Economic Feasibility Analysis of the Central Expressway Project - Alternative Analysis

Final Report

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Table of Contents

1. INTRODUCTION ........................................................................................................................................1
   1.1 Description of the Proposed Central Expressway Project ..............................................................1
   1.2 Study Methodology .........................................................................................................................1

2. ALTERNATIVE ANALYSIS FOR CENTRAL EXPRESSWAY PROJECT ............................................3
   2.1 No Project Alternative .......................................................................................................................3
   2.2 Improvement to “Main Line”, North and Batticaloa bound railway lines .................................4
   2.3 Improvement and Widening of A001, A006, A009 and A011 Highways ..................................5

3. ALTERNATIVE ROUTES ANALYSIS FOR PROPOSED CENTRAL EXPRESSWAY .......................7
   3.1 Section 1 (Colombo to Meerigama) ..............................................................................................7
       3.1.1 Highway Engineering and Transport Aspects .................................................................9
       3.1.2 Hydrological Considerations ............................................................................................11
       3.1.3 Environmental & Social Issues .......................................................................................11
       3.1.4 Geotechnical Engineering Aspects ...............................................................................12
   3.2 Section 2 (Meerigama to Kurunegala) ......................................................................................15
       3.2.1 Highway Engineering and Transport Aspects ...............................................................15
       3.2.2 Hydrological Considerations ............................................................................................17
       3.2.3 Environmental & Social Issues .......................................................................................17
       3.2.4 Geotechnical Engineering Aspects ...............................................................................18
   3.3 Section 4 (Kurunegala to Dambulla) ..........................................................................................19
       3.3.1 Highway Engineering and Transport Aspects ...............................................................19
       3.3.2 Hydrological Considerations ............................................................................................21
       3.3.3 Environmental & Social Issues .......................................................................................21
3.3.4 Geotechnical Engineering Aspects.............................................................22

3.4 Final Trace Selection (Kadawatha to Dambulla) ........................................22

3.5 Section 3 – Kandy Link..................................................................................23

3.5.1 No Action Alternative..............................................................................23

3.5.2 Alternative Route Analysis ..................................................................24

3.5.3 Highway Engineering Aspects..............................................................29

3.5.4 Transportation related Considerations..................................................32

3.5.5 Hydrological Considerations.................................................................33

3.5.6 Environmental & Social Issues..............................................................33

3.5.7 Geotechnical Engineering Aspects.........................................................34

4. CONCLUSION ..................................................................................................36
List of Tables

Table 1-1. Interchange Locations.................................................................2
Table 2-1: Details of links to be improved in Main line of Sri Lanka Railways .............5
Table 3-1: Summary of Section 1 Alternative Corridors ........................................9
Table 3-2: Multi Criteria Analysis for Section 1 Alternatives ................................14
Table 3-3: Differences between Section 2A and Section 2B proposal ......................16
Table 3-4: Tunnel Details ..............................................................................21
Table 3-5: Assessment summary of the options ..................................................28
Table 3-6: Sub sections of Section 3 ..................................................................30
Table 3-7: Summary of Tunnel details ...............................................................30
Table 3-8: Comparison of tunnel and cut options ...............................................31
List of Figures

Figure 3-1: Corridors taken for Section 1 and selected initial traces for Section 3 ..................8
Figure 3-2: Traces considered for Section 1 ..................................................................................8
Figure 3-3: Traces of different sections on the General soil map of Sri Lanka .........................13
Figure 3-4: Alternatives for Sections 2 and 4 .............................................................................16
Figure 3-6: Traces of different sections on the General geomorphology map of Sri Lanka ....18
Figure 3-5: Traces of different sections on the general physical map of Sri Lanka ............18
Figure 3-7: Route Alternatives for Section 3 ..............................................................................25
Figure 3-8: Selected option for detail analysis ..........................................................................27
Figure 3-9: Route deviation from Ch 8+300 to Ch 10+800 .........................................................31
Figure 3-10: Route deviation at Galagedara ..............................................................................32
Figure 3-11: Landslide hazard map of Kandy district ...............................................................34
Figure 3-12: Landslide hazard map of Kegalle district .............................................................35
Figure 4-1 Central Expressway Final Alignment ......................................................................37
1. **INTRODUCTION**

The objective of the current study is to evaluate the alternatives identified in the selection of the final alignment of the proposed Central Expressway Project (CEP). The report is submitted as a supplementary report to the ‘Economic Feasibility Analysis of the Central Expressway Project’ submitted in April 2016.

1.1 **Description of the Proposed Central Expressway Project**

The expressway is proposed to start from the Outer Circular Highway and extend up to Dambulla, a link to Kandy from the main Colombo-Dambulla link is also envisaged. It is designed as a four lane expressway with operating speeds of 100km/h on the Colombo-Dambulla link and 80 km/h on the Kandy link.

1.2 **Study Methodology**

The scope of the current study was to carry out the CEP alternative analysis based on information available in existing studies done for the same corridor. Alternative traces selected for this study are based on the alternative traces proposed in the past feasibility studies on Colombo Kandy Alternative Highway and the Northern Expressway. The expressway alternative analysis was carried out based on the information available after reviewing the following feasibility study reports.

