Government of Nepal
Ministry of Federal Affairs and Local Development
Central Level Project Implementation Unit
Earthquake Emergency Assistance Project
Lalitpur, Nepal

Earthquake Emergency Assistance Project
(ADB Loan 3260-NEP)

Detailed Project Report

Haldebeshi – Dhobi – Dhadebeshi Road

Rehabilitation and Reconstruction Project
CH: 0+000 – 38+899.19 Km
Ramechhap

Section I: Detail Engineering Survey, Design and Estimate

Volume 1: Main Report (Final)

April 2017

ACKNOWLEDGEMENT

Gaurav Integrated Development Associates Nepal (P) Ltd/NEST (P) Ltd/Jaarsa Engineering Consultancy (P) Ltd. JV, the Consultant would like to extend its gratitude to Decentralized Rural Infrastructure and Livelihood Project – Additional Financing (DRILP-AF), Central Implementation Support Consultant (CISC), Ekantakuna, Lalitpur, Nepal for providing an opportunity of Preparation of Detailed Project Reports for Rehabilitation and Reconstruction of Haldebeshi – Dhobi – Dhadebeshi Road, Ramechhap. Also, we would like to acknowledge all the members of CISC for their kind co-operation.

We would further like to acknowledge DDG, SDE Mr. Vijaya Muni Bajracharya, Er. Dilli Raj Adhikari of DDC Ramechhap, CISC team, Er. Saroj Acharya of DTO, Sub Engineer, the local people of the project area and all the individuals involved in this project works for their kind co-operation and help at every step of preparation of this report.

Last but not least, team would like to be glad for the technical and supporting staffs of Gaurav Integrated Development Associates Nepal (P) Ltd/NEST (P) Ltd/Jaarsa Engineering Consultancy (P) Ltd. JV who have done remarkable assistance to complete the assignment.

Gaurav Integrated Development Associates Nepal (P) Ltd
NEST (P) Ltd
Jaarsa Engineering Consultancy (P) Ltd.
April 2017

EXECUTIVE SUMMARY

The detailed engineering survey, design and cost estimate for rehabilitation and reconstruction of Haldebeshi – Dhobi – Dhadebeshi Road has been prepared for ADB funded Emergency Earthquake Assistance Project (ADB L0an 3260-NEP) following the principles of build back better. The road traverses through Tilpung, Nagdaha, Bijulikot and Saipu VDCs of Ramechhap District. The length of the Haldebeshi – Dhobi - Dhadebeshi road is 38.89 km. The distance from Haldebeshi to Dhobi is 19.930 km.

The existing road starts from Haldebeshi, Tilpung VDC-2 and ends to Dhadebeshi, Saipu VDC-4 passing via. Nagdaha and Bijulikot VDCs. Throughout the length, the existing road condition is moderate and undulated. In majority of road up to Dhobi, the alignment is stone pitched. However, stone pitching is in poor condition in some sections. The existing road have grade below 12% in most of the sections upto 22 kilometers from Haldebeshi. The existing grades are extremely high up to 18.5% in sections after 22 kilometers. The maximum grades are in the sections Ch: 22+450 to 23+420, Ch: 25+210 to 25+720, Ch: 26+860 to 27+810, Ch: 30+580 to 31+100, Ch: 31+875 to 32+800, etc. The existing road width varies from 5 m to 8 m wide. Narrow sections have minimum road width of 3 m.

During the design, existing road has been followed as far as possible; however the alignment has been shifted in some places especially at loops to maintain the geometric design parameters and at problematic areas of steep gradient. The alignment changes are in the sections Ch: 23+070 to 23+580, 25+500 to 25+900, 27+230 to 27+380, 28+140 to 28+380, 31+580 to 31+840, 33+150 to 33+310 and 33+310 to 33+830. Nepal Rural Road Standard (2055) 2nd revision, December 2014 has been followed for the design. The maximum and minimum grade adopted in the design is 12% and 0.5% respectively. The road has been designed to maintenance from Haldebeshi to Dhobi and gravel standard from Dhobi to Dhadebeshi.

For pavement design of gravel standard from Dhobi to Dhadebeshi, CBR value is calculated from results of DCP test and from this the required thickness of sub-base has been calculated. From the results of DCP test and judging economic in gravel road, the thickness of sub base 150 mm has been adopted. Capping layer of 100 mm has been provided below sub base in sections where sub base thickness required is higher than 150 mm from result of DCP test and pavement design. Bio-engineering works have been proposed in places prone to landslides and erosions. For spoil management, the proper locations along the site have been identified.

The design was reviewed during joint field verification by team of Consultant and CISC. The comments and feedback received by the consultants have been incorporated in preparing the final design.

The cost estimates are based on applicable DoLIDAR norms. In cases where DoLIDAR norms are not available, DOR norms have been used. The unit item rates for each item have been calculated on the basis of approved district rate for fiscal year 2073/74. While calculating item rates, it is assumed that a qualified contractor will undertake construction following mechanized approach for road works.

The cost of civil works has been estimated to be Rs. 215,697,563.16. The total cost for rehabilitation and reconstruction to gravel standard including contingencies consisting of small miscellaneous expenses, work charge staff and VAT as per GON rules is calculated to be Rs. 271,778,929.58. Per km cost including VAT is Rs. 6,265,925.77. It is envisaged that the construction works can be completed within 18 months from award of contract and estimates are based on it. Provision of physical contingency 10% has been indicated in the cost estimate.

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SALIENT FEATURES

Features	**Description**
Name of the Road	Haldebeshi – Dhobi – Dhadebeshi Road
Scope	Reconstruction and Rehabilitation
DRCN No.	21DR025
Location	
Region:	Central Development
Zone:	Janakpur
District:	Ramechhap
VDC/Municipality	Tilpung, Nagdaha, Bijulikot, Saipu
Major Settlements	Haldebeshi, Jhangre, Katahare, Kharibote, Aarubote, Nagdaha, Dhobi, Kotgau, Poku, Sirise Setapahara, Dhade
Length	38.89 km
Starting Point	Haldebeshi, Tilpung VDC-2
End Point	Dhadebeshi, Saipu VDC-4 (Steel Truss Bridge bordering Ramechhap and Okhaldhunga districts)
Beneficiaries Population in ZOI	Population – 1500 , Households – 300
Geographical feature	
Terrain	Mid-Hills
Altitudinal Range	532 m to 1828 m
Climate:	Tropical to Sub-tropical
Geology:	Lesser Himalayan Rocks (Phyllite and Gneiss), Colluvium, Alluvium and Residual Soil
Meteorology:	Unevenly Distributed Precipitation
Design Standard	
Standard:	NRRS(2055) 2nd revision, December 2014
Existing Surface:	Earthen, Stone pitched
Proposed Pavement:	Cobble (Ch: 0+000 – 19+930) Gravel (Ch: 19+930 – 38+899)
Geometrics	
Right Of Way:	10 m on either sides (Center line)
Formation Width:	6.25 m (includes 1m drainage & 0.75 m Shoulder either side)
Carriage Way Width:	3.75 m
Shoulder Width:	0.75 m on either side
Maximum Gradient	12%
Minimum Gradient	0.5%
Lane	Single

Features	Description
Structures (Qty/No.)	
Drainage Structures	
a) Side Drain	Throughout the alignment at hill side, Cascade drain for grade greater than 7%
b) Causeway	8 (RCC)
c) Pipe Culvert	29
d) Slab Culvert	1
e) Irrigation Crossing	15
Retaining Structures	
a) Stone Masonry Wall	11473.13 cu. m.
b) Stone Revetment Wall	243.80 cu. m.
c) Gabion Retaining and Breast Wall	7,983.50 cu. m.
Earth Work	**Road works**
a) Excavation/Cutting	178,990.47 cu. m.
b) Embankment/Filling	21610.45 cu. m.
Pavement	
a) Gravel	16,507.23 cu. m.
b) Cobble	6,680.00 cu. m.
Cost Estimate (Rs.)	
1. Civil Works (Base cost)	215,697,563.16
2. 13% VAT (of 1)	28,040,683.21
3. Sub-Total (1+2)	243,738,246.37
4. Per km Cost (including VAT)	6,265,925.77
5. Work Charge Staff and Small Miscellaneous Expenses @ 3%	6,470,926.89
6. Physical contingency @ 10% (of 5)	21,569,756.32
7. Grand Total	271,778,929.58

