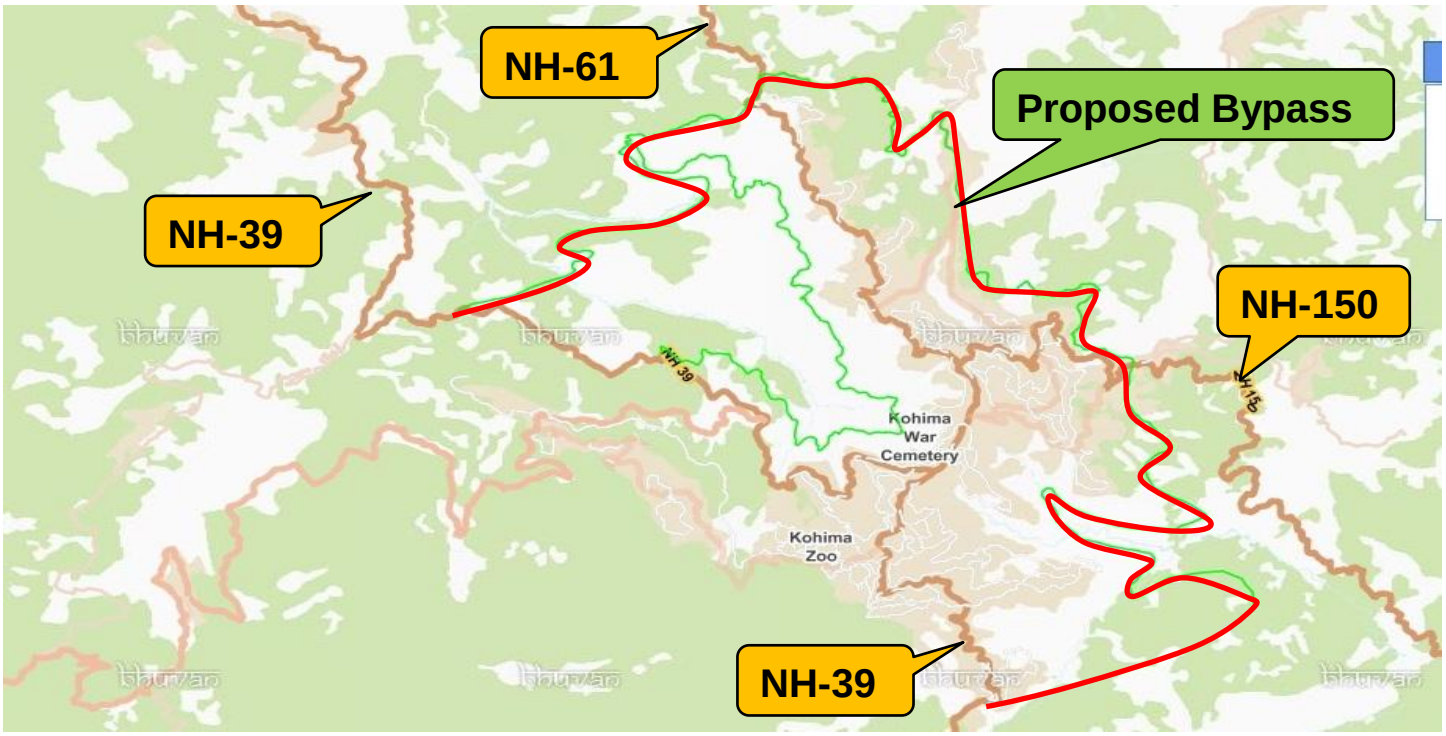
NATIONAL HIGHWAY INFRASTRUCTURE DEVELOPMENT CORPORATION LTD
Government of India
(Ministry of Road Transport and Highways)

Preparation of Detailed Project Report (DPR) and providing pre-construction services in respect of 4 Laning of **Kohima Bypass** connecting NH-39 (New NH-02),NH-150 (New NH-02), NH-61 (New NH-29) and NH-39 (New NH-02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland.



FINAL DETAILED PROJECT REPORT

SAFETY AUDIT REPORT(VOLUME-X)

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SAFETY AUDIT OF ALIGNMENT

1.0 Introduction

1.1 General Background

The National Highways & Infrastructure Development Corporation Ltd.(NHIDCL) has been entrusted for Consultancy Services for carrying out Feasibility Study, Preparation of Detailed Project Report (DPR) and providing pre-construction services in respect of 4 Laning of Kohima Bypass connecting NH-39 (New NH-02), NH-150(New NH-02), NH-61(New NH-29) and NH-39 (New NH-02) on Engineering, Procurement and Construction (EPC) mode in the state of Nagaland for proper structuring and implementation of projects on EPC mode .