In addition to this the observations made during the reconnaissance surveys carried out along the trace by the consultants was also incorporated in the evaluation.
2. ALTERNATIVE ANALYSIS FOR CENTRAL EXPRESSWAY PROJECT

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

2.1 No Project Alternative

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

The existing transportation system is mainly through Colombo – Kandy (A001), Ambepussa – Kurunegala – Trincomalee (A006), Kandy – Jaffna (A009), Maradankadawala – Habarana – Tirikkondiadimadu (A011) Highways, Southern Expressway (E01) Colombo Katunayake Expressway (E03) and Outer Circular Highway (E02). At present it takes more than 12 hours to travel a distance of approximately 400km between Colombo and Jaffna in the Northern Province or Colombo and Trincomalee and Batticaloa (nearly 300km) in the Eastern Province. Although rehabilitation and resurfacing works have been done in the recent past, these roads are mostly of two lanes with exceptions near few town areas where there are four lane facilities. It should also be noted that even with the improved road surfaces the maximum operational speeds on these roads are limited to about 40kmph within town areas and 60kmph outside town area.
Projected socio-economic growth in the North and Eastern regions and other key cities connected by above roads will exert an increased demand on the existing traffic flow along these roads. Such a situation will further increase the travel time between Colombo and key cities like Kurunegala, Dambulla, Jaffna, Trincomalee and Kandy. Already the sections of A001 Highway between Colombo and Ambepussa and Ambepussa to Kurunegala section of A006 Highway are highly congested with traffic. Increased travel time will lead to an increase in vehicle operational costs. Further the existing road surface will deteriorate at a much faster rate leading to more frequent recurrent maintenance work.

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

2.2 Improvement to “Main Line”, North and Batticaloa bound railway lines

The “Main Line” of Sri Lanka Railways has two to three parallel lines from Colombo up to Rambukkana, beyond which it comprises a single line except at railway stations. The North and Batticaloa Lines which radiate from the “Main Line” at Polgahawela comprise only of a single railway line.

An alternative to provide four parallel lines up to Polgahawela and two lines beyond Polgahawela on the “Main Line”, North and Batticaloa Lines was considered as an option to improve connectivity between Colombo and the Northern and Eastern Provinces. However, construction of an additional railway line parallel to the existing line (including stations for goods and passengers) will be a much more expensive proposition requiring much greater land acquisition and associated environmental and social impacts. Details of the links to be
improved are shown in Table 2-1. Cost for improvement in major railway links will be very costly since the link shown in the Table 2-1 passes through highly populated areas in the western province.

Table 2-1: Details of links to be improved in Main line of Sri Lanka Railways

<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Distance Approx. (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fort</td>
<td>Ragama</td>
<td>15.4</td>
</tr>
<tr>
<td>Ragama</td>
<td>Gampaha</td>
<td>12</td>
</tr>
<tr>
<td>Gampaha</td>
<td>Veyangoda</td>
<td>10.2</td>
</tr>
<tr>
<td>Veyangoda</td>
<td>Mirigama</td>
<td>12.7</td>
</tr>
<tr>
<td>Mirigama</td>
<td>Polgahawela</td>
<td>23.6</td>
</tr>
<tr>
<td>Polgahawela</td>
<td>Pothuhera</td>
<td>12.3</td>
</tr>
<tr>
<td>Pothuhera</td>
<td>Kurunegala</td>
<td>8.9</td>
</tr>
<tr>
<td>Kurunegala</td>
<td>Maho</td>
<td>43.2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>138.3</strong></td>
</tr>
</tbody>
</table>

While rail can offer significant reduction of passenger vehicles off the roads, the demand for railway generally only occurs at peak times, resulting in unallocated capacity at other times. Furthermore, there are limitations to the flexibility of fixed railway lines in supporting freight distribution, which comprises a significant amount of demand for traffic along this north-south link.

As a result, the excessive costs of improving rail connections are considered to be too high to continue with this as a reasonable alternative.

### 2.3 Improvement and Widening of A001, A006, A009 and A011 Highways

Many sections of the A001, A006, A009 and A011 highways have been improved in the recent past and where possible widened to have four traffic lanes and some sections are already in the process of been upgraded to four lanes, the Colombo – Ambepussa section of A001 highway and Ambepussa – Kurunegala section of A006 highway could be considered equivalent to Section 1, 2 of the proposed CEP. At present these two highway sections have far exceeded their capacity. In order to sustain future traffic demand, the Colombo –
Ambepussa section of A001 highway would need to be widened to 6 lanes. Such a move would have an enormous amount of land acquisition and resettlement impacts given the dense land uses immediately adjacent to the road corridor. Furthermore, even if this section of highway is upgraded to 6 lanes, given the maximum speed limits imposed on ‘A-level highways, it would not allow for a significant gain in travel time. Additionally, there would be an increased risk of accidents for both vehicles and pedestrians.

As a result of above factors, it is considered that the improvement and widening of the key highways which represent the existing link between Colombo and the Northern and Eastern Provinces is not an acceptable option.