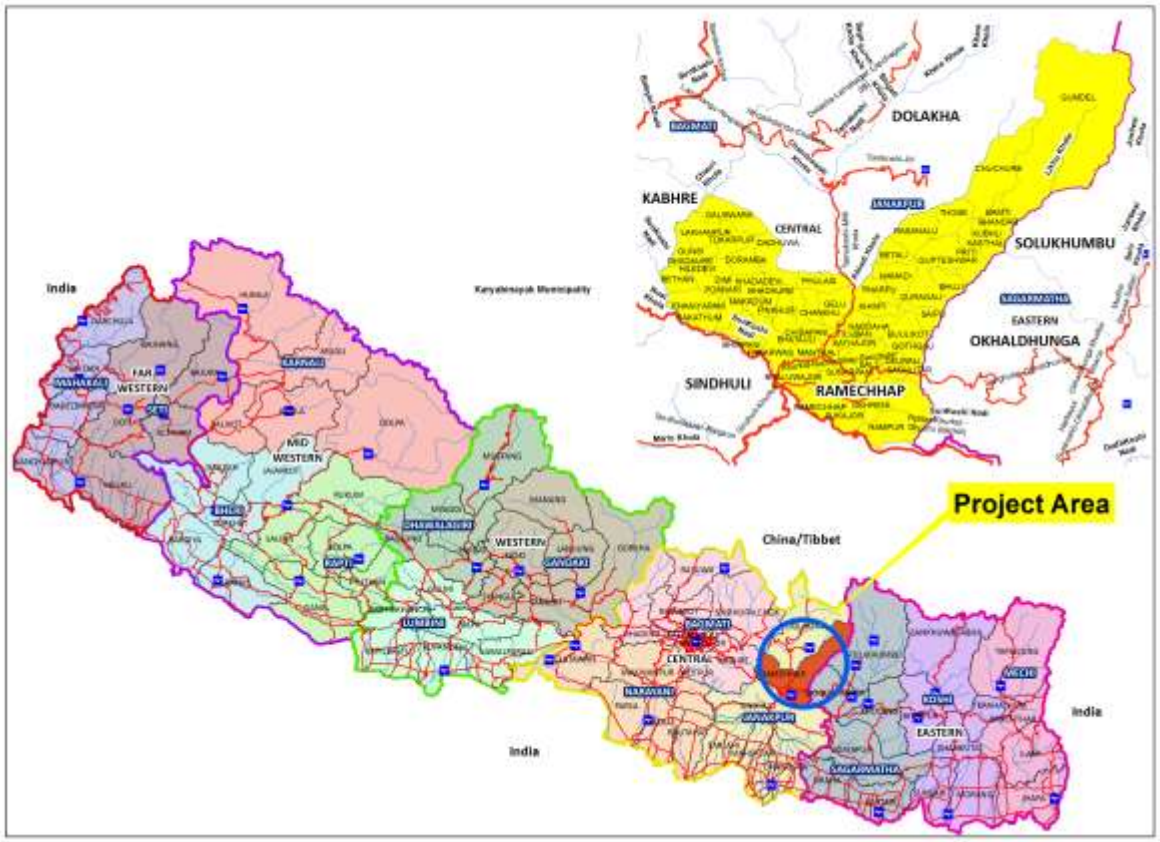

Figure 1: Map of Nepal showing Ramechhap District

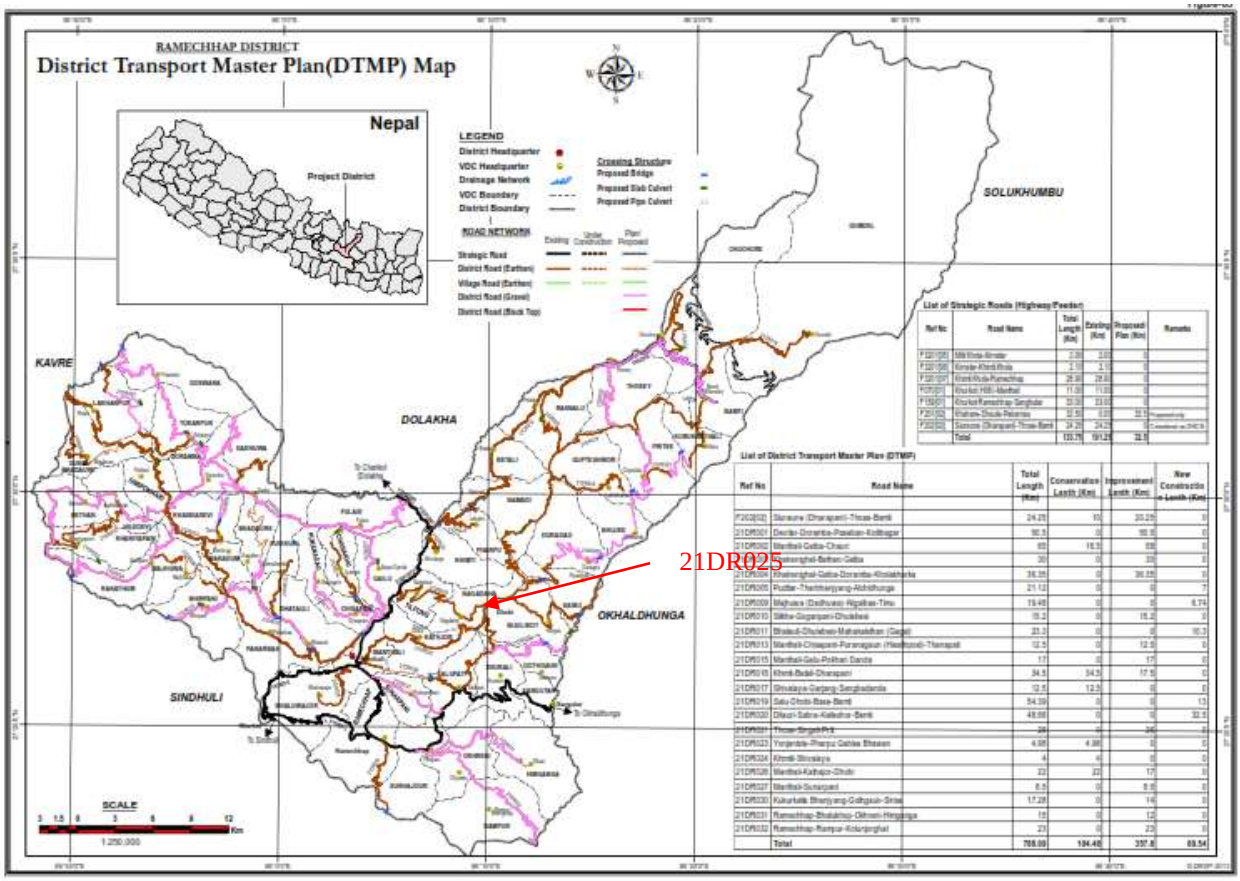

Figure 2: Haldebeshi-Dhobi-Dhadebeshi Road in DTMP Map

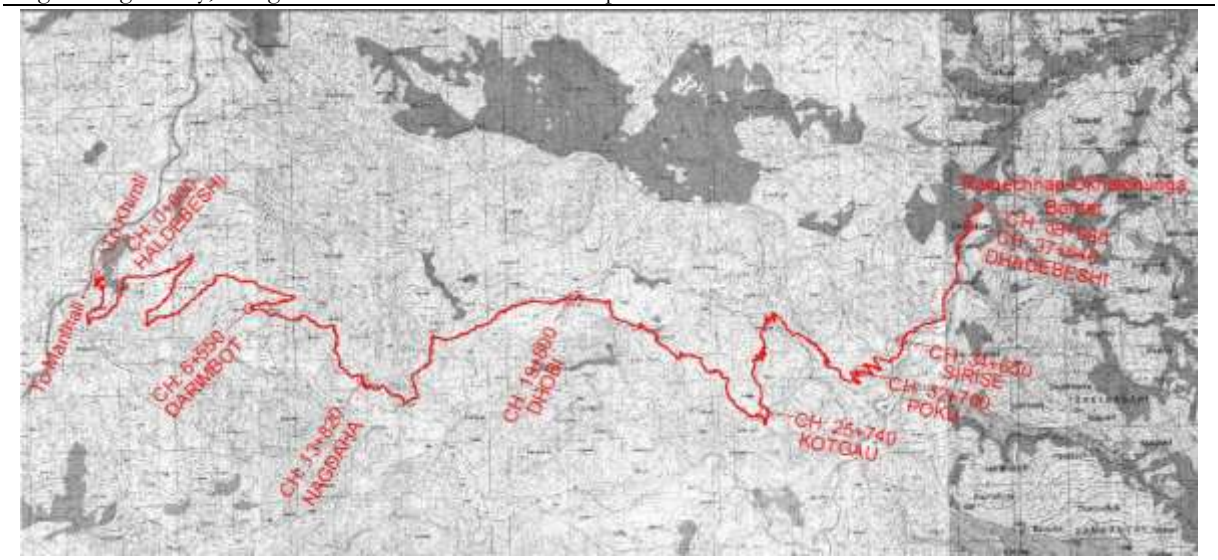

Figure 3: Road Alignment in Topo Map

ACRONYMS/ ABBREVIATIONS

DDC	District Development Committee
DoLIDAR	Department of Local Infrastructure Development and Agriculture Roads
DRILP	Decentralized Rural Infrastructure and Livelihood Project
DTO	District Technical Office
FY	Fiscal Year
GDP	Gross Domestic Product
GON	Government of Nepal
IRC	Internal Rate of Return
Km	Kilometer
LEP	Labor-Based, Environment- Friendly, and Participatory
MT	Metric Tonne
m	Meter
mm	Millimeter
m^2	Square Meter
m^3/cum	Cubic Meter
NRRS	Nepal Rural Road Standard
NA	Not Applicable
PWD	Public Work Directives
PCC	Plain Cement Concrete
RCC	Reinforced Cement Concrete
Rs.	Rupees
rm	Running Meter
SDC	Swiss Agency for Development and Co-operation
TOR	Terms of Reference
TU	Traffic Unit
VDC	Village Development Committee
VAT	Value Added Tax
VOC	Vehicle Operating Cost
ZOI	Zone of Influence

1. INTRODUCTION

1.1. Project Background

The rehabilitation and reconstruction of local roads network damaged due to major earthquake of 25 April 2015 and May 12 2015 has high priority for the Government of Nepal (GoN) . The Asian Development Bank (ADB) funded Earthquake Emergency Assistance by Project (ADB Loan 3260-NEP) is aimed to accelerate the recovery and reconstruction of the local roads damaged by the earthquake. The rehabilitation and reconstruction of about 385 km of rural roads damaged by the earthquake and landslides in 10 of the earthquake hit districts (Dolakha,Kavrepalanchowk, Laitpur, Chitwan, Sindhuli, Solukhumbu, Okhaldhunga, Ramechhap, Gorkha and Lamjung). Haldebeshi – Dhobi – Dhadebeshi Road of Ramechhap district is one of the roads proposed for rehabilitation and reconstruction under EEAP.

AS part of the Technical Assistance from Swiss Agency for Development and Cooperation (SDC) also provided technical assistance to EEAP. AF-Iteco, Switzerland,currently providing services as Central Implementation Support Consultants (CISC) for Decentralized Rural Infrastructure and Livelihood Project-Additional Financing has been entrusted to act as Consultant for this project and has given the assignment for preparation of Detailed Project Reports for rehabilitation and reconstruction of selected rural road subprojects of Dolakha and Ramechhap to Joint Venture of Gaurav Integrated Development Associates Nepal (P) Ltd, NEST (P) Ltd and Jaarsa Engineering Consultancy (P) Ltd.

1.2. Project District and Proposed Road

The Haldebeshi – Dhobi – Dhadebeshi Road lies in Ramechhap district. Ramechhap, the project district, is located in Janakpur Zone of the Eastern Development Region of Nepal. The district is located within 27° 28′ to 27° 50′ latitude and 85° 50′ to 86° 32′ longitude. The district borders with Okhaldhunga and Solukhumbu Districts in East, Sindhupalchowk and Kavrepalanchowk Districts in West, Dolakha District in North and Sindhuli District in South. Manthali is the districts headquarter of Ramechhap.

