2	-1	-1	-1	-1		1	-2		1	-1	1	-1	2	2	2	-20	
Population density										-1	-1																									2	1		1	
Utility networks													-1		-1	-2	-2							-1		-1			1			3			-1	1	1		-3	
Water uses										-1	-1		-1		-1	-1	-1												1			1		-2	-1	1	1		-5	
Historical/ religious/ archeological sites												-1	-2		-1	-2	-1							-1		-1													-9	
Education						-2	-2						-2		-1	-1	-1						-1									3					1		-6	
																																							-97	-97
Economic																																								***Economic***
Land values	-1	-1	-1	-1		-1	-1	-1	-1			1	-1	2		-1	-2				-1	1		-1		-1	-1		1	-1		2				3	3	1	-3	
Employment opportunities										2	2	1	-1	1	1	-1	2	1	1	1		1	1	2	1	-1	2				2	1	-2		2	3	3		25	
Livelihood						-1	-1			1	1	1			1	-1	-1				-1				1											3	3		6	
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	
Regional economic conditions							-2																													3	3		4	

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	Tunneling	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		
National economic conditions																																				3		3	
																																					67	67
Transportation																																							***Transportation***
Transportation/ accessibility/ movement							-2	-1	-1			-1	-1	-1	-1	-1	-1		-1		-2		-2	-1	-1	-1	-1						-1		3	3	-15	
Existing transportation systems								-1									-1		-1		-2		-2	-1	-1	-1									3		-7	
Existing parking facilities																					-1														-1	3	3	4	
Traffic hazards																	-1		-1		-1		-1	-1	-1	-1					2		-1		-2	2	3	-3	
																																					-21	-21

4.1 Impacts on Geology /Soil

The proposed expressway is going on a complicated terrain and hence there is some direct impacts in terms of slope stability after the possible road cuts. During road cuts along the mountainous terrain, there will be a problem on groundwater discharge through the cut slopes. It can affect groundwater stability of the upper slope areas. In addition, rock slides can be expected when road cuts are going on across the escarpment slope of the mountain.

In addition, the proposed road stretch is moving along the landslide dominant zone, especially near to the Kandy district and Galagedara area. There is a significant risk from natural landslide when the construction is going on. It is possible to stabilize natural landslide via groundwater and surface water management and using necessary slope stability techniques. Therefore, it is necessary to follow the given mitigation measures in the section 5.1, in order to protect the prevailing environment. Further, land subsidence can be expected if proposed road is moving around carbonate rocks.

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 moving of soil particles by wind. Also, excavated soils can accumulate in drainage systems 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.

4.1.1. Possible environmental threats due to construction of tunnels

The Section 3 of CEP includes 3 tunnel sections, Tunnel 1 (Ch 15+120 - 15+410 – 290m), Tunnel 2 (Ch 23+430 - 23+630 – 200m) and Tunnel 3 (Ch 27+490 - 27+725 – 235m). The tunnels act as twin tunnels with two lanes for each.

According to the geological observations (See Section 3.2.3.1), all the three tunneling sites have weak geological conditions in terms of rock weathering, groundwater stability and slope stability. Therefore, high levels of vibration could lead to unstable conditions causing fall out of rocks, propagation of cracks across weathered rock layers, triggering of slope instability and also excessive amounts of ground water seepage.

Rock blasting can impact on the nearby rock structure, including the generation of new fractures in previously intact rock, the dilation of existing joints and discontinuities, and the promotion of slip along unfavourably oriented joints and fracture surfaces. The generation of new fractures in previously intact rock and the dilation of existing joints and discontinuities can occur due to high levels of vibration, which can occur 'near-field' that can occur close to the blast zone. In addition, initializing slippage along unfavourably oriented joints can occur as a result of vibration effects and can occur hundreds of metres from the blast.

Unsuccessful blasting which does not achieve its objectives can lead to increased production costs in the form of secondary breakage requirements, loading and removal costs and machine maintenance costs. In order to reduce the likelihood of unsuccessful blasting, some operators in the past have tended to over blast. Over-blasting can create unacceptable instability and permanent damage to the rock mass, together with other structures and utilities within influencing distance of the blast.

In addition, high levels of vibration could cause cracks in nearby structures. High levels of noise can severely disturb the neighbourhood, including the workers.

4.1.2. 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 contaminant can easily mobilize to soil layers due to higher fracture density in paddy lands. According to the general geology of the area, there are no possible locations for land subsidence along the proposed stretch. However, detailed study is necessary prior to the construction of the road.

4.1.3. Impacts due to extraction and transportation of construction material and disposal of soil

Table 4.2. presents a summary of the anticipated impacts during construction phase for some of the activities that involve extraction and transportation of material.

Table 4.2: Anticipated impacts during construction due to extraction and transportation of material

Activity	Factors Affecting Impacts	Remarks
Construction material, exploitation, handling and storage	Improper handling and storage of construction material; e.g. bitumen, 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.	
Spoil disposal	Run-off during rains will deliver debris and sediments, etc.	
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

4.2. Hydrological impacts

4.2.1 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 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. Wash off materials can also deposit in 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 flood plain 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 4.3 gives a list of locations where there is a potential for some impacts during construction stage.

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

Location	Present Land Use	Possible Impact
0+400 to 0+650	Paddy field	Continuity of irrigation water supplies to the paddy fields and drainage from the paddy fields can be disrupted as the water flow down the cascade system can be blocked by the pilot road embankment
0+800 to 1+000		
1+050 to 1+100		
1+600 to 1+700		
2+150 to 2+400		
2+900 to 3+000		
3+600 to 3+700		
3+950 to 4+050		
4+650 to 4+750		
5+400 to 5+450		
5+600 to 5+650		
5+750 to 6+000		
7+150 to 7+250		
7+500 to 8+000	Walgam Oya	Pilot road can encroach into Walgam Oya (stream) and reduce its conveyance and retention capacities.
8+050 to 8+450	Paddy field	Drainage paths through paddy fields into the stream can disturb due to the pilot road.
9+150 to 9+400		

Location	Present Land Use	Possible Impact
10+850 to 11+400	Paddy field	Continuity of irrigation water supplies to the paddy fields and drainage from the paddy fields can be disrupted as the water flow down the cascade system can be blocked by the pilot road embankment. Flood retention area of Bohora Oya and its tributary is also reduced due to the road embankment
11+900 to 12+700	Paddy field	
13+650 to 13+850	Paddy field	
14+100 to 14+700	Paddy field, Bohora Oya	
15+500 to 16+150	Paddy field, Rambukkan Oya	Pilot road embankment can encroach into Rambukkan Oya and Parape Kuda Oya flood plains and reduce the flood retention areas. Further it can block the irrigation water supplies and drainage paths at the paddy fields
16+550 to 17+050	Paddy field, Parape Kuda Oya	
17+050 to 17+550	Parape Kuda Oya	
17+550 to 18+800	Paddy field, Parape Kuda Oya	
18+800 to 19+800	Parape Kuda Oya	
20+900 to 21+250	Paddy field	Continuity of irrigation water supplies to the paddy fields and drainage from the paddy fields can be disrupted as the water flow down the cascade system can be blocked by the pilot road embankment
21+800 to 22+600	Paddy field	
23+650 to 23+750	Paddy field	
23+850 to 23+950	Paddy field	
24+150 to 24+250	Paddy field	
24+550 to 25+550	Paddy field	Continuity of irrigation water supplies to the paddy fields and drainage from the paddy fields can be disrupted as the water flow down the cascade system can be blocked by the pilot road embankment
25+750 to 25+950	Kospothu Oya	Free flow of Kospothu Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
26+200 to 26+300	Kospothu Oya	Free flow of flood can be affected if the pilot road is constructed close to the right boundary of ROW
26+500 to 26+850	Kospothu Oya	Free flow of Kospothu Oya will be disturbed if a bridge with adequate opening size is not provided in pilot road.
27+200 to 28+100	Kospothu Oya	
30+550 to 31+750	Paddy field, Kospothu Oya	

4.2.2. During Operational Stage

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 change and water logging or flooding can occur on the upstream side of the road. Culvert and bridge opening sizes given in the Hydrological Study for the Central Expressway, Section 3 from Pothuhera to Galagedara prepared by SLLRDC (2016), were compared against the design discharges and found to be adequate. However, their use in terms of providing an uninterrupted passage for catchment discharge will cease if they are not placed at the correct position or not aligned properly. Though, the invert levels of the waterway structures are given in the above report, it is important that at the construction stage, the inverts are again matched with ground levels as there can be minor readjustments in the ground levels due to erosion and deposition at waterways during the period leading to the start of the construction. 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 4.4 is a list of locations with possible impacts on the hydrological landscape during operational stage of the project.

Table 4.4: Locations and relevant impacts on surface water hydrology during operational stage

Location	Present Land Use	Possible Impacts
0+400 to 0+650	Paddy field	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.
0+800 to 1+000		
1+050 to 1+100		
1+600 to 1+700		
2+150 to 2+400		
2+900 to 3+000		
3+600 to 3+700		
3+950 to 4+050		
4+650 to 4+750		
5+400 to 5+450		
5+600 to 5+650		
5+750 to 6+000		
7+150 to 7+250		
7+500 to 8+000	Walgam Oya	Expressway is on via duct. Run off from expressway can pollute Walgam Oya.
8+050 to 8+450	Paddy filed	Expressway is on 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.
9+150 to 9+400		

Location	Present Land Use	Possible Impacts
10+850 to 11+400	Paddy field	Proposed road is on an embankment (except for a length of 120m at two critical locations). At some places a significant amount of potential retention areas is reduced due to the embankment. This can raise flood levels.
11+900 to 12+700	Paddy field	
13+650 to 13+850	Paddy field	
14+100 to 14+800	Paddy field	Expressway is on viaduct. No significant impact on the drainage pattern.
15+500 to 16+150	Paddy field, Rambukkan Oya	Expressway is on viaduct for 420m. Run off from the Expressway can reach Rambukkan Oya and pollute the water which is used for drinking and irrigation purposes at downstream reaches.
16+550 to 17+200	Paddy field, Parape Kuda Oya	Parape Kuda Oya is within ROW. Expressway is on viaduct for 330m. Proposed road is on an embankment for the rest, which reduces potential retention area. Existing minor streams and drainage paths into the Oya can be disturbed if culverts are not properly placed. Run off from the Expressway can reach Kuda Oya and pollute the water which is used for drinking and irrigation purposes at downstream reaches.
17+200 to 18+000	Parape Kuda Oya	Propose road is in the same general direction of Parape Kuda Oya. Via ducts are provided for 1390m at locations were the road is on or too close to the stream. Piers of the via duct can disturb the flood flow, but that will not raise the water levels significantly.
18+000 to 18+800	Paddy field, Parape Kuda Oya	
18+800 to 19+900	Parape Kuda Oya	
20+900 to 21+250	Paddy field	Creeks crossing the proposed road will be disturbed if culverts are not kept at the same place where the creeks are.
21+800 to 22+600	Paddy field	Creeks crossing the proposed road will be disturbed if culverts are not kept at the same place where the creeks are.
23+650 to 23+750	Paddy field	Proposed road is on an embankment (except for two via ducts of length 50m). 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.
23+850 to 23+950	Paddy field	
24+150 to 24+250	Paddy field	
24+550 to 25+550	Paddy field	
25+750 to 25+800	Kospothu Oya	A total length of 1183m is on via duct. Free flow of Kospothu Oya will be disturbed if the piers of the via ducts are placed on the stream. Run off from the
26+200 to 26+300	Kospothu Oya	

Location	Present Land Use	Possible Impacts
26+500 to 26+850	Kospothu Oya	Expressway can polute Kospothu Oya which is used for drinking and irrigation at downstream reaches.
30+550 to 31+750	Paddy field, Kospothu Oya	

4.3. Social and Cultural impacts

The proposed expressway from Pothuhara to Galagedara has been designed to be constructed in terms of a principle policy of having a minimum social impacts 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, the unavoidable technical and other requirements of an expressway construction project itself have some social impacts. A team of researchers gathered information on the social impacts of the project and peoples' perception of them. The following sections reveal them.