Therefore the alternative analysis is confined to selection of most viable alignment for the construction of the Central Expressway which will be discussed in the following chapters.
3. ALTERNATIVE ROUTES ANALYSIS FOR PROPOSED CENTRAL EXPRESSWAY

The sections that were identified in the proposed Central Expressway Project for the alternative analysis are as follows:

- Section I – Colombo to Meerigama
- Section II – Meerigama to Kurunegala
- Section III – An expressway Link to Kandy
- Section IV – Kurunegala and Dambulla

Evaluation of alternative routes for each section was done considering multi-criteria analysis which included the highway engineering, transport, hydraulic, geotechnical and environmental aspects. A quantitative multi-criteria analysis based on ratings assigned under weighted criteria under each of the above factors is conducted to Section 1 only due to the complexities that arose since the performance of each alternative under different criteria varied for the section. However, for the subsequent sections the selection of the alternative can be justified satisfactorily based on qualitative multi criteria evaluation.

3.1 Section 1 (Colombo to Meerigama)

Four corridors were examined for Section 1; Two of them are starting from Enderamulla; one with an additional spur towards Ambepussa to allow traffic to access and egress the A1 (A-B-H), one following the A-B-H corridor from Enderamulla to Gampaha and then deviating to the west before falling back in to the A-B-N corridor at Meerigama (A-C-H), the other two are starting from a new interchange and Kadawata interchange in OCH trace; one to the east of the existing A1 (D) starting from an interchange between Enderamulla and Kadawata, and the other starting from Kadawatha via CKAH (Q) trace up to Gampaha and follows the A-B-H corridor at the end. Figure 3-1 shows the alternatives considered for Section 1. Figure 3-2 shows the proposed alternative traces.
Figure 3-1: Corridors taken for Section 1 and selected initial traces for Section 3

Figure 3-2: Traces considered for Section 1
### 3.1.1 Highway Engineering and Transport Aspects

Initial comparisons of the selected alternatives are indicated in Table 3-1. These costings, along with an assessment of the relative benefits and drawbacks associated with the options, are included in Table 3-1.

<table>
<thead>
<tr>
<th>Alternative Corridors</th>
<th>Length (km)</th>
<th>Probable Construction Cost (Rs billions)</th>
<th>Relative benefits</th>
<th>Relative Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. A-B-H</td>
<td>45</td>
<td>129</td>
<td>• Runs close to the railway corridor thereby minimizing resettlement and social impacts. • Affects least number of properties (791)</td>
<td>• High construction cost.</td>
</tr>
<tr>
<td>2. A-C-H</td>
<td>46</td>
<td>113</td>
<td>• Provides easy access to Bandaranayake International Airport.</td>
<td>• Affects highest number of properties (916). • Perceived high social impact. • High construction cost.</td>
</tr>
<tr>
<td>3. D</td>
<td>42</td>
<td>96</td>
<td>• Would alleviate traffic issues at New Kelani Bridge and OCH/CKE junction.</td>
<td>• Affects high number of properties (900) • Does not provide direct link to port. • Perceived high social impact. • Difficult to incorporate new interchange on OCH.</td>
</tr>
<tr>
<td>4. Q-B-H</td>
<td>36.5</td>
<td>128</td>
<td>• Would alleviate traffic issues at New Kelani Bridge and OCH/CKE junction • Runs close to the railway corridor thereby minimizing resettlement and social impacts • Shortest distance to OCH and southern Expressway</td>
<td>• Does not provide direct link to port. • Affects moderate number of properties (800) • High construction cost</td>
</tr>
</tbody>
</table>

Table 3-1: Summary of Section 1 Alternative Corridors
The costs given in Table 3-1 are illustrative only for the purposes of comparison between different routes and should not be assumed to be detailed cost estimates. In conclusion, route via CKAH was chosen for further study although it was assessed as one of the highest construction cost options, its reduced impact on social and resettlement issues resulted in it emerging as the preferred option. In addition, it was assessed that land costs would be lower than for the other options due to the lower number of residential properties impacted and this would at least partially offset the highest construction cost. Route via CKAH has the shortest distance to the OCH. South bound traffic can bypass the busy interchanges in city center. Upon additional study, the link to Danowita is discarded in preference to extending Section 1 from Meerigama to Ambepussa (H) to connect to the A6. The main benefit of this alignment is that it allowed traffic on the A6 to easily access the expressway without having to travel along the already highly congested A1 between Ambepussa and Danowita.