The total area of Ramechhap district is 1,546 km^2, among which 38.28% is agricultural land, 42.78% is forest area, 7.39% is cattle pasture land and rest 11.55% is others. The total population of the district is 202,646 as per last census of 2011, out of which 93,386 are male and 109,260 are female. The population density is 137 people per sq. km and average household size is 5.26 person. Ramechhap is mainly accessed through Kathmandu, Dhulikhel, Nepalthok and Khurkot road, the section of BP Highway. Only light vehicles are allowed to travel through the road. For heavy vehicles, the route to Ramechhap is from Khadichaur of Sindhupalchowk district which is the link road of Araniko Highway connecting through Charikot of Dolakha district and Manthali of Ramechhap to capital city Kathmandu.

The Haldebeshi – Dhobi – Dhadebeshi Road is 38.89 km long. The distance up to Dhobi is 19.93 km. The road starts from Haldebeshi, Tilpung VDC-2 and ends to Dhadebeshi, Saipu VDC-4 passing via. Nagdaha and Bijulikot VDCs. The proposed road passes through various settlements. The major settlement areas are Haldebeshi, Katahare, Kharibote, Aarubote, Nagdaha, Dhobi, Kotgau, Sirise, Dhade. The road connects eastern part of Ramechhap district with the district headquarter in Manthali through Dolakha – Ramechhap road and rest of the country through B.P. Highway via. all-weather connectivity. The status of the road of the project along the alignment is stone soling up to Dhobi and earthen track from Dhobi to Dhadebeshi.

1.3. Scope of works

The detailed engineering survey, design and cost estimated for rehabilitation and reconstruction of Haldebeshi – Dhobi – Dhadebeshi Road section has been carried out by the consultants. Accordingly the scope of works covers:

Following works are included in the scope of works:

a. Detailed engineering survey of the road including fixing centreline.

b. Detail desing of the road according to DoLIDAR's NRRS(2055) 2nd revision December 2014 to gravel pavement.

c. Prepare drawings including alignment plan, design profile, design cross-section and typical drawings

d. Prepare detailed cost estimate

e. Prepare technical study report

2. ENGINEERING SURVEY AND STUDY

2.1. Desk Study

During the process of desk Study, the available reports and maps were collected and reviewed. All relevant guidelines, norms, specification were collected. NRRS (2055), 2nd revision December 2014 and DoLIDAR Norms & Specification has been studied and referred for adoption of design standard and specification.

2.2. Field Survey

After the desk study, engineering team comprising of highway engineer, surveyor and local supervisor had been mobilized in field. The team contacted DTO office and with co-operation with staffs of DTO, the team mobilized to the site. The DTO team at Manthali assisted the survey team.

2.3. The Survey Team

The survey team for detailed survey work of Haldebeshi – Dhobi - Dhadebeshi Road constitute of Civil Engineer and Surveyors.

The team members are:

Civil Engineer: Sabin Bajracharya (Contact no: 9841780002)

Surveyor: Sudip Karki (Contact no: 9843036196)

2.4. Topographical Survey

Survey Procedure

Detailed engineering survey was carried out for the design work of the road. The accuracy and effectiveness of design work depend on the accuracy of survey works, hence due care was given during survey works.

The fieldwork consists of detailed engineering survey of the project road. The linear traverse method was adopted for the survey and topographical survey was conducted for the proposed alignment. The topographic survey of the sites was carried out in detail using TOTAL STATION and survey points were recorded. It was ensured that the density of the survey points was adequate to prepare the detailed topography of the site. Contours were thus generated on scale 1:1000 with the details like contours at interval of 1m, channel bifurcation and merging points, survey control point, settlements/villages, utility services, etc.

The RL of center point of the cross section were measured using TOTAL STATION instrument readings. The observation of horizontal angles at each right and mean of two was done with both left and right faces and mean of two was used for calculation to eliminate errors due to eccentricity and centering. The TOTAL STATION instrument carried out profile leveling at an interval of 20 m and at all points where sudden changes of topography was observed. During the field works, all the data needed were recorded and registered.

BM was established where deemed necessary and fixed.

Instrument Station

Instrument is placed on the site from where forward and backward is clearly seen with taking maximum detailed point for detailing.

Bench Marks (BM)

In this study, the coordinates from the GPS for Benchmark values have been used. The bench marks are used as reference point during construction phase. At site, the benchmarks have been placed in permanent structures and the Benchmark numbers has been clearly written with enamel paints. *(Refer Annex for the detail BM list and Descriptions)*

2.5. Topography and Geomorphology

2.5.1 Topography

Geographically, the road area lies in the hilly terrain. The existing road passes through bed rock, soil and vegetation covers.

The proposed road alignment is located in Middle Mountain physiographic region. The elevation is in the range from 532 m to 1828 m above mean sea level (msl) but actually the elevation of the Lesser Himalaya or Middle Mountain in the Mid-Eastern Nepal range from 1,000 m to 1,800 m msl except the elevation of the river valley.

The altitude range of physiographic region is shown in Table.

Table 1: Physiographic Region

S.N.	Physiographic Region	Altitude Range (m) amsl
1.	Middle Mountain	700-2000
2.	High Mountain	2000-2500
3.	High Himalayan	2500-8000

Source: Department of Survey, HMG/Nepal, 1998

2.5.2 Geomorphology

Geologically, the study area lies in Ulleri formation. The area surrounds mainly phyllites and augen gneisses with bands of schists, carbonates and quartzites. The dominant rock types along the road alignment are also phyllites, quartzites, schists and gneisses. The common soil types include colluvial, alluvial and residual soils.

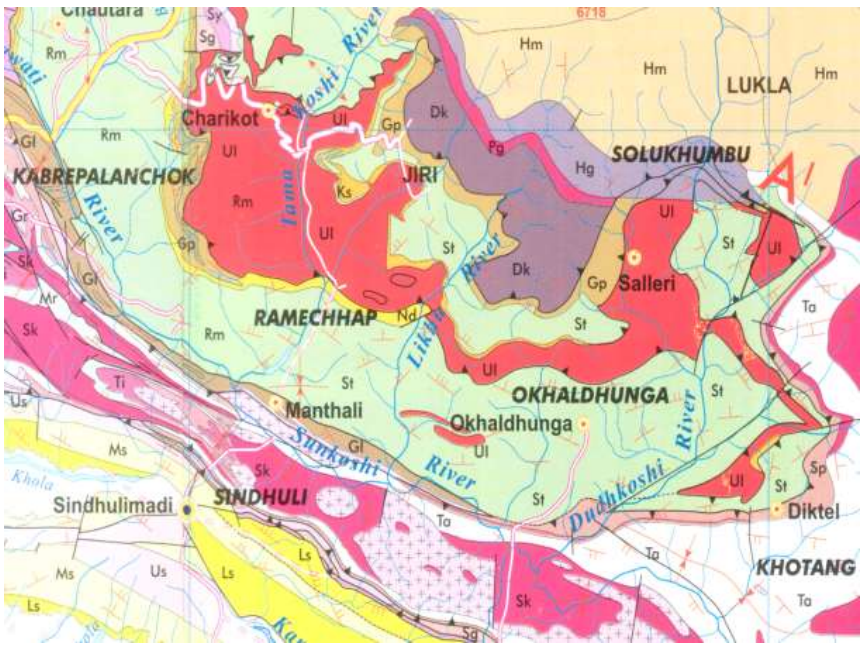

Figure 4: Location of Sub-project in Geological Map

Table 2: Geology and Soil Type Along Road Alignment

Section	Chainage	Elevation (m asl)	Aspect	Geology	Soil Type
Haldebeshi – Nagdaha	0+000 – 13+900	532-1604	West – East	Phyllite, Gneiss, Schist	Alluvial, Residual
Nagdaha – Dhobi	13+900 – 19+930	1604 - 1803	West – East	Phyllite	Collivual, Alluvial,
Dhobi – Sirise	19+930 – 34+400	682 - 1828	West – North East	Phyllite, Gneiss, Schist, Quartzite	Collivual, Alluvial, Residual
Sirise – Dhadebeshi	34+400 – 38+080	682 - 780	South – North	Quartzite	Alluvial, Colluvial

Table 3: Geology and Soil Type along Road Alignment

S. No	Geological Classification		Slope grade	
	Major Classification	Minor classification	Cut Slope	Fill Slope
1	Soil	Colluvium Alluvium Residual	1V:0.33H	1V:1.5H
2	Rock	Ordinary Medium	1V:0.20H	1V:1.5H
3	Rock	Hard	1V:0.16H	1V:1.5H

Source: Department Of Road, GoN

2.6. Vegetation Survey

The vegetation in the project area has been controlled by altitude and aspects. The project area is dominated by trees characteristic of Sub-tropical Pine Forest like Alder (Alnus nepalensis). Additionally, there are representations of Sub-tropical Broadleaved Forest like Chilaune (Schima wallichii).

The trees reported alongside of the road alignment include Salla (Pinus Patula), Gobre Salla(Abies pindrow, Uttis (Alnus nepalensis), Duthilo (Ficus nerifolia), Kafal (Myrica esculenta), Katush (Castanopsis indica), Khanyo (Ficus semicordata), Taki (Bahunia purperea), Lakuri (Fraxinus floribunda), Okhar (Juglans regia), Paiyu (Prunus cerasoides), etc.

Shrub species include Jhadi banmara (Lantana camara), Bilaune (Maesa chisia), Jhingani (Eurya acuminata), Aiselu (Rubus ellipticus, Rubus paniculatus), Clematis sps., Lokta (Daphne bholua), etc. Ground vegetations include Dhursul (Colebrookia oppositifolia), Rudhilo (Pogostemon benghalensis), Banmara (Eupatoreum adenophorum), Blumea sps, Bukiphool (Osbeckia sps.), Datiwan (Achyranthus sikkimensis), Gandhe (Ageratum conizoides), Kuro (Bidens pilosa), Titepati (Artemisia sps.), Kuro (Xanthium strumarium), Sisno (Utricia diocia), Amriso (Thysanolena maxima), Urena lobata, Eubhorbia sps and various other grasses like Imperata cylindrica, Brachiaria sps, Echinochloa sps, Pennisetum sps, Cynodon dactylon, etc.

