EXECUTIVE SUMMARY

E.1 Introduction

The Government of India has envisaged to create a world-class infrastructure facility, to boost the economic development in the country, for which National Highways Authority of India (NHAI) plays key role. NHAI has been entrusted to implement the development of some of the stretches of National Highways under National Highway Development Programme on EPC/BOT basis. As part of this endeavor, the Public Works Department (PWD) of Government of Goa has decided for the development of existing Goa/Karnataka Border- Panaji Goa Section of NH-4A from Km 84/133 to 153/075 on BOT (Toll) basis under NHDP-III (Anmod to Panaji section) to four Lane configuration.

Public Works Department (PWD) of Goa has appointed M/s Aarvee Associates Architects Engineers & Consultants Pvt. Ltd., Hyderabad to provide consultancy services for detailed engineering study for the above road section.

The project stretch excludes following reaches:

1. From Km 118.000 (Kandepar) to Km 125.000 (Safa Maszid)
2. From Km 143.400(Ella) to Km 153.075 (Panaji).

E.2 Project Description

The Project Highway is a section of NH-4A(Belgaum-Anmod-Ponda-Panaji) between Anmod and Panaji, passing through villages Molem, Sangod, Dharbandora, Piliem, Tiska, Candepar, Curti, Ambegal, Veling, Boma, Banastarim, Corlim, Old Goa, Ribandar. The entire stretch of NH-4A lies in the states of Karnataka and Goa. It provides an important link between NH-4 and NH-17. The entire alignment passes through hilly and rolling terrain except few reaches towards Goa.

As the project road is passing through the Bhagawan Mahaveer Wildlife Sanctuary the present forest diversion proposal covers only the stretch from Existing Km 84.133 to Km 97.000. This includes Reserved Forest area between Km 95.550 to Km 97.000 on RHS and from Km 96.300 to Km 97.000 on LHS . The Wildlife area,exists between Existing Km 84.133 to Km 95.550 on RHS, National Park from Km 84.133 to Km 96.300 on LHS.

