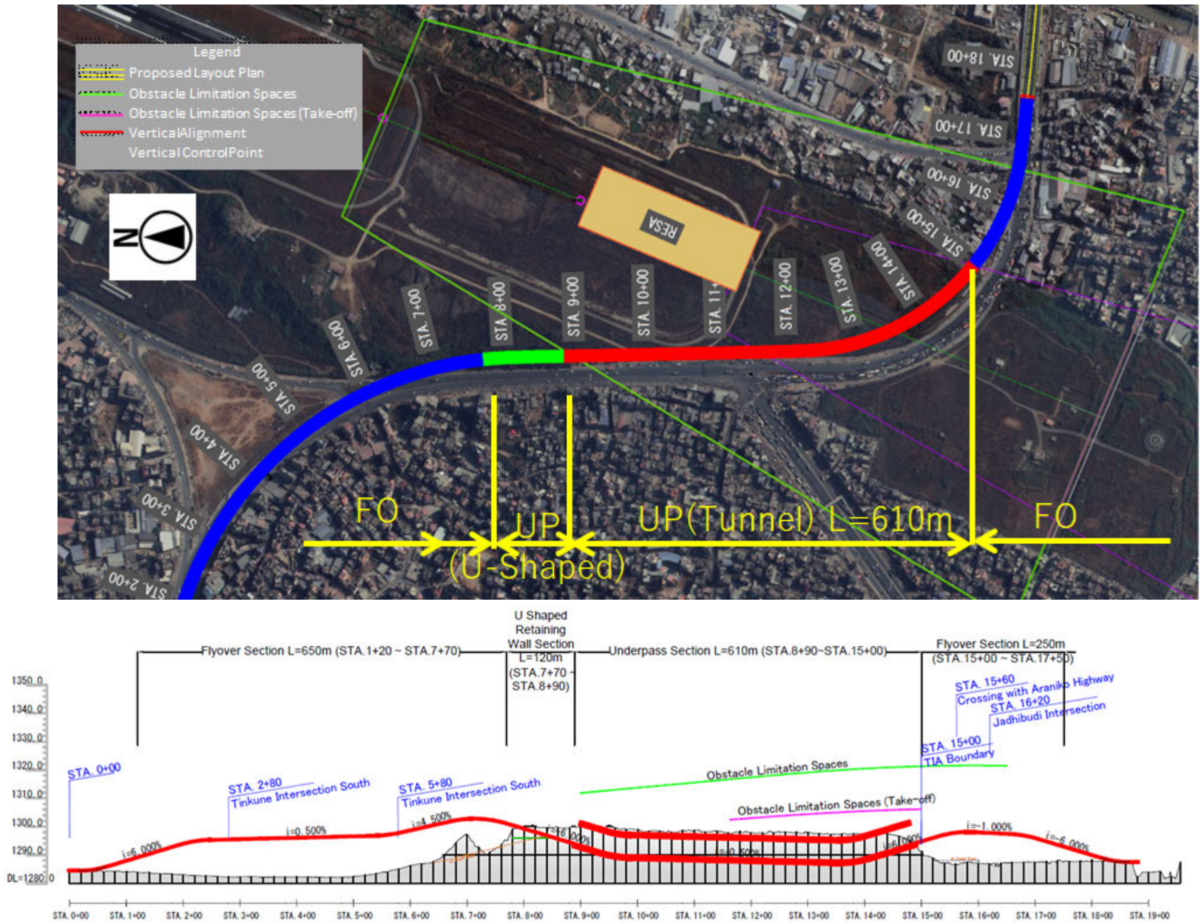
CHAPTER 9. OUTLINE DESIGN OF STRUCTURES

9.1 Introduction

The concept of structure application in the grade-separated (GS) section for the project roads is well studied and explained in Chapter 7. Based on that, Figure 9.1.1 shows the location of the selected grade-separated structures. The GS structures consist of the underpass in the TIA area, the flyover at the Tinkune Intersection, and the flyover at the Jadibuti Intersection.



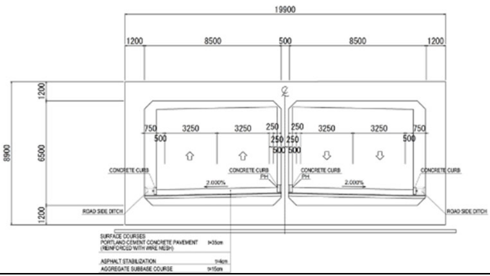
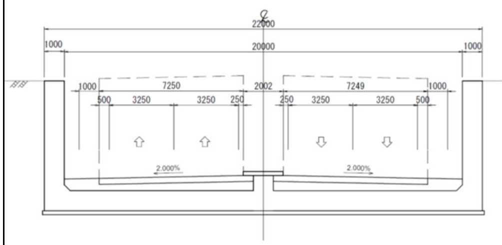
Source: JICA Survey Team

Figure 9.1.1 Overview of Grade-Separated Structures

9.2 Underpass Structure

The underpass structure shall be installed below the TIA land surface. For the underpass section, box culverts and U-shaped retaining walls are basically applied. While they propose to install box culverts in the OLS area in TIA land, U-shaped retaining walls are applied in the remaining sections. The minimum clearance for the inner space for both structures is 5 m, with an additional 1.5 m margin for the installation of tunnel facilities. Table 9.2.1 illustrates the structural features for the underpass.

Table 9.2.1 Structural Features for the Underpass

	Box Culvert	U-shaped Retaining Wall
Overview		
Applied Sites	- Section under the OLS	- Section with no OLS constraints
Length Inner Height	60 0m 6.5m	120m -
Construction Method	- Open-cut at the area where TIA permits - Earth retaining wall (in the case of limited horizontal space to the existing road)	- Open-cut - Earth retaining wall (in the case of areas with land use restrictions)

Source: JICA Survey Team

9.3 Flyover Structure

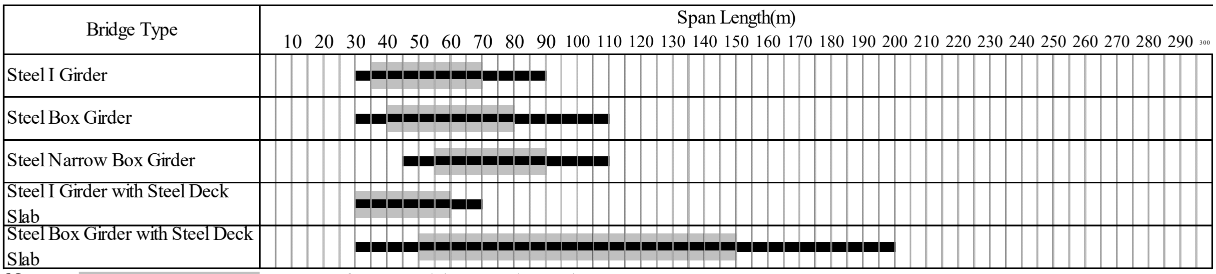
9.3.1 Applicable Types of Superstructure, Substructure, and Foundation

(1) Applicable Type of Superstructure

Since the project flyovers (FOs) are inside the city area, it is recommended to apply a girder type bridge. Table 9.3.1 and Table 9.3.2 show the relationship between applicable bridge type and span length for steel bridge and PC bridge, respectively.

Since construction cost of a steel girder is generally high, a PC bridge is suitable for project FOs. In contrast, a steel bridge is for sections that require long span length and fast construction, such as across an intersection.

Table 9.3.1 Applicable Bridge Type with Span Length (Steel Bridge)



Note: : Range of Span Lenth has enough experience

Source: JICA Survey Team

Table 9.3.2 Applicable Bridge Type with Span Length (PC Bridge)

Bridge Type	Erection Method	Span Length(m) 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 250 350
T/I Girder	Crane Election	
Hollow Slab	All Staging	
Box Girder	All Staging	
	Cantilever Erection	

Note: : Range of Span Lenth has enough experience

Source: JICA Survey Team

(2) Applicable Type of Substructure

A T-shaped pier column with an RC structure is the applicable type of substructure for the project. However, steel structure type or portal pier column type shall be applied considering the relationship between the horizontal alignment of both GS structure and at-grade road.

(3) Applicable Foundation Type

Major features of geological conditions in Kathmandu Valley are shown below according to the boring data described in Chapter 3:

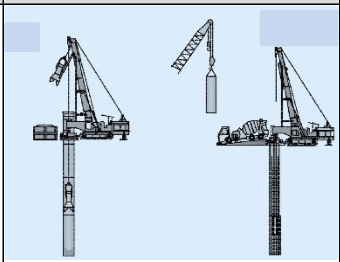
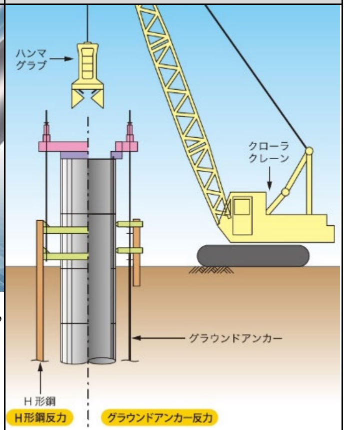
- No bearing layer reaches up to the 50 m to 60 m depth level
- A mixture of silt/cray layer with an N-value of 10 to 20 is within the intermediate layers.

In consideration of the geological conditions mentioned above and the scale of the flyovers for the project, applicable foundation types to consider are as follows;

- Cast-in-situ concrete pile
- Steel rotation pile
- PC well

As a result of the comparative study shown in Table 9.3.1, the concrete pile is cast-in-situ for the project FOs. The applied pile diameter is 1.2 m, considering the size of the flyover structure. It is also the common pile diameter utilized in Nepal recently.

Table 9.3.3 Comparison of Foundation Types

	Cast-in-Situ Concrete Pile	Steel Rotation Pile	PC Well
Sketch	 Source: HP of MLIT	 Source: HP of JFE Steel Co., Ltd.	 Source: HP of Nippon Hume Co., Ltd.
Characteristic	It is the most common method for foundation installation in Nepal. It is the most economical and common for both bearing pile and friction pile.	It is the latest technology developed in Japan. Addition of large diameter plate in the pile tip can increase the bearing capacity.	It is the latest technology developed in Japan. The pile body is precast concrete, so quality is easy to control and construction space can be narrower.
Applicability to the Project	Since it is the most common foundation type in Nepal, there is no issue. However, it may be necessary to mobilize construction equipment since diameter used in Nepal is small.	Since mobilizing materials and construction equipment from Japan is necessary, construction cost becomes higher.	Bearing capacity can be acquired from ground reaction force. However, the pile cannot gain bearing capacity due to the absence of bearing layer in the geological condition of Kathmandu Valley.
Evaluation	Superior	Inferior	Inferior

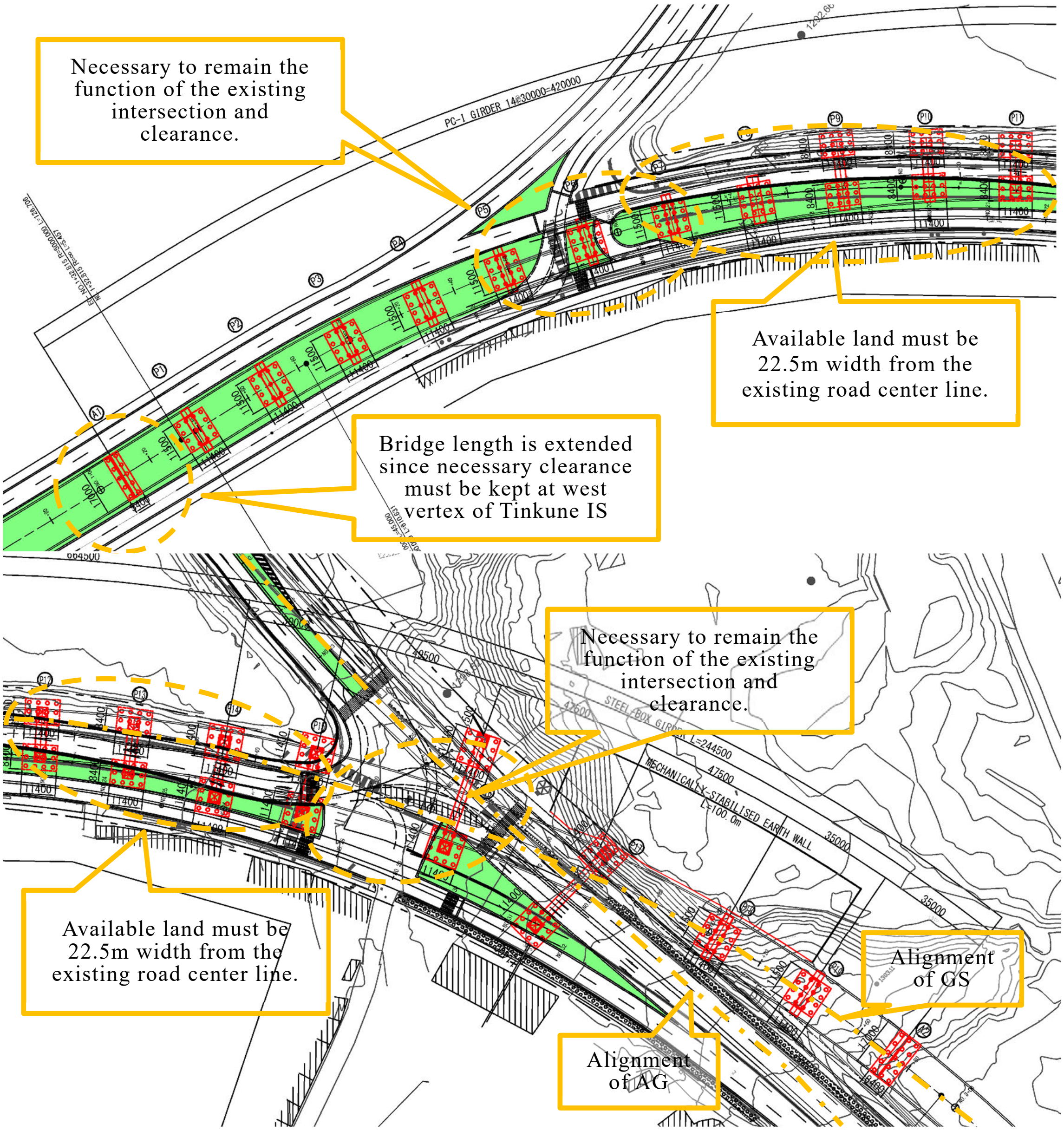
Source: JICA Survey Team

9.3.2 Tinkune Intersection

(1) Constraint Conditions

Several constraints are considered in designing a bridge plan on the GS section of the project road, as shown in Figure 9.3.1. The main points are the following:

- No adverse impacts on the existing traffic control or operation, meaning that the present control or operation of the three locations of the project intersections shall remain the same in all directions.
- The ROW south of Tinkune Intersection must be 22.5 m-width from the existing road centerline, representing the ROW width when Nepal used the yard system for distance measurement. Consequently, the GS alignment must transverse through the specified ROW area in the case of the TK-2R application.
- The crossing angle between GS and AG becomes very sharp at the south vertex of the intersection. Therefore, the span length at this point requires a longer span.