The alternative distances are measured from the start of the new expressways from OCH. The alternative Q-B-H has the shortest distance out of all alternatives hence has the highest travel time savings. It is followed by alternative D which has almost equal distance. The alternatives A-B-H and A-C-H follows as alternatives with least travel time savings. The accessibility can be evaluated as the location of the connection to the OCH and the key local cities that the alternatives passes through. The connection point to the OCH has three attributes; the accessibility to the city centre (port), Accessibility to the airport, Accessibility to the Southern traffic. It could be considered that majority of the traffic would enter towards the south from existing Southern and OCH expressways. Therefore, the connection being more southwards has a benefit of shorter distance and better accessibility for the travellers. While Alternative D has the south most connection to OCH, the trace passes through few urban centres thereby having less accessibility. Alternative Section C also has less urban centres connected while Section B has the highest and best connectivity to the urban centres with connection to locations like Gampaha, Veyangoda and also running parallel to the existing railways as well. Therefore, Section Q-B-H can be selected as the best trace in terms of transport considering travel time savings and accessibility.
3.1.2 Hydrological Considerations

Routes A and B are runs on low lying areas where floods are very frequent. These are hydrologically very sensitive areas where the existing drainage system can be adversely affected by the proposed road. Further, the northern end of the route Q, and some parts of the route H are also on areas with frequent floods. In flood areas, the adverse impacts caused by the road embankment on the drainage pattern is very difficult to be completely mitigated. Further, the road embankment reduces the flood retention areas in route A and B which can raise the flood levels.

In contrast, the routes D and C are mainly on highlands where the adverse impacts on the existing drainage pattern are not significant and any localised impacts can be easily mitigated by design. Whenever, the proposed road goes across a stream or a low lying area, by providing bridges or culverts with adequate sizes and levels, the existing drainage patterns can be maintained undisturbed.

Therefore, the Alternative 3 with route D is the best alternative as it does not go through any major flood plains. The route C is also on high grounds and therefore the route A-C-H or Alternative 2 is the second best. The route B is mainly on the Attanagalu Oya-Deeli Oya flood plains making the Alternatives with route B, less preferred in hydrological view point. Alternative 4 is however better than alternative 1 as the route Q (in Alternative 4) is less vulnerable to floods compared to the route A (in Alternative 1).

3.1.3 Environmental & Social Issues

Out of the four alternatives that are being considered, A-B-H and Q-B-H would have the least impact on properties. The other two alternatives (A-C-H and D) would affect at least 100 properties more. Out of A-B-H and Q-B-H, the latter can be considered to be the better option because the length of the trace is 8.5 km shorter. Q-B-H can therefore be considered as the option that would have the least perceived social impacts due to resettlement and acquisition of private property.
All the four alternatives generally traverse mostly parallel to railway lines, and through paddy, marshy and uncultivated areas. In certain sections, the traces have been aligned so as to minimize the impact on existing settlements. The impacts on the existing land use are comparatively the same for all the four alternatives.

All the four traces fall within the same catchment areas of Attanagalu Oya and Diyaelle Oya. Therefore, the impacts on quantity and quality of surface water would be almost the same for all the four traces. The impact on surface water bodies, such as irrigation tanks and reservoirs are not significant, other that the impacts on Kapu wewa (which falls on A-B-H) near Ragama. By selecting the Q-B-H as the preferred trace such impacts can be avoided.

Impacts on water quality, air quality are almost the same for all the four traces. Impacts due to noise and vibration during construction and during operations are again comparatively the same for all the four traces, due to similar land use and habitation characteristics. Ambient water quality, air quality, noise and vibration levels do not show any significant variations among selected locations of similar character along the four traces.

### 3.1.4 Geotechnical Engineering Aspects

The alternatives have been plotted on the general soil map, elevation and geomorphology maps of Sri Lanka as given in Figure 3-3. All these traces indicate quite similar geological and topographical conditions in Section 1.

However, it has to be noted that a serious input is needed for ground improvements as most of these traces lie on very low grounds such as paddy fields. Detailed investigations are necessary for any ground improvement methodology to be adopted. All the traces have similar weightings in geological and topographical aspects.
3.1.5 Multi-criteria analysis for Evaluation of Alternatives for Section 1

Due to the complexities of selecting the most suitable trace for Section 1, a weighted rating was calculated for each alternative under identified set of criteria. Each criteria was given a weightage by the consultant team to reflect the relative importance of the particular criteria. Each consultant assigned a rating (a score from 1-5) under each category in his area of expertise for each alternative. The weighted rating was then calculated and the alternative trace with the highest weighted rating was deemed the most suitable one for the section. The results of the analysis is given in Table 3-2.
Table 3-2: Multi-Criteria Analysis for Section 1 Alternatives

<table>
<thead>
<tr>
<th>Category</th>
<th>Total Weightage</th>
<th>Impact factor</th>
<th>Weightage</th>
<th>Rating</th>
<th>Weighted score</th>
<th>Rating</th>
<th>Weighted score</th>
<th>Rating</th>
<th>Weighted score</th>
<th>Rating</th>
<th>Weighted score</th>
</tr>
</thead>
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<tr>
<td>Highway Engineering</td>
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<td>Availability of local resources</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>2</td>
<td>6</td>
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<td></td>
<td>Constructability issues</td>
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<td>Impact to drainage system</td>
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<td>Environmental and</td>
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<td>6</td>
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<td>Water</td>
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<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Geotechnical</td>
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<td>Geological Sensitive areas</td>
<td>8</td>
<td>2</td>
<td>16</td>
<td>2</td>
<td>16</td>
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<td>16</td>
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<tr>
<td></td>
<td></td>
<td>Total weighted rating</td>
<td></td>
<td></td>
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<td></td>
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<td>Rank</td>
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</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>Alternative 1</th>
<th>Alternative 2</th>
<th>Alternative 3</th>
<th>Alternative 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total weighted rating</td>
<td>202</td>
<td>222.5</td>
<td>227</td>
<td>239</td>
</tr>
<tr>
<td>Rank</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>
3.2 Section 2 (Meerigama to Kurunegala)