2.7. Construction Material Survey

The construction materials survey was conducted to assess the availability of the materials within the proposed alignment. Several quarry sites are identified for the materials like gravel, aggregates, sand, stone, boulders, etc. which could be extracted from quarries. For the materials like cement, R.C. pipes, HDP pipe, geo-textiles, etc. market survey is conducted to identify the location for procurement. The table below shows the location of different quarry sites and market for procurement of construction materials.

Table 4: Possible Quarry Sites

Material	Site	Distance
Gravel	Tamakoshi River, Haldebeshi	Within 1 km from starting point
Sand	Tamakoshi River, Haldebeshi	Ch: 0+000
Boulder	Tamakoshi River, Haldebeshi	Ch: 0+000
	At site of roadway cutting	
Aggregate	Tamakoshi River, Haldebeshi	Ch: 0+000
	Roadway Cutting	

2.8. General Inventory

During the survey, no side drains were observed along the existing road alignment. However, retaining structures like gabion walls, gravity wall and breast wall along, several chainage were observed. During the design, priority has been given to protect the existing gabion walls as much as possible. Despite this, the retaining structures have to be dismantled while improving the grade of alignment as per NRRS.

The table below shows the locations of existing retaining structures in the existing alignment.

Table 5: Existing Structures along Road Alignment

Chainage		Length	Existing Structure Type	Remarks
From	To			
0+420	0+430	10	Gabion	
0+440	0+450	10	Gabion	
0+880	0+890	10	Gabion	
0+970	1+030	60	Gabion	
0+980	1+040	60	Gabion	
1+080	1+090	10	Gabion	
1+140	1+150	10	Gabion	
1+340	1+360	20	Gabion	
1+530	1+550	20	Gabion	
1+560	1+570	10	Gabion	
1+670	1+690	20	Gabion	
1+700	1+720	20	Gabion	
1+740	1+760	20	Gabion	
2+200	2+210	10	Gabion	
2+300	2+310	10	Gabion	
2+380	2+390	10	Gabion	
2+420	2+430	10	Gabion	
2+440	2+450	10	Gabion	
2+460	2+470	10	Gabion	
2+480	2+490	10	Gabion	
2+590	2+620	30	Gabion	
2+710	2+720	10	Gabion	
3+070	3+080	10	Gabion	
3+100	3+120	20	Gabion	
3+190	3+210	20	Stone Masonry	
3+570	3+590	20	Gabion	
3+610	3+620	10	Gabion	
3+630	3+640	10	Gabion	
3+690	3+700	10	Gabion	
3+710	3+820	110	Gabion	
3+830	3+840	10	Gabion	
4+410	4+510	100	Gabion	
4+690	4+700	10	Gabion	
4+710	4+720	10	Stone Masonry	

Chainage		Length	Existing Structure Type	Remarks
From	To			
4+720	4+730	10	Gabion	
4+740	4+750	10	Stone Masonry	
4+760	4+790	30	Stone Masonry	
4+800	4+820	20	Gabion	
4+870	4+890	20	Gabion	
5+080	5+110	30	Gabion	
5+150	5+180	30	Gabion	
5+710	5+720	10	Gabion	
5+730	5+740	10	Gabion	
7+270	7+350	80	Gabion	
7+370	7+380	10	Gabion	
7+390	7+410	30	Gabion	
7+630	7+660	30	Gabion	
7+700	7+720	20	Gabion	
8+440	8+450	10	Gabion	
8+720	8+730	10	Gabion	
9+630	9+640	10	Gabion	
10+310	10+320	10	Gabion	
11+620	11+630	10	Gabion	
11+640	11+650	10	Gabion	
11+720	11+730	10	Gabion	
12+210	12+220	10	Gabion	
14+390	14+400	10	Gabion	
15+120	15+130	10	Gabion	
15+140	15+150	10	Gabion	
15+190	15+200	10	Gabion	
15+400	15+410	10	Gabion	
15+420	15+430	10	Gabion	
15+440	15+450	10	Gabion	
15+480	15+500	20	Gabion	
15+830	15+840	10	Gabion	
16+030	16+040	10	Gabion	
16+050	16+060	10	Gabion	
16+350	16+370	20	Gabion	
16+590	16+600	10	Gabion	
16+600	16+610	10	Gabion	
17+220	17+230	10	Gabion	
17+310	17+330	20	Gabion	
17+330	17+340	10	Gabion	
17+430	17+440	10	Gabion	
17+500	17+510	10	Gabion	
17+570	17+580	10	Gabion	
18+750	18+760	10	Gabion	
19+140	19+150	10	Gabion	
20+360	20+370	10	Gabion	Dismantle not required
20+540	20+560	20	Gabion	Dismantle required (New gabion proposed)
22+290	22+300	10	Gabion	Dismantle required
22+360	22+390	30	Gabion	Dismantle not required
22+540	22+560	20	Stone Masonry	"
23+040	23+050	10	Stone Masonry	Stone Revetment Wall proposed
23+660	23+730	70	Gabion	Dismantle not required

Chainage		Length	Existing Structure Type	Remarks
From	To			
23+730	23+750	20	Stone Masonry	"
23+910	23+920	10	Gabion	"
23+960	23+970	10	Gabion	"
24+200	24+210	10	Gabion	"
24+280	24+290	10	Gabion	"
24+310	24+330	20	Gabion	Dismantle required (Masonry Wall Proposed)
24+590	24+600	10	Gabion	Dismantle not required
25+090	25+110	20	Stone Masonry	"
25+250	25+270	20	Gabion	Dismantle not required
25+350	25+360	10	Stone Masonry	"
25+650	25+680	30	Gabion	Dismantle required
25+730	25+740	10	Gabion	"
26+010	26+030	20	Gabion	Dismantle not required
25+110	25+120	10	Gabion	Dismantle required
26+150	26+200	50	Gabion	Dismantle not required
26+300	26+310	10	Dry	"
26+310	26+320	10	Gabion	"
26+400	26+410	10	Dry	"
26+510	26+540	30	Gabion	"
26+920	26+940	20	Gabion	"
27+070	27+080	10	Gabion	"
27+760	27+770	10	Gabion	Dismantle required
28+020	28+060	40	Stone Masonry	"
28+090	28+120	30	Stone Masonry	Dismantle not required
28+530	28+540	10	Gabion	"
28+610	28+620	10	Gabion	"
28+680	28+690	10	Gabion	Dismantle required (New gabion proposed)
28+840	28+890	30	Stone Masonry	Dismantle not required
28+970	28+990	20	Gabion	"
29+150	29+160	10	Gabion	"
29+210	29+220	10	Gabion	Dismantle required
29+330	28+340	10	Gabion	Dismantle not required
29+440	29+460	20	Gabion	"
29+770	29+780	10	Gabion	"
30+300	30+330	30	Gabion	Dismantle required (New gabion proposed)
30+670	30+680	10	Gabion	Dismantle not required
31+130	31+160	30	Gabion	"
31+440	31+490	50	Gabion	"
31+820	31+910	90	Gabion	"
31+970	32+030	60	Gabion	"
32+220	32+300	80	Gabion	"
32+430	32+500	80	Gabion	Dismantle required
33+060	33+120	60	Gabion	Dismantle not required
33+430	33+440	10	Gabion	Dismantle required
33+830	33+840	10	Gabion	Dismantle required (New gabion proposed)
34+080	34+110	30	Gabion	"
34+460	34+470	10	Gabion	Dismantle not required
34+590	34+610	20	Gabion	"
34+640	34+660	20	Gabion	"

Chainage		Length	Existing Structure Type	Remarks
From	To			
35+110	35+170	50	Gabion	"
35+210	35+220	10	Gabion	"
35+610	35+660	50	Gabion	"
35+700	35+730	30	Gabion	Dismantle required
35+810	34+840	30	Gabion	Dismantle not required
35+910	35+950	40	Stone Masonry	"
35+980	36+000	20	Gabion	"
36+260	36+270	10	Gabion	"
36+340	36+360	20	Gabion	"
36+400	36+410	10	Gabion	"
36+510	36+530	20	Gabion	"
36+560	36+590	30	Stone Masonry	"
36+730	36+760	30	Gabion	"
37+120	37+140	20	Stone Masonry	"
37+150	37+160	10	Gabion	"
37+190	37+220	30	Gabion	Dismantle required
37+240	37+250	10	Gabion	Dismantle not required
37+460	37+470	10	Stone Masonry	"
37+480	37+500	20	Gabion	"
37+560	37+580	20	Dry	Dismantle required
37+670	37+680	10	Stone Masonry	"
38+430	38+470	40	Gabion	Dismantle not required
38+760	38+770	10	Stone Masonry	Dismantle required
38+770	38+780	10	Stone Masonry	Dismantle not required

Also, it was observed that in the road section pipe culverts of diameter 0.6 m were provided for cross drainage purpose. Side drains are present in few sections of the existing alignment. Further, the existing gradient of road profile lies within the limiting gradient permitted by NRR standards.