4.3.1. Social impacts on settlements

The proposed expressway runs through 38 GN Divisions in which there are 7301 households with a population of 26645. Each GN Division consists of 2-3 villages. Accordingly, 97 villages or rural communities would be affected by the project depending on their locations. As was observed in the field studies, all the settlements have deep rooted cultural and social structures evolved in those areas for a considerable period of time since their occupation. Well grown home gardens and the 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.

4.3.2. 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 the 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 relocate. 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 disabled members, members suffering from chronic illnesses, pregnant mothers, who should not be continuously exposed to dust, noise, and other negative impacts of the project activities may require temporary relocation.

Permanent and temporary relocation is a compulsory requirement of the project and it is one of the main concern of the people in the project site. In public consultations with communities, members of the older generation were crying over this issue of relocation on the assumption that they do not have the capacity required for 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 refrain from making the aging parents aware of the project and the

issue of relocations as they may find it difficult to tolerate it. 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 in the air on the project and its destination. 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 other than requiring them to relocate.

4.3.3. Impacts of land acquisition

The Resettlement Action Plan (RAP) had already been prepared for the proposed project and land acquisition, payment of compensations and resettlement would be done in accordance with that. 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 a 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, through a considerable length of it. Even though such a selection of lands save the high lands with human settlements, there is no way to replace the quantity of paddy fields. 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 lands coming under the ownership and control of the Buddhist temples such as Bamba Vihara. They are considered as sacred properties as they had been offered to the Buddha Sasana for exclusive use of Buddhist institutes. However, some lands have been occupied by people for cultivation and residential purposes with 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 lower value for their lands and compensations through a difficult process protracted for years and characterized with bribery and corruption.

4.3.4. 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 38 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 communities and this rigid separation has a negative impact on the economic activities of people as they are compelled by this separation to find new access roads and means of transportation from their

residential places to places of work, markets and other services. Closure of easy access by the expressway may deprive people of their livelihoods by reducing work and business.

The construction work in paddy lands may hamper 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.

4.3.5. Social impact on infrastructure facilities

The project may cause a temporary social nuisance as a result of its impacts in the course of construction on the existing infrastructure facilities such as roads and transport, public utilities, housing and common properties. As the expressway has been designed to traverse through paddy lands, forest land and sparsely populated areas for a considerable length of it, any impact on infrastructure facility remain 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 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, the 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.

4.3.6. 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 lethal impact on inhabitants of 38 GN divisions as well as the work force of the project. Any work without proper precautionary measures has the probability of causing harm to 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 far as the population in the 38 GN Divisions is concerned 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 and 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 would not be taken for granted as the majority of families get drinking water from wells.

4.3.7. Impact 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 on all main roads providing access to work sites of the project

4.3.8. Impact on Culturally, historically and archeologically important places

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

Among the identified properties three (3) properties had been considered as direct impacts as at least part of the property is crossed by the 120 m road corridor. Two (2) properties were identified as having indirect high impacts, six (6) properties with indirect middle level impacts and four (4) properties will have indirect low impact due to expressway construction. Table 4.5 summarises the anticipated impacts on culturally, historically and archeologically important places due to the proposed project.

Table 4.5: Impact on Culturally, historically and archeologically important places

No	Title	Type of the Property	Heritage Category	Coordinates	Chainage & (Side)	Distance	Possible Impact[i] level	Sensitiveness[ii]	Remarks
01	Sri Vijeya Sundarama Rajamaha Viharaya	Buddhist Temple	CHA	07°24'03.3" 080°16'37.2"	01+120 (R)	1.5 Km	Indirect Low	Middle	Sensitive and fragile properties
02	Mayurawathi Rajamaha Viharaya	Buddhist Temple	CHA	07°24'18.3" 080°16'58.0"	01+340 (R)	700 m	Indirect Middle	High	Sensitive and fragile properties
03	Pothgul Viharaya, Lihinigiriya	Buddhist Temple	CH	07°24'26.9" 080°17'18.6"	01+700 (R)	75 m	Direct High	High	Located margin to EW construction pathway
04	Sri Aswaththarama Viharaya	Buddhist Temple	CH	07°23'40.7" 080°19'39.3"	06+500 (L)	670 m	Indirect Middle	Middle	Geo-morphological barriers up to some extend
05	Vivekarama Purana Viharaya	Buddhist Temple	CH	07°22'58.1" 080°19'43.1"	06+940 (R)	550 m	Indirect Middle	Middle	Geo-morphological barriers up to some extend
06	Sri Saranapala Road Viharaya	Buddhist Temple	CH	07°23'31.7" 080°20'09.8"	07+760 (L)	720 m	Indirect Low	Low	EW will be constructed opposite side and geo-morphological barriers up to some extend
07	Sri Negrodarama Senasanaya	Buddhist Temple	C	07°22'50.8" 080°20'11.7"	07+760 (R)	425 m	Indirect Middle	Middle	Lack of geo-morphological barriers
08	Sambudda Mandiraya & Ella Bodiya	Buddhist Temple	C	7°23'27.23" 80°20'27.39"	08+100 (L)	710 m	Indirect Low	Low	EW will be constructed opposite side and geo-morphological barriers
09	Keththarama Viharaya	Buddhist Temple	C	07°23'03.6" 080°21'03.6"	9+220 (L)	265 m	Indirect Middle	Needs to be assessed	EW will be constructed opposite side and geo-morphological barriers up

									to some extend
10	Roadside Statue 01 (Christian)	Christian Statue	C	07°22'36.2" 080°21'27.3"	10+300 (R)	45 m	Direct High	High	Located EW construction pathway
11	Roadside Statue 02 (Christian)	Christian Statue	C	07°22'13.2" 080°21'37.9"	11+060 (R)	60 m	Direct High	High	Located EW construction pathway
12	Church (Maha Palliya)	Christian Church	C H	7°22'4.26" 80°21'38.14"	11+200 (R)	285 m	Indirect High	Needs to be assessed	EW will be constructed opposite side and geo-morphological barriers not prominent
13	Galadenikada Purana Viharaya	Buddhist Temple	C H	07°21'52.1" 080°21'39.1"	11+300 (R)	615 m	Indirect Middle	Needs to be assessed	EW will be constructed opposite side and geo-morphological barriers up to some extend
14	Dambulu Rajamaha Viharaya	Buddhist Temple	C H A	07°21'11.3" 080°21'43.9"	11+660 (R)	1750 m	Indirect Low	Needs to be assessed	EW will be constructed opposite side and geo-morphological barriers prominent
15	Galagedara Mosque	Islamic Mosque	C	07°22'23.0" 080°30'55.1"	31+680 (L)	420 m	Indirect High	Middle	Lack of geo-morphological barriers, close proximity & located same side of EW

[i] Possible impact rating valuation based on the distance from expressway and surrounded nature of geo-morphology
[ii] Sensitiveness rating based on the heritage properties & their attributes and subject to change based on further assessments

Impacts Level

Direct (High) – 3; Indirect High – 2; Indirect Middle – 6; Indirect Low – 4

Sensitiveness

High – 4, Middle – 5; Low – 2; Needs to be assessed – 4

Types

All kinds of Buddhist Temples and Statues – 11; Christian Church and Statues – 3; Islamic Mosques – 1; Other Cultural Monuments – 1

4.4. 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 – Section 3. Potential significant ecological impacts are discussed with reference to terrestrial and aquatic ecosystems.

4.4.1. 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

4.4.1.1. Loss of Natural Habitats and Habitat Fragmentation

A larger proportion of the proposed CEP is located on habitats heavily or moderately modified 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.

Landscape connectivity is the degree to which the landscape facilitates animal movement and other ecological flows. High levels of landscape connectivity occurs 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 an 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.

4.4.1.2. 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.

4.4.1.3. 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.

4.4.1.4. 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 impacts by workers and their camp operations is moderate and restricted to the construction phase only.

4.4.1.5. 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.

4.4.1.6. 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.

4.4.1.7. 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 areas beyond, threatening natural vegetation. These invasive species (plants or animals) may in turn displace native species. Invasive plant species could also spread from construction equipments. 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.

4.4.1.8. Impacts on Animal Movement Paths

There were no permanent terrestrial animal movement pathways observed in the project area. 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. 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.

4.4.1.9. 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

4.4.1.10. 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.

4.4.1.11. 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.

4.4.1.12. 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.

4.4.2. Ecological impacts during the Operational phase

4.4.2.1. 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.

4.4.2.2. 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 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.

4.4.2.3. 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 losses 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.

4.4.2.4. 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 close to forest areas. The nature of this impact is moderate, long term and irreversible.

4.4.2.5. 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 tires, and carbon monoxide emissions from vehicles.

4.4.2.6. 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.

4.4.2.7. 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.

4.5. Impacts on Surface water and groundwater

4.5.1. During construction stage of project

The proposed highway crosses (or passes adjacent to) several rivers, numerous streams, irrigation tanks and some paddy low-lying areas. At locations where the highway passes through paddy fields or above water bodies, the impacts on water quality will be relatively more significant during construction stage than operational stage. Locations such as Rambukkan Oya (15+600 km), Kuda Oya (16+000 km), Kospothu Oya (25+800 km), numerous irrigation canals (there are 83 minor and medium streams and creaks in the project area), and major river basins (the above-mentioned major rivers and their tributaries) where the highway passes adjacent to these tanks, streams and canals are more vulnerable to siltation from surface runoff.