Whereas an examination of other corridors had been undertaken, no serious alternatives meeting the shortest distance between Meerigama and Kurunegala and providing any significant benefits had been identified, However, two alternatives were identified as Section 2A and Section 2B. The Section 2A corridor, was taken forward for further design. However, an additional option for the northern part of Section 2A from a point approximately 5 km north of Boyawalana was proposed. This alignment is termed “Section 2B” and is discussed in more details below.

3.2.1 Highway Engineering and Transport Aspects

There is one significant difference that being the proposed deviation from the Section 2A for the northern 22 km of Section 2. This alignment, rather than terminating on the A10 at Pellandeniya west of Kurunegala, is headed in a more easterly direction and terminates on the A10 close to the Kurunegala railway station. The adoption of this proposal for the northern section of Section 2 results in shifting of the southern portion of Stage 4 eastwards, running from Kurunegala railway station to Melsiripura. A summary of the difference between the Section 2A and Section 2B proposals is given in Table 3-3. These are discussed below. Section 2B was selected as the preferred alternative considering the connectivity to the Section 4 and to Kurunegala. Section 2B provide two interchanges; Dambokka and Potuhera in south of Kurunegala to alleviate traffic issues in Kurunegala and A6. Figure 3-4 shows alternatives considered for Section 2 and 4. The two Sections 2A and 2B are almost equal distance from Nakalagamuwa interchange to the A10, where the alignment 2A connects the A10 approximately 7km NW of Kurunegala town. The trace 2B has a better accessibility with Dambokka, Polgahawela and Kurunagela being better connected.
Figure 3-4: Alternatives for Sections 2 and 4

### Table 3-3: Differences between Section 2A and Section 2B proposal

<table>
<thead>
<tr>
<th>Item</th>
<th>Issue</th>
<th>Section 2A</th>
<th>Section 2B</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>Design speed for Stages 1 and 2</td>
<td>120 km/h</td>
<td>120 km/h for Section 1 and 100 km/h for Northern part of Section 2</td>
</tr>
<tr>
<td>02</td>
<td>Termination point of Section 1</td>
<td>Section 1 extended from Meerigama to Ambepussa</td>
<td>Section 1 terminates at Meerigama</td>
</tr>
<tr>
<td>04</td>
<td>Junctions at Meerigama</td>
<td>Service interchange south of Meerigama and system interchange to the north</td>
<td>Service interchange south of Meerigama and system interchange to the north</td>
</tr>
<tr>
<td>04</td>
<td>Layout of Section 1 in vicinity of Narangoda Paluwa</td>
<td>Vertical alignment passes beneath the existing railway close to Walpola Station area</td>
<td>Vertical alignment passes over the existing railway close to Walpola Station area</td>
</tr>
<tr>
<td>05</td>
<td>Northern Section of Section 2</td>
<td>Alignment commences at Meerigama and heads in an approx. NNE direction, terminating on the A10 at Pellandeniya</td>
<td>Deviates from Section 2A near Godakuruwa/Wilgamuwa, and terminates to the east of Kurunegala</td>
</tr>
</tbody>
</table>
3.2.2 Hydrological Considerations

Both alternative routes, goes along flood areas for about 10 km from Nakalagamuwa (Alternative 2A through Narammala flood area and Alternative 2B along Kuda Oya flood plains). However, alternative 2A is generally on the downstream reaches of hydro-catchment areas compared to Alternative 2B where the stream flow rates are higher. Therefore, the possibility of adversely changing the existing drainage pattern by the proposed road is high in Alternative 2A. Therefore, the alternative 2B is the preferred option.

3.2.3 Environmental & Social Issues

The environmental impacts in terms of water environment, air, noise and vibration are mostly comparable between the two alternative trances (2A and 2B).

The selected alignment of Stage 2 of the expressway (2B) mostly traverses through paddy lands, coconut estates and uncultivated areas in order to minimize resettlement. For the most part, the alignment lies on the Ambepussa Kuda Oya, Maha Oya and Maguru Oya basins. Compared to Section 1, this segment does not lie on sensitive flood prone areas. However, the proposed trace passes through low-lying areas, crosses several rivers and streams, irrigation canals, etc., and therefore water quality deterioration will be relatively significant during construction because substantial amounts of cutting and filling operations. Noise and vibration levels during construction have to be observed closely as there are several sensitive receptors close to the proposed trace.

Exposure to ground vibration will cause impacts on the fauna, especially those who are associated with natural habitats in the Maha Oya flood plains. Ch 21+600 to 22+740 of the proposed expressway passes on the southern border of Weragalakanda forest which has been a government reservation land and has come under the jurisdiction of the Forest Department recently.
3.2.4 Geotechnical Engineering Aspects

Section 2 trace is from Meeligama to Kurunegala. Two alternatives have been plotted on the figures 3-3, 3-5 and 3-6 as 2A and 2B. All these two traces will have low lands as well as small cut areas. However, both exhibit very much similar geological and topographical situations.