M/s Highway Engineering Consultant (HEC) in Association with Agnitio Infrastructure Projects Pvt. Ltd. (AIPPL) has been instructed to commence the services from 12.12.2016 vide NHIDCL HQ letter no. NHIDCL/ DPR/ Nagaland/ Kohima Bypass/2016/179 dated 11.01.2017.

1.2 Project description

The project lies in the Northeastern part of India. Kohima is capital of the state of Nagaland. The Kohima district share its border with Dimapur District in the West, Phek District in the East, Manipur State and Peren District in the South and Wokha District in the North.

The current project is to bypass the heavely congested Kohima town. The maximum length of the proposed bypass is new alignment. Hence, details of existing road does not have any major impact on the project.

However, we have collected data of existing road considering 0.00 chainage at High court junction. The alignment of existing road starts from High Court junction and terminates near BSF camp on NH-150 through NBCC Junction. Total length of the existing road is 10.300 kilometer.

1.3 Project silent features

Items	Proposed
Project Chainage	Km.0+00 to Km 44+519
Total Project Length	44+519 Km
Bypass	The project itself is bypass of Kohima town
Grade Separated Structures	One
Cattle and Pedestrian underpass/ Overpass	Nil
At Grade Junctions- Major	2 Number
At Grade Junctions- Minor	2 Numbers
Bridges	Major Bridges – 3 Minor Bridges – 1 Overbridge/Flyover – 1 Tunnel-1
Culverts	Total Culverts : 268
	Box Culverts: 268

1.4 Scope of Services

The scope of safety audit is as per supplement-III of terms of reference.

2.0 Methodology

2.1 Introduction

Road Safety Audit (RSA) is defined as "the formal safety performance examination of an existing or future road or intersection by an independent, multidisciplinary team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users".

Road Safety is a multi-sectorial and multi- dimensional issues. It incorporates the development and management of road infrastructure, provisions of safer vehicles, legislations and law enforcements, mobility planning, provisions of health and hospital services, child safety ,urban land use planning. In other words, its ambit spans engineering

aspects of both roads and vehicles on one hand and the provision of health and hospital services for trauma cases on the other. Road safety is a shared, multi- sectional, responsibility of the government and a range of civil society stakeholders. The success of road safety strategies in any country depends upon a broad base of support and common action from all stakeholders.

A Key features of a road safety audit is the use of a team of professionals with varied expertise. The team shall include highway safety engineers, highway design engineers, maintenance personal, and law enforcement. Additional specialties shall be added to the team as needed. The team members must not be involved in the design or maintenance of the facility being examined, so that they can have an objective point of view.

Central Road Research Institute (CRRI) has studied road safety elements extensively in the past and has come up with various manuals such as manual for safety in road design (1998), Road safety Audit Manual (2003) and Revised Road safety Audit manual (2010). Indian Road Congress (IRC) has published Special provision SP: 88-2010, Manual on road Safety Audit. The methodology used for the design stage audit process is based on these manuals.

2.2 Road Safety Audit methodology

The copies of the Feasibility report and the detailed design plans included in the contract shall be obtained from the contractor. The plans indicate existing/ proposed conditions of the project road along with details of facilities and details of utility and specifications. The proposed project improvements shall be examined against various guidelines, stipulations as mentioned in the Indian safety Guidelines/ Manuals. Also the latest Indian Road Congress (IRC) guidelines along with circulars, ministry of Road Transport & Highways, Govt. of India (MORT & H) circulars that have safety considerations shall be referred by the consultants for more-in-depth review. The guidelines/codes of practices considered for the safety audit are listed below in para 3.5. Moreover, special emphasis shall be given to IRC: SP-88. Manual on road safety audit, Indian road congress, New Delhi for the audit.

2.3 Safety Audit at Feasibility stage (Preliminary design stage)

Safety Consultant with help of Contactor shall collect all relevant project documentation such as:

- **Design Drawings:** which shall include drawings of horizontal alignment, vertical profile and typical cross sections, cross drainage works, interchanges, major intersections, traffic diversion plans and traffic control measures, road drainage measures, typical details slope protection measures, pedestrian crossings, drawings of street lighting.
- **Contract documents:** this information will be used by the audit team to assess the project from a safety perspective.