Note: the area filled by green color is traffic island.
Source: JICA Survey Team

Figure 9.3.1 Constraints for the FO Planning at the Tinkune Intersection

(2) Bridge Length and Span Arrangement

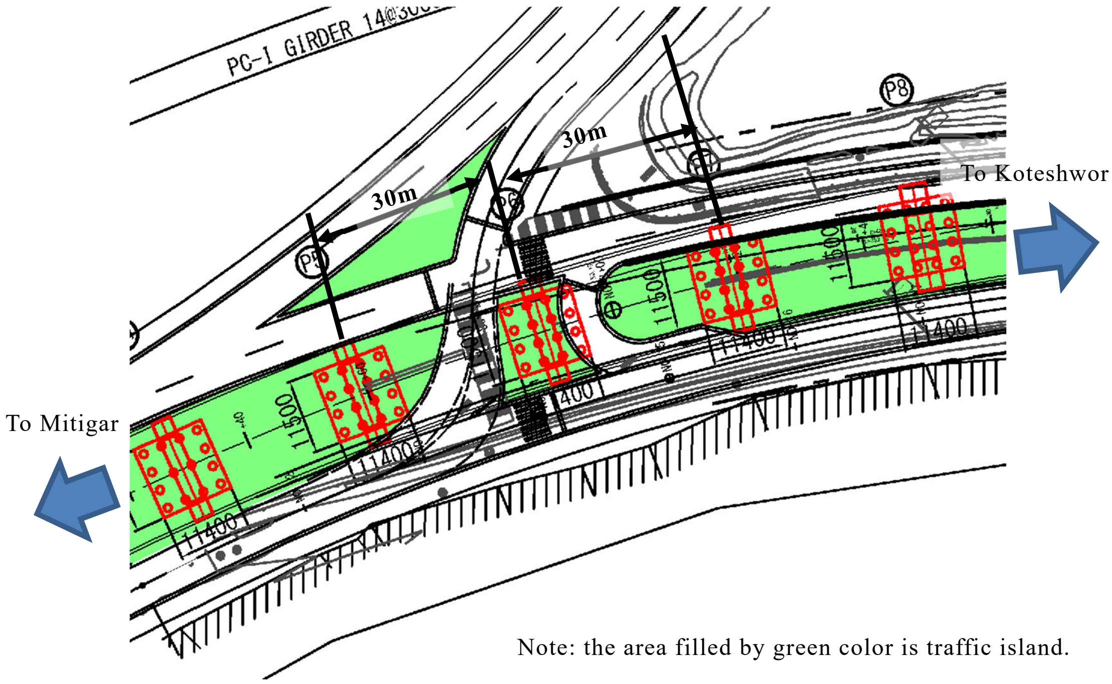
In consideration of the above-mentioned constraints for the FO planning, bridge length and span arrangement of the flyover around the Tinkune Intersection are the following:

- Bridge Length: 664.5 m
- Span Arrangement: 14@30m (PC-I girder) + 30m + 49.5m + 2@47.5m + 2@35m (steel girder)

(3) Type of Superstructure

1) PC-I Girder Section

The PC-I girder type is basically applied from the starting point of the flyover to the vicinity of the south vertex of the intersection, along the east ramp of the Tinkune Intersection. This includes the crossing point west of the Tinkune Intersection because 30 m span length is deemed sufficient to cross the point, as per the AG intersection plan illustrated in Figure 9.3.2.



Source: JICA Survey Team

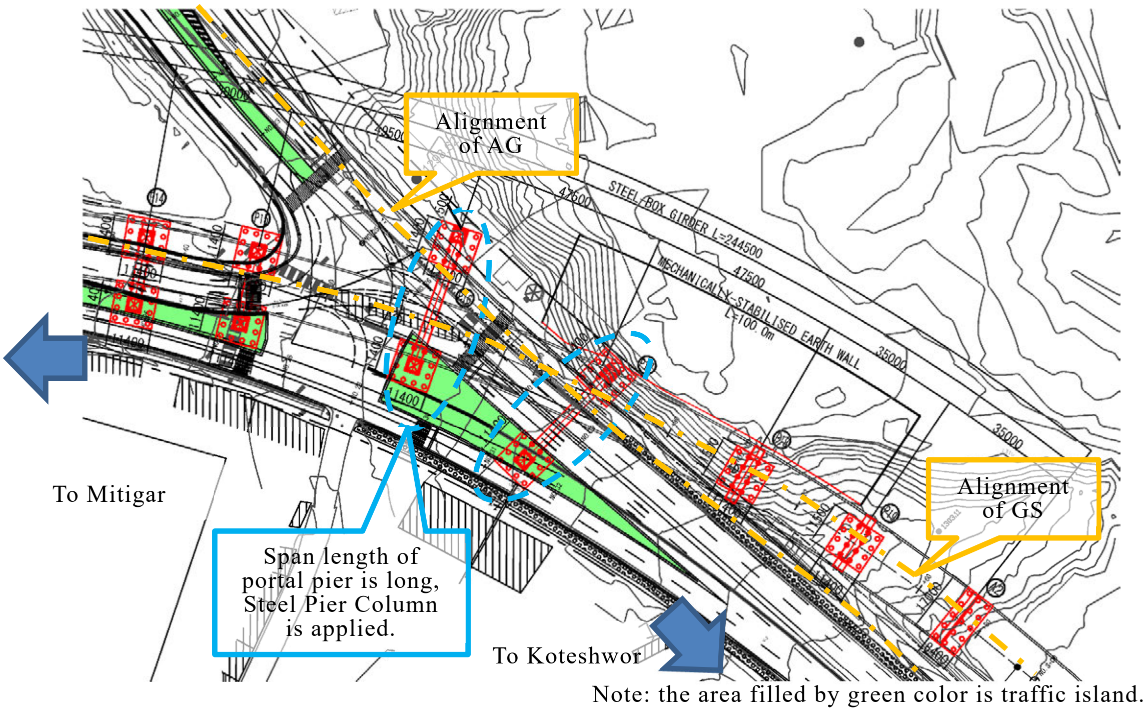
Figure 9.3.2 Span Arrangement West of the Tinkune Intersection

There is no other crossing point up to the south vertex of the intersection. The advantages of the application of a pre-cast PC-I girder are the following:

- It is the most economical type of superstructure.
- It has a shorter erection period than that of a cast-in-situ.

2) Steel Girder Section

A steel girder type is applied from the south of the Tinkune Intersection to the ending point of FO section, connecting to the underpass (UP) section. Since the crossing angle between horizontal alignment of the GS structure and the AG road is very sharp, and there is no traffic island on the AG road under the GS structure, a portal type of piers with steel pier columns is applied in order to reduce span length. Even though, the crossing length at this point requires longer spans, around 50 m, a steel box girder is suitable for this section, as shown in Figure 9.3.3.

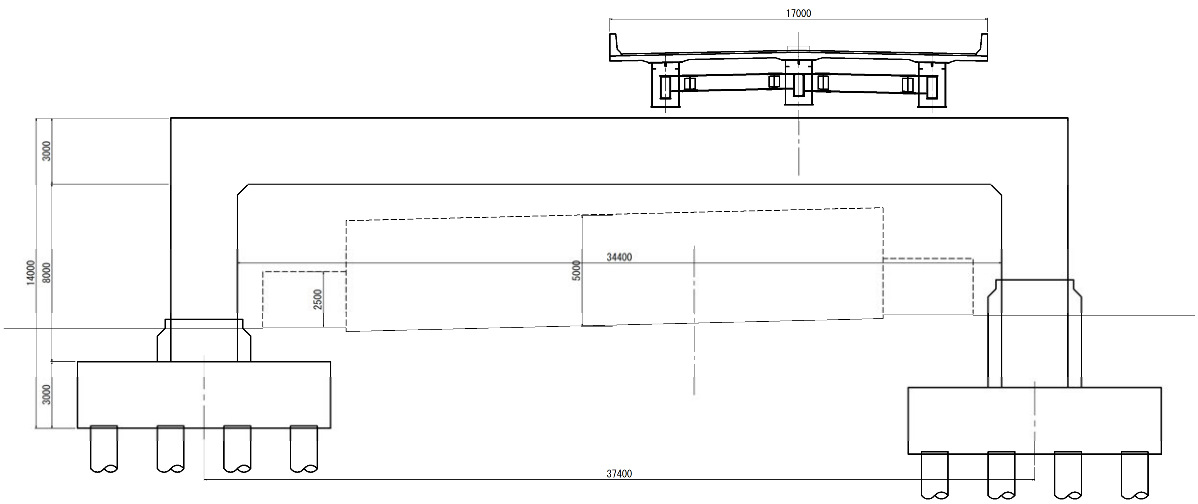


Source: JICA Survey Team

Figure 9.3.3 Span Arrangement South of the Tinkune Intersection

(4) Type of Substructure

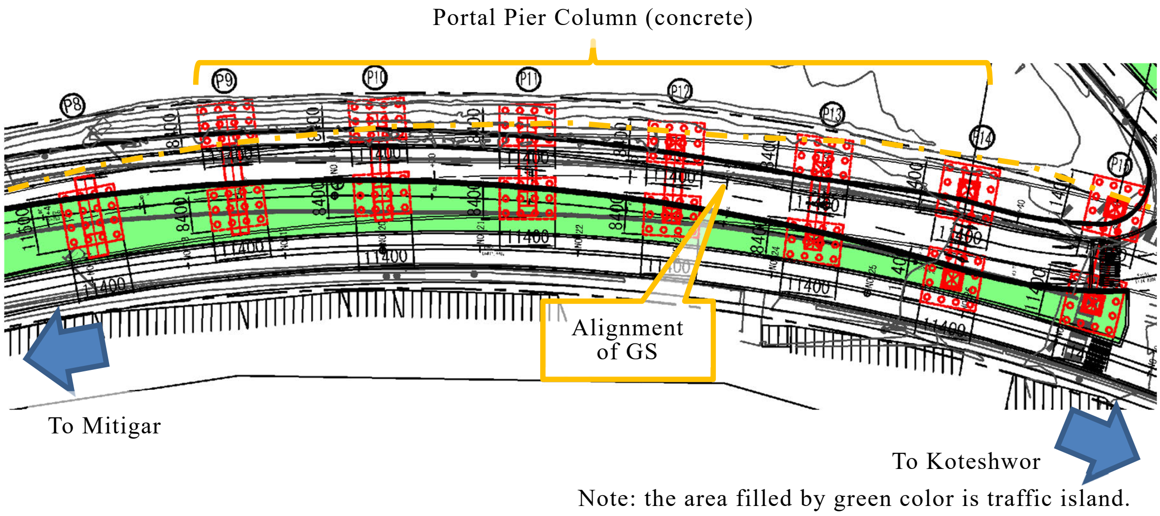
A T-shaped concrete pier column type is the substructure applied for the Tinkune flyover. However, a steel portal pier column is also used as explained in previous section. Figure 9.3.4 illustrates the front view of the steel pier.



Source: JICA Survey Team

Figure 9.3.4 Front View of Steel Portal Pier Column for the Tinkune Flyover

In addition, the portal pier column is also applied to the section between the west intersection and the south one of the Tinkune because the horizontal alignment of the GS does not follow the one of the AG, as shown in Figure 9.3.5.