Figure 3-5: Traces of different sections on the general physical map of Sri Lanka

Figure 3-6: Traces of different sections on the General geomorphology map of Sri Lanka
3.3 Section 4 (Kurunegala to Dambulla)

Two alternatives for the southern part of the Section 4 was proposed and named the two options as Section 4A and Section 4B. Section 4A commences on the the A10 at Pellandeniya west of Kurunegala where the Section 2A terminates. Section 4A heads eastwards from Pellandeniya to cross the A6 close to Melsiripura and then runs roughly parallel to the A6 on its eastern side.

3.3.1 Highway Engineering and Transport Aspects

Section 4A route was eliminated from further study as the topography would have resulted in an alignment which would have to lie a significant distance to the west of the existing A6, and would therefore prove costly to link the expressway to the A6 which would be required to provide good connectivity between the existing and new road networks. In addition, the proposal by the Ceylon Electricity Board to construct a new high voltage electricity line in this area would have provided additional constraints on the design. Therefore, the decision was taken to follow the corridor from east of Kurunegala and run roughly parallel to the A6 to Dambulla.

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

3.3.1.1 Design Alternatives for Section 4B

Tunnels have been proposed for the following locations to avoid large cuts in soft ground profiles (no rock formation) and possible environmental social issues associated with deep cut in soft ground locations. It was found that the deep cut (more than 20m) in the southern expressway had failed at the initial stage of construction and large costs had been involved in slope protection. Hence, it is recommended to have tunnels in locations where cut depth exceeds 20m. The details of the locations proposed for tunnels are given in Table 3-4.
Table 3-4: Tunnel Details

<table>
<thead>
<tr>
<th>Tunnel No</th>
<th>Location</th>
<th>Tunnel Length, m</th>
<th>Maximum Cut height, m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From</td>
<td>To</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>107+680</td>
<td>107+900</td>
<td>220</td>
</tr>
<tr>
<td>2</td>
<td>108+110</td>
<td>108+390</td>
<td>280</td>
</tr>
<tr>
<td>3</td>
<td>110+890</td>
<td>111+240</td>
<td>350</td>
</tr>
</tbody>
</table>

### 3.3.2 Hydrological Considerations

The most significant adverse hydrological impact of the route 4A is that it intercepts two irrigation tanks. Whereas, the route 4B runs parallel and very close to Deduru Oya for about 10 km. While there will be no impact on Deduru Oya drainage pattern by the proposed road due to high ground levels, there can be impacts on the water quality of Deduru Oya due to road surface runoff. Since this impact can be mitigated by design, this will not be a major issue.

The route 4A is relatively on the downstream reaches of hydro-catchment areas of Deduru Oya, Gettuwana Oya and several other minor streams compared to the route 4B. Hydro-catchments at lower reaches have high flow rates which are more vulnerable to impacts and that makes the alternative 4B the preferred option.

### 3.3.3 Environmental & Social Issues

Among the two traces considered, viz., 4A and 4B, the latter has been selected based on several dominant factors, mainly economic and financial.

Some factors have to be noted when selecting 4B as the preferred option, for which mitigation of environmental impacts are needed. There are several water bodies that will be subjected to water quality degradation. Some of them are: tanks and irrigation canals at Pahalagattuwana, Denagamuwa Ela, Kalugala Ela, Bathalagoda Wewa, Ketigana Wewa, Uda
Tuttiri wewa, Meddeketiya Wewa and rivers/streams such as Deduru Oya, Kimbulwana Oya -close to the Walaswewa blasting area, Welametiya Oya, Dambulu Oya, Mirisgoni Oya and Gokarella stream.

The Kurunegala and Melsiripura interchanges are close to sensitive recipients that will be subjected to high dust/PM10, noise and vibration. Sensitive recipients such as Bambawa Temple and the tank within the Galewala-Dambulla interchange are archaeological sites that may be subjected to dust, noise and vibration.

Bridges / flyovers would be required at several locations where sensitive recipients occur. These areas would be subjected to impulsive noises and high vibration especially during pile driving works. This process is likely to cause disturbance to nearby residents. Some rock blasting is likely to occur in the Deduru Oya area for the construction of piers since the bed comprises unweathered rocky outcrops, which will cause disturbance to both water quality and flow characteristics of the river.

3.3.4 Geotechnical Engineering Aspects

Section 4 trace is from Kurunegala to Dambulla. Two alternatives have been plotted on the Figures 3-3, 3-5, and 3-6 as 4A and 4B.

All these two traces will have similar geological and topographical situations will have low lands as well as small cut areas.

3.4 Final Trace Selection (Kadawatha to Dambulla)

The alternative routes proposed in the CKAH study as well as the NEP study was mainly considered when designing the expressway from Kadawatha to Dambulla. The initial part of the Colombo and Kandy Alternative highway Project from Kadawatha to Gampaha was selected for the initial part of the Expressway and then it follows the route selected for the
Expressway from Gampaha to Dambulla, in order to minimise the overall impact of the project. The CEP starts at Kadawatha from the Kadawatha system interchange.