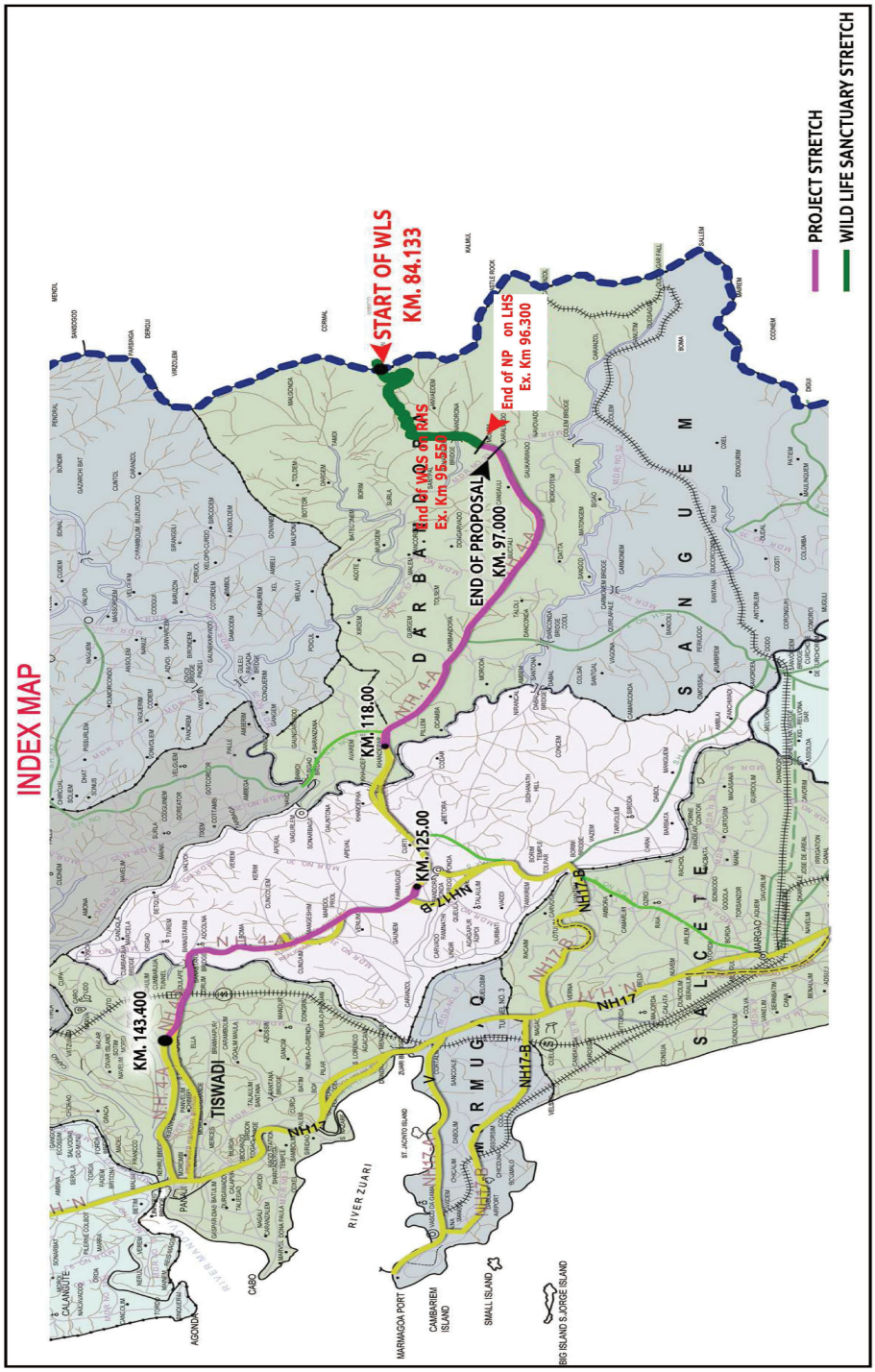

Figure: E.1 Index Map

E.3 Alignment Option Study

Reconnaissance, map studies and detailed investigati ons of the influence area were carried out for identifying the existing road network, land use p attern and industrial activities along the project co rridor. Different alignment options are considered, evaluated and recommendations are presented in the subsequent sections.

Project road has inconsistent terrain conditions with a mix of hilly, highly rolling and plain topography. The following standards have been followed for improving the horizontal geometry. For the purpose of horizontal design the project road is divided in to following sections.

Section I: Km 84.133 to 97.000 (Mountainous/Steep terrain).

The Project Highway starts with mountainous/steep terrain form Km 84.133 at Goa/Karnataka border. Existing alignment has substandard horizontal as well as vertical geometry due to steep terrain from Existing Km 84.133 to Km 94.000. There are hairpin bends, where the speed about 20 kmph.

The consultants have studied in details for improving the horizontal geometry of existing 2 lane carriageway as well as new 2 lane carriageway in consultation with the PWD. The stretch under consideration is passing through wild life sanctuary. Hence, following options were studied for improvement proposal.

Option - 1: Widening on hill side

Hard rock outcrop is visible in this stretch. For widening new carriageway on hill side requires blasting operations and frequent closing of live traffic. Further, blasting may pose sever impact on wild life in surrounding area.

There are locations, where landslides also observed in this stretch. Hence widening on hill side may result in heavy breast walls.

Option - 2: Widening on Valley side without improving the existing

Widening on valley side do not requires closing live traffic. It will have minimum impact on wild life, since it do not requires any blasting operations.

Widening new carriageway on valley side requires construction of either retaining wall or via-duct to support new carriageway.

To have minimum impact on local environment and ease of construction, the consultants have proposed via-duct for the new carriageway. It be independent

of existing carriageway (no common median) and will comply with geometric standards stipulated in 4 laning manual.

Option - 3: Widening on Valley side with realignments

Cost of viaduct is directly proportional to the length of via-duct. The consultants have studied in detail for feasibility of shortening the length of via-duct within permissible gradients. After detailed study at site, based on the topographical survey and preliminary design of vertical alignment, it was identified that from Km 89 to Km 92 can be connected with smooth geometry within permissible gradients. Based on above three options, Option 3 is most feasible, even though the construction cost is higher than the options 1&2.

Table E.1: Merits and Demerits

Description	Option-1	Option-2	Option-3
Traffic Management	Road closure during blasting and removal of debris operations	Road closure while forming ramps on the valley side	Road closure while forming ramps on the valley side
Stability issues	It would not be possible to cut hill to the required slope since that would disturb road on the hill side. Thus, adequate slope stabilizing structures are to be provided to prevent landslides.	Existing slopes on hill side are to be stabilized. Construction of viaduct may not involve any stability related concerns.	Existing slopes on hill side are to be stabilized. Construction of viaduct may not involve any stability related concerns
Structures involved	Breast Walls, Soil Nails etc. may be required for ensuring slope.	Viaduct structure; earth retaining structures	Viaduct structure; earth retaining structures
Environmental issues	This option would involve disturbing of hill slopes in the wild life sanctuary.	This option would involve insignificant disturbance to environment during construction time.	This option would involve insignificant disturbance to environment during construction

Description	Option-1	Option-2	Option-3
Extra Forest Land to be acquired	26.4 hectares. This option would involve disturbing of hill as the complete widening on hill side and the entire land will be occupied. In this option revegetation of forest cover will not be possible as additional 2 lanes will land on hills.	26.6 hectares. This option would involve insignificant disturbance of hill as the new 2 lane will come on valley side and the land required is only at pier locations. In this option the above land is utilized for construction project. After the construction the vegetation of forest cover will be reinstated except at pier locations which is the nominal area.	11.1hectares. This option would involve insignificant disturbance of hill as the new 2 lane and some existing 2 lane realignments will come on valley side and the land required is only at pier locations. In this option the above land is utilized for construction project. After the construction the vegetation of forest cover will be reinstated except at pier locations which is the nominal area.
Geometric alignment	Will follow the existing alignment; Substandard curves will remain.	Will follow the existing alignment; Substandard curves will remain.	Sharp sub-standard curves will be improved.
Construction time	Less compared to other two options	Viaduct formation will be time consuming.	Slightly more time compared to option 2 since substructure height will be higher.