Design stage Road Safety Audit

Carry out a Feasibility stage audit as per IRC SP: 88-2010 and other applicable manual, guidelines, standards (IRC, MORTH, NHAI & Relevant international standards) and prepare a draft safety report.

Review of project Documents:

Once all the background information is collected, the audit team shall assess/ evaluate and analyze all the available information. For audits during development/ construction stage, the audit team shall examine the details about the existing project and constrains involved on a section by section basis. This provides an opportunity to consider the impact of the design on all road users.

Safety Report

The audit report shall clearly and concisely identify aspects of a project which could impact negatively on the level of safety for users.

All safety hazards which warrant immediate improvement shall be identified with words such as “FOR IMMDIATE ATTENTION”. Any safety problems which the audit team considers to be significantly hazardous shall be identified as “IMPORTANT”. The

following Reports and documentation shall then be generated in line of the above audit/ Review.

- ❖ Safety Drawings with its recommendations on safety related measures
- ❖ Safety Report

2.5 Safety Audit Checks

All design drawings/ documents shall be checked based on the minimum criteria.

2.5.1. Highway Alignment

The design plans were checked for the following alignment inconsistencies IRC SP: 84-2014, Clause 2.8.1. (Radii of Horizontal curves) and IRC SP 48:1998 (Hill Road Manual).

The minimum radius of the horizontal curves for different terrain will be reviewed based on the manual of specifications and standards for two lane highways and IRC:38 Guidelines for Design of Horizontal curves for highways and design tables, table 3. "Minimum radius for horizontal curves for Different terrain conditions and for minimum design speeds".

2.5.1.2 Super elevation criteria

The Super elevation for the design speed and different horizontal curve radii for this project will be checked based on the IRC: 38 Guidelines for Design of Horizontal curves for highways and design tables, table 4. Super elevation for different speeds and curve radii.

2.5.1.3 Widening on horizontal curves

When travelling at higher speeds on curves the drivers have difficulty to steer the vehicles to be in center of the lane, where in extra widening of the pavement is needed on horizontal curves. The design plans will be checked as per IRC 38: Table 7. Extra width of pavement at horizontal curves.

2.5.1.4 Vertical Curve

The minimum length of the Vertical curves for different terrain will be reviewed based on the IRC SP: 23 Vertical curves for highways, table -7 Minimum length of the Vertical curves.

2.5.2. Visibility sight distance

The Visibility sight distance report, MxRoads/ Civil 3D files created by the designer/contractor shall be checked based on IRC: SP 84:2014 and IRC SP 48:1998 (Hill Road Manual).

2.5.3. Typical Cross sections & widening scheme

The Typical cross sections and widening scheme has been provided by the designer will be checked for any inconsistencies such as availability of sufficient hard shoulders, widths of the carriageway and for cross slopes and side drains.

2.5.4. Guardrails, Hedges and Railings

The design plans shall be checked as per IRC: SP 84 Manual of Specifications and standards for four laning of highway through public private partnership, fig 9.1: warrants for roadside Barriers on Embankments.

2.5.5. Truck lay byes

Location

Proximity to the junctions

The locations of truck lay byes in the design plans will be observed with respect to their proximity to the junctions. It is recommended that the locations of the truck lay bye be at least 50m away from the junctions.

Layout

The details of the truck lay byes need to be provided as part of the design plans. Truck lay bye are recommended to be designed with a taper for trucks existing to and from the Service road/highway.

2.5.6. Bus Lay byes

Location

Proximity to the junctions/ Intersections

The locations of Bus lay bye will be checked as per IRC 80 "Pick up bus stops on rural highways".

2.5.7. Acceleration and Deceleration lanes at Intersections

The design plans for the Acceleration and Deceleration lane shall be reviewed based on the IRC: SP-41 Guidelines for the design of at grade intersections in Rural and Urban Areas.

2.5.8 Lane Transitions along Bridges:

Proper merging/ diverging lane should be provided for smooth man oeuvre of the traffic on the main carriageway as prescribed in fig 3.2 in IRC SP -27 workshop on Highway Safety for lane gain and lane drop specifications while approaching the bridge sections.

2.5.9. Review of Structural drawings:

Structural drawings submitted will be reviewed for safety features such as crash barrier, RCC railings, and guardrails location details.