2.9. General Alignment Description

The Haldebeshi – Dhobi – Dhadebeshi Road alignment lies in the hilly region of Nepal. The elevation of the road alignment increases gradually from the starting point Haldebeshi to Dhobi at chainage 19+930. From Dhobi to end point Dhadebeshi the road gradient gradually decreases. The road alignment starts from Haldebeshi and ends at Dhadebeshi via. Dhobi. The total length of the road is 38.08 km and existing width varies from 3m to 10m. However in new design, the proposed road width shall be 5.25m except at extra widening, passing places and bus bays area

In existing road alignment, from starting point Haldebeshi to Dhobi, only at few sections longitudinal grade is greater than 12%. However, from Dhobi to Dhadebeshi at several sections the longitudinal grade is greater than 12%. The sections having existing grade greater than 12% are listed in table below:

Table 6: Existing High Grade Sections

Chainage		Existing Grade	Remarks
From	To		
4+245	4+480	13.00 %	
6+535	6+700	13.59 %	
16+845	16+915	14.00 %	
17+375	17+565	13.80 %	
22+160	22+360	13.55 %	
22+930	23+050	12.90 %	
23+210	23+275	14.40 %	
23+550	23+720	14.82 %	
24+535	24+650	16.44 %	
25+840	26+100	13.80 %	
27+220	27+330	15.00 %	
27+590	27+730	13.40 %	
27+730	27+850	12.80 %	
28+355	28+525	13.20 %	
28+585	28+690	12.45 %	
29+200	29+330	13.60 %	
29+490	29+625	14.00 %	
29+800	29+920	14.14 %	
31+220	31+450	14.40 %	
31+520	31+570	14.47 %	
32+450	32+560	13.01 %	
33+010	33+150	14.40 %	
33+520	33+680	13.00 %	
33+720	33+860	14.65 %	
34+455	34+580	13.84 %	

The existing high grade obtained beyond permissible gradient from survey are considered and reduced to limiting gradient as per NRRS in upgraded design. The gradient has been maintained below 10% wherever possible. In stretches where the grade exceeds 10%, the grade has been maintained below 12% as per NRRS. The chainage vs. altitude is presented in following figure 5.

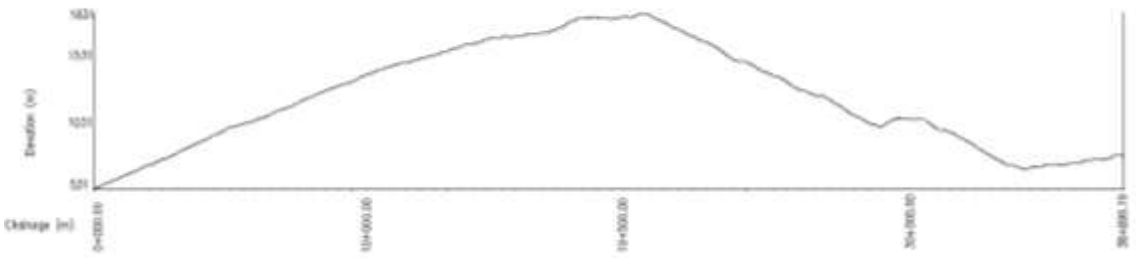

Figure 5: Chainage vs Altitude Graph of Road Alignment

2.10. Land Use Pattern

The land use pattern along the road corridor was recorded during field survey. The land use pattern of along the road alignment is shown in table 7 below:

Table 7: Land use along the road alignment

Chainage		Description
From	To	
0+000	0+080	Settlement Area, Haldebeshi, Tilpung-2
0+080	1+460	Mixed Forest and Cultivation Area
1+460	1+940	Forest Area
1+940	2+180	Settlement Area, Jhangre, Tilpung-2
2+180	4+820	Cultivation Area, Scattered settlement
4+820	5+050	Settlement Area, Katahare, Tilpung-5
5+050	6+500	Cultivation Area
6+500	8+050	Mixed Forest and Cultivation Area, Darumbote, Tilpung-4
8+050	11+150	Mixed Forest and Cultivation area, Scattered Settlements
11+150	13+810	Cultivation Area.
13+810	14+000	Settlement Area, Nagdaha Bazaar, Nagdaha-5
14+000	15+000	Mixed Forest and Cultivation Area
15+000	17+100	Forest Area
17+100	18+750	Cultivation area, Few houses
18+750	19+300	Mixed Cultivation Area and Forest
19+300	19+930	Cultivation Area, Settlement Area, Dhobi Bazaar, Bijulikot-1
19+930	24+030	Cultivation Area, Mixed Forest, Few houses
24+030	26+450	Mixed Forest and Cultivation Area, Scattered Settlements
26+450	26+900	Cultivation Area, Few houses
26+900	28+800	Mixed Cultivation and few houses
28+800	30+850	Mixed Forest and Cultivation Area
30+850	31+640	Cultivation Area
31+640	32+350	Settlement Area, Poku village, Saipu-1
32+350	34+400	Mixed Forest and Cultivation Area
34+400	34+760	Settlement Area, Sirise Bazaar, Saipu – 3
34+760	37+620	Cultivation Area, Few houses
37+620	37+720	Settlement Area, Dhadebeshi, Saipu -4
37+720	38+080	Cultivation Area, Scattered Settlements

Source: Field Survey, 2016

2.10.1 Passing Bays and Bus Lay Bys

In general, passing bays are located at interval of 300m following the NRRS (2055) 2nd revision December 2014 and bus lay bys location are fixed along nearby major settlements. However, ensuring proper visibility and to minimize the maximum cut/fill due to extra width governed, the location of passing bays are shifted at several locations which do not comply the NRRS. Total numbers of 69 passing bays are proposed at appropriate locations. 9 bus lay bays near settlement areas have been proposed. *(Refer Annex 2 for detail locations of passing places and bus lay bys)*

2.10.2 Cross Drainage and Irrigation Crossing

Depending upon the nature of road profile, type of natural drainage system, pipe culverts, causeways and slab culverts are proposed at different sections of road. 7 numbers of pipe culverts of dia. 0.9m and 22 numbers of pipe culverts of dia. 0.6m have been proposed for cross drainage structures. Total numbers of 1 slab culvert of 6m span have been proposed in the road alignment. Also, total number of 2 causeways of 15m length, 5 of 12m length and 1 of 6m length has been proposed as required. 15 numbers of 0.30m dia. pipes are recommended for irrigation crossings wherever required during the time of road construction. (*Refer Annex 3 for detail locations of cross drainage structures)*

Along the road alignment from chainage 19+930 to 38+899.19 km, pipe culverts of 0.6m diameter for cross drainage purpose are present in various locations. The chainages where pipe culverts present in the road alignment which are in good condition and need not be dismantled during the construction time are listed below in the table:

Table 8: Existing Pipe Culverts along the road alignment

SN	Chainage	Diameter (m)
1	13+551	0.6
2	21+991	0.6
3	22+289	0.6
4	23+908	0.6
5	23+961	0.6
6	24+281	0.6
7	24+898	0.6
8	27+072	0.6
9	28+968	0.6
10	29+151	0.6
11	35+191	0.6

2.10.3 Retaining Structures

Retaining structures are designed to restrain soil to unnatural slopes and are used to those areas where landscape of the lands needs to be reshaped. Stone masonry walls and gabion walls are proposed based on their appropriateness.

Gabion Masonry Wall

Based on the suitability of the kind of structures, gabion walls are proposed for high cut slopes and terraces, where higher walls are required. Also, the walls are proposed on the areas having poor foundation and seepage condition due to its flexibility for certain differential settlement and some slope movements. Besides, the wall is proposed on the hill sides to restrain against slope movement at landslide zones.

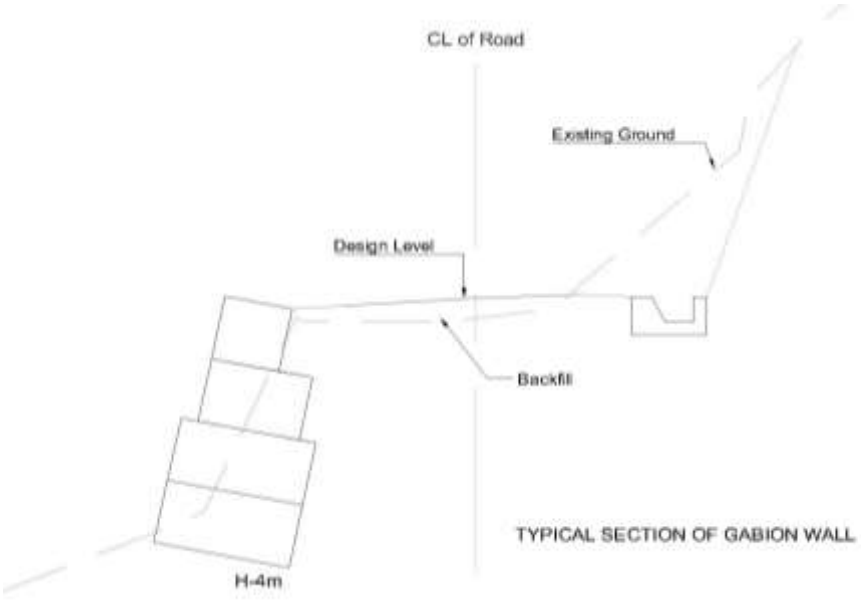

Figure 6: Typical Road Cross Section Showing Gabion Wall

Stone Masonry Wall

Stone Masonry gravity walls are designed on the valley side where the road section becomes narrow due to existing settlement to both sides. Besides, the walls are designed to the locations where rocks exists beneath the foundation as well as the wall is designed where the height of wall do not exceed more than 3m. For the slope and foundation width of the wall, DoLIDAR approach manual, Overseas Road Note 16, DRSP and RAIDP manual is followed.

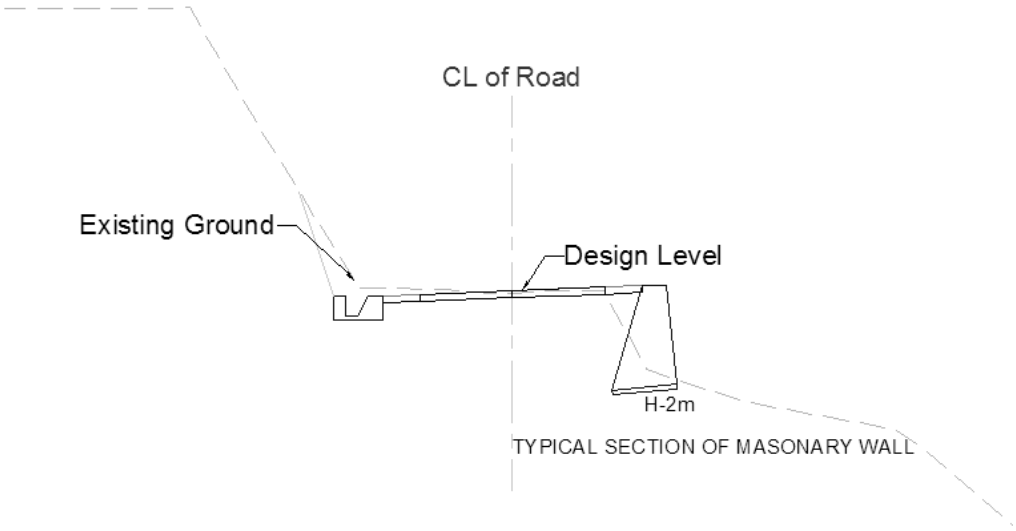

Figure 7: Typical Road Cross Section Showing Stone Masonry Wall

2.11. Traffic Safety Measures

Traffic safety measures are important component for roads. Traffic safety is important to reduce the chance of accident occurring. For prevention of serious accidents in hill roads, safety barriers are essential. The delineator posts at the loops and steep valley slopes are significant for traffic safety purpose.