Source: JICA Survey Team

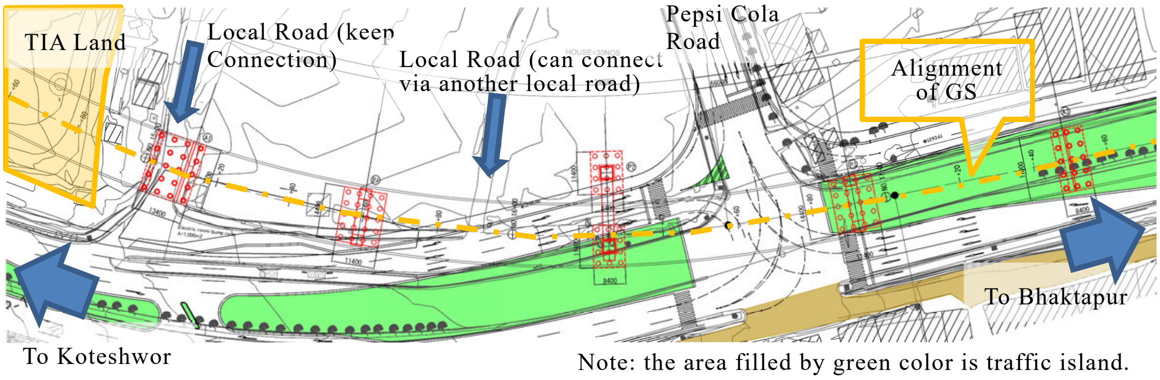
Figure 9.3.5 Section for Portal Pier Column (Concrete)

9.3.3 Jadibuti Intersection

(1) Constraint Conditions

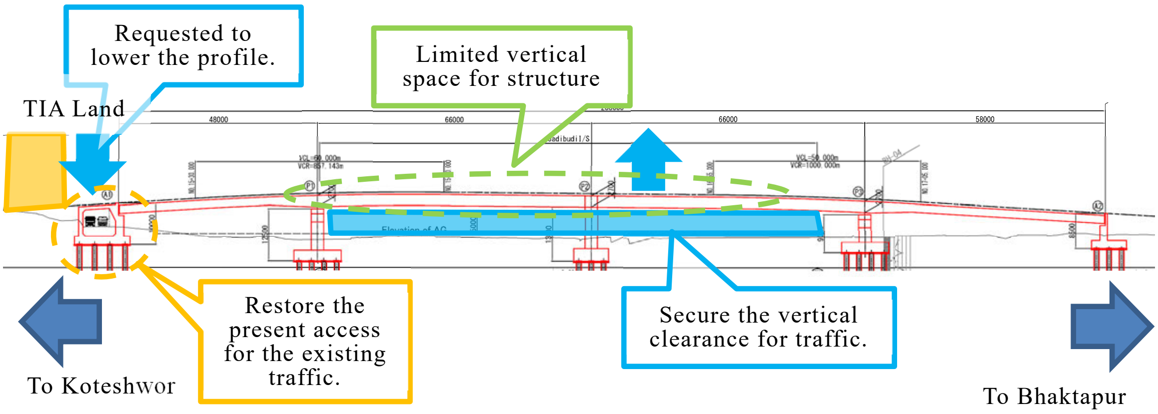
In order to formulate a FO plan around the Jadibuti Intersection, the following constraints for the FO plaining must be taken into consideration, as illustrated in Figure 9.3.6 and Figure 9.3.7. The main points are the following:

- The FO planning for the Jadibuti Intersection affects the local road along the airport territory connected from the northern side. Based on the discussion result with DOR, the local road is required to restore its access to Araniko Highway.
- Since it is required to keep 2 m of cover depth above the box culvert of the UP section in the project roads within TIA land, as well as the project road has to end before the Manohara River Bridge, careful profile setting across the Jadibuti Intersection is required considering the AG road elevation around the intersection and the girder depth depending on the applicable superstructure types.



Source: JICA Survey Team

Figure 9.3.6 Constraints around Jadibuti Intersection (Plan View)



Source: JICA Survey Team

Figure 9.3.7 Constraints at Jadibuti Intersection (Profile)

(2) Bridge Length and Span Arrangement

In consideration of the constraints mentioned above, the bridge length and span arrangement of the FO across the Jadibuti Intersection are as follows:

- Bridge Length: 238 m
- Span Arrangement: 48m + 2@66m + 58m

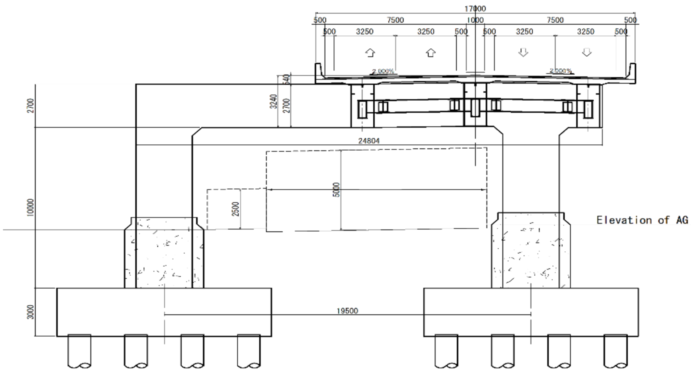
(3) Type of Superstructure

Because of the constraints caused by the profile for the GS section from TIA land to Araniko Highway and the required clearance for vehicles on the AG road around the intersection, only 4m height can be usable for the FO structure. A steel structure that integrates the superstructure with the substructure (beam) is necessary to accommodate both the superstructure and substructure beam depths within this limited space. In addition, it also requires a shortened construction period at the intersection because it is located along Araniko Highway, the most significant road to connect the center of Kathmandu Valley and Bhaktapur (the east center of

Kathmandu Valley). Accordingly, the application of a special steel structure is justifiable in this section.

(4) Type of Sub-structure

Although basically, the T-shaped concrete pier column type is applied at the FO section across the intersection, the integrated steel structure combining superstructure and substructure must be at the west of the intersection, as shown in Figure 9.3.8 and described in the previous section.



Source: JICA Survey Team

Figure 9.3.8 Front View of Steel Portal Pier Column for Jadibuti Flyover

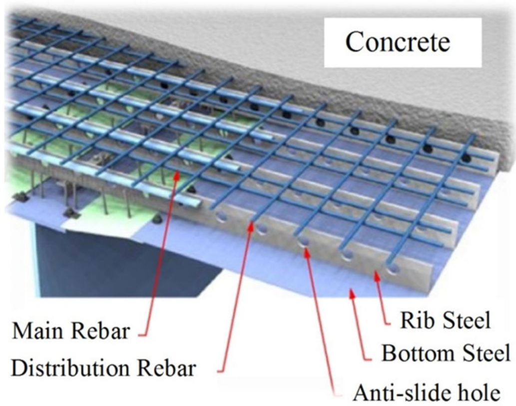
Note that a box type of abutment shall be appropriate to restore the present access for vehicles from the local road along the airport territory to Araniko Highway, as explained in Figure 9.3.6 and Figure 9.3.7.

9.3.4 Latest Technologies for the Project Structures

Considering safety during construction and shortening the construction time. advanced technologies for the project are as follows:

(1) Steel Composite Deck Slab

Steel composite deck slab is a new type of deck slab structure with a composite of steel and concrete materials. The bottom of the composite deck slab is a steel plate reinforced by T/I shaped steel. Deck concrete is poured after the installation of the bottom steel.



Source: HP of New Technology Information System

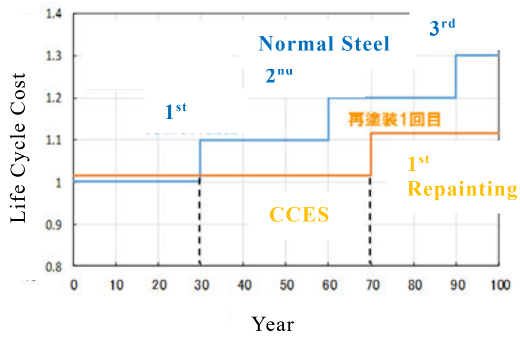
Figure 9.3.9 Composite Deck Slab

The deck slab has more durability compared with conventional RC deck slab. It can also achieve speedy construction. Due to the installation of steel plate at first, there is no risk about leakage of wet concrete during construction and cause no restriction of traffic usage underneath of the deck slab during construction work.

As mentioned above, since the steel box girder type is for congested project intersections, it is very effective to apply the technology to reduce the safety risk on traffic on the AG roads. Figure 9.3.9 illustrates a sketch of the composite deck slab.

(2) Coating Cycle Extension Steel (CCES)

Repainting work is an unavoidable work for maintenance of steel structures. Heavy anti-corrosion coating (C-5 type coating specified by "Specification for Steel Bridge Painting and Anti Corrosion") is highly recommended to reduce a burden of the maintenance work by DOR. Although some observed that the repainting cycle of the C-5 type is about 60 to 70 years, this cycle would be shorter depending on the surrounding conditions, such as seashore areas, the area using antifreeze agent and the section where water accumulates.



Source: HP of JFE Steel Co., Ltd.

Figure 9.3.10 Image of Repainting Work for CCES

Originally, "Coating Cycle Extension Steel" was developed and has started to be applied in Japan at severe surrounding condition area, such as seashore area or the area using antifreeze agent to make the repainting cycle longer. The repainting cycle where the surrounding condition is very severe, can be secured as same duration as applied normal surrounding condition.

Since the project site is in the city center, surrounding condition is not severe compared to seashore area or the area using antifreeze agent. Nevertheless, significant damage to the paint was observed, especially in areas prone to water accumulation, even within the city center. The application of C-5 type coating is proposed to reduce the burden of maintenance work in future. In addition, the application of coating cycle extension steel is also recommended.

Figure 9.3.10 shows an image of the advantage for using CCES.

CHAPTER 10. OUTLINE DESIGN OF TUNNEL FACILITIES

10.1 General

Table 10.1.1 lists the facilities for installation inside and outside road tunnels to secure safe and smooth traffic flow. The necessity of these facilities is determined by the tunnel class, classified according to the traffic volume and length of the tunnel, the surrounding environment, and the structural conditions of the project tunnel. The facilities are designed based on the standards stated in Table 10.1.1 and in consideration of consistency with the Nagdhunga Tunnel Project, under construction financed by JICA Yen Loan.

Table 10.1.1 Facilities for Road Tunnels

Facilities		Equipment
Tunnel Ventilation	Tunnel Inside	Jet Fan/ CO meter/ VI meter/ AV meter
	Tunnel Outside	Local Control Panel
Tunnel Lighting	Tunnel Inside	Interior Lighting/ Entrance Lighting/ Emergency Lighting
	Tunnel Outside	Local control panel, etc.
Emergency Facilities	Tunnel Inside	Emergency Telephone/ Push Button Alarm/ Fire Detector/ Fire Extinguisher/ Fire Hydrant/ Guide Board, Hydrant/ CCTV Camera, etc.
	Tunnel Outside	Local Control Panel/ Water Supply Pump/ Water Tank/ Pump Panel/ Emergency Information Board, etc.
Other Facilities	Tunnel Inside	-
	Tunnel Outside	Electrical Room/ Management Office/ Power supply system/ Back-up Generator, etc.

Source: JICA Survey Team

10.2 Standards and Guidelines to Apply

There are no standards or guidelines for tunnel facilities in Nepal. Although the Indian tunnel standard, IRC SP 91-2010 Guidelines for Road Tunnels, has a chapter on tunnel facility design, it does not state the specific installation conditions and consideration for each facility. On the other hand, Japanese standards clearly describe the installation conditions and methodologies for tunnel facility design based on its ample experience in tunnel construction and operation. The design of most tunnel facilities in the Nagdunga Tunnel Project is based on Japanese standards.

Given the above considerations, the standards and guidelines shown in Table 10.2.1 are applied to tunnel facility design for the planned tunnel in the project roads, considering consistency with the Nagdunga Tunnel Project.

Table 10.2.1 List of Applied Standards/Guidelines for Tunnel Facility Design

Standards/Guidelines	Issue	Year
Road Tunnel Technical Standards for Tunnel Ventilation	Japan Road Association	2008
Road Tunnel Technical Standards for Emergency Facilities	Japan Road Association	2001
CIE88-2004, Ver.2	International Commission on Illumination (CIE)	2004
Installation Standard for Road Lighting Facilities	Japan Tunneling Association	2006
Traffic Capacity for Road	Japan Road Association	1984

Source: JICA Survey Team

10.3 Tunnel Ventilation Facility

10.3.1 General

Tunnel ventilation plays a crucial role in expelling harmful substances emitted by vehicles from the tunnel outside and maintaining a safe and comfortable driving environment by ensuring the concentration of pollutants within the tunnels stays below established control standards. Additionally, it is important to enhance the working conditions for maintenance personnel responsible for tunnel upkeep.

The need for tunnel ventilation and the specific requirements for ventilation equipment depend on several factors such as the tunnel's cross section, length, and traffic volume. When the natural wind-induced ventilation inside the tunnel proves insufficient to achieve the desired safety and comfort conditions, a mechanical ventilation system must be considered.

10.3.2 Design Condition

Table 10.3.1 lists the design conditions for tunnel ventilation used for the project tunnel.

Table 10.3.1 Design Conditions for Ventilation Facility

Item	Condition	Remarks
Tunnel Length	600 m each	Cross section with lanes toward to Manohara River Cross section with lanes toward to Maitighar
Vertical Gradient	-0.5%～6.0 %	Both tunnels are same
Tunnel Altitude	Approx. 1,300m	
Cross Section Area	45.9 m^2	
Typical Tunnel Diameter	6.7m	Inner Section Area/Perimeter of Inner Section
Traffic Condition	One Way Traffic	
Design Speed	50 km/h	
Mix Rate of Large Vehicle	27.7 %	

Source: JICA Survey Team

10.3.3 Ventilation Calculation Results

(1) Design Traffic Capacity and Design Hourly Volume

Table 10.3.2 and Table 10.3.3 present the design traffic capacity and design hourly volume of the project tunnel.