The construction of the proposed highway, interchanges and related facilities, material and machinery yards and storage-related facilities involves 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 affecting 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 wastewater 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.

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.

Human wastes arising from worker camps (during construction), that are not properly treated and are disposed at 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.

4.5.2. 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.

4.6. Air quality, Noise and vibration impacts

4.6.1. Noise and vibration nuisance to nearby settlements and habitats

Estimating expressway noise is a complex process which may require detailed analysis using computer models. However, the following method proposed in other countries e.g. US Federal Highway Association or Federal Expressway Administration, is a general expressway noise estimating method that predicts the equivalent noise level Leq4 (engine/propulsion + tyre noise) and is adequate for most noise assessments for roads in flat or non-hilly terrains. This method has previously been adopted by the University of Moratuwa in Southern Expressway Project funded by the ADB and JBIC.

The advantage of the method is that the Leq is an average noise level and as such is not dependent on the statistic of the traffic flow. In other words, the method is not dependent on the traffic flow pattern (free movement, movement with even spacing, queuing / flowing in clusters) (University of Moratuwa, 2006a, b).

The model developed by the Federal Highway Association or Federal Expressway Administration (FHWA) of the USA presented here calculates a single Leq and it is based on calculating the hourly Leq for automobiles and commercial vehicles (medium and heavy trucks) separately and then adding all these logarithmically to obtain the hourly Leq s as follows (University of Moratuwa, 2006a, b).

$$Leq = Loe + 10 \log (N/ST) + 10 \log (15 / d)^{1+ a} + Ds - 13$$

$$Leq\ (hr)\ total = 10 \log [10^{Leq\ cars/10} + 10^{Leq\ buses/10} + 10^{Leq\ trucks/10}]$$

Where;

Loe = Reference mean energy level for the type of vehicle, found by measurement or published literature (80 dB(A) for trucks, 75 db(A) for cars and 77dB(A) for trucks

N = No of class vehicles passing through Time T. S is the average Speed in km/hr

d is the perpendicular distance in meters, from the centre of the traffic lane to the location of the observer (i.e., the location where the noise level is desired) Ds is the shielding factor such as provided by noise barrier

a is a factor that relates to the absorption characteristics of the ground cover between the road and observer (about 0.5 for moderately absorptive surfaces such as lawns, fields or soft soils)

Results of calculated noise levels at the interchanges for different time horizons are shown in Table 4.6. AWDT values were extracted from the feasibility study prepared by SMEC and Ocyana Consultants (2013) and the EIA team was advised to make use of the AWDT values presented for Scenario 4 - GDP Linked CV Growth (page 169 of the feasibility report: Appendix A;). The present trace is different from the trace depicted in the feasibility study, but it is assumed that the traffic counts are similar to the present trace (in the absence of specific traffic counts for the finalized trace).

Table 4.6 : Noise emissions for the different speeds in 2016

Ambepussa-Devalegama chainage (AWDT is 3480)					
Type of Vehicle	**Speed (km/hr)**				
	70	**80**	**90**	**100**	**120**
Cars and Buses - Leq(hr)	65.7	65.1	64.6	64.2	63.4
Trucks or commercial vehicles - Leq(hr)	65.2	64.7	64.1	63.7	62.9
Total Leq	68. 5	67.9	67.4	66.9	66.1
Devalegama-Rambukkana Chainage (AWDT is 2560)					
Type of Vehicle	**Speed (km/hr)**				
	70	**80**	**90**	**100**	**120**
Cars and Buses - Leq(hr)	64.3	63.8	63.3	62.8	62.0
Trucks or commercial vehicles - Leq(hr)	63.9	63.3	62.8	62.3	61.5
Total Leq	67.1	66.5	66.0	65.6	64.8
Rambukkana-Galagedara Chainage (AWDT is 2580)					
Type of Vehicle	**Speed (km/hr)**				
	70	**80**	**90**	**100**	**120**
Cars and Buses - Leq(hr)	64.5	63.9	63.4	62.9	62.1
Trucks or commercial vehicles - Leq(hr)	63.9	63.4	62.8	62.4	61.6
Total Leq	67.2	66.6	66.1	65.7	64.9

Leq values are calculated considering a distance of 15 m from the centre line, of the traffic , AWDT= Average Weekday Daily Traffic

Table 4.7 : Noise emissions for the different speeds in 2036

Ambepussa-Devalegama chainage (AWDT is 13,530)					
Type of Vehicle	**Speed (km/hr)**				
	70	**80**	**90**	**100**	**120**
Cars and Buses - Leq(hr)	70.8	70.2	69.7	69.3	68.5
Trucks or commercial vehicles - Leq(hr)	71.5	70.9	70.4	69.9	69.2
Total Leq	74.2	73.6	73.1	72.6	71.9
Devalegama-Rambukkana Chainage (AWDT is 10,850)					
Type of Vehicle	**Speed (km/hr)**				
	70	**80**	**90**	**100**	**120**
Cars and Buses - Leq(hr)	69.9	69.3	68.8	68.3	67.5
Trucks or commercial vehicles - Leq(hr)	70.5	69.9	69.5	68.9	68.2
Total Leq	73.2	72.7	72.1	71.7	70.9
Rambukkana-Galagedara Chainage (AWDT is 11,460)					
Type of Vehicle	**Speed (km/hr)**				
	70	**80**	**90**	**100**	**120**
Cars and Buses - Leq(hr)	70.1	69.5	69.0	68.6	67.8
Trucks or commercial vehicles - Leq(hr)	70.8	70.2	69.7	69.2	68.4
Total Leq	73.5	72.9	72.4	71.9	71.1

Leq values are calculated considering a distance of 15 m from the centre line, of the traffic

Basically the results from the model revealed that noise level generation (total Leq) increases with the time horizon due to the increase in the vehicular fleet, hence peak noise values will be in 2036.

Very similar results were noted for the Southern Expressway using the same model (University of Moratuwa, 2006a, b).

Noise levels (Leq) near sensitive receptors like schools, colleges, etc. and in residential areas, are found to be marginally higher than desired levels for the respective land categories with time. Furthermore, it is evident that the projected noise levels exceed the standard values stipulated for low noise areas (Pradeshya Sabah areas; daytime 6 am to 6 pm and night time values 6 pm to 6 am the following day values of 55 dB(A) and 45 db(A), respectively), medium noise areas (i.e., urban and municipal council areas; daytime and night time values of 63 dB(A) and 50 db(A), respectively) and silent zones (daytime and night time values of 50 dB(A) and 45 db(A), respectively) under the National Environmental (Noise Control) Regulations No. 01 of 1996.

All sensitive noise recipients identified (see Table 4.8) will be subjected to high noise in future time horizons. Noise barriers will be needed in future at selected places.

Table 4.8 : Maximum allowable or design noise levels set by the Department of Transportation under Federal Highway Association (FHWA), USA for highway traffic

Land Category as per FHWA (USA)	Leq or L10	Description	Remarks
A	60dB(A) (exterior)	Lands on which serenity and quiet are of extraordinary significance and serve an important public need and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose	Forest patches such as Siyambalagamuwa
B	70 dB(A) (exterior) 55 dB(A) interior	Picnic areas, recreation areas, playgrounds, active sports area, parks, residences, motels, hotels, schools, churches, libraries and hospitals	Example are the 2 interchanges and nearby busy areas. Other areas are, Ambepussa-Kurunegela Road (A6 Road; cross-point), Deyawadiwala-Pitawala Road (N240117 and E156971), Rambukkana-Katupitiya Road intersection, Dombemada-Rambukkana-Kurunegala Road / cross point (N242106 and E153556), Ch 27 + 675 km (Pubbiliya),

Land Category as per FHWA (USA)	Leq or L10	Description	Remarks
			Kotawella Kanishta Vidyalaya (Ch 14+350 km), Parape Maha Vidyalaya with Sri Veediya Sri Maha Pirivena (Ch 17+050 km), Wataraka Maha Vidyalaya (Ch 21+200 km), Galagedara Central College (Ch 31+560 km), Galabawa Maha Vidyalaya (Ch 26 + 200 km) and Kaamawa Dombemada Kanishta Vidyalaya (Ch 8 + 500 km). Also the Galadegera interchange which has 3 hospitals (Bhikshu Wattauwa, Ministry of Health and District Hospital, Galagedara) and Galagedera Magistrates Court Note that the areas surrounding the above schools could be described as silent zones too as per the National Environmental (Noise Control) Regulations No.1 1996
C	75 dB(A) (exterior)	Developed lands, properties or activities not included in A or B	-
D	No Limit	Undeveloped lands	This includes agricultural lands such as paddy fields (example, Ch 2+400 km, Ch 12+100 km, Ch 16+000 km, Ch 25+740 km and Galwetihena paddy fields; N242322 and E152853)

(Source: Weiner and Mathews, 2012)

In addition to traffic noise, pneumatic construction equipment used for maintenance work may generate excessive noise levels, though the affects could be temporary.

4.6.2. Air quality impacts on nearby settlements and habitats

During the operational phase, air pollution caused by transport will be expected to be present in the atmosphere, notably primary pollutants such as NOx, CO and hydrocarbons (HC) and derived or secondary pollutants formed from chemical reactions in the atmosphere (such as photochemical oxidants). Direct emissions are mainly found to come from exhaust pipes, engines, fuel tanks, carburetors, etc.

The current approaches in the field of modeling air pollution from road traffic can be classified into three categories: macroscopic, mesoscopic and microscopic. In a macroscopic model, the traffic is represented as a compressible fluid, and the movement of each vehicle cannot be monitored.

Emissions are usually determined depending on total traffic volume and average speed of traffic flow. Thus, the macroscopic models may not represent, in general, the influence of speed fluctuations. A macroscopic model for estimating emissions from road traffic has been developed by the Transport Research Laboratory (TRL) in Great Britain in 1982. This model will be used to estimate emissions of Stage 3 of the expressway.