2.12. Data Entry and Analysis

After the completion of topographical survey, confirmation was done ensuring the density of points is enough to produce contours at an interval of 1m. For some areas re-survey were done at the same time to increase the density of point to fill some voids. The data recorded in total station were extracted in excel sheet and with the help of SW-DTM inbuilt with Auto CAD, the data were processed. During this time, the redundant data were first eliminated from the list and final contour was drawn.

Likewise, the existing road centerline and road edges were plotted on the contour with the help of SW-DTM. For the design of new alignment, profile and road width, SW-Road was used with necessary changes in alignment on the existing road alignment.

3. ROAD CORRIDOR COMMUNITY PROFILE

3.1. Influence VDCs

The proposed Haldebeshi – Dhobi – Dhadebeshi Road is 38.89 km long. The distance up to Dhobi is 19.930 km. The road starts from Haldebeshi, Tilpung VDC-2 and ends to Dhadebeshi, Saipu VDC-4 passing via. Nagdaha and Bijulikot VDCs. The proposed road passes through various settlements. The major settlement areas are Haldebeshi, Katahare, Kharibote, Aarubote, Nagdaha, Dhobi, Kotgau, Sirise, Dhade. The road connects eastern part of Ramechhap district with the district headquarter in Manthali through Dolakha – Ramechhap road and rest of the country through B.P. Highway via. all-weather connectivity. The status of the road of the project along the alignment is stone soling up to Dhobi and earthen track from Dhobi to Dhadebeshi.

Table 9: Demographic Features of Influence VDCs

Sn.	Influenced VDC	Total HHs	Total Population
1.	Tilpung	828	4195
2.	Nagdaha	777	3679
3.	Bijulikot	1087	5058
4.	Saipu	616	2876
Total		**3308**	**15808**

Source: Census 2011, Central Bureau of Statistics, Nepal

Table 10: Population Composition of ZOI Survey Households

Name of Road/District	Total HHs	Female Headed HHs	Total Population	Caste Wise Population					
				Brahmin	Chhertri	Thakuri	Dalit	Janjati	Others
Haldebeshi – Dhobi - Dhadebeshi Ramechhap	300	36	1500	-	700	-	200	550	50

Ethnic Groups	No of HHs	%
Bramin/Chhetri	108	36
Janajati	183	61
Dalit	6	2
Others	3	1
Total	170	100

Source: Social Field Survey, 2016

3.2. Cast Ethnicity

The population of the ZOI is the residence to people of different cast. Majority of people here are Chettri, Tamang and Magar. Other castes include Newar, Ghartibhujel, Sanyasi, Hill-Brahmin, Damai, Sherpa, Rai, Kami, Sarki, etc. The area is a home to diverse ethinic or indigenous communities like Newar, Tamang, Sherpa, Gharti/Bhujel and Magar and occupational castes like Damai/Dholi, Kami, Sarki and other indigenous people. In Haldebeshi –Dhobi - Dhadebeshi Road, Categorization of ethnic groups based on household as shown in table above classified into three major ethnic groups: Brahmin/Chhetri, Janajati (Indigenous Community), and Dalit. The survey shows 61 percent of the households belong to Janajati group. Similarly, Brahmin/Chettri comprised about 36 percent of the households, 2% of the households is Dalit and remaining 1% others.

3.3. Occupation

The majority of people in the project area have major occupation as agriculture. Besides, people are involved in horticulture and livestock farming. Minority of the people here are involved in business and government offices. People here are also involved in labor works for daily income. The social field survey data in the project area shows that 95% of the male population was engaged in paid work including agriculture farming, livestock farming, business and other types of employment; 16% of female are involved in these works. 5% of the male population was not able to earn an income from

their daily activities. 84% of female are not involved in any income generating activities. This high proportion of women in unpaid work is an indicator of their hardship in their own house, and also their low involvement in economic activities.

3.4. Education and Health Status

In the project district, about 35% of people are literate population who can both read and write. The population those who can only read is 2.9% and 62% population are not educated. In project ZOI, schools are present in Haldebeshi, Nagdaha, Dhobi and Sirise. Shree Kalika School is present in Poku village at Ch: 32+000 of the alignment.

There are no any hospitals in the project area. Few health centres are present in the market/settlement areas. For severe health problems, people here have to travel to Manthali, the district headquarter. However, due to many trainings and programs by different government and non-government organizations involved in health improvements and awareness towards health and sanitation, the health status of people has improved.

4. DESIGN STANDARDS AND PARAMETERS

4.1. Geometric Design Standard

The geometric design standards and parameter are strictly followed from NRRS published by DoLIDAR 2nd Revision December 2014, with the salient features, as outlined in the table below. The design standards adopted for the upgrading of the road are that of fair weather earthen road with low traffic volume. The roads can be upgraded in a compatible manner as the traffic volume increases and availability of resources justify additional inputs.

Table 11: DoLIDAR Standard

S. No	Road Components	Design Standards	Remarks
		Hills	
1.	**Carriageway Width (m)** • Traffic < 100 VPD • Traffic>100VPD<400VPD	3.00 3.75	
2.	**Shoulder Width (m)**	0.75	On both sides
3.	**Roadway Width (m)** • Traffic < 100 VPD (see notes below) • Traffic>100VPD<400VPD	4.50 5.25	Excludes width of drain, parapet & retaining wall top
4.	**Right of Way (m)**	20.00	10m RoW on either side from the road centerline
5.	**Design Speed** • Ruling • Minimum	25 20	
6.	**Stopping Sight Distance (m)**	20.00	
9.	**Radius of Horizontal Curves (m)** • Ruling • Minimum	≥20.00 12.50	
10.	**Hairpin bends**		
	Desirable Spacing (m)	100	100 m spacing is desirable but may be less as per site condition.
	Minimum Radius (m)	12.5	Exceptional Case: 8.5m
	Minimum Roadway width at apex(m)	5.5	For curves with radius <12.5m provide 7.00 width
11.	**Gradient (%)**		
	Ruling	7	
	Limiting	10	
	Exceptional	12	Up to 15% in hill roads for short stretch of 50m in unavoidable situation except in hairpin bends.
	Maximum for Bridge approach	6	
	Minimum in hill roads	0.50	
12.	**Extra Widening (m)**		
	For curve radius ≤ 20m	1.5	
	For curve radius 20 -60 m	0.60	
	For curve radius > 60 m	Nil	

S. No	Road Components	Design Standards	Remarks
		Hills	
13.	**Camber minimum (%)**		
	Earthen Roads	5	Hills: Unidirectional camber sloping either towards hill side or valley side
	Gravel Roads	4	Hills: Unilateral camber in carriageway sloping towards hill side
	Bituminous Roads	3	Hills: Unilateral camber in carriageway sloping towards hill side
14.	**Passing zone/Bus lay Byes**	**Passing zones:** width of carriage way width 5.5m and length about 12 m along outside edge and 30 m along inside ie. Towards the carriageway side and each end tapered gradually towards the carriageway. **Bus Lay Bys**: minimum width additional 3 m (ie. total minimum carriageway width is 6m) and and length about 12 m along outside edge and 30 m along inside ie. Towards the carriageway side and each end tapered gradually towards the carriageway.	
15.	**Traffic Signs and Road Safety**	As detailed in the NRRS 2013	
16.	**Carriageway Width (cross-drainage structures)**		
	Culvert	4.5	Distance between parapet walls
17.	**Road side drains**	**Hill roads:** trapezoidal drain with masonry (1:4) back wall and 10cm thick M-15 grade concrete sloped bed throughout the road length as required **Built up areas:** Drain as specified in DoLIDAR Technical Guideline with adequate cover slabs for crossings.	
Surfacing Options			
1.	**Gravel Surface**	**Hill roads :** 15cm gravel surfacing in carriageway to be extended in the hill side shoulder up to inner edge of the drain. Tapering gravel hard shoulder (15cm to 6cm) in the valley side with slope towards the valley.	

5. ENGINEERING DESIGN

The design parameters adopted for Haldebeshi – Dhobi - Dhadebeshi Road follow DoLIDAR Nepal Rural Road Standard (2055), 2nd Revision December 2014.

5.1. Road Classification

The proposed road has been classified as District Road Core Network (DRCN) and assigned Code No. is 21DR025.

5.2. Design Speed

The design speed has a crucial role in geometric parameters of the roads. The design speed depends on various factors like; super elevation, sight distance, radius and length of horizontal curve, extra widening of pavement, and the length of vertical curve (summit and valley) etc. According to the design standards followed, the ruling design speed adopted 25km/hr in flat section. However at hairpin bends, horizontal curve and steep sections, the adopted design speed as per NRRS is 20km/hr

5.3. Right of Way

As per the design standard of DoLIDAR, right of way adopted for Haldebeshi – Dhobi - Dhadebeshi Road is 10 m either side.

5.4. Roadway Width

Roadway width adopted for the proposed road is 5.25m. It includes 3.75 m width Carriageway width and 0.75m of shoulder on either side.

5.5. Extra Widening

It is necessary to widen the carriage way at sharp horizontal curves for the free movement of vehicles. Only mechanical widening has been proposed to compensate the extra width occupied by the vehicle on the sharp curve. For this, the inner part of the curve is proposed for widening as per NRRS as listed below in table.

Table 12: Extra widening

SN.	Radius		Extra widening(m)
	From	To	
1	0	20	1.5
2	20	60	0.6
3	60	1000	0

5.6. Sight Distance

Since, the road is located in hill area; stopping site distance must be secured properly. In this project, a minimum of 20 m is secured for design speed 20 km/hr and 25 m is secured for the flat section having design speed of 25 km/hr.