2.7 Adopted Designs speed less than IRC minimum design speed

The desirable minimum design speeds of 60 kmph (Radius 150 m) & absolute minimum design speeds of 40 Km/hr (Radius 75m) for mountainous and steep terrain is recommended as per IRC: SP 84:2014 table 2.1 & 2.6 and IRC SP 48:1998 (Hill Road Manual).

The alignment is designed for deign speed of 60 Km/h but at some locations the speed has been reduced to 40 Km/h due to site constraints.

As per the horizontal alignment report, the places of deviation for minimum speed i.e 40 Km/h (Radius 75 m) is not observed.

Recommendations:

At locations where the design speed is less than the recommended ruling design speed of 60 Kmph for National Highways, in such scenario proper speed reducing measures with installation of traffic control devices such as road signs as per IRC and other standard guidelines shall be adopted. It is recommended that the maximum allowable operating / posted speed on the project highway shall be 40 Km/h. The same shall be posted at the beginning and end of the project stretch with repeater signs at regular intervals as per IRC 67-2012.

2.8 Highway Alignment

The design plans were checked for the following alignment inconsistencies

2.8.1. Radii of Horizontal Curves

Ruling & Absolute minimum radius for horizontal curves for national highways for mountainous & steep terrain conditions per IRC 38 and IRC SP: 84:2014 and IRC SP 48:1998 (Hill Road Manual) are 150 m and 75 m. The design plans were reviewed and the location with radius that does not meet IRC Standards is shown in table in para 2.7 of this report.

2.8.2 Transition Lengths:

The design plans were checked for the length of transition of horizontal curves provided. The plans were observed to be meet the minimum transition lengths as per Table 9 of IRC: 38 (IRC: 73, Table 17).

2.8.3 Super elevation Criteria

Super elevation shall be provided as per IRC 73 Corresponding to the design speed and radius of the horizontal curve adopted. As per the IRC 73 the super elevation required on horizontal curves should be calculated from the formula or table no 4 from IRC 38.

$$e=v^2/225R$$

Where

e = Super elevation in meter per meter,

v= Speed in Kmph

R= Radius in meters,

The design plans were reviewed and the minimum rate of super elevation was met all locations in the subject project.

2.8.4 Widening on horizontal curves

Safety Consultants have reviewed the details of extra widening provided by the contractor.

The length of extra widening provided for horizontal curve meets the minimum requirement as per IRC SP 84, Table 2.3:

2.8.5. Vertical Curves

The design plans were checked for the minimum length of the vertical curves as part of this audit process based on the IRC: SP 23 vertical curves for highways, table 7. Minimum length of the vertical curves. The length of the vertical curve for minimum design speeds of 60 kmph & 40 kmph for mountainous & steep terrains are 40m & 20m respectively.

In this plan & profile all minimum length of vertical curves are satisfied with the IRC codal provisions.

Recommendations:

Locations where vertical curve length is less than the minimum requirement of 20m for steep terrain, the alignment shall be improved to meet the minimum requirement as per IRC : SP 23 vertical curves for highways , table 7. Minimum length of the vertical curves.

2.9. Guardrails, Hedges and Railings

Safety consultants have reviewed the cross section drawings and at hazardous locations, it is recommended to provide W Beam metal crash barriers / parapet walls for safety of the passengers.

2.11. Vertical Curves

Vertical curves will be designed to provide for visibility at least corresponding to the safe stopping sight distance. More liberal values will be adopted wherever this is economically feasible. Valley curves will be designed for headlight sight distance.

Description of Road Safety Issue

The Project road is designed for 60 Kmph design speed, whereas the absolute minimum speed is 40 Kmph for mountainous & steep terrain. Project sections less than ruling design speed (i.e 60 Km/hr) should be subjected to speed restriction signs.

Recommendation to Address the Issue:

- Speed restriction signs to be provided at relevant locations. If required restriction signs to be repeated to warn the road users.
- Sharp Curves to be supplemented by Chevron markings on outer side of the curve.
- Series of Chevron signs to be placed before the start of curves to warn drivers.
- Studs should be placed on road edges to warn the drivers the extent of Carriage way available during night time.
- Where overtaking is Prohibited (Curves) the same should be supplemented by road markings and if required by road studs relevant to the type of centerline marking.(Ref: IRC 35, IRC 66)