The model defines CO emissions as a direct function of average traffic speed and flow and then expresses the emissions of other pollutants (e.g., HC, NOx and Pb) by the volume of CO emissions. The empirical relationship between speed, flow and CO emission is;

$$E(CO) = 1{,}031 \times q \times v^{-0.795} \times 10^{-4}$$

Where;

1. E (CO) volume of CO emissions (g/m)
2. q is the traffic flow per hr
3. v is the average speed

Tables 4.9 and 4.10 show the estimated CO emissions in 2016 and 2036, for selected speeds of 70 km/hr, 100 km/hr and 120 km/hr based on traffic data provided by SMEC International. AWDT values were extracted from the feasibility study prepared by SMEC and Ocyana Consultants (2013) and the EIA team was advised to make use of the AWDT values presented for Scenario 4 - GDP Linked CV Growth (page 169 of the feasibility report: Appendix A). The present trace is different from the trace depicted in the feasibility study, but it is assumed that the traffic counts are similar to the present trace (in the absence of specific traffic counts for the finalized trace)

Table 4.9 : CO emissions for the different speeds in 2016

Interchange	Traffic flow per hr	CO emissions in g at different Speeds (km/hr)		
		70	100	120
Ambepussa- Devalegama	145	0.510	0.384	0.332
Devalegama- Rambukkana	107	0.377	0.284	0.245
Rambukkana- Galagedara	108	0.380	0.286	0.248

Table 4.10 : CO emissions for the different speeds in 2036

Interchange	Traffic flow per hr	CO emissions in g at different Speeds (km/hr)		
		70	100	120
Ambepussa- Devalegama	564	1.98	1.49	1.29
Devalegama- Rambukkana	452	1.59	1.20	1.04
Rambukkana- Galagedara	678	2.39	1.80	1.55

Air to fuel ratio (mixing ratio) has a marked impact on exhaust emissions and the sparking in the engine. Fluctuations in driving mode mean that there are demands being made on the engine and hence emissions will depend on the driving mode. Therefore, at idling conditions, most engines require rich mixtures as combustion products tend to remain in the engine cylinder whereas during lower speeds and deceleration conditions, the closed throttle in the engines causes an increase in the manifold vacuum, resulting in a reduced air intake and exceedingly rich mixtures. Hence in either case, a rich mixture has more than stoichiometric amount of HCs, so the excess unburnt HCs as well as CO will pass out in the exhaust (Baker, 1977; Bunce, 1993; Kularatne, 1999). This is why higher CO levels are evident at lower speeds or during deceleration conditions. However, CO emissions per m travelled increases with time as a response to an increase in the vehicular traffic. Nevertheless, tail pipe dimensions in terms of diameter and length (which depends on the type of engines/HP, etc.) and possible exhaust velocities are needed for further CO predictions and subsequent predictions of NOx and HC based on CO levels obtained as per the TRL model.

In reality, compared with the air quality in Class A and B roads or roads within city limits and other highly urbanized areas where there are heavy traffic congestions, it is expected that the gaseous emissions (CO, NOx) and PM2.5, etc generated by the traffic in the expressway will be less. This is because in the expressway traffic congestions are unlikely and the vehicles would be travelling at a relatively constant velocity (perhaps at higher velocities ≥ 70 km/hr).

4.7. Other potential social and environment impacts

4.7.1. Nuisance to neighborhood

During construction stage of project

The construction stage of the project will need skilled workers including labourers and operators of machinery. The labour requirement, which is estimated at around 2000, will be supervised by supervisors, technical officers and engineers.

It is evident that there will be a demand for labour and the contractor will fulfill this demand by bringing labour from other parts of the country or from other countries. Migrant labour brought in for construction is likely to have different cultural norms. Cultural conflicts may arise due to these differences among the workers and settlers especially near worker camps. Activities such as selling of illicit liquor, poaching and other illegal activities may also increase within the project area causing a nuisance to the neighborhood.

Disposal of labour camp waste is likely to present a public nuisance as there will be an attraction of stray dogs and other animals towards these disposal sites. Dumping of spoil and washing of concrete trucks at road sides of local roads will also be a public nuisance.

Construction of temporary service roads, diversion and closure of sections of local roads will cause the local public to travel a further distance to reach a given point. Local roads may also need to be temporarily closed during the construction hours which will also cause a nuisance to public in the area.

During operational stage of project

The main hindrances that the public in the area will face is the limitation of movement, i.e. the people will have to move through limited access points to move from one side to the other side of the expressway.

4.7.2. Traffic congestion

During construction stage of project

Section 3 of CEP is located within an area with medium traffic. Traffic diversions and making single file traffic will hinder/ obstruct the normal traffic movement along main roads such as Ambepussa – Kurunegala – Trincomalee (A006) Highway, and Katugastota – Puttalama (A010) Highway.

There may be traffic congestions in local roads especially if trucks carrying construction material and debris move on such roads which are mostly narrow roads.

Flag men operated crossings will be placed at locations where the temporary service roads cross national roads. If the traffic along the main road is stopped for a longer time duration (more than 10~15 minutes) it will be a nuisance to the drivers leading to disputes with contractors staff and also economic impact due to transportation delays.

However, this will be a temporary impact which will be significant during construction stage.

During operational stage of project

With operation of the project it is anticipated that the traffic loads on A006, A010 Highways will be reduced, which is a major beneficial impact of the project. There will be a saving in travel time and improved road passenger safety compared to vehicle movement along A006 and A010 Highways. As all feeder roads to the expressway will also be developed to at least two lane condition (and at least up to immediate town centre) there will be no traffic congestions along these roads.

With operation of Section 1,2 and 3 of CEP it is expected that a person travelling from Colombo to Kandy will reach his/ her destination in less than one and half hour.

4.7.3. Impacts on railway line

Proposed Section of CEP will cross railway line of Sri Lanka Railways at Pothuhera. The expressway will be designed to pass over these locations on a viaduct structure.

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.

4.7.4. Health, safety and accidents

During construction stage of project

As a major infrastructure development project it is anticipated that a number of skilled and unskilled labourers will be working at site with heavy machinery and material. Construction activities will be carried out across local roads as well as national roads and over railway lines, at times in the vicinity of live traffic and frequently in close proximity to pedestrians.

Construction activities such as soil excavation, piling, backfilling, embankment work will require operation of heavy machinery. Movement of dump trucks and trucks loaded with material will also be common during the early stages of construction. There is a risk of people and workers getting hit by such machinery which may cause fatal injuries.

Blasting activities along the trace and at quarry sites will also be a potential source of accidents and injury. Use of power tools will also increase the risk of accidents especially to workers. The risk of fire and electrocution should also be considered during a project of this magnitude. Risk of fire and electrocution is significant in labour camps, material and fuel stores.

Exposure of works in to hazardous fumes and flames is another occupational hazard during construction. Falling from heights may also happen if the workers do not use proper safety measures when working at heights above 2 m from ground level.

Exposure to dust, exhaust gases and other fumes will lead to respiratory diseases both in workers and public living close to construction sites. This impact is broadly discussed under impacts of air quality.

As Section 3 of the CEP is located within the wet zone and intermediate zone, the project area will receive rains during most parts of the year which creates the possibility of stagnant water bodies.

Stagnant water (at construction sites such as borehole locations) and domestic waste collected at site (especially in worker camps) may lead to spread of mosquitoes and flies causing vector born diseases to workers and neighbouring communities. Food borne diseases could also be common if the workers do not have proper facilities for cooking and storing of food material. Unhygienic site conditions will also lead to the spread of other domestic pests such as rats and cockroaches.

As a result of increased worker force, there is a possibility of an increase in Sexually Transmitted Diseases (STD) in the area as a significant health impact.

During operational stage of project

Accidents on the expressway will be the most significant impact on health, safety and accidents during the operational stage of the project. However, fencing off of the ROW will prevent people, livestock and wild animals moving in to the expressway.

The proposed expressway will provide a high quality, well designed closed environment for high speed travel. Compared to the existing travel arrangements, the proposed expressway will provide a significant improvement on general road user safety.

It is possible that with better pavement conditions, drivers travelling along the expressway may try to travel at speeds much higher than the operational speed of the expressway increasing the potential of high speed vehicle accidents. Another contributory factor for the potential risk of accidents is the road worthiness of vehicles that will move on the expressway.

CHAPTER 5: PROPOSED MITIGATION MEASURES

5.1 Proposed mitigation measures for the impacts on Geology ad Soil

- It is necessary to investigate subsurface geological conditions by drilling. The drilling would be done up to the possible basement rock of the area under the guidance of geologist and geotechnical engineer.
- Detail surface geological and structural geological mapping is necessary before construction of tunnel. Tunnel mapping would be done during the tunneling in order to identify the weaker zones.
- Different types of tunneling possibilities would be reviewed after the subsurface investigation of the area.
- Possible tunnel constriction would minimize earth vibrations in order to protect the building structures, surface slope failures and land subsidence.
- According to filed observations it can be noted that most of the sections of the proposed tunnels will be constructed through the soft ground. Therefore, before any tunneling, in order to maintain groundwater stability, the soft ground will be hardened by applying proper cement grouting. Also, in order to maintain groundwater stability tunnel casing will be done and alignment of tunnels would be done under supervision.
- In addition, during the tunneling surface soil failures can be expected. Therefore suitable slope stability methods would be applied prior to tunneling along the weaker areas.
- Further, tunneling can be avoided by shifting the proposed road. Especially around the proposed tunnel 2, there is an isolated hill which will be avoided by slightly shifting the proposed road.
- Tunnel construction can temporarily have an impact on the vegetative cover along the tunnel axis. The prevailing groundwater stability of the area will be maintained.
- There are no simple ways of reducing the PPV during the excavation phase of the tunnels. Reducing the cutter head speed of a TBM, or reducing the thrust on the face may reduce vibration, but impacts of vibration will be strictly monitored.
- According to suggestions given by the National Building Research Organization (NBRO) and Geological Surveys and Mines Bureau (GSMB), detail geological and structural mapping and geotechnical investigations shall be done for the selected sensitive areas.
- According to the suggestions given by the NBRO suspected landslide locations along the proposed road shall be studied using landslide hazard zone map of NBRO. Necessary recommendations given by the NBRO under request made by RDA would be incorporated at the final designing stage.
- Detail designing will be done by the constructor and detailed geology and geotechnical investigations would be conducted around possible road cuts, tunneling and suspected landslide area prior to the detail designing.
- Monitoring shall be done by RDA during and after construction around critical locations with the help of team of experts in NBRO, GSMB and other institutions in the country.
- Most of the proposed road cuts are going through the toe of the mountain slope. Therefore, it is necessary to implement slope stability methods.
- According to suggestions of NBRO and GSMB, slope stability shall start from the upper regions of the slope towards the toe area prior to the road cuts. An appropriate slope stability method shall be designed after detailed geotechnical study.
- The most suitable slope stability methods will be selected according to experts opinions based on geotechnical investigations. Both high risk possible natural landslide locations and every road cuts will be studied for slope stability during the constriction.
- It is recommended to continuous monitoring of the stabilized slopes periodically for the certain period of time, especially, during the rainy season. Necessary suggestions from NBRO and GSMB will be incorporated for the monitoring process.