5.7. Horizontal Curvature

In each intersection, points are provided. As per the DoLIDAR Standards, the minimum radius of horizontal curve is taken as 12.5m.

5.8. Vertical Curvature

Spiral vertical curve is provided for vertical intersection points.

5.9. Longitudinal Section

A general minimum gradient of 0.5% was adopted in very flat conditions. Maximum recommended grade of 12% as per the DoLIDAR Standard was adopted. The gradient at loop should be up to 4% but due to geography of the alignment at loops, this gradient of 4% is difficult to maintain. However, the grade is maintained as permissible by the design guidelines.

5.10. Cross Section

The cross section at every 10m chainage point was considered to obtain the existing ground condition. The cross section design was carried out taking plan and profile under consideration.

5.11. Passing Bays and Bus Lay Bys

For passing bays, width of carriage way width is 5.5m and length about 12 m along outside edge and 30 m along inside ie. towards the carriageway side and each end tapered gradually towards the carriageway. For bus lay bys, minimum width is additional 3 m (ie. total minimum carriageway width is 6m) and and length about 12 m along outside edge and 30 m along inside ie. towards the carriageway side and each end tapered gradually towards the carriageway. Total numbers of 39 passing bays are proposed at appropriate locations. 4 bus lay bys near settlement areas have been proposed. The passing bay and bus lay bys has been proposed in such a way that no additional retaining structure is required. *(Refer annex for details of location)*

5.12. Water Management Measures

An utmost consideration is given to water management during design and their estimate. Depending upon the nature of existing natural channel and road profile, appropriate cross drainage types are proposed for water management. For this, Pipe culverts, Causeways, slab culvert and irrigation crossings are proposed along the road as per need.

For surface water management, side drainage towards hill side with varying sizes are proposed along the whole road stretches and the hill side camber principle is adopted for proper management of surface water. The minimum size of cross drainage adopted pipes of 600 mm except for irrigation channel. For crossing of irrigation channel, the minimum dia of pipes proposed is 300mm. *(Refer annex for details of location)*

5.13. Side Drains

Side drains are required to prevent structural damage to the road. The water collected from surface runoff is required to be collected and drain off from nearby rivulet, culverts or cross drainage to protect the exiting road structures. For this, different kinds of side drains could be used as appropriate.

In this project, stone masonry trapezoidal type side drainage is proposed along the whole stretches towards hill side since the road is designed with only one camber slope towards hill side. The total width of drainage proposed is 1m in width and depth 0.5m. In some stretches, the depth of drainage varies up to 1.0m as per site requirements. Also, covered type side drainage is proposed in settlement/ market area for total stretch of 1000m. The size of the cover is proposed as 1.0X0.50X0.15m. Further, cascade type side drainage is proposed along the road stretches having its gradient greater than 7%. The typical drawing for side drains is included in Volume 3 drawings.

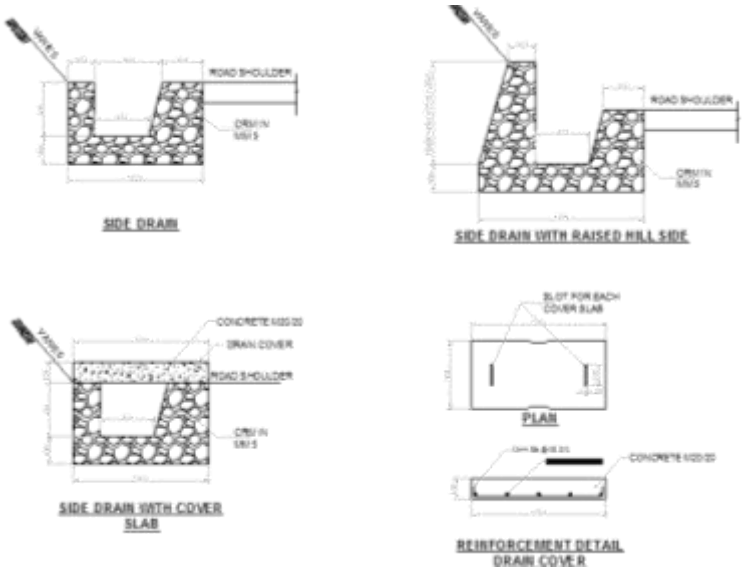

Figure 8: Typical Drain Proposed

5.14. Dynamic Cone Penetration Test and Pavement Design

The existing road is planned to be rehabilitated and reconstructed with gravel surface. For determining the thickness of the gravel base and sub-base the strength of sub-grade has to be determined. There are number of tests which can be used to measure strength properties of sub grade soil. All these test are empirical and are useful in their correlation in design. For the evaluation of sub grade strength, Dynamic Cone Penetration Test was conducted.

It was originally developed as an alternative for evaluating the properties of flexible pavement or sub grade soils. The conventional approach to evaluate strength and stiffness properties of asphalt and sub grade soil involves a core sampling procedure and a complicated laboratory testing such as resilient modulus, Marshall Tests and others. Due to its economy and simplicity, better understanding and reduce cost and effort DCPT is widely carried out. DCPT consists of upper and lower shafts. Upper shaft has a 8 kg drop hammer with a 575 mm drop height and is attached to the lower shaft through anvil. Lower shaft contains an anvil and a cone attached at the end of the shaft. The cone is replaceable and has a 600 cone angle. A reading device, an additional rod is used as an attachment to the lower shaft with marks at every 5.1mm.

The basic principle involved in the operation of this apparatus is the measuring of the resistance offered by the pavement layers to the penetration of a standard cone driven by the hammer freely falling through a height. The amount of penetration (in mm) of the cone is generally reported in terms of the average penetration per blow, DCPI (mm/blow). The greater the value of DCPI indicates softer sub grade soil and vice versa.

The dynamic cone penetration test in the alignment was conducted at interval of 500m. In the road alignment, the properties of sub grade soil differ in different chainages. The DCP test is generally carried out at the interval of 250m. In relatively uniform areas, testing at interval of 500m is acceptable. During the field visit, it was observed that at the average interval of 500m the properties of sub grade is uniform and does not differ very much.

There are various methods of calculation of CBR value from penetration index. In this design, Overseas Road Note 8 was followed to calculate the CBR value. According to Overseas Road Note 8,

$$log_{10}(CBR) = 2.48 - 1.057\ log_{10}\left(\frac{mm}{blow}\right)$$

Pavement performance depends greatly upon the quality and uniformity of materials incorporated into the pavement structure. Careful monitoring of material quality and the dimensions of pavement layers during construction improves overall compliance with specifications as well as in-service performance of the pavement.

In this project for pavement design, Overseas Road Note 8 is used for calculation of CBR value. After calculation of CBR value by Overseas Road Note 8, it is classified in six classes according to Road Note 31.

The required thickness of gravel is calculated based on classes. The details of the pavement design calculations are attached in Annex 4. For the design, considering the results of DCP test and judging economic in gravel road, the uniform thickness of sub base 150 mm has been adopted. Capping layer of 100 mm has been provided over sub base in sections where sub base thickness required is higher than 175 mm from result of DCP test and pavement design.

ENGINEERING DESIGN AND DRAWINGS

The engineering design is prepared based on Nepal Rural Road Standards published by DoLIDAR. Despite this at some locations, the design differed with the guidelines set by DoLIDAR due to the nature of topography, settlement and local issues. The table below shows the chainage and nature of design adjustment done based on site condition

The engineering drawings are prepared with the use of AutoCAD as drafting tools. In drawings, plan profile and cross-sections are published and presented for the whole length of road. However, for the road structures like; passing bys, retaining walls, cross drainage, side drains, traffic safety etc. only typical standard drawings with necessary detailing are shown in drawings. For scaling of the drawing, given ToR and standard practices are followed. All required drawings are placed in "Volume3: Design Drawing". Some typical sample of plan, profile and sections are placed below;