Recommended Option:

Since, the project stretch falls in wildlife sanctuary and National Park, Option-3 which involves minimum acquisition of the forest land falling in wildlife sanctuary and National Park and improvement of the existing alignment to the proper geometric standards is recommended.

The alignment options were discussed with the competent authority (Ministry) in the presence of PWD officials at Delhi on 02/02/2016. The alignment Option-3 is approved by Authority vide letter no. RW/NH/37015/14/2016/NHDP-IV A, dated 26.02.2016.

Typical Cross Sections (TCS):

TCS-VIII(a): Typical Cross Section for 4 Lane divided highway at same level with Raised Median (Cut Portion)

The TCS indicates widening of the existing road on hill side for a length of 600m starting from Km 85.380 to Km 85.980. Here widening on valley side is not feasible due to hair pin bend on RHS. Hence, to avoid overlapping of the bend section of hair pin, the existing road has been proposed to widen on LHS with cutting. This is the only location where the natural hill will be disturbed. The area proposed to cut is about 1.35 hectares with a width of 13m.

TCS-VIII(b): Typical Cross Section for 4 Lane divided highway with 2 Lane Elevated Structure on Valley Side

The TCS indicates widening of the existing road on Valley side wherever the existing road is geometrically suitable for 4 lane standards.

This TCS is applicable in seven locations covering a total length of about 4.027 km of the project road.

TCS-VIII(c): Typical Cross Section for 4 Lane divided highway with 4 Lane Elevated Structure.

The TCS indicates construction of 4 lane Elevated Corridor wherever the existing road is geometrically not suitable for 4 lane standards. Also in places wherever the existing sharp curves are smoothened to match up with the proposed geometrics standards. This TCS is applicable in six locations covering a total length of about 3.040 km of the project road.

TCS-VIII(d): Typical Cross Section for 4 Lane divided highway in Plain/Rolling terrain.

The TCS indicates widening of the existing road on LHS/RHS to 4 lane highway standards.

This TCS is applicable in One location covering a total length of about 4.400 km of the project road.

TCS-VI: Typical Cross Section for approaches to Vehicular Underpass (VUP) with Slip Roads on both sides.

This VUP facilitates smooth movement of Collem-Sacordem road traffic. This TCS is applicable in One location covering a total length of about 0.800 km of the project road in Reserve Forest area (out side of WLS).

Details of the forest Area needed for diversion:

Total area for diversion(Wildlife Sanctuary+National Park +Reserved Forest)–32.085 Ha

Area Proposed in Wildlife sanctuary and National Park - 31.015 Ha

Area proposed for diversion in Wildlife Sanctuary - 6.750 Ha.
Area proposed for diversion in National Park - 24.265 Ha.
Permanent Area for Diversion in Wildlife/National Park – 11.1 Ha.

Area Proposed and Permanent for diversion in Reserved Forest – 1.070

Area for temporary diversion - 19.915 Ha.(Wildlife & National Park)

Area for Permanent Diversion:
As per the recommended option, the proposed structure involves construction of a via duct on valley side and similar structures of lesser length will be constructed on hill side wherever curves will be improved. Total area for permanent diversion in the project road is dependent on the total number of piers constructed and the cross-sectional area of each pier.

The area for permanent diversion also includes one Ha of cutting of the hill to improve the existing alignment from Existing Km. 85.400 to 86.000.

In addition to the above paved shoulders are also proposed on either side thoroughout the length of the project road.

As the proposed improvements are of permanent in nature a total 11.1 Ha of fresh forest land in wildlife sanctuary/National Park area is needed for diversion.

Area for Temporary Diversion:
Given the hilly terrain of the project road, it was proposed to form 18m wide temporary road for the movement of materials and machinery at the foot of the hill.

Approach points will be identified based on the slope and other conditions convenient to reach the temporary road.

In addition to this, two locations were identified at Km 90.400 to 90.600 with an area of 0.4 Ha and the second one at Km 91.800 to 92.000 with an area of 0.6Ha for storage of construction materials.

The above mentioned area is needed to execute improvements to the existing road. Hence this 19.915 Ha of area will be released back for afforestation after completion of the proposed improvements to the road.