- Rock basting during the construction will also impact on surrounded slope stability. Therefore, during the rock blasting GSMB recommendations will be followed.
- Geological cross-sections shall be constructed where necessary along the proposed road stretch and structurally weaker zones shall be studied by the team of experts.
- Tunnel mapping shall be done during the construction stage of the tunnels along the proposed road under the guidance of a team of experts in the relevant field.
- Rock blasting around the possible road cuts and tunneling areas shall be done under the guidance of GSMB. Blasting shall be controlled by the constructor according to the GSMB suggestions.
- Evacuation plan shall be constructed with the guidance of NBRO and GSMB around the proposed tunneling and steep road cuts. It is recommended to evacuate all the people living on the upper slopes of the tunneling areas.
- Monitoring of groundwater pressure and water table fluctuations around the tunneling location is necessary prior to the constructions. piezo-meters shall be installed around the selected locations along the proposed road in order to investigate prevailing conditions in groundwater.
- Monitoring of groundwater pressure shall be done along the slopes around the tunneling axis and along the narrow valleys around the proposed tunnels as well.
- Monitoring of groundwater pressure shall be done during both dry and rainy seasons and variations of groundwater table shall be recorded prior to the construction. In addition, groundwater pressure monitoring using piezo-meters will be done around the significantly higher slope cut areas along the proposed road.
- According to the piezo-meters readings and other information aquifer conditions around the proposed road shall be studied. Based on that, prevailing stability of the aquifer shall be analyzed and possible impacts of them from proposed construction shall be investigated.
- In general, possible environmental threats on regional aquifers and possible kast aquifer conditions shall be investigated in detail.

5.2 Proposed mitigation measures for the hydrological impacts

5.2.1. During Construction Stage

1. Pilot road will have temporary culverts, bridges and an embankment designed for floods with 2 or 5 year return periods (depending on the severity of the flood). Therefore, if the 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.

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 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 irrigation and drainage canals/paths will be kept across the construction area so that the farming outside the ROW is not disturbed. Consent of the relevant irrigation engineer and/or the agrarian services officer and the farm organization will be obtained when there is any construction across these canals.

5.2.1. During Operational Stage:

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 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 can be achieved through the design. Hydraulic model test results and the other analysis shown in the Hydrological Study Report, Central Expressway - Section 3, Pothuhera to Galagedara, SLLRDC (2016), confirm that the road finish level is kept above the 100 year flood level plus the free board.

3. Opening sizes of bridges and culverts will be kept large enough to freely pass the flood flow to the other side of the road without any additional efflux. No excess efflux or constriction is shown in the Hydrological Study Report, Central Expressway - Section 3, Pothuhera to Galagedara, SLLRDC (2016), at any of the proposed waterway structures.

4. To avoid water collecting 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.

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. Therefore, viaducts will be constructed at the locations where the road embankment encroaches into a stream.

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. To avoid collection of water in and around the proposed road, all road surface drainage paths, chutes through cut slopes, chutes down the embankment, drains from centre median drains, toe drains etc. will be properly maintained.

8. 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.

9. Loss of retention areas due to embankment will be avoided if that leads to an increase in flood levels. At sections, 10+850 km to 11+400 km, 11+900 km to 12+700 km, 13+650 km to 13+850 km and 14+100 km to 14+700 km, retention areas are significantly reduced. However, these paddy fields are on relatively steep terrain and there is no record of past floods. Therefore there is no significant impact due to the reduction of potential retention areas.

5.3. Proposed mitigation measures for the Social, cultural impacts

Mitigation of social impacts is an extremely important component of this project which requires an acquisition of considerable acreage of lands occupied by people and institutions. Over 1162.5 Acres of land occupied by 2069 householders are to be affected requiring permanent relocation for 857 of them. Around 707 households, 35 businesses and 1303 farmland owners are among the total number of project affected householders. A population of 8465 people of those households will be affected by the project. As the

proposed expressway is constructed for the benefit of the nation as a whole, those national objectives need to be achieved but with due restoration of affected local communities, their means of sustenance and well-being.

The meaning of good governance ultimately lies in the well-being of all the communities and not in the well-being of some people at the cost of others, particularly the PAPs. This factor was emphasized by almost all the community members in the public consultation and social surveys, while acknowledging the national need of such a gigantic project for the development of the country. All of them were 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 compeled 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 mitigation tasks as agreed upon with them. It is with due recognition of peoples' perception of the impacts of the project and their plight that all the mitigations measures are designed.

5.3.1. 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, impelled to reconsider the influential sections of the road design allowing them to continue their residential, religious and commercial tasks unabated.

While being responsive to all such requirements, the project reconsidered all the questionable sections of the proposed expressway and thereby mitigated the adverse impacts to the fullest possible extent. Such alterations in the road design as well as difficulties of addressing such requirements would be properly conveyed to the relevant people in terms of technical aspect of the project design to avoid public misunderstanding of any change in it. As was apparent in the field surveys, people had heard rumors that road destinations will be altered in response to desires of influential politicians. Such public misunderstandings indicated 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 the viable amendments to the proposed road design, it is still required to adopt measures for mitigating the inevitable negative social impacts of it 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.1585/7 on 20 January 2009, Land Development Ordinance of 1935, State Land Ordinance No. 8 of 1947, Prescriptive Ordinance No.22 (1871), Road Development Authority Act No.73 of 1981, National Environmental Act No.47 of 1980 and subsequent amended Act No.56 of 1988 and the National Involuntary Resettlement Policy of Sri Lanka(NIRP), Gazette Notification No.858/14 of 23February 1995, Forest Ordinance, Poor Law Ordinance No. 30 of 1939, Paddy Land Act No.01 of 1959, Agrarian Services Act of 1979, Labor laws, laws pertaining to women, children and youth, and Mahawali Authority of Sri Lanka Act No.23 of 1979 were referred to assure the maximum justice for the project affected people.

As far as 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 Policy

Statement of the Asian Development Bank. Accordingly, the Project Executing Agency- the road Development Authority of Sri Lanka (RDA) is held responsible for adopting a Grievance Redress Mechanism implemented through Grievance Redress Committees (GRC) comprised of relevant and prescribed stakeholders. The Project Management Unit (PMU) of the RDA functions as the key organ of supervising the overall implementation of the project, evaluation and monitoring. Gender parity is specially emphasized as a universal policy of making decisions pertaining the grievance redress mechanism of the project.

5.3.2. Mitigation of impacts of relocation of families

Relocation of families and institutions is one of 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 857 households and institutions, and temporary relocation of over 115 households.

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 Project Management Unit, prepared a comprehensive Resettlement Action Plan (RAP) for both permanent and temporary relocation of families and institutions. The RAP addresses all the issues of resettlement of displaced families and institutions and prescribe all necessary measures of mitigating the social impacts and provision of compensation.

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 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 would be taken into account for safeguarding their future by means of the grievance redress mechanism. A family centered compensation payment system would 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 of their communities. Therefore, resettlement lands located in or in the vicinity of the original residential places were identified and acquired for constructing new houses and other institutions and such resettlements would facilitate continuation of existing socio-economic relations and other businesses less interrupted by the project. 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) would be completed before the commencement of the construction activities. The RDA would make all efforts possible to convince 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 would be properly addressed as evacuation of properties they enjoyed generation after generation is a highly sensitive phenomenon. Even after compensating for all assets belonging to them, they would 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 would be addressed in the RAP with special reference to the period of such displacements in terms of the order of the construction tasks and project requirements analyzed from the perspective of public safety and the safeguarding of livelihoods. Therefore the PAPs will

be informed in advance of 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 would 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 would be specially taken into account and measures would be adopted to assure the proper accomplishments of such needs in both temporary and permanent resettlement processes. Resettlement of these categories of PAPs needs special attention of the project proponent as some of them are not strong enough to carry out resettlement work or 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 would assure all the PAPs a better life compared to that 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 would be developed in all the resettlements and maintained with due attention of the relevant authorities.

5.3.3. Mitigation of Impacts of land acquisition

The residential and agricultural lands in the project affected area remain scare, 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 would 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 would be carried out according to a well-designed plan of land requirement of the project and only the exact quantity of land would be acquired after proper demarcation of boundaries and a legal document of the acquired land with an approved plan would be provided to the land owners. Furthermore, all such land owner would 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 would assure the protection of the remaining portions of the lands acquired for the project. In particular, construction work in the acquired portions of lands, may cause soil erosion, land slips, inundation, sludge concentration, diversion of water streams, land cracks and unexpected disasters in the remaining portions of lands, unless precautionary measures are taken simultaneously. Such project caused problems may have an adverse impact on the people living in the remaining portions of lands. The project is responsible for such damages and accidents and compensation would be paid for people suffered from them. The following policy principles will be prescribed for granting compensations in terms of the RAP of the project

5.3.3.3. 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 would be paid as the cost of replacement. Replacement cost will be paid for all buildings irrespective of their age and the PAPs would be allowed to retain the salvaged materials. Those who had wattle and daub (Katumati) shelters or cadjan thatched huts would also be entitled to a cash grant for the loss of shelters in addition to other compensations they are entitled for.

5.3.3.4. 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. and in such cases lands would 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 would 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.

5.3.3.5. Determination of rates for properties acquired

Prevailing market rates of relevant properties will 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) and the World Bank Involuntary Resettlement Policy (WB-IRP), make it mandatory to grant an amount of compensation that is sufficient to replace the lost assets of PAPs. Therefore the project will pay due attention to these and other guidelines of GRM in determining the relevant rates.

5.3.3.6. Special needs of vulnerable households

As mentioned in the 5.2.6 section, the vulnerable households with special needs consists of women headed families, families with elderly persons, differently abled persons, people below the poverty line and people without legal ownership for properties. They are entitled to obtain a special grant of Rs. 15000 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 the benefit of them in the process of resettlement. Furthermore, the PMU will work with national level institutions at the DSD level that provide institutional support the well-being of such PAPs.

5.3.3.7. 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 areas acquired. 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 deprives 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 would be paid a part of the compensation.

5.3.3.8. 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.

5.3.4. Mitigation of Impacts on livelihood

Acquisition of farm lands, home gardens, arable lands, lands used for industrial, business and services and certain construction work requirement have an adverse impact on the livelihoods of affected individuals and families. Restoration of their livelihoods is one of the most important mitigation measures that the project would adopt with special attention to the poor families and various types of economic dependents. Food security of the affected people would 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 would attempt to find temporary and long lasting means of income for the PAPs.