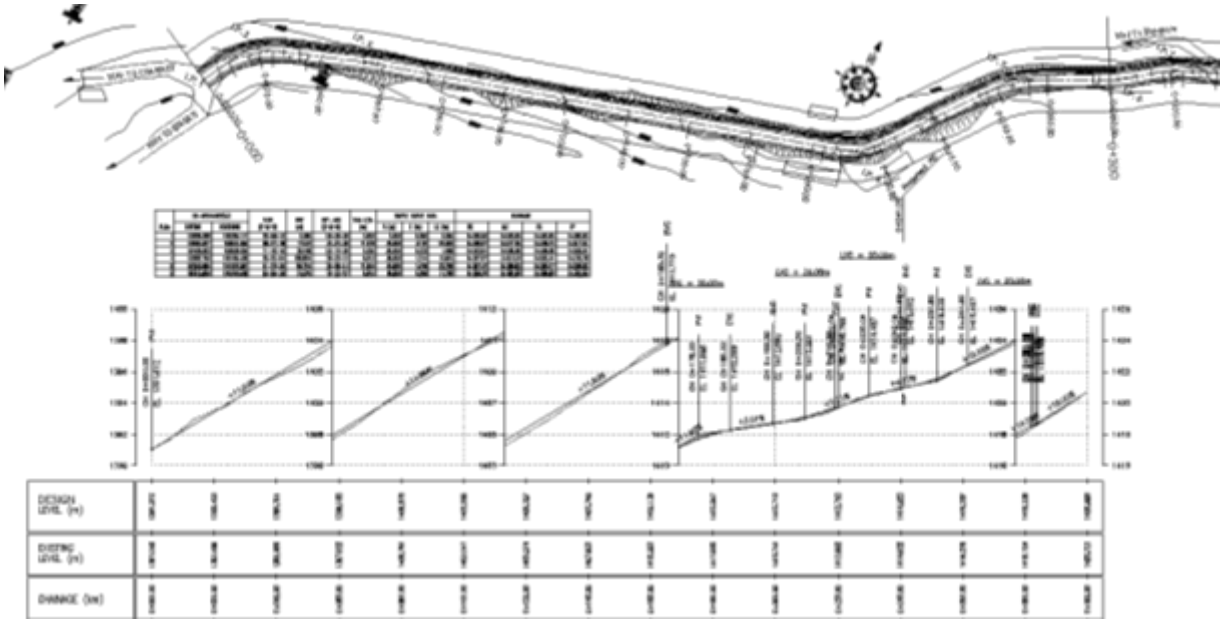

Figure 9: Plan and Profile Sheet Sample

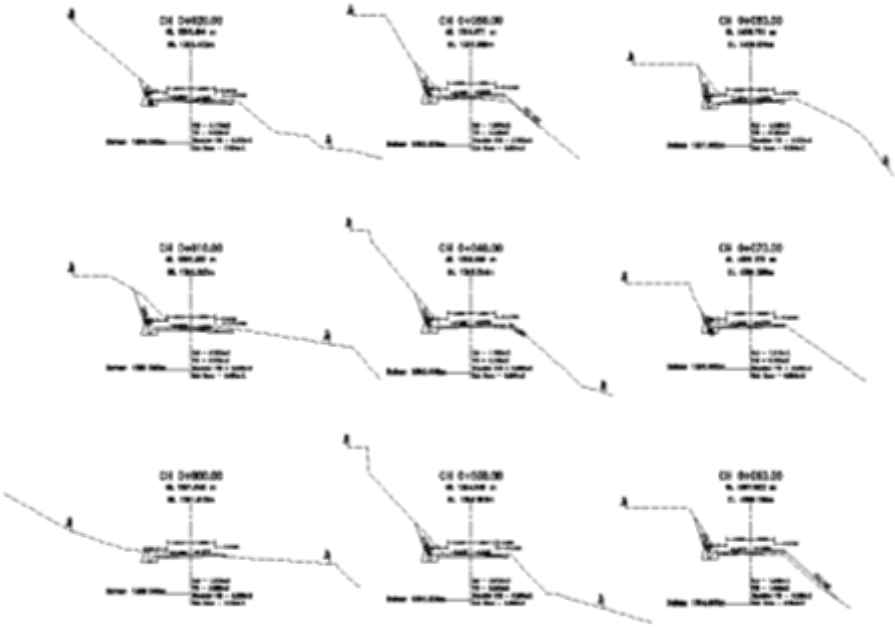

Figure 10: Cross Section Sheet Sample

6. ENGINEERING ESTIMATES

6.1. The Project Cost Estimate

The cost of civil works has been estimated to be Rs. 215,697,563.16. The total cost for rehabilitation and reconstruction to gravel standard including contingencies consisting of small miscellaneous expenses, work charge staff and VAT as per GON rules is calculated to be Rs. 271,778,929.58. Per km cost including VAT is Rs. 6,265,925.77. It is envisaged that the construction works can be completed within 18 months from award of contract and estimates are based on it. Provision of physical contingency 10% has been indicated in the cost estimate.

6.2. Quantity Estimate

For estimating the cost of the project, detailed quantity estimation had been done for each item of works to be included in the project activities. The detail quantity estimates have been provided in Volume 2 cost estimate and the summary sheet of quantity estimation. *(Refer Annex 6 for summary of quantities)*

6.3. Analysis of Rates

For estimating the cost of each item of works, prevailing norms of DoLIDAR and DOR for rate analysis has been used throughout. Rate analysis of each of the items has been carried out according to the approved norms of DoLIDAR and approved district rates of Ramechhap District and as mentioned there in the Kathmandu District rates for materials (cement, Steel, Hume Pipe etc.) for the Fiscal Year 2073/2074 with transportation have been followed.

For rate of earthwork quantities, rate for earthwork excavation by machine and manually for roadway and drain and for foundation of structure is adopted 95% and 5% as carried out by DOR. The detailed analysis of rate and the approved district rates are provided in Volume 2, The Cost Estimate.

7. ENVIRONMENT PROTECTION MEASURES

Along the Hallebeshi – Dhobi – Dhadebeshi section, landslides are seen and environment protection measures are essential at these sites. The chainages which require proper bio-engineering works and landslide rehabilitation for the road is included in table below.

Table 13: Recommended Bioengineering Details

Landslide Chainages		Length (m)	Breadth (m)	Approximate Area in m²
From	To			
4+360	4+380	20	10	200
6+600	6+660	60	15	900
36+980	37+160	180	15	2700
37+840	37+940	100	10	1000
38+340	38+480	140	15	2100
As required during construction works				600
Total				**7500**

Retaining walls have been proposed in the design as noted essential during the site visit Bioengineering is mandatory in this location. Also, bioengineering works has been proposed in other locations where landslides have occurred though small in scale. In locations, where erosion has been witnessed, gabion breast walls have been proposed.

Suitable materials obtained from excavation will be used for embankment filling, and backfilling of structures. Despite this, the surplus excavated materials obtained will be disposed at construction site as required. Wherever possible, the surplus spoil will be used to fill eroded gullies, quarries and depressed areas. Dry stone toe walls are required in some locations for disposal of spoils. Some of the recommended spoil disposal sites are listed in table below:

Table 14: Recommended Spoil Disposal Sites

Chainages	Recommended Spoil Disposal Sites
2+430	Kholsi, Spoil disposal in valley side of the road
11+150	Kholsi
28+050	Simle Khola site
31+040	At valley side spoil disposal

Source: Field Survey, 2016

8. CONCLUSION AND RECOMMENDATIONS

The Haldebeshi – Dhobi - Dhadebeshi Road alignment is the alternative route to Okhaldhunga district via. Ramechhap. It is one the prioritized road for improvement by Ramechhap DTO. This road is the connectivity to numerous settlements of eastern parts of the district like Nagdaha, Dhobi, Sirise, Dhade etc. The alignment from Haldebeshi to Dhobi has been stone paved in majority of the sections. The road from Dhobi to Dhadebeshi was opened by the Likhu Hydropower. Few cross drainage structures are present in the alignment, however the alignment is degraded and in poor condition because of inadequate maintenance provisions. This road alignment is significant since it provides easy access to people from different VDC's of Eastern region of Ramechhap district to the district headquarter, Manthali.

The improvement in road alignment also helps people encourage in getting the better benefit to services which results in better living standard of the local people. All the settlements along the proposed road alignment and its neighborhood have immense potential of vegetable, fruit and other cash crops production. People can increase the production of cereal crops and cash crops so that it can be exported. This will increase the cash flow in the area.

While considering the improvement of the road to gravel standard, provisions have been made for adequate cross drainage as well as side drains. However for the preservation of gravel surface it is important that surface water does not flow through the road surface. As such it is recommended that during rainy season in construction phase the adequacy of side drains and cross drainage shall be observed and modification as required shall be made to preserve the road asset.

Annex 1: Bench mark List and Description Cards

S. No.	Easting	Northing	RL	Remarks
1	410628.876	3035223.931	532.866	BM-1
2	410648.834	3035240.574	538.790	BM-2
3	410494.669	3034475.561	682.256	BM-3
4	410538.484	3034463.205	697.829	BM-4
5	411114.635	3035159.981	809.931	BM-5
6	411091.231	3035171.123	802.494	BM-6
7	412393.164	3035525.266	979.523	BM-7
8	412381.104	3035473.029	983.529	BM-8
9	411870.185	3034753.760	1030.567	BM-9
10	411856.215	3034721.173	1034.280	BM-10
11	411866.186	3034466.685	1116.443	BM-11
12	411773.509	3034461.680	1115.414	BM-12
13	412848.633	3035185.151	1236.051	BM-13
14	412812.294	3035196.375	1222.918	BM-14
15	413703.747	3034987.801	1303.394	BM-15
16	413694.711	3034962.625	1309.985	BM-16
17	413718.044	3034528.801	1451.878	BM-17
18	413751.883	3034499.863	1452.785	BM-18
19	414673.956	3034290.579	1504.821	BM-19
20	414706.228	3034272.205	1507.234	BM-20
21	415001.403	3033764.365	1563.509	BM-21
22	415034.503	3033789.595	1549.266	BM-22
23	415591.491	3033258.986	1614.879	BM-23
24	415579.877	3033223.468	1625.468	BM-24
25	416258.364	3032977.028	1656.519	BM-25
26	416270.983	3032959.494	1661.164	BM-26
27	416682.369	3033677.652	1689.299	BM-27
28	416650.887	3033681.097	1669.026	BM-28
29	417089.865	3034094.556	1729.682	BM-29
30	417113.242	3034099.275	1727.844	BM-30
31	417697.500	3034330.470	1798.463	BM-31
32	417650.566	3034364.808	1790.361	BM-32
33	418813.020	3034733.919	1801.663	BM-33
34	418820.973	3034709.299	1808.304	BM-34
35	419699.598	3034795.222	1837.228	BM-35
36	419820.175	3034673.400	1816.003	BM-36
37	420722.942	3034120.496	1658.149	BM-37
38	420923.113	3033920.990	1622.146	BM-38
39	421289.674	3033772.491	1547.100	BM-39
40	421341.877	3033779.143	1539.830	BM-40
41	421975.001	3033344.283	1471.403	BM-41

S. No.	Easting	Northing	RL	Remarks
42	422014.575	3033355.445	1464.011	BM-42
43	422441.814	3032636.814	1379.241	BM-43
44	422413.481	3032646.714	1373.253	BM-44
45	422519.440	3033253.527	1233.915	BM-45
46	422535.766	3033201.838	1238.955	BM-46
47	422657.606	3034258.840	1046.948	BM-47
48	422632.565	3034242.032	1055.789	BM-48
49	423517.216	3033968.554	1053.892	BM-49
50	423648.951	3033853.819	1065.862	BM-50
51	424297.321	3033360.848	899.945	BM-51
52	424189.058	3033419.614	912.598	BM-52
53	424614.631	3033681.829	719.871	BM-53
54	424597.861	3033729.512	711.098	BM-54
55	425390.834	3034199.903	703.961	BM-55
56	425441.580	3034255.960	714.220	BM-56
57	426154.330	3035213.779	742.734	BM-57
58	426101.880	3035258.818	751.396	BM-58
59	426376.640	3036046.601	762.756	BM-59
60	426354.463	3036040.325	762.222	BM-60
61	426548.474	3036440.355	773.576	BM-61
62	426543.458	3036495.212	773.584	BM-62