Table 10.3.2 Design Traffic Capacity

Items	Cross Section		Remarks
	For Bhaktapur	For Maitighar	
Basic Traffic Capacity (C_B)	4,400 vehicles/h	4,400 vehicles/h	Traffic Capacity for Road, Page.22
Correction Factor of Carriageway (γ_L)	1.00	1.00	Traffic Capacity for Road, Page.20
Correction Factor of Side Space (γ_C)	0.98	0.98	Traffic Capacity for Road, Page.25
Passenger Car Conversion Factor of Large Vehicle (γ_T)	0.67	0.84	Traffic Capacity for Road, Page.31
Correction Factor of Roadside Condition (γ_I)	0.90	0.90	Traffic Capacity for Road, Page.27
Available Traffic Capacity (C)	3,881vehicles/h	3,881vehilcles/h	$C= C_B \times \gamma_L \times \gamma_C \times \gamma_I$
Plan Level (P_L)	0.90	0.90	Traffic Capacity for Road, Page.84
Design Traffic Capacity (C_D)	2,340vehicles/h	2,934vehicles/h	$C_D = C \times P_L \times \gamma_T$
Driving Speed/Design Speed Ratio（VS/VD）	0.7	0.7	Traffic Capacity for Road, Page.84
Driving Speed at Design Traffic Capacity	35km/h	35km/h	Design Speed (50km/h) ×（VS/VD）

Source: JICA Survey Team

Table 10.3.3 Design Hourly Volume

Items	Cross Section		Items
	For Bhaktapur	For Maitighar	
Design Traffic Volume (ADDT)	120,973vehicles/day		
K Value (K)	9 %		Traffic Capacity for Road, Page.80
D Value (D)	51 %		
Design Hourly Volume	5,548 vehicles/h		=ADDT×K/100×D/100 (Traffic Capacity for Road, p81)
Driving Speed/Design Speed Ratio（VS/VD）	0.6	0.6	Traffic Capacity for Road, Page.84
Driving Speed at Design Hourly Volume	30km/h	30km/h	Design Speed (50km/h) ×（VS/VD）

Source: JICA Survey Team

(2) Design Concentration of CO and Soot

Table 10.3.4 shows the acceptable design concentration levels for CO and soot in tunnels.

Table 10.3.4 Design Values for CO and Visibility

Design Speed	CO	Soot (100 m transmittance)
More than 80km/hour	100ppm	50%
Less than 60km/hour		40%

Source: Road Tunnel Technical Standards for Tunnel Ventilation

(3) Design Emission of CO and Soot

Table 10.3.5 shows the vehicle’s design emissions of CO and soot.

Table 10.3.5 Design Emission of CO and Soot

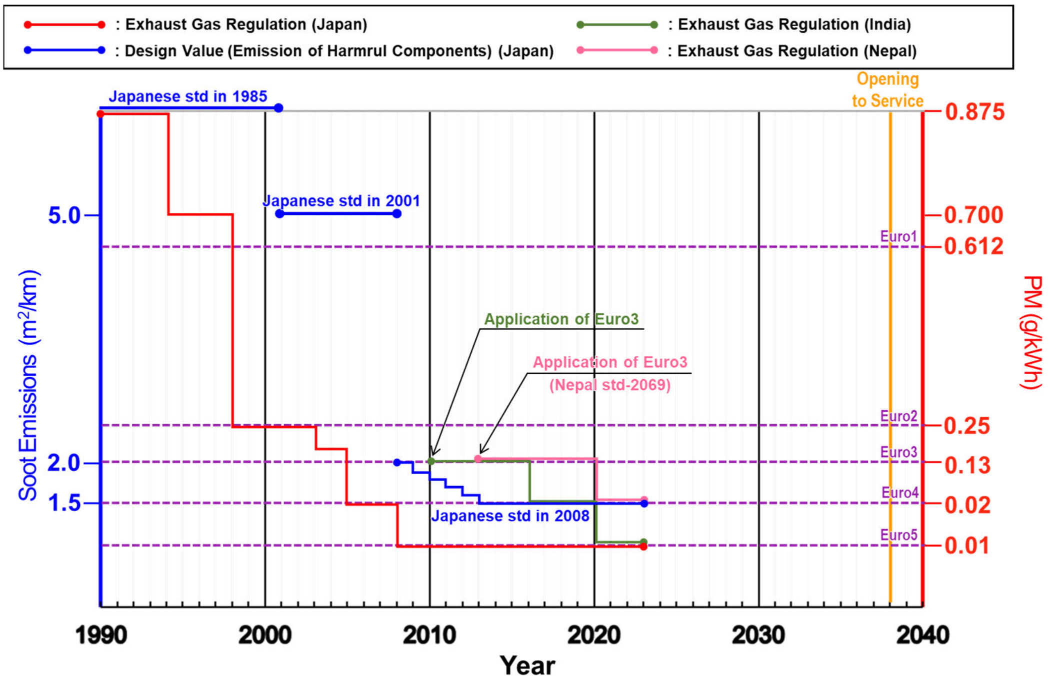
Vehicle Types	Soot (m^2/km)	CO (m^3/km)
Large Vehicles	2.0	0.007
Passenger Cars	0.4	

Source: JICA Survey Team

Although the ventilation design for the project tunnel is based on the Japanese standards listed in Table 10.2.1, the design emissions of both CO and soot are set on the situation of local emission regulations in Nepal for the following reasons:

- In Nepal, an exhaust gas regulations based on EURO-4 have been applied since 2020, and local vehicle performance is currently shifting from EURO-3 level to EURO-4 one (see Figure 10.3.1).
- On the other hand, the design emission value of soot in the Road Tunnel Technical Standards for Tunnel Ventilation, Japan (2008) was set corresponding to the EURO-4 level, which does not match the current vehicle performance in Nepal.

- Given the above conditions, the design emission of soot corresponding to EURO-3 level is estimated and adopted for the Project tunnel
- In the ventilation design for the Nagdunga Tunnel Project, the design emission of soot corresponding to EURO-3 level, same as the design emission applied for the project, was adopted based on the exhaust gas regulation in Nepal (see Table 10.3.6)



Source: JICA Survey Team

Figure 10.3.1 Status of Exhaust Gas Regulations in Nepal, India, and Japan

Table 10.3.6 Design Emission of Soot for the Project Tunnel

Projects/Standards	Vehicle Types	Design Emission of Soot (m^2/km) ※
Road Tunnel Technical Standards for Tunnel Ventilation	Large Vehicles	1.5
	Passenger Cars	0.3
Nagdhunga Tunnel Project	Large Vehicles	2.0
	Passenger Cars	0.4
Preparatory Survey for the Project for Intersection Improvement in Kathmandu	Large Vehicles	2.0
	Passenger Cars	0.4

※ Design emission unit of soot indicates the amount of soot (m^3) generated when one vehicle drives 1km and is calculated by multiplying the soot concentration factor (1/m) by the emission amount of soot.

Source: JICA Survey Team

(4) Required Ventilation Volume

In the ventilation design, it is necessary to calculate the required ventilation volume satisfying the design concentration of both soot and CO. The required ventilation volumes of soot and CO are computed using the following formulas:

Unit Ventilation Volume of Soot (Formula 10-1)

$$q = \left\{ \frac{3\sigma + \sqrt{9\sigma^2 + 8\mu \times K_{VI} \times A_r \times 1000}}{60 \times \sqrt{8A_r \times 1000} \times K_{VI}} \right\}^2$$

σ : Standard Deviation for Soot Emissions of Vehicles (m^2/km)

μ : Average Soot Emissions of Vehicles (m^2/km)

K_{VI} : Soot Concentration Factor (1/m)

A_r : Inner Section Area (m^2)

Required Ventilation Volume of Soot (Formula 10-2)

$$Q_{req} = q \times N \times \frac{L}{1000}$$

q : Unit Ventilation Volume of Soot

N : Traffic Volume (vehicles/h)

L : Section lengths by Vertical Gradient (m)

Unit Ventilation Volume of CO (Formula 10-3)

$$q = \frac{\mu \times K_h}{T_t \times K_{CO} \times 10^{-6}}$$

μ : Average CO Emissions of Vehicles (m^3/km)

K_h : Elevation Correction Factor

T_t : Average Transit Time Interval of Vehicles (s)

K_{CO} : Design Concentration of CO (ppm)

Required Ventilation Volume of CO (Formula 10-4)

$$Q_{req} = q \times N \times \frac{L}{1000}$$

q : Unit Ventilation Volume of CO

N : Traffic Volume (vehicles/h)

L : Section lengths by Vertical Gradient (m)

Table 10.3.7 to Table 10.3.10 show the required ventilation volumes of both soot and CO at the design hourly volume and design traffic capacity.

Table 10.3.7 Required Ventilation Volume (Soot) at Design Hourly Volume

Items	To Bhaktapur		To Maitighar	
	Section-1	Section-2	Section-1	Section-2
Design Hourly Volume (N)	5,548 vehicles/h	5,548 vehicles/h	5,548 vehicles/h	5,548 vehicles/h
Section Length (L) ※1	545m	55m	55m	545m
Vertical Gradient	-0.5%	6.0%	-6.0%	0.5%
Average Deviation of Soot Emission (σ)	0.89	3.49	1.10	0.52
Average Soot Emission (μ)	0.87	2.66	1.05	0.49
Design Concentration Factor (K_{VI})	0.0092	0.0092	0.0092	0.0092
Inner Section Area (A_r)	45.9m^2	45.9m^2	45.9m^2	45.9m^2
Required Ventilation Volume by Sections	88 m^3	30 m^3	11 m^3	49 m^3
Required Ventilation Volume (Q_{req})	118 m^3		60 m^3	

※1: see Figure 10.3.3 and Figure 10.3.4
Source: JICA Survey Team

Table 10.3.8 Required Ventilation Volume (Soot) at Design Traffic Capacity

Items	To Bhaktapur		To Maitighar	
	Section-1	Section-2	Section-1	Section-2
Design Traffic Capacity (N)	2,340 vehicles/h	2,340 vehicles/h	2,340 vehicles/h	2,340 vehicles/h
Section Length (L) ※1	545m	55m	55m	545m
Vertical Gradient	-0.5%	6.0%	-6.0%	0.5%
Average Deviation of Soot Emission (σ)	0.89	3.49	1.10	0.52
Average Soot Emission (μ)	0.86	2.66	1.05	0.49
Design Concentration Factor (K_{VI})	0.0092	0.0092	0.0092	0.0092
Inner Section Area (A_r)	45.9m^2	45.9m^2	45.9m^2	45.9m^2
Required Ventilation Volume by Sections	37 m^3	13 m^3	6 m^3	26 m^3
Required Ventilation Volume (Q_{req})	50 m^3		32 m^3	

※1: see Figure 10.3.3 and Figure 10.3.4
Source: JICA Survey Team

Table 10.3.9 Required Ventilation Volume (CO) at Design Hourly Volume

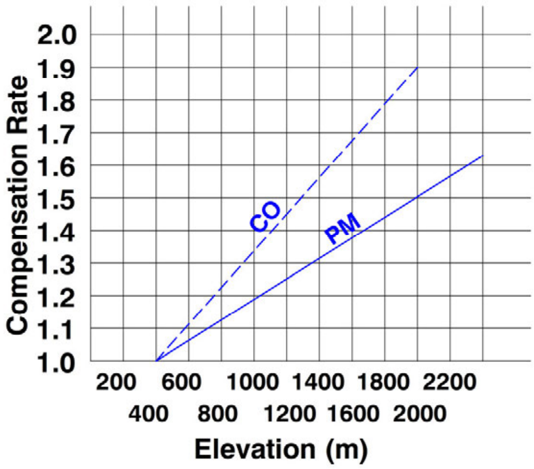
Items	To Bhaktapur		To Maitighar	
	Section-1	Section-2	Section-1	Section-2
Design Hourly Volume (N)	5,548 vehicles/h	5,548 vehicles/h	5,548 vehicles/h	5,548 vehicles/h
Section Length (L) ※1	545m	55m	55m	545m
Vertical Gradient	-0.5%	6.0%	-6.0%	0.5%
Average CO Emission (μ)	0.005 m^3/km・vehicles	0.005 m^3/km・vehicles	0.005 m^3/km・vehicles	0.005 m^3/km・vehicles
Elevation Correction Factor (K_h) ※2	1.51	1.51	1.51	1.51
Average Transit Time Interval of Vehicles (T_t)	0.65	0.65	0.65	0.65
Design Concentration of CO (K_{CO})	100ppm	100ppm	100ppm	100ppm
Required Ventilation Volume by Sections	64 m^3	6 m^3	6 m^3	64 m^3
Required Ventilation Volume (Q_{req})	70 m^3		70 m^3	

※1: see Figure 10.3.3 and Figure 10.3.4
※2: see Figure 10.3.2
Source: JICA Survey Team