As replacement of paddy lands with similar lands in another area is impossible, the project would attempt to provide them with alternative means of employments such as profitable self-employments and vocational training for younger generation of PAPs. Agricultural skills of the PAPs may be further useful for the cultivation of commercial crops on high lands. Therefore, arable high lands (such State Lands) in or in

the adjacent area of the project would be identified and distributed among those who want to continue their agricultural means of living and also who find it difficult to adapt to a new means of livelihood. Proper assistance and financial support for the cultivation of home gardens of newly resettled families would be conducive to replace the loss of home garden crops within a few years. This suggestion would not be taken for granted as home garden crops constitute a considerable portion of the economic backbone of rural peasant communities.

The project would 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 would be a condition of employing people in the construction of the expressway and the PMU would 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 would be employed as a measure of mitigating negative economic impacts of the project.

Prolonged temporary relocation may also be conducive to 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 would consider ways and means of protecting the livelihoods of people relocated for a particular period of time.

5.3.5. 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, drainage systems may be affected by construction works of the project. The PMU would identify all the possible locations of breakdowns in all the infrastructure systems and precautionary measures as well as remedial measures would be adopted in advance. Construction work in the paddy lands will affect the irrigation canals disturbing the smooth supply of water for the fields fed by them. Unexpected inundation may also be caused by soil dumping, excavation and land filling. Until the restoration of irrigation canals after construction of the road, a temporary alternative water supply system would be constructed in affected paddy lands and their proper functioning will be regularly maintained with the assistance of authorities legally responsible for the administration of them.

Adverse impacts on the public roads and all the other access roads would be mitigated by regular maintenance with renovations and restorations. The project would be held responsible for any damage caused by the transport of materials and other construction works. Use of main roads and other access roads would 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 would 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 impacts on residents and other institutions. Uninterrupted power supply in the course of construction would be assured by the PMU in consultation with and 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.

5.3.6. Mitigation of Impacts on public safety and health

Mitigations measures are required to assure public safety and health in both construction and operation periods of the proposed expressway. Long term security measures would be adopted in all the vulnerable points and sections of the expressway including the sections running through areas with high population density, potential areas having a high 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 would be controlled in terms of clearly stipulated security guidelines prescribed by the PMU. All the contractors and work forces would 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 would be paid to prevent HIV/AIDS and other types of diseases in areas where there would be such vulnerabilities. Prevention of dengue fever would 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 would 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 people living in outside locations supplying materials, processing of materials, storing of materials, would 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 would 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 would be specially taken into account with proper precautionary measures. Drastic impacts of deep cuts of the project site and land filings on the availability of well-water would also be mitigated with alternative means such as tube wells and pipe born water supply. Until such measures are adopted regular water requirements of people would be met with water carried from outside the project.

Disposal of garbage and industrial waste would be carried out using a proper mechanism 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 would be carried out after taking precautionary measures. People in the area or communities including children and women at homes in particular, would 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.

5.3.7. 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.

5.4. Proposed mitigation measures for the Ecological Impacts

5.4.1. Mitigation of Ecological impacts during the Construction phase

5.4.1.1. Loss of Natural Habitats, Habitat Fragmentation and obstructions for Animal Movement

The detail design would minimise the impacts 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

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 5.1). 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.

Figure 5.1: 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 5.2). Tunnels or 'eco-pipes' are typically round pipes of relatively small diameter (e.g. < 1.5 meters diameter).

Figure 5.2: Bridge underpasses and culverts designed to facilitate animal movement

5.4.1.2. 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.

5.4.1.3. 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.

5.4.1.4. 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. Such waste will not be released untreated into the environment and water bodies under any circumstances. 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.

5.4.1.5. 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 would 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.

5.4.1.6. 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.

5.4.1.7. 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.

5.4.1.8. 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 Endemic 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

5.4.1.9. 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.

5.4.1.10. 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.

5.4.1.11. 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.

5.4.2. Mitigation of Ecological impacts during the Operational phase

5.4.2.1. Road kills

Reducing animal access to roads: Meshed fences of at least 2 m height can be used throughout to cover most of the places. At interchange points, measures 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 on 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 cases 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, design given in figure 5.3 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 5.3 below

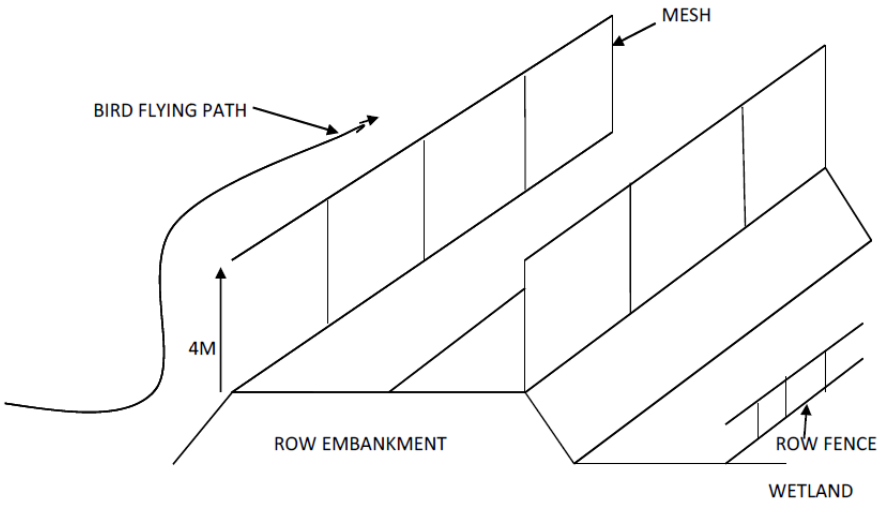


Figure 5.3: A sketch showing a bird flying pathway diversion structure

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

It is difficult to impose any development restrictions on private lands. However on state lands a minimum reservation on either side of the road shall be kept intact.

5.4.2.4. 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.

5.4.2.5. 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).

5.4.2.6. 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.

5.4.2.7. 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 determine the types of birds, butterflies, and other fauna, inhabiting the site (garden) after construction. Low maintenance native plant species will be used wherever possible.

5.5 Mitigatory Measures for Surface water and groundwater pollution

5.5.1. Measures to minimise the impacts of land clearing and pollution of Surface Waterways

The following measures are recommended;

1) Land clearing, cut/fill operations excavations, and bridge construction works will be done during the dry weather conditions. The monthly rainfall patterns in the Project Area (at least for the last 5-10 years) will be studied using data available from the Department of Meteorology (nearest station) to plan the construction schedule.

2) Placement of silt fences11 (Figure 5-12) will be done along the road sides that are surrounded by low lying areas such as paddy fields or waterways (e.g. Ch 17+000 to Ch 17+200 km, Ch 18+650 to 18+950 km & Ch 18+750 to Ch 19+150 km of the Kuda Oya and Wataraka Moratuwa at Ch 21+200 km). The contained sediments will be regularly removed and disposed as a fill material or used as backfill material.

3) Land clearing debris and CD wastes, fill material and quarry muck will not be stored close to waterways and areas subjected to inundation (e.g. paddy areas).

4) Spoil or land clearing debris will be used to rehabilitate quarry sites and borrow areas

5) During site clearing and excavation of any banks for the construction of bridge abutments, it will be ensured that the containment bunds / coffer dams are incorporated into the excavation areas and these are regularly checked and well maintained to prevent the downstream migration of contained sediments.

6) Any downstream users of the waterways will be identified and if such users are present they will be advised to temporarily stop using water, providing them with an alternative water supply. Where possible, the pollution of rivers will be avoided with the implementation of mitigation measures.

7) Cofferdams and silt curtains are needed in the following waterways where bridges would be constructed over waterways e.g. :

*) Rambukkana Oya (Ch 15+830 to Ch 16+060 km, Ch 16 + 900 km, Ch 25+740 km and Ch 30+200 km)

Kuda Oya (Ch 18 + 000 km, Ch 18+700 to Ch 18+800 km & Ch 18+750 to 19 +150 km)

• Any banks that have been damaged during construction will be rehabilitated by suitable measures such as rubble packing or the construction of concrete retaining walls with weep holes, or gabion walls. Detailed Method Statements would be prepared to provide specific / precise recommendations

• The topsoil from cut and fill operations will be preserved at identified locations with the provision of watering /grass development on the stockpile surface to prevent air pollution. The embankment will be designed above High Flood Level (HFL) wherever the area is prone to flooding.

- The use of pesticides (weedicides) for any weed clearing work will be avoided.

• Vehicle washing will be undertaken on paved locations with draining water collected into settlement/treatment ponds before release. Alternately, vehicle/machinery and equipment serving and maintenance works will be carried out only in designated locations such as outside service stations.

5.5.2. Construction Demolition Waste (CD Waste) Management and Oil Spill Management

CD waste and oil spill management will be necessary in order to manage pollution. Relevant aspects are discussed in the EMP.

5.6. Mitigatory Measures for Air quality, Noise and vibration impacts

5.6.1. Migratory measures due to impacts on Air quality, noise and vibration

Strict mitigation measures will not be needed for air and water quality deterioration during the pre-construction stage. Baseline measurements of air, noise, vibration and water quality will be carried out prior to commencement of construction.

Where there are nearby structures (at least < 500 m or as determined by the Engineer /CEA/GSMB), dilapidation surveys and pre-construction monitoring of vibration frequencies (Hz) and PPVs has to be undertaken by the Contractor/s surveys will be conducted throughout the trace with a special emphasis on the following mentioned location;

- 2 interchanges and areas nearby
- Rambukkana Oya (Ch 15+830 to Ch 16+060 km, Ch 16 + 900 km and Ch 30+200 km)
- Kuda Oya (Ch 18 + 000 km, Ch 18+700 to Ch 18+800 km & Ch 18+750 to 19 +150 km)
- Ambepussa-Kurunegela Road (A6 Road; cross-point / Ch 5 km)
- Deyawadiwala-Pitawala Road intersection (13+075km)
- Rambukkana-Katupitiya Road intersection (14+375km)
- Dombemada-Rambukkana-Kurunegala Road / cross point (6+900km)
- Ch 27 + 675 km (Pubbiliya)
- Ch 13+900 km
- Kaamawa Dombemada Kanishta Vidyalaya (Ch 8 + 500 km)
- Kotawella Kanishta Vidyalaya (Ch 14+350 km)
- Parape Maha Vidyalaya with Sri Veediya Sri Maha Pirivena (Ch 17+050 km)
- Wataraka Maha Vidyalaya (Ch 21+200 km)
- Ch 7 + 940 km
- Galagedara Central College (Ch 31+560 km)
- Galabawa Maha Vidyalaya (Ch 26 + 200 km)
- Sri Valukaramaya temple at Ch 18 + 000 km

RDA will discuss the results of the dilapidation studies with the CEA and GSMB for further suggestions. Reports will be detailed outlining the civil engineering details such as number of storeys, construction material used for the buildings, proximity to the Project Site, GPS locations and cracks and fissures (length and width) with dated photographic evidence.