3.5 Section 3 – Kandy Link

3.5.1 No Action Alternative

The No Action Alternative means there would be no expressway link built between Kurunegala 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 Pothuhara 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 Kurunegala. Therefore, Section 3 of the expressway cannot be considered in isolation from Section 1 and 2.

Hence No Action Alternative is not a suitable alternative.
3.5.2 Alternative Route Analysis

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 impact in sections of particularly difficult terrain.
Initial corridors studied for the Kandy link (Section 3) are illustrated in Figure 3-7

Note that Figure 3-7 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 standard.

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 Meerigama, 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 Meerigama, 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 Potuher 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 because of value for money considerations and expected local resistance to the adoption of the Ring Road. 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 3-8 illustrate 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.

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 3 options are shown in Table 3-5.
<table>
<thead>
<tr>
<th>Alternative Corridors</th>
<th>Length (km)</th>
<th>Relative benefits</th>
<th>Relative dis-benefits</th>
</tr>
</thead>
</table>
| F-K*                  | 43.5        | • Potentially opens areas for development  
• 80kmph design speed achieved to negotiate escarpment.  
• Lower social and environmental impact | Moderately lower distance to Colombo than X-K* |
| X-K*                  | 32.5        | • Potentially opens areas for development  
• 80 -100kmph design speed achieved to negotiate escarpment.  
• Lowest construction cost  
• Lowest social and environmental impact  
• Extension of Section 1 to Ambepussa (Link H)allow 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  
• 80kmph design speed achieved to negotiate escarpment.  
• High social and Environmental impact | 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 hugely detrimental effect on the city and its residents. Therefore, the link from Galagedara to
Kandy was dropped and propose the improvement of A10 road from Galagedara to Kandy to an expressway stand. However, upgrade of A10 Road from Galagedara to Kandy also will not be considered as an immediate need.

3.5.3 Highway Engineering Aspects

3.5.3.1 Proposed Design Alternatives

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.

The section of the alignment from its intersection with Stage 2B (i.e. Pothuhera) to the bottom of the escarpment (at Galagedara) passes through terrain which does not pose many engineering difficulties. Also, population densities are relatively low therefore its effect on existing settlements are 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 center of Kandy without having a hugely detrimental effect on the city and its residents. Therefore, the expressway will terminate at Galagedara merge to A10 road.

Section 3 was divided into following subsections based on the connectivity and the topography of the sections.
Table 3-6: Sub sections of Section 3

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Section length</th>
<th>Chainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 3 - A</td>
<td>Pothuhara - Walagamulla</td>
<td>6.7</td>
<td>0- 6.7 km</td>
</tr>
<tr>
<td>Section 3 - B</td>
<td>Walagamulla - Kotawella</td>
<td>7.4</td>
<td>6.7 km – 14.1 km</td>
</tr>
<tr>
<td>Section 3 - C</td>
<td>Kotawella - Parape</td>
<td>4.4</td>
<td>14.1 km – 15.5 km</td>
</tr>
<tr>
<td>Section 3 - D</td>
<td>Parape - Galabawa</td>
<td>8.4</td>
<td>15.5 km - 23.9 km</td>
</tr>
<tr>
<td>Section 3 - E</td>
<td>Galabawa - Galagedara</td>
<td>5.6</td>
<td>23.9km – 32.5 km</td>
</tr>
</tbody>
</table>

3.5.3.2 Proposed Tunnel sections

The initial design of the Expressway way 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 3-7 summarizes the details of tunnels.

Table 3-7: Summary of tunnel details

<table>
<thead>
<tr>
<th>Tunnel No</th>
<th>Main Alignment</th>
<th>RHS Alignment</th>
<th>Cost (LKR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Main Alignment 15+120 - 15+410 - 290 m</td>
<td>RHS Alignment 15+120 - 15+410 - 290 m</td>
<td>2.639 Bn</td>
</tr>
<tr>
<td>2</td>
<td>Main Alignment 23+430 - 23+630 -200 m</td>
<td>RHS Alignment 23+430 - 23+630 -200 m</td>
<td>1.878 Bn</td>
</tr>
<tr>
<td>3</td>
<td>Main Alignment 27+490 - 27+725 - 235 m</td>
<td>RHS Alignment 27+495- 27+665 - 170 m</td>
<td>1.762 Bn</td>
</tr>
</tbody>
</table>

Comparisons of tunnel and cut options are given in below Table 3-8
Table 3-8: Comparison of tunnel and cut options

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

3.5.3.3 Route Adjustments

The route selected for the Section 3 was adjusted to minimized the impacts and increase the benefits when finalized 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 3-9.

Figure 3-9: 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 3-10.