Table 10.3.10 Required Ventilation Volume (CO) at Design Traffic Capacity

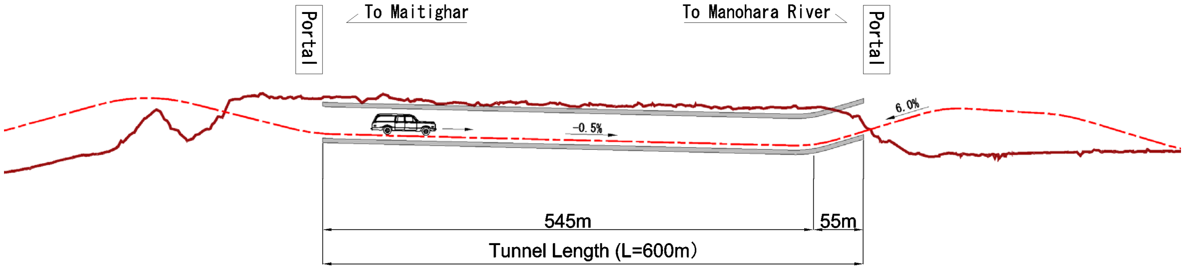
Items	To Bhaktapur		To Maitighar	
	Section-1	Section-2	Section-1	Section-2
Design Traffic Capacity (N)	2,340 vehicles/h	2,340 vehicles/h	2,934 vehicles/h	2,934 vehicles/h
Section Length (L) ※1	545m	55m	55m	545m
Vertical Gradient	-0.5%	6.0%	-6.0%	0.5%
Average CO Emission (μ)	0.005 m^3/ km・vehicles	0.005 m^3/ km・vehicles	0.005 m^3/ km・vehicles	0.005 m^3/ km・vehicles
Elevation Correction Factor (K_h) ※2	1.51	1.51	1.51	1.51
Average Transit Time Interval of Vehicles (T_t)	1.54	1.54	1.54	1.54
Design Concentration of CO (K_{CO})	100ppm	100ppm	100ppm	100ppm
Required Ventilation Volume by Sections	27 m^3	3 m^3	3 m^3	34 m^3
Required Ventilation Volume (Q_{req})	30 m^3		37 m^3	

※1: see Figure 10.3.3 and Figure 10.3.4
※2: see Figure 10.3.2
Source: JICA Survey Team



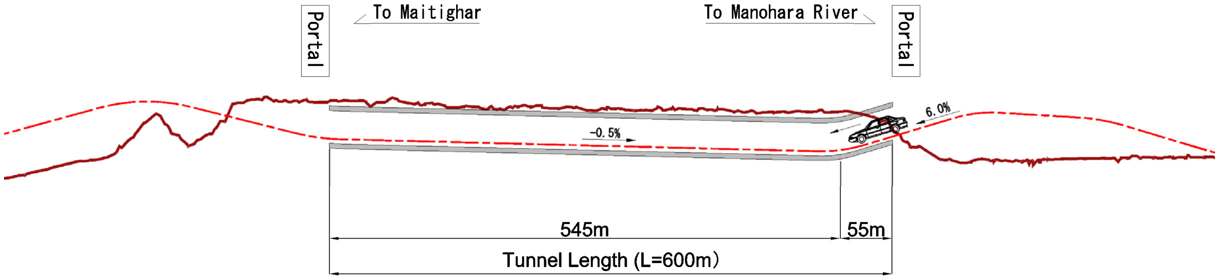
Source: Road Tunnel Technical Standards for Tunnel Ventilation

Figure 10.3.2 Elevation Compensation Factor



Source: JICA Survey Team

Figure 10.3.3 Section Length of Cross Section bound for Bhaktapur



Source: JICA Survey Team

Figure 10.3.4 Section Length of Cross Section bound for Maitighar

(5) Natural Ventilation Volume

Natural ventilation volume inside a tunnel depends on the pressure of natural wind, the pressure difference at portals, and the traffic piston pressure due to traffic flow. The natural ventilation volume is computed using the following formulas:

Theory of Natural Ventilation (Formula 10-5)

$$\Delta P_r + \Delta P_{MT} + \Delta P_t = 0$$

ΔP_r : Pressure on Tunnel Wall Resistance (Pa)

ΔP_{MT} : Pressure generated by Pressure Difference between Portals (Pa)

ΔP_t : Traffic Piston Pressure (Pa)

Pressure on Tunnel Wall Resistance (Formula 10-6)

$$\Delta P_r = \left(1 + \xi_e + \lambda \frac{L_r}{D_r}\right) \times {U_r}^2 \times \frac{\rho}{2}$$

ξ_e : Coefficient of Tunnel Portal Loss

λ : Coefficient of Tunnel Wall Friction Loss

L_r : Tunnel Length (m)

D_r : Typical Tunnel Diameter (m)

U_r : Wind Speed at Carriageway (m/s)

ρ : Air Density in Tunnel (kg/m^3)

Pressure Due to Pressure Difference between Portals (Formula 10-7)

$$\Delta P_{MT} = \left(1 + \xi_e + \lambda \frac{L_r}{D_r}\right) \times {U_n}^2 \times \frac{\rho}{2}$$

ξ_e : Coefficient of Tunnel Portal Loss

λ : Coefficient of Tunnel Wall Friction Loss

L_r : Tunnel Length (m)

D_r : Typical Tunnel Diameter (m)

U_n : Wind Speed in Tunnel (m/s)

ρ : Air Density in Tunnel (kg/m^3)

Traffic Piston Pressure (Formula 10-8)

$$\Delta P_t = -\frac{A_m}{A_r} \times \frac{\rho}{2} \times n_+ \times (V_{t+} - U_r)^2$$

A_m : Vehicle Equivalent Resistance Area (m^2)

A_r : Inner Section Area (m^2)

ρ : Air Density in Tunnel (kg/m^3)

n_+ : Total Number of Vehicles in Tunnel (vehicles)

V_{t+} : Driving Speed at Design Hourly Volume (m/s)

U_r : Wind Speed at Carriageway (m/s)

Natural Ventilation Volume (Formula 10-9)

$$Q_r = A_r \times U_r$$

A_r : Inner Section Area (m^2)

U_r : Wind Speed at Carriageway (m/s)

Table 10.3.11 shows the values of the parameters used to compute the natural ventilation volume of the planned project tunnel.

Table 10.3.11 Natural Ventilation Volume of the Planned Project Tunnel

Parameters	Values	Remarks
Coefficient of Tunnel Portal Loss (ξ_e)	0.6	Road Tunnel Technical Standards for Tunnel Ventilation, P.56
Coefficient of Tunnel Wall Friction Loss (λ)	0.025	Road Tunnel Technical Standards for Tunnel Ventilation, P.56
Typical Tunnel Diameter (D_r)	6.70 m	
Air Density in Tunnel (ρ)	1.2 kg/m^3	Road Tunnel Technical Standards for Tunnel Ventilation, P.56
Wind Speed in Tunnel (U_n)	2.5 m/s	Road Tunnel Technical Standards for Tunnel Ventilation, P.79
Vehicle Equivalent Resistance Area (A_m)	2.97 m^2	Road Tunnel Technical Standards for Tunnel Ventilation, P.81
Inner Section Area (A_r)	45.9 m^2	
Total Number of Vehicles in Tunnel (n_+)	111vehicles	
Driving Speed at Design Hourly Volume (V_{t+})	30 km/h	Refer to Table 10.3.3
Wind Speed at Carriageway (U_r)	4.54 m/s	Calculated by Formula 10-8
Natural Ventilation Volume (Q_r)	208.5 m^3	

Source: JICA Survey Team

(6) Necessity of Mechanical Ventilation

Table 10.3.12 and Table 10.3.13 compare the required ventilation volumes and the natural ventilation volumes for cross-sections of Bhaktapur and Maitighar, respectively. Since the natural ventilation volumes are greater than the required ventilation volumes in both cross-sections, the mechanical ventilation system is not required for the planned project tunnel.

Table 10.3.12 Necessity of Mechanical Ventilation (Cross-section Bound for Bhaktapur)

Items	Design Hourly Volume		Design Traffic Capacity	
	Soot	CO	Soot	CO
Required Ventilation Volume (Q_{req})	118 m^3	70 m^3	30 m^3	30 m^3
	Target			
Natural Ventilation Volume (Q_r)	208.5 m^3/s (>118 m^3/s)			
Necessity of Mechanical Ventilation	Unnecessary			

Source: JICA Survey Team

Table 10.3.13 Necessity of Mechanical Ventilation (Cross-section Bound for Maitighar)

Items	Design Hourly Volume		Design Traffic Capacity	
	Soot	CO	Soot	CO
Required Ventilation Volume (Q_{req})	60 m^3	70 m^3 Target	32 m^3	37 m^3
Natural Ventilation Volume (Q_r)	208.5 m^3/s (>70 m^3/s)			
Necessity of Mechanical Ventilation	Unnecessary			

Source: JICA Survey Team

10.4 Tunnel Lighting Facilities

10.4.1 General

Tunnel lighting is significant in securing traffic safety within the tunnel. It is composed of interior lighting, entrance light, and emergency light. A detailed layout and specifications are considered based on the following factors. In recent years, LED lighting, which meets the following factors, have been used as tunnel lighting in many countries, including Japan. Therefore, the planned project tunnel will utilize LED lighting.

- High efficiency with long life
- High durability against high temperature and humidity
- Appropriate luminescent color
- High luminous flux to meet the required high lighting level
- Easy maintenance
- Low running cost

(1) Interior Lighting

Interior lighting is installed at regular intervals over the entire length of the project tunnel to provide the necessary brightness for the drivers to see obstacles ahead at a constant speed.

(2) Entrance Lighting

Entrance lighting adjusts the difference between outdoor brightness and one in the tunnel. Therefore, it is required to set the necessary luminance to mitigate the influence of the difference in luminance when drivers enter the tunnel.

(3) Emergency Lighting during Power Failure

Power failure requires emergency lighting to prevent visual obscuration for the drivers already running in the tunnel. Power shall be supplied from the UPS immediately as an uninterruptible power source and connected to the backup generator.

(4) Lighting Outside the Tunnel Portal

Streetlight must be adequately installed to guide drivers emerging from the tunnel, especially at night. The absence of streetlight at the portals could constrict driver's visual field, potentially resulting in accidents.

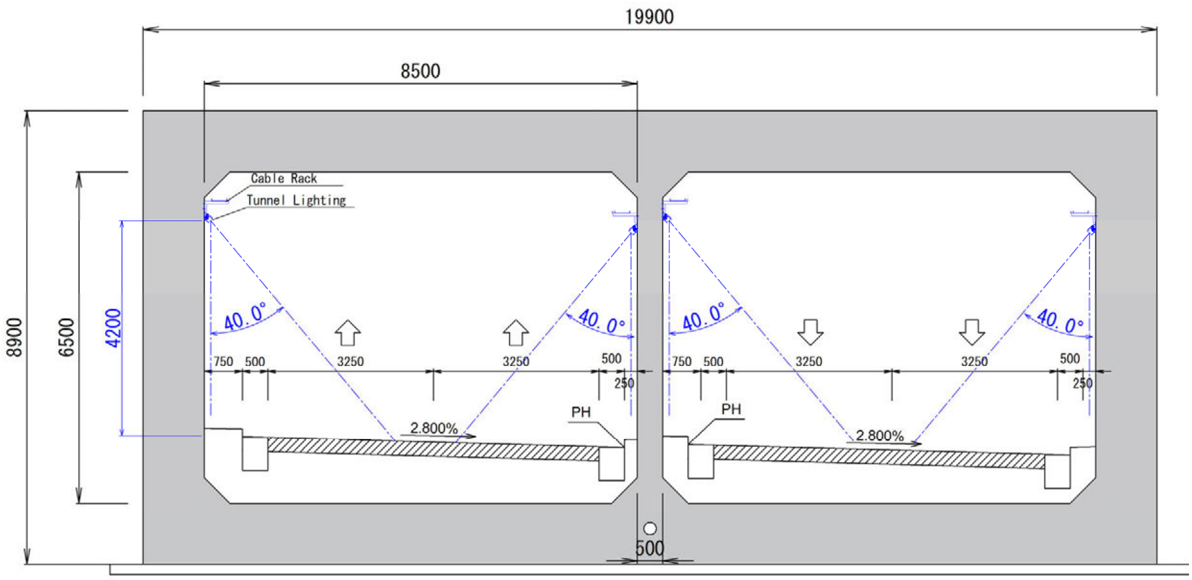
10.4.2 Design Conditions for Tunnel Lighting

Table 10.4.1 and Figure 10.4.1 show the design conditions for lighting the project tunnel.