5.6.2. Specific Measures for Borrow areas and Quarry sites

Borrow areas and the quarry sites have yet to be identified by the Contractor/s, though a few areas which are under operation at present would be utilised (e.g. borrow areas at Ch 29+900 km and Ch 24+280 km). Another potential site is a quarry at Ch 7+940 km). These identified sites may require separate detailed investigations (environmental assessments) including preparation of site specific EMPs and EMoPs which need to be done after evaluation of Contractor's Method Statements and Environmental Compliance Plans (ECPs).

However, the following measures will be implemented by the Contractor under the supervision of the RDA and CEA and GSMB for all borrow areas and quarry sites:

- Clearing of vegetation cover in borrow areas and quarry sites will be minimised to avoid erosion. At each borrow area and quarry site the stripped vegetative topsoil will be piled and re-spread to reinstate land cover.
- Borrowing of earth and quarrying of rock material for construction activities will be undertaken at approved sites only. These sites will be located far away from water bodies in order to avoid impacts on water quality problems during rainy periods. These sites will also be located far away from residential areas to avoid disturbing residents with high noise and vibration levels.
- Land used to acquire fill material will be cut into profiles of flat surfaces leaving no over burden. After borrowing, the slope/gradient of the area will be graded to match or blend with existing contours. The edges of pits will be re-sloped to allow any fallen animals to escape.
- Potential borrow and quarry sites in locations prone to landslides will be avoided during rainy periods (NBRO's assistance will be obtained to identify landslide prone areas).
- A high visibility fence which is easily visible to animals around the pits to discourage animals wandering into the area will be avoided.
- The area will be planted with native trees. Thatching of exposed soil areas with dead or live vegetation or with any stripped native vegetation will be done to reduce the generation of surface run-off during rainy periods.
- Rehabilitation plans will be provided by the contractor to the Monitoring Committee. Progress will be documented periodically with dated photographs to show the changes.

5.6.2.2 Noise and vibration nuisance to nearby settlements and habitats Noise and Vibration control

Following measures are recommended to mitigate potential noise and vibration impacts. These measures will be made applicable to the entire project Site including access roads, all burrow pits, all quarry sites and batching plants, quarries and rock crushing plants.

• There will not be night time works. If that is not possible, the community will be informed in residential areas (applicable to areas where residential areas occur – example, interchanges especially Galagedara, Deyawadiwala-Pitawala Road, Rambukkana-Katupitiya Road intersection, Dombemada-Rambukkana-Kurunegala Road / cross point, Ambepussa-Kurunegela Road (A6 Road; cross-point) & Ch 27 + 675 km (Pubbiliya) and residential areas in the vicinity of the schools) in advance regarding the necessity of doing construction works during night time.

• All machinery and equipment will be well maintained and they will have noise reduction devices such as exhaust silencers.

• At locations where there are schools (Kotawella Kanishta Vidyalaya Ch 14+350 km, Parape Maha Vidyalaya - Ch 17+050 km, Wataraka Maha Vidyalaya - Ch 21+200 km, Galagedara Central College - Ch 31+560 km, Kaamawa Dombemada Kanishta Vidyalaya (Ch 8 + 500 km) & Galabawa Maha Vidyalaya - Ch 26 + 200 km) construction activities will be conducted only after the school hours and during weekends/holidays.

• When sheet piling is undertaken vibratory hammers will be used rather than drop hammers. This is applicable to areas where there are residential areas (e.g. the 2 interchanges, Rambukkana Oya (Ch 15+830 to Ch 16+060 km, Ch 16 + 900 km and Ch 30+200 km), Kuda Oya (Ch 18 + 000 km, Ch 18+700 to Ch 18+800 km & Ch 18+750 to 19 +150 km), Ch 37 +970 km, Ambepussa-Kurunegela Road (A6 Road; cross-point), Deyawadiwala-Pitawala Road intersection (N240117 & E156971), Rambukkana-Katupitiya Road intersection, Dombemada- Rambukkana-Kurunegala Road / cross point, Ch 27 + 675 km (Pubbiliya), Kotawella Kanishta Vidyalaya (Ch 14+350 km), Parape Maha Vidyalaya with Sri Veediya Sri Maha Pirivena (Ch 17+050 km), Ch 13+900 km, Kaamawa Dombemada Kanishta Vidyalaya (Ch 8 + 500 km), Wataraka

Maha Vidyalaya (Ch 21+200 km), Galagedara Central College (Ch 31+560 km), Galabawa Maha Vidyalaya (Ch 26 + 200 km) and temple at Ch 24 + 975 km).

• Dilapidation surveys will be conducted of the nearest infrastructure (at least 500 m from the expressway or as decided by the Project Engineer / CEA) in areas where these sensitive recipients occur. The pre-construction frequency of vibration and Peak Particle Velocities (PPVs) will be monitored. Reasonable compensation will be given by the Contractor for genuine vibration induced damages (e.g. due to heavy traffic caused by tippers). The Contractor will maintain a Complaints and Public Grievances Log Book that will be easily accessible to the public.

• Necessary Personal Protective Equipment (PPE) (ear plugs or muffs with hard hats/helmets) will be given to the workforce involved in noisy activities such as rock blasting. Ear plugs will be used when noise levels are between 80 dB (A) and 90 dB(A), but ear muffs if levels are 90-110 dB (A) and both ear plugs and ear muffs when levels exceed 110 dB (i.e. when engaged in impulsive noise generating works if any).

• The vehicles to be used for the construction phase will be regularly well maintained to avoid generation of significant noise levels. Wherever possible attempts will be made to make use of low noise generating machinery.

• Traffic management practices such as use of vehicles in good condition, conducting material transportation will be implemented during the transport of materials, including quarry material in order to reduce traffic noise.

• With reference to the siting of asphalt, metal crushing and concrete plants, proper site planning together with noise abatement measures will be practiced to reduce air-borne noise transmission. Such facilities will be located 500m upwind and 100m downwind of sensitive receptors (e.g. residential areas and schools).

5.6.1.1 Designing of noise barriers

RDA will design permanent noise barriers with required heights along the sides of the trace facing the Kotawella Kanishta Vidyalaya (Ch 14+350 km), Parape Maha Vidyalaya with Sri Veediya Sri Maha Pirivena (Ch 17+050 km), Wataraka Maha Vidyalaya (Ch 21+200 km), Galagedara Central College (Ch 31+560 km), Kaamawa Dombemada Kanishta Vidyalaya (Ch 8 + 500 km), Galabawa Maha Vidyalaya (Ch 26 + 200 km) and the Galagedara interchange area such that the 3 hospitals namely Bhikshu Wattauwa, Ministry of Health and District Hospital , Galagedara and Galagedera Magistrates Court are shielded from traffic noise. This will be included in the Contractor's documents (Tender Documents). These noise barriers will be permanent structures that will be constructed at the time of constructing the highway. Therefore, these structures will be considered during the detailed designing stage. Further the noise barrier locations shall be finalized during the construction stage after considering the noise modeling developed for the road section. Total Noise barriers length (both Side) along the Expressway shall be around 4250m.

5.6.2.3 Air quality due to impacts on nearby settlements and habitats

Measures to minimise ambient air quality deterioration

The following mitigation measures will be implemented during construction. These mitigation measures are applicable to the entire project site including access roads, all borrow pits, all quarry sites and batching plants, quarries and rock crushing plants.

- All vehicles delivering construction material that could generate dust (e.g. fill material, cement and aggregates) and taking away CD wastes will be covered with tarpaulin sheets to avoid spills.
- Speed limits of 5-10 km/hr will be maintained within the Project area to ensure worker and community safety. Speed limit signboards will be erected at regular intervals on the sub roads. The drivers would be made aware of such speed limits. Transport through more populated areas will also be avoided especially during peak traffic times.

- Frequent sprinkling of water on exposed earth surfaces and unpaved access roads will be undertaken when dust plumes are likely or when surfaces are dried. Adequate water will be provided at the site for dust suppression.
- The workforce will be provided with protective working gear such as dust masks, eye goggles, safety helmets and boots.
- Any equipment (e.g. cement mixers) that could generate dust will also be located downwind of any habitation areas or away from inhabited areas and other sensitive receivers such as schools and temples.
- Assembly, operation and dismantling of plants, machinery and equipment will be handled in such a way so as to minimise the generation of dust.
- Construction vehicles and machinery will be regularly maintained and serviced to minimise air pollutants such as $PM_{2.5}$.
- Construction material stockpiles, spoil and any land clearing debris will be well covered at all times.

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 stated in chapter 4. 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. RDA is responsible for implementing the EMP in the construction Period. The construction contractor would be bound to implement the EMP during the construction period on behalf of RDA.

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 will 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 RDA through the selected 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 PMU is equipped with dedicated staff for safeguard compliance which consist of Environment Social Safeguard officer and his assistants. 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. Contractor will conduct environmental monitoring associated with the construction, after that the contractor shall report them to the PMU (Project Management Unit).

6.6. Reporting

Monthly reports shall be submitted to the PMU, who will then submit them to ESDD for checking. The ESDD shall submit the reports to CEA/ NWP-EA. Reports will be sent monthly.

CHAPTER 7: EXTENDED COST BENEFIT ANALYSIS

7.1. Introduction

7.1.1. 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.

7.2. 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

7.2. 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.
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).

7.3. Decision Criteria

The three decision criteria considered in the ECBA were:

- Net Present Value (NPV)
- Benefit Cost Ratio (BCR)
- Internal Rate of Return (IRR)

7.3.1. 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

7.3.2. 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:

$$BCR = \sum_{i=1}^{n} \frac{B_i}{(1+r)^i} \Big/ \sum_{i=1}^{n} \frac{C_i}{(1+r)^i}$$

7.3.3. 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.

7.4. Costs and Benefits

7.4.1. 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.

7.4.1.1. Project costs

The total project cost of the CEP Section 3 from Pothuhera to Galagedara will be around 94.66 billion LKR without Vat (652million US$). Total Project Cost for the CEP (for all sections) will be around 445.3 LKR billion (Without Vat) (3071.03 million US$). The following Table shows the summary of costs for the Section 3 of CEP.

Table 7.2 : The summary of costs for Section 3 of CEP from Pothuhera to Galagedara

Contract package	Section	Length km	Cost Rs. Bn (Without Vat)	Cost Rs. Bn (With Vat)
Section 3 - A	Pothuhara - Parape	18.5	55.10	62.00
Section 3 - B	Parape - Galagedara	14.0	39.56	44.51
Total for Section 3		**32.5**	**94.66**	**106.51**

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 report 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. 1.53 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. 14.07 bn incurring every 10 years. This includes rehabilitation cost, upgrading of equipment and vehicles.