![Figure 3-10: Route deviation at Galagedara](image)

### 3.5.4 Transportation related Considerations

The trace although the shortest in alternative X-K*, the total distance a traveller from Colombo has to travel up to Rambukkana from Meerigama onwards varies from the 3 alternatives considered. In that aspect the alternative X-K* would be the longest distance while the other two are equal in distance. However, it should be noted that the distance from Kurunagela end remains shortest for the alternative X-K*. While alternative X-K* has a better connectivity to Polgahawela, the alternative G-J-K* provides the best accessibility in terms of connecting A1 and A6 along with more townships south of the expressway.
3.5.5 Hydrological Considerations

There are no major adverse impacts to the hydrologically sensitive areas and flood plains in any of the alternative routes in Section 3. Streams are on deep valleys in this rolling terrain making it technically possible to avoid interruptions to the existing drainage pattern by providing bridges or culverts. However, the route G-J-K* or Alternative 3 is the longest and has the highest number of stream crossings which makes it least preferred. The route F-K* or alternative 1 has a lesser number of stream crossings than alternative 3 making it a better alternative than the alternative 3. Alternative 2 with the shortest route and the least number of stream crossings is therefore the best alternative.

3.5.6 Environmental & Social Issues

Alternative K-X* has been selected as the preferred alternative.

Along the preferred alternative, 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.

Rambukkana Oya, Kuda Oya at Parape and the Kospothu Oya are the main rivers encountered by the proposed alternative. Irrigation canals and drainage canals could also be observed in the project area.

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 16 km to 32 km 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. The proposed alternative for Section 3 crosses or goes parallel to several small to medium waterways, thus affecting the riverine/riparian vegetation directly or indirectly. Naturalized plantation forests are the major forested habitats encountered closest to the study corridor.
3.5.7 Geotechnical Engineering Aspects

This Section 3 is from Pothuhera to Galagedara and 3 alternatives are shown as F-K*, X-K* and G-J-K* in the Figures 3-3, 3-5 and 3-6. Out of these three alternatives, G-J-K* traverses in a relatively difficult terrain which will definitely involve several cut areas. Therefore, compare to other 2 alternatives, G-J-K* will not have similar ground conditions to other two. Other two traces have similar geological and topographical conditions.

However, it has to be noted that, K* trace will traverse on high land area which is susceptible to landslides as shown in figures 3-11 and 3-12. Dark red area indicates possible landslide locations.

Figure 3-11: Landslide hazard map of Kandy district
Figure 3-12: Landslide hazard map of Kegalle district
4. CONCLUSION

The study has evaluated the proposed alternative routes for the Central Expressway in order to select the best possible alignment considering the following factors,

- Highway Engineering
- Transportation
- Hydrological
- Geotechnical
- Environmental and Social.

The expressway was divided into four sections for the purpose of the analysis and alternative traces were evaluated for each section of the expressway. The final expressway alignment would be a combination of the selected traces for each section of the expressway. The alternative traces for each sections were generated from past feasibility studies on Colombo-Kandy Alternative Highway and the Northern Expressway.

The selected traces from the alternatives for each section based on the multi-criteria analysis is as follows.

Section 1: Q-B-H - Kadawatha to Mirigama via Gampaha, Veyangoda
Section 2: 2B - Mirigama to Kurunegala via Potuhera, Dambokka
Section 4: 4B - Kurunegala to Dambulla via Galewala
Section 3 (Kandy link): X-K - Potuhera to Galagedara via Rambukkan

The selected trace for the proposed Central Expressway in Colombo will start at Kadawatha interchange with the Outer Circular Highway -III (OCH -III). The expressway will extend up to Dambulla via Meerigama, Kurunegala. Additional link will be constructed to Galagedara (starting from Potuhera IC via Polgahawela and Rambukkan). In addition, there will be a highway constructed connecting the expressway to Ambepussa starting from Mirigama IC and given in Figure 4-1.
Figure 4-1: Central Expressway Final Alignment

<table>
<thead>
<tr>
<th>Interchange</th>
<th>Chainage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kekirawahe</td>
<td>0+000</td>
</tr>
<tr>
<td>Gampaha</td>
<td>21+354</td>
</tr>
<tr>
<td>Yevangoda</td>
<td>24+985</td>
</tr>
<tr>
<td>Mirigama South</td>
<td>37+560</td>
</tr>
<tr>
<td>Mirigama North (System)</td>
<td>37+980</td>
</tr>
<tr>
<td>Nakalagegama</td>
<td>36+140</td>
</tr>
<tr>
<td>Potuhara (System)</td>
<td>66+000</td>
</tr>
<tr>
<td>Dambalka</td>
<td>70+179</td>
</tr>
<tr>
<td>Kurunegala</td>
<td>75+883</td>
</tr>
<tr>
<td>Ridigama</td>
<td>89+310</td>
</tr>
<tr>
<td>Melsripura</td>
<td>108+210</td>
</tr>
<tr>
<td>Galuwela</td>
<td>124+410</td>
</tr>
<tr>
<td>Dambulla</td>
<td>139+960</td>
</tr>
</tbody>
</table>

Ambepussa Link

- Mirigama - North | 0+000
- Ambepussa        | 9+160

Galagedara Link

- A. Potuhara       | 0+000
- B. Poigahavella  | 4+650
- C. Rambukkana    | 13+850
- D. Galagedara    | 32+480