Table 10.4.1 Design Conditions for Tunnel Lighting

Parameters	Conditions	Remarks
Tunnel Length	600 m	
Carriageway Width	6.5 m (3.25m × 2lanes)	
Pavement Type	Cement Concrete Pavement	
Average Luminance Conversion Factor	13 lx/cd/m^2	Installation Standard for Road Lighting Facilities, Page.108
Design Hourly Volume	5,548 vehicles/h	
Design Speed	50 km/h	
Design Road Surface Luminance	6.0 cd/m^2	CIE88-2004 Ver2, Page.68
Lamp Type	LED	
Luminous Flux	9,300 lm	
Installation Height	4.2m	
Maintenance Factor	0.50	Installation Standard for Road Lighting Facilities, Page.100
Uniformity Ratio	More than 0.4	Installation Standard for Road Lighting Facilities, Page.70
Axle Uniformity Ratio	More than 0.6	Installation Standard for Road Lighting Facilities, Page.70

Source: JICA Survey Team



Source: JICA Survey Team

Figure 10.4.1 Typical Installation of Tunnel Lighting

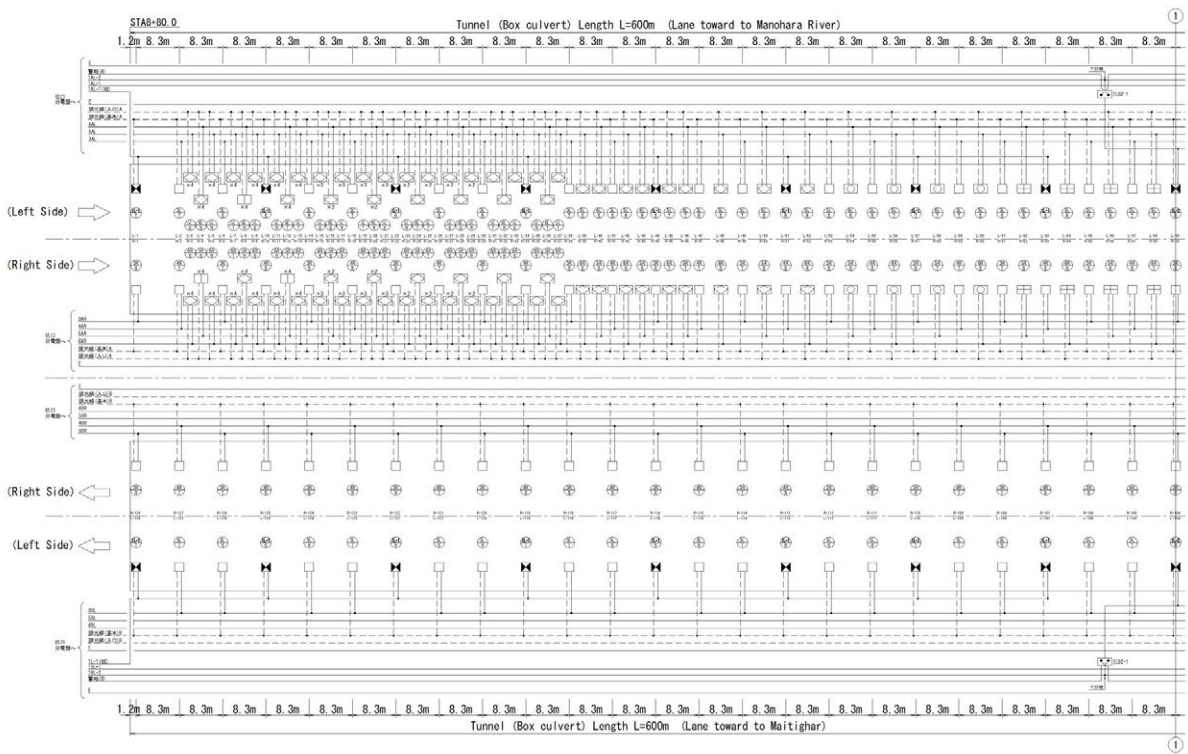
10.4.3 Design Results

Table 10.4.2 and Figure 10.4.2 to Figure 10.4.4 present the results of the tunnel lighting design for the project tunnel.

Table 10.4.2 Design Results (Tunnel Lighting)

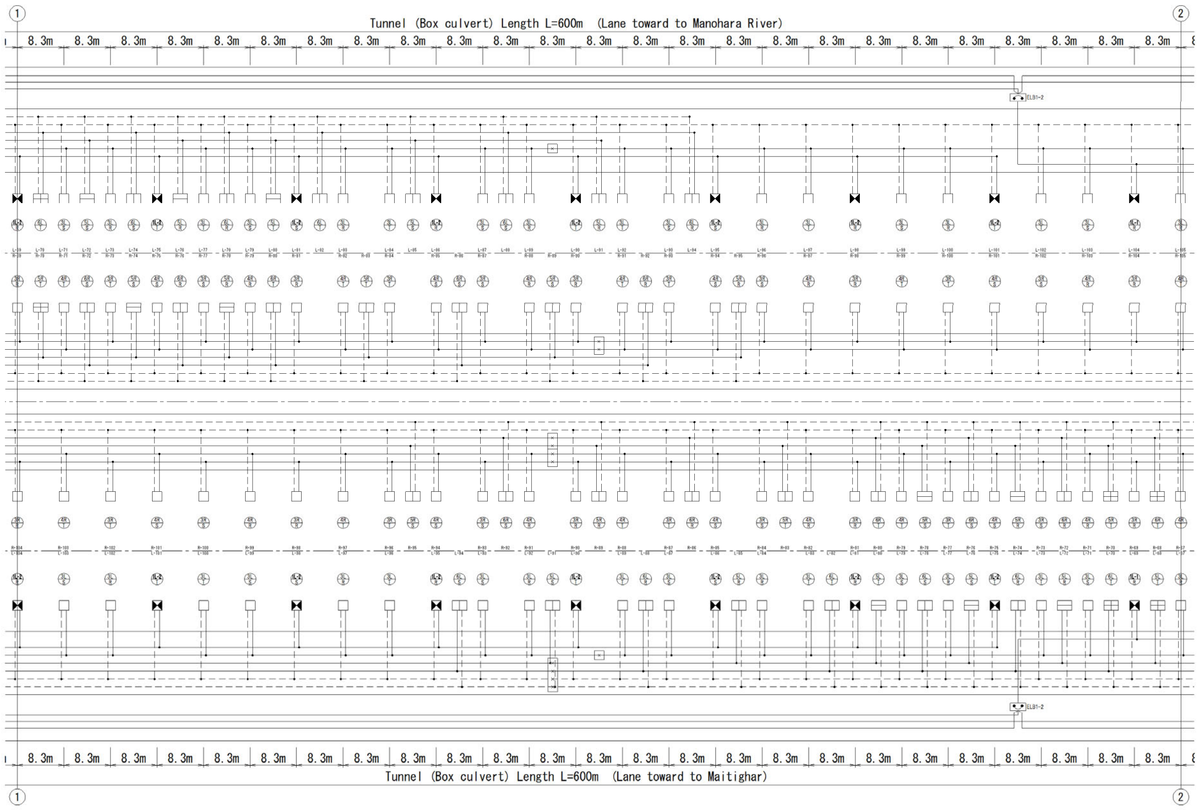
Parameters		Cross Section	
		To Bhaktapur	To Maitighar
Installation Intervals		8.3 m	8.3 m
Number of Lights	Entrance Lighting	162	162
	Interior Lighting	121	121
	Emergency Lighting	25	25
	Streetlight at Portals*	2	2
Road Surface Luminance		6.04 cd/m^2 > 6.00 (OK)	6.04 cd/m^2 > 6.00 (OK)
Uniformity Ratio		0.91 > 0.4 (OK)	0.91 > 0.4 (OK)
Axle Uniformity Ratio		Left Side Lane: 0.95 > 0.6 (OK) Right Side Lane: 0.95 > 0.6 (OK)	Left Side Lane: 0.95 > 0.6 (OK) Right Side Lane: 0.95 > 0.6 (OK)

*Streetlight at portals is same spec as streetlight to be installed at road section.
Source: JICA Survey Team



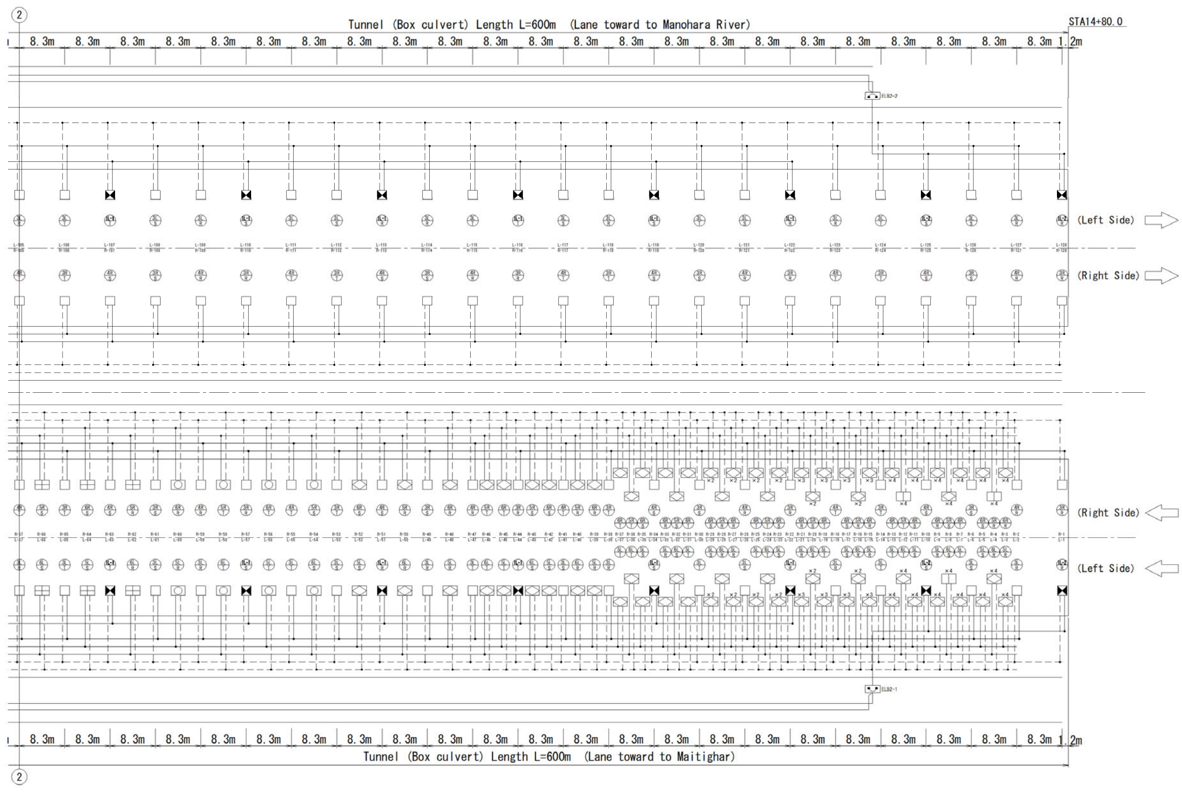
Source: JICA Survey Team

Figure 10.4.2 Layout of Tunnel Lighting (1/3)



Source: JICA Survey Team

Figure 10.4.3 Layout of Tunnel Lighting (2/3)



Source: JICA Survey Team

Figure 10.4.4 Layout of Tunnel Lighting (3/3)

10.5 Tunnel Emergency Facilities

10.5.1 General

Tunnel emergency equipment and facilities are designed to facilitate the transmission of information to both road users and road administrators. These are essential for coordinating evacuation, enabling self-extinguishment, and supporting firefighter activities in the event of accidents or disasters inside the tunnel.

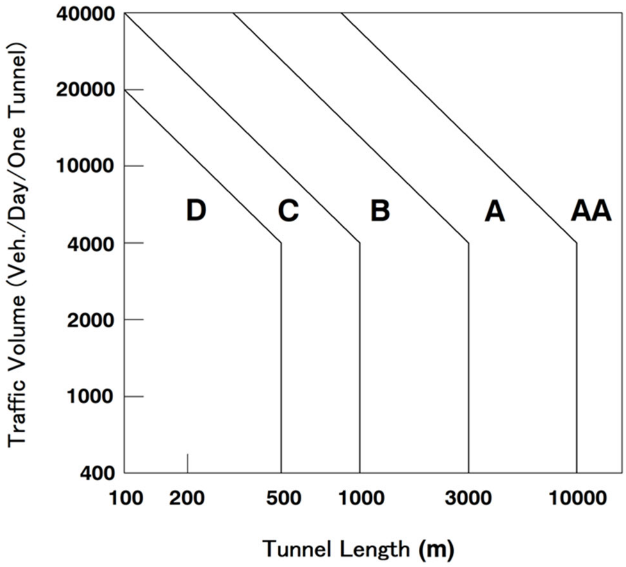
10.5.2 Tunnel Classification and Necessary Emergency Facilities

In the Japanese Standard, necessary emergency facilities are determined depending on the tunnel classification shown in Table 10.5.1, which is classified from Class-AA, Class-A, Class-B, Class-C to Class-D according to the traffic volume inside the tunnel and tunnel length as shown in Figure 10.5.1. According to the table, the higher the tunnel classification, the more emergency equipment is required.

Table 10.5.1 Necessary Emergency Facilities Based on Tunnel Class

Emergency Facility \ Tunnel Class		AA	A	B	C	D
Reporting Equipment	Emergency Phone	○	○	○	○	
	Alarm Pushbutton	○	○	○	○	
	Fire Detection	○	△			
Alarm Equipment	VMS outside Tunnel	○	○	○	○	
Fire Extinguishing Equipment	Fire Extinguisher	○	○	○		
	Fire Hydrant	○	○			
Evacuation Guide Equipment	Escape Route Sign	○	○	○		
	Radio Break-in Systems/Public Address Systems	○	△			
	Evacuation Gallery	○	△			
	Smoke Control Systems	○	△			
Other Equipment	Hydrant	○	△			
	Radio Communication System	○	△			
	Water Spray System	○	△			
	Closed Circuit Television System	○	△			

Note: ○: Required △: Installation to be considered depending on other factors
Source: Road Tunnel Technical Standards for Emergency Facilities



Source: Road Tunnel Technical Standards for Emergency Facilities

Figure 10.5.1 Tunnel Classification

10.5.3 Types of Emergency Facilities

The outlines of emergency facilities are summarized below. The basis for the installation intervals described is the Road Tunnel Technical Standards for Emergency Facilities of the Japanese Standard.

(1) Emergency Phone

Emergency phones shown in Figure 10.5.2 shall be installed at 200 m intervals along the tunnel to report accidents or disasters that occurred in the tunnel to the tunnel administrator.

Emergency Phone on Wall

Emergency Phone at Entrance

Emergency Phone (Box Type)

Source:
https://radiate.jp/20130421/higashi-fushimi/
https://blogs.yahoo.co.jp/biwako_1164/59547680.html
https://travel.watch.impress.co.jp/img/trw/docs/1049/821/html/12.jpg.html

Figure 10.5.2 Emergency Telephone Types

(2) Alarm Pushbutton

Alarm pushbuttons shown in Figure 10.5.3 shall be installed at 1.2 to 1.5 m above the road surface in the tunnel and at 50 m intervals to report tunnel accidents or disasters to the tunnel administrator. Alarm pushbuttons generally work with emergency phones and fire extinguisher equipment.

Push Button Alarm

with Fire Extinguisher & Fire Hydrant

Push Button Alarm

Source:
https://car.watch.impress.co.jp/img/car/docs/685/703/html/049.jpg.html
https://www.iwasaki.co.jp/projects/examples/detail.php?EID=t34&cat=3

Figure 10.5.3 Push Button Alarm Types

(3) Fire Detection

Fire detections, shown in Figure 10.5.4, react to the smoke generated by fire accidents inside tunnels and detect the fire accident. Its installation is at 50 m intervals along the tunnel. In most cases, it functions to activate the VMS outside the tunnel, fire extinguishing equipment, and the ventilation facility.

Source:
http://nexcokiyomi.hida-ch.com/index_7.html
http://www.pref.akita.jp/chuodo/new/newimg/h19.05.31new.html

Figure 10.5.4 Fire Detector

(4) VMS Outside Tunnel

VMS (Variable Message Signs), shown in Figure 10.5.5, provides information on fire accidents, traffic accidents, disasters, and the like to road users by visual signals (alarm display) or audible alarms.

It is necessary to have an adequate communication function to inform the road users in or near the tunnel about disaster and accident situations. The installation of VMS must not interfere with fire extinguishing and evacuation activities.

VMS (Sign Board)

VMS Control Panel

Source: http://kitanihon-t.com/results/
http://www.iwate-shinkodenki.com/case/case25.html

Figure 10.5.5 VMS

(5) Fire Extinguishers

The placement of fire extinguishers, shown in Figure 10.5.6, must be installed at 50 m intervals for self-firefighting by road users for the tunnel.

Source:http://www.pref.yamanashi.jp/kanjo/kanri/manriki.html
https://car.watch.impress.co.jp/docs/news/688076.html

Figure 10.5.6 Fire Extinguisher

(6) Fire Hydrants

Fire hydrants, shown in Figure 10.5.7, shall be installed at 200 m intervals for self-firefighting by road users for the tunnel. The fire hydrants are occasionally together to support the activities by firefighters.

Source:http://asahisetsubi.co.jp/construction/463/
http://photozou.jp/photo/show/629359/116028160

Figure 10.5.7 Fire Hydrant

(7) Escape Route Sign

Escape route signs, shown in Figure 10.5.8, shall be installed at 200 m intervals to inform the location of tunnel portals to road users in the tunnel.

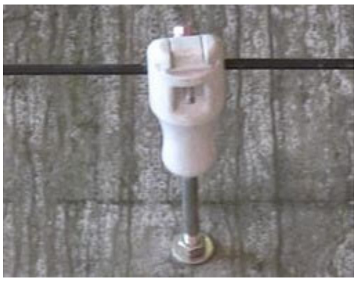
Source: https://www.iwasaki.co.jp/projects/examples/detail.php?EID=rhi07&cat=1
http://www.pref.yamanashi.jp/kanjo/kanri/manriki.html

Figure 10.5.8 Escape Route Sign

(8) Radio Break-in System and Public Address System

A radio break-in system provides the broadcast in the tunnel using lead antenna at the tunnel entrance. When an accident occurs in the tunnel, this system transmits the radio signals to road users. In addition, the public address system also provides the information on accident situations and evacuation to tunnel users away from their vehicles by radio broadcasting with speakers installed along the tunnel.

Figure 10.5.9 shows the radio break-in system and public address system.



Radio Break-in System
(Guide Wire for AM Radio)

Radio Break-in System
(AM Aerial Wire)

Public Address System

Source: https://travel.watch.impress.co.jp/img/trw/docs/1048/548/html/53.jpg.html

Figure 10.5.9 Radio Re-Broadcasting System and Loudspeaker System

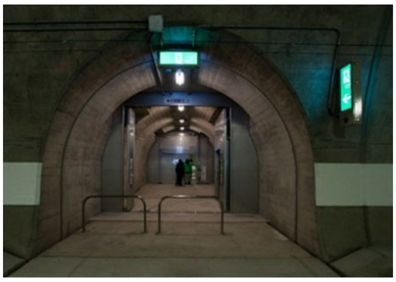
(9) Smoke Removal System and Evacuation Gallery

The purpose of the tunnel ventilation system is to remove smoke and provide ventilation inside the tunnel. The jet fan is one of the ventilation systems installed to extract smoke in the event of a fire accident in the tunnel.

An evacuation gallery has three types: the evacuation tunnel, evacuation connection tunnel, and evacuation port. Their purpose is to evacuate road users to a safe space.

Figure 10.5.10 shows the smoke removal system and the evacuation gallery.

Smoke Removal System (Jet Fan)



Evacuation Gallery (Evacuation Connection Tunnel)

Source: http://www.hanshin-exp.co.jp/company/skill/library/tech/post.html
https://radiate.jp/20081213/kitakan_opening_tochigi-ibaragi/

Figure 10.5.10 Smoke Removal System and Evacuation Route

(10) Hydrant at Tunnel Portal

Hydrants, shown in Figure 10.5.11, shall be installed at tunnel portals at both ends to support the firefighting activity by firefighters.

Source:http://daikitihanayama.web.fc2.com/2004Touring/yasya/Re/y3.html
http://www.pref.yamanashi.jp/kanjo/kanri/manriki.html

Figure 10.5.11 Hydrant

(11) Radio Communication System

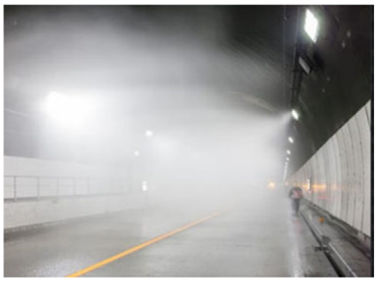
A radio communication system, shown in Figure 10.5.12, shall be installed under the tunnel lighting or the tunnel center wall to allow tunnel operation staff, firefighters, and police to use radios.

Source:
https://car.watch.impress.co.jp/img/car/docs/685/703/html/048.jpg.html

Figure 10.5.12 Radio Communication System

(12) Water Spray System

A water spray system, shown in Figure 10.5.13, shall be installed to suppress the spread of the fire by ejecting fine water particles.



Source: http://www.densetsu-ndd.co.jp/construction/construction-329/

Figure 10.5.13 Water Spray System

(13) CCTV System

A CCTV (Closed Circuit Television) system, shown in Figure 10.5.14, shall be installed adequately considering the tunnel's horizontal/vertical alignment, tunnel length, focal length of cameras, etc. The cameras are at 150 to 200 m intervals on the tunnel wall.

Source: http://www.densetsu-ndd.co.jp/construction/construction-329/

Figure 10.5.14 CCTV System

10.6 Emergency Facilities in Planned Tunnel

10.6.1 Tunnel Class and Necessary Emergency Facilities

The design traffic volume of the planned project tunnel is 40,321 vehicles/day/tunnel, and the tunnel length is 600 m. The planned project tunnel is a double box culvert with separated ibound and outbound lanes. Therefore, the computed traffic volume (vehicles/day/one tunnel) for tunnel classification is half the value of the design traffic volume (2038). Because the traffic volume of motorcycles is smaller than that of passenger cars in Japan, the traffic volume of motorcycles is neglected in the design traffic volume under Japanese standards. However, in the case of Nepal, the proportion of motorcycles traffic is high, so the number of motorcycles is converted to the one of passenger cars using the pcu conversion factor, and it is included in the design traffic volume for tunnel classification (see Figure 10.6.1).

From the conditions above, the tunnel class of the planned project tunnel can be classified as Class A, as shown in Figure 10.6.2. Accordingly, Table 10.6.1 shows the necessary emergency facilities to be installed along the project tunnel.

Design Traffic Volume (2038)

Vehicle Types	Bike	Car	Truck	Bus	Total
PCU Conversion Factor	0.51	1.00	1.94	2.30	
Traffic Volume (PCU/day)	41,978	26,593	7,770	18,550	94,891
Traffic Volume (vehicle/day)	82,310	26,593	4,005	8,065	120,973

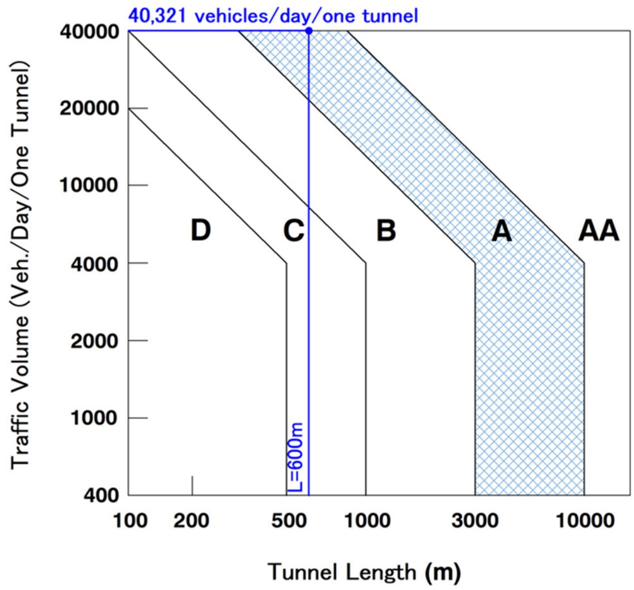
Half Value

Design Traffic Volume for Tunnel Class

Vehicle Types	Bike	Car	Truck	Bus	Total
Traffic Volume (vehicle/day/tunnel)	20,989	13,297	2,003	4,033	40,321

Source: JICA Survey Team

Figure 10.6.1 Design Traffic Volume for Tunnel Classification



Source: Road Tunnel Technical Standards for Emergency Facilities

Figure 10.6.2 Tunnel Classification of Planned Tunnel

Table 10.6.1 Necessary Emergency Facilities for Planned Project Tunnel

Emergency Facility \ Tunnel Class		AA	A	B	C	D
Reporting Equipment	Emergency Phone	○	○	○	○	
	Alarm Pushbutton	○	○	○	○	
	Fire Detection	○	△ (unnecessary)			
Alarm Equipment	VMS outside Tunnel	○	○	○	○	
Fire Extinguishing Equipment	Fire Extinguisher	○	○	○		
	Fire Hydrant	○	○			
Evacuation Guide Equipment	Escape Route Sign	○	○	○		
	Radio Break-in Systems/Public Address Systems	○	△ (unnecessary)			
	Evacuation Gallery	○	△ (unnecessary)			
	Smoke Control Systems	○	△ (unnecessary)			
Other Equipment	Hydrant	○	△ **(necessary)**			
	Radio Communication System	○	△ **(necessary)**			
	Water Spray System	○	△ (unnecessary)			
	Closed Circuit Television System	○	△ **(necessary)**			

Note: ○: Required △: Installation to be considered depending on other factors
Source: Road Tunnel Technical Standards for Emergency Facilities

(1) Emergency Facilities to be considered based on Tunnel Conditions

As shown in Table 10.6.1, Class A tunnels require emergency facilities depending on tunnel conditions. The necessity of these facilities is as follows:

1) Fire Detection

Installation of requirements for the fire detection are as follows:

shall be installed under any of the following conditions:
- The water spray system is to be installed, and earlier detection of the fire accident location is required, or
- The smoke control system is to be installed, and earlier detection of the fire accident location is required, or
- From the viewpoint of tunnel management, its installation is required.

Source: Road Tunnel Technical Standards for Emergency Facilities (Japan)

As described in 7) below, since the water spray system and the removal control system are not requirements in the planned project tunnel, fire detection is also not required to be installed in the planned project tunnel.

2) Radio Break-in Systems/Public Address Systems

Installation requirements for the radio break-in systems/public address systems for the project tunnel are as follows:

shall be installed under any of the following conditions:

- Tunnel length is more than 3,000 m, or
- Evacuation gallery is to be installed with tunnel, or
- Walkway along the tunnel is to be installed, or
- In case that tunnel has branching or merging sections.

Source: Road Tunnel Technical Standards for Emergency Facilities (Japan)

As described in 3), since the planned project tunnel does not meet the above conditions, the radio break-in systems/public address systems are not required to be installed in the project tunnel.

3) Evacuation Gallery

Installation requirements for the evacuation gallery for the project tunnel are as follows:

shall be installed on expressways or motorways under any of the following conditions:

- Tunnel length is more than 750 m, and the traffic volume per tunnel is more than 10,000 vehicles/day, or
- Tunnel length is more than 3,000 m, and the traffic volume per tunnel is more than 4,000 vehicles/day.

Source: Road Tunnel Technical Standards for Emergency Facilities (Japan)

Since the planned project tunnel does not meet the above conditions, the evacuation gallery is not required in the project tunnel.

4) Smoke Control Systems

Installation requirements for the smoke control systems are for the project tunnel as follows:

shall be installed under any of the following conditions:

- Tunnel length is more than 3,000 m, or
- A one-way tunnel on expressways or motorways with a length of a downhill gradient (vertical alignment) of more than 2.5% or 750 m or longer, and a traffic volume is more than 10,000 vehicles/day.

Source: Road Tunnel Technical Standards for Emergency Facilities (Japan)

Since the planned project tunnel does not meet the above conditions, the smoke control system is not required to be installed in the project tunnel.

5) Hydrant

Installation requirements for the hydrant are as follows:

shall be installed under any of the following conditions:
- It is required from the viewpoint of firefighting activities

Note: Regarding the necessity of the hydrant, the DoR must discuss and coordinate with the fire department. In addition, since a water distribution system is a requirement for tunnels with a fire hydrant, it is rational to install the hydrant as well.
Source: Road Tunnel Technical Standards for Emergency Facilities (Japan)

The tunnel for the project extends beneath the airport's land; hence, it is essential to install hydrants along the planned route of the project tunnel. This instrument is crucial to facilitate prompt firefighting activities and minimize potential impacts on the airport operations. (In Japan, tunnels with fire hydrants typically follow the same practice.)

6) Radio Communication System

Installation requirements for the radio communication systems for the project tunnel are as follows:

shall be installed under any of the following conditions:
- Tunnel length is more than 3,000 m, or
- Its installation is required from the viewpoint of tunnel management.

Source: Road Tunnel Technical Standards for Emergency Facilities (Japan)

Given the substantial traffic volume anticipated for the planned project tunnel, it is imperative to install a radio communication system that prioritizes safety during tunnel evacuations in case of accidents. In the Nagdunga Tunnel Project (Class-A Tunnel), despite the tunnel's length is less than 3,000 m, a radio communication system was installed with safety considerations in mind.

7) Water Spray System

Installation requirements for the water spray system for the project tunnel are as follows:

shall be installed under the following conditions:
- Tunnel length is more than 3,000 m with traffic volume per tunnel or more than 4,000 vehicles/day, and
- The water spray system can function effectively considering the tunnel management system (24-hour monitoring system, etc.), and the traffic operation, including the evacuation gallery, etc.

Source: Road Tunnel Technical Standards for Emergency Facilities (Japan)

Since the planned project tunnel does not meet the above conditions, the water spray system is not required.

8) CCTV (Closed Circuit Television) System

Installation requirements for the CCTV system are as follows:

Shall be installed under any of the following conditions:

- The water spray system is installed, and the monitoring inside the tunnel is required, or
- Its installation is necessary from the viewpoint of tunnel management.

Source: Road Tunnel Technical Standards for Emergency Facilities (Japan)

Since the traffic volume of the planned project tunnel is quite heavy and the tunnel passes through the airport territory, the installation of a CCTV system is required in the tunnel to secure safety inside the tunnel. In the case of the Nagdunga Tunnel Project (Class-A Tunnel), even though the water spray system was not implanted, the CCTV system was installed to enhance tunnel safety.

9) Layout and Quantity of Emergency Facilities

Table 10.6.2 and Figure 10.6.2 present the number and layout of the emergency facilities to be installed in the planned project tunnel.

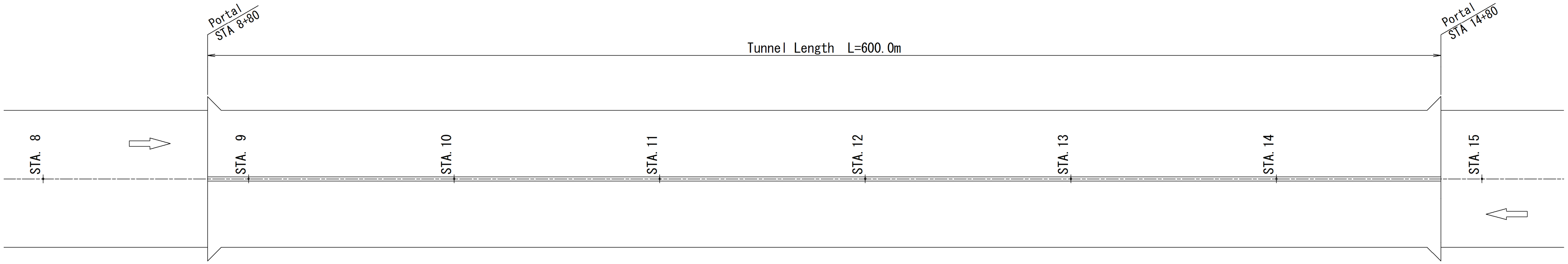
Table 10.6.2 Number of Emergency Facilities installed in Planned Tunnel

Facilities		Cross Section	
		To Manohara River	To Maitighar
Emergency Phone		2	2
Alarm Pushbutton		11	11
VMS		1	1
Fire Extinguisher		11	11
Fire Hydrant		11	11
Escape Route Sign		3	3
Hydrant		3	3
Radio Communication System		2	2
Radio Break-in Systems/Public Address Systems		1	1
CCTV System	Tunnel Inside	2	2
	Tunnel Outside (at portals)	1	1

Source: JICA Survey Team

Tunnel Class-A

Equipment	Quantity												
CCTV Camera(Monitor System)	2	200	200	200									
Radio Communication System	2	9		9									
Radio Break-in System (Radio Broadcast System)	1	560	40										
Water Contral Valve	2	200	200	200									
Hydrant	3	70	200	200	130								
Fire Hydrant	11	50	50	50	50	50	50	50	50	50	50	50	50
Fire Extinguisher	11	50	50	50	50	50	50	50	50	50	50	50	50
Alarm Pushbutton	11	50	50	50	50	50	50	50	50	50	50	50	50
Emergency Phone	2	200	200	200									
Escape Route Sign(Guide Board)	3	100	200	200	100								



Tunnel Class-A

Equipment	Quantity												
Escape Route Sign(Guide Board)	3	100	200	200	100								
Emergency Phone	2	200	200	200									
Alarm Pushbutton	11	50	50	50	50	50	50	50	50	50	50	50	50
Fire Extinguisher	11	50	50	50	50	50	50	50	50	50	50	50	50
Fire Hydrant	11	50	50	50	50	50	50	50	50	50	50	50	50
Hydrant	3	70	200	200	130								
Water Contral Valve	2	200	200	200									
Radio Break-in System (Radio Broadcast System)	1	560	40										
Radio Communication System	2	9	582	9									
CCTV Camera(Monitor System)	2	200	200	200									

Source: JICA Survey Team

Figure 10.6.3 Layout of Emergency Facilities

10.7 Other Facilities (Tunnel Electric room/O&M Team Office)

10.7.1 General

Table 10.7.1 and Table 10.7.2 list the description of the tunnel electric room and O&M Team office for the project tunnel. The required total area of the tunnel electric room is 375 m^2.

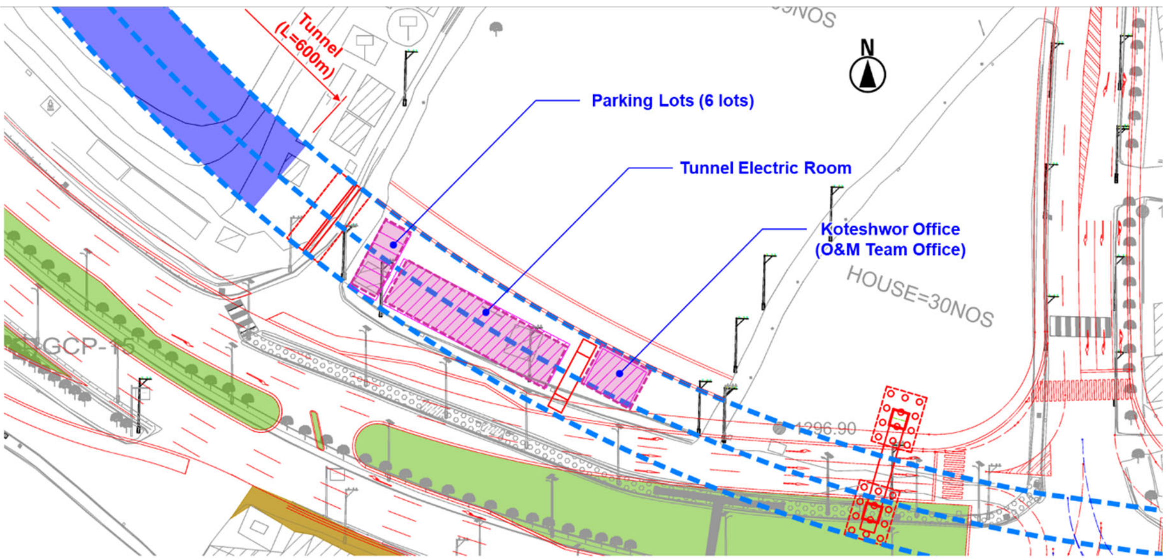
Table 10.7.1 Description of Tunnel Electric Room

Items	Description
Function	-To receive the electric power for the tunnel -To control tunnel lighting, and emergency facilities, etc.
Facilities to be installed	-Communication Machine Room -Electric Room -Generation Room -Pump Room -Water Tunk for Fire Extinguisher
Location	See Figure 10.7.1 (Layout of the tunnel electric room is shown in Figure 10.7.2)
Area	40m^2 (Communication Machine Room) + 108m^2 (Electric Room) + 48m^2 (Generation Room) + 40m^2 (Pump Room) + 64m^2 (Water Tunk) + 75m^2 (Hand Hole Space for Maintenance) = **375m^2**

Source: JICA Survey Team

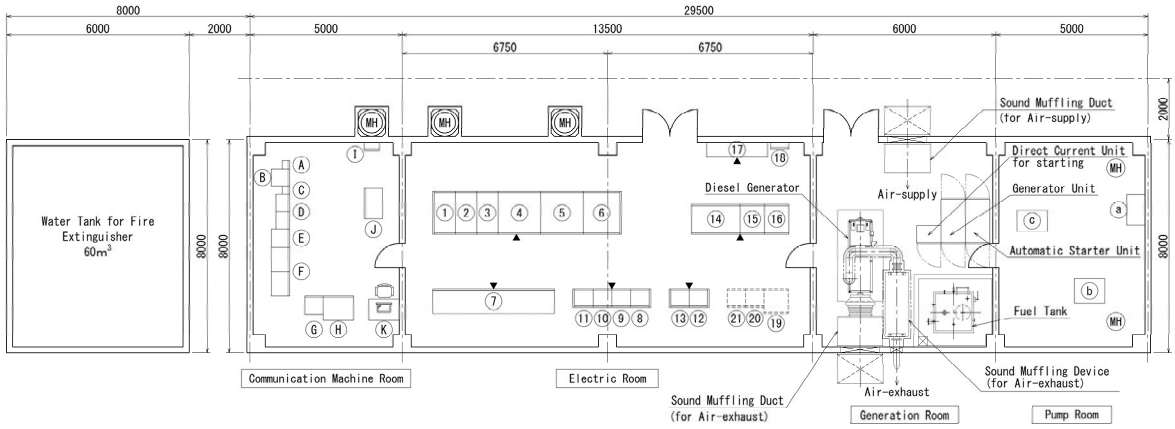
Table 10.7.2 Description of O&M Team Office (Koteshwor Office)

Items	Description
Function	Workspace for O&M Team to conduct the tunnel patrol and the traffic control in the event of emergency cases (see Chapter 16 for further details)
Facilities	Workspace for 8 workers, Toilet
Location	See Figure 10.7.1
Area	80m^2



Source: JICA Survey Team

Figure 10.7.1 Location Map of Electric Room and Koteshwor Office (Proposed)



Legend

Mark	Item
A	Police Radio
B	Shared Device
C	Management Radio
D	Radio Re-broadcast (AM・FM)
E	Remote Monitoring/Control Device
F	I T V
G	Monitoring/Control Dvice
H	Receiver Unit
I	Splice and Connector box
J	V D F
K	CCTV Monitoring Space (Workstation)

Mark	Item
a	Control Device for Fire Extinguisher Pump
b	Fire Extinguisher Pump
c	Automatic Water Supply Equipment

Mark	Item
1	Power Receiving Unit
2	Power Compensator Unit for Power Failure
3	Power/Lighting Transformer Unit
4	Power Transformer Unit
5	Lighting Transformer Unit
6	Transformer Unit
7	Power Compensator Unit for Power Failure
8	Lighting Control Unit
9	No.1 Lighting Control Center
10	No.2 Lighting Control Center
11	No.3 Lighting Control Center

Mark	Item
12	No.1 Ventilation Control Center
13	No.2 Ventilation Control Center
14	Inverter Unit
15	Battery Charger Unit
16	Storage Battery Unit
17	Low-voltage Switching Unit
18	Earth Terminal Unit
19	Ventilation Control Unit
20	Ventilation Measurement Unit
21	Traffic Volume Processing Device

Source: JICA Survey Team

Figure 10.7.2 Layout of Electric Room (for reference only)

10.7.2 Required Power Supply

Table 10.7.3 shows the required power for the project tunnel and its operation.

Table 10.7