Table 7.3: 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	106.51
Section 4	Kurunegala-Dambulla	60.15	153.09

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 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 7.4 provides a summary of the nature of cost items identified under above categories and methods used to estimate these costs.

Table 7.4: 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 data availability, 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 7.5.

Table 7.5: 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	166.56	RAP/SIA survey
Cost of environmental damage		
Impacts on biodiversity and natural vegetation		
Loss of carbon sink values due to clearance of natural vegetation	0.88	EIA
Cost of environmental mitigation and monitoring program		
Cost of all proposed environmental monitoring measures	1.38	EIA

7.4.2. 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.

7.5. 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 NEP

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 7.6.

Table 7.6: Daily VKT for the stage combination 1, 2 and 3

(Scenario 3)
Base case 'Do Minimum' Traffic Modeling Results

	Units	2021	2026	2036
VKT				
FOR TOLLED ROADS				
PV NB	km	965,413	1,567,497	4,529,998
PV B	km	226,007	384,322	993,341
LCV	km	80,598	103,204	158,744
MCV	km	232,509	312,451	569,916
HCV	km	13,722	16,888	24,661
Total	**km**	**1,518,248**	**2,384,361**	**6,276,660**
VKT				
FOR NON TOLLED ROADS				
PV NB	km	13,653,108	18,170,602	32,832,086
PV B	km	1,914,935	2,704,188	5,069,967
LCV	km	1,125,955	1,341,671	1,884,972
MCV	km	5,207,680	6,027,550	7,902,504
HCV	km	309,125	354,551	457,989
Sub Total	**km**	**22,210,804**	**28,598,561**	**48,174,554**
Grand Total	**km**	**23,729,052**	**30,982,922**	**54,424,214**

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 7.7: 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. Similar estimate was adopted in the Northern Expressway Economic Feasibility study report.

7.5.1. Travel Time Savings

The value of Time estimates are based on the values given in 'Assessing Public Investment in the Transport Sector', 2000, Department of National Planning.

Table 7.8: Daily VHT for base case and CEP

Base case

	Units	2021	2026	2036
VHT				
PV NB	hours	514,075	827,994	3,527,241
PV B	hours	70,751	117,173	489,993
LCV	hours	38,587	52,281	145,158
MCV	hours	176,978	234,724	621,496
HCV	hours	10,890	14,613	41,258
Total	**hours**	**811,281**	**1,246,786**	**4,825,146**

Source: Economic Feasibility Analysis for Central Expressway Project, University of Moratuwa 2016

Table 7.9: 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

7.5.2. 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 accidents 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 NEP
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 7.10.

Table 7.10: Summary of the projected benefits of CEP 2019-2048

Benefits	Present Value in LKR bn
Vehicle operating cost savings	69.60
Travel time savings	728.39
Saving of accident costs	8.16

7.6. Other Unquantified Benefits

In addition, following benefits will be resulted due to establishment of CEP sections 1 and 2 and not included in the cost benefit analysis due to lack of data for making a reliable assessment.

Table 7.11: 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 NEP 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.

7.7. 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 7.4.1 and 7.4.2.

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 7.12.

Table 7.12: ECBA Results

Item	Discounted Value (LKR bn)
Benefits	
• Saving of Vehicle Operating Cost (VOC)	69.60
• Travel Time Cost Savings	728.39
• Saving of accident cost	8.16
Total	**806.15**
Costs	
• Construction costs	248.75
• Operating costs	27.31
• Acquisition cost	50.47
• Cost for loss of carbon sequestration ability	0.88
• Opportunity cost of land	166.56
• Environmental mgt. cost	1.38
Total	495.35

Decision Criteria	
BCR	1.26
NPV (LKR bn)	127.71
IRR	8.62%

7.8. 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 7.13. a-c.

Table 7.13.a: BCR, NPV and IRR values resulted in the CBA study under the scenario 1

Item	Value
BCR	1.00
NPV	LKR bn 4.71
IRR	7.07%

Table 7.13.b: BCR, NPV and IRR values resulted in the CBA study under the scenario 2

Item	Value
BCR	1.05
NPV	LKR bn 30.25
IRR	7.35%

Table 7.13.c: BCR, NPV and IRR values resulted in the CBA study under the scenario 3

Item	Value
BCR	1.03
NPV	LKR bn 17.48
IRR	7.22%

7.9. Conclusion and Recommendation

Under the assumptions made in the base case, the project is viable with a Rs billion 128 net present value. Tables 6.13 (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 only marginally 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.

1. This Environmental Impact Assessment (EIA) has been prepared to assess the section 3 CEP Pothuhera to Galagedara. The scope of the EIA covers the proposed expressway corridor from Pothuhera to Galagedara. The EIA has investigated environmental and social implications associated with the proposed project.

2. Under analysis of alternatives several options were considered out of which the proposed project was selected as the best alternative.

3. From the baseline studies of the existing environment it is seen that a considerable stretch of the proposed trace traverses through paddy fields and low lying areas and that it crosses a few streams. It is also observed that the proposed route traverses through a variety of natural, semi natural and human-modified landscapes. However, the proposed expressway does not traverse through any national parks, sanctuaries or declared wetlands. The trace traverses through three administrative districts; Kandy in Central Province, Kegalle in Sabaragamuwa Province and Kurunegala in North Western province in the country. It runs through 38 GN divisions in 4 DS divisions.

4. Impacts due to Soil Erosion and construction of tunnels have been mitigated by designs.

5. According to the findings of the EIA study it could be seen that the proposed expressway alignment will cause considerable adverse impacts to the environment, physical environment, Ecological environment and social environment. But, such impacts are limited to a few locations only.

6. Since the trace traverses through a complicated terrain and because of the proposed tunnels the impacts on geological aspects are considered as the most significant and these aspects had been studied in detail. Mitigatory measures such as slope stability methods would be undertaken to minimise potential impacts.

7. Since the proposed trace goes through a large extent of paddy fields and low lying areas there will be significant hydrological impacts also. Mitigatory measures will be taken through design to minimise these impacts. 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 and land floods.

8. The other major impacts would be on the social environment arising as a result of construction, displacement of people, and resettlement. Therefore, impacts on the livelihood of people could occur. All social, economic and cultural factors that have been discussed in this report imply that there is a significant impact on their livelihood as a result of land acquisition. Over 1162.5 Acres of lands occupied by 2069 householders are to be affected requiring permanent relocation for 857 of them. Around 707 households, 35 businesses and 1303 farmland owners are among the total number of project affected householders. A population of 8465 people of those households will be affected by the project. 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.

9. Affected people and communities do not fully disagree with the proposed project as there are many positive impacts towards regional and national development. During the surveys, many stated that they too can utilise the expressway to achieve their life goals, but they have to sacrifice their assets and cultural heritage in the entirety resulting in direct negative impacts to them and their next generation. Hence, they are expecting a direct involvement of RDA to compensate, resettle them, restore their livelihood elsewhere and give. This will be done prior to commencement of the project.

10. Although the proposed expressway does not go through a national park, wildlife habitat or a sanctuary because of the large stretch of natural habitats. 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 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.

11. 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.

12. Almost all the impacts, physical, social and ecological impacts related to displacement could be mitigated to a great extent using the proposed mitigation measures.

8.2. Recommendations

The following recommendations are made in this study.

1. Implementation of the selected road layout for Section 3 is recommended subject to mitigation measures, Resettlement Action Plan and Environmental Monitoring and Management Plans, as found through the EIA study.

2. Since the project covers a vast extent of land in addition to the EIA clearance, several other clearances and approvals need to be obtained from various government institutions, some of which are already issued, some of which are still pending. All of the required clearances would be obtained prior to the commencement of the project.

3. Although geological investigations of the proposed expressway indicate low threats from land subsidence since certain sections of the proposed road runs through steep mountain slopes and because of the tunnels the impact on land form and stability can be considered as significant and hence special emphasis would be placed on aspects of geo technical and earth resources.

4. Stable slopes will be designed to prevent the possibility of land slides along the road cuts and possible land subsidence. In the construction stage guidance will be sought from the National Building Research Organization throughout the project. Road cuts will be done under proper supervision and slope stability techniques will be implemented at all required project sites.

5. Continuous monitoring will be done during construction to ensure that measures such as relief drains, cascades, grouting, reinforcements and rock bolting are taken and that any localities prone to natural landslide are stabilized. During both construction and post construction stages slope stability around the road will be regularly monitored.

6. Since the road stretch is also going through a substantial extent of low lying areas including paddy lands, the impacts on hydrological aspects also would be given special attention.

7. In the design stage itself most the hydrological or drainage impacts will be mitigated by designing viaducts, large box culverts and other methods to minimise backwater impacts. Paddy cultivation could be continued on either sides of the expressway and impacts on irrigation water issues would be mitigated by providing additional site specific openings.

8. 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 an 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.

9. The existing irrigation canals and drainage facilities will be properly maintained in the project area. All the requirements stipulated by Irrigation Department, Sri Lanka Land Reclamation and Development Corporation and Department of Agrarian Development will be incorporated in to detail designs and contract documents of the project.

10. It will be ensured that construction will take place in the dry period.

11. The other major issue of concern is the social impacts due to land acquisition and resettlements. Resettlement and offer of compensation for the affected parties will be implemented considering the views of stakeholders as far as possible in collaboration with all concerned line agencies especially Division Secretaries. Payment of cash compensation and providing suitable resettlement sites (for the parties who are willing to resettle) will be done in compliance with the current policies adopted by RDA in similar projects. This aspect will also be monitored with diligence.

12. Public consultations will be conducted throughout the resettlement process in order to ensure that resettlement plan is implemented as stated and that unforeseen issues and grievances are addressed accordingly.

13. Although major impacts on ecological aspects are not anticipated since there are some indirect impacts, in particular on the Siyambalangamuwa forest reserve complex, mitigatory measures such as underpasses for terrestrial fauna, and canopy bridges and mesh enclosures for arboreal fauna to cross the expressway and go from one forest patch to another will be established and monitored.

14. During the construction and operational stages, the hospital, courts and schools at Galagedera will be affected by noise and hence a noise barrier will be put up in this area. In the operational stage noise barriers will be put up in certain other selected places because of high traffic noise levels.

15. As construction activities might affect groundwater levels of some dug wells in the vicinity of ROW precautionary measures will be taken to minimise this impact and a temporary water supply will be provided for the users of the affected dug wells during construction.

16. The EMP and EMoP for the project will be updated in the detail design stage and incorporated in to respective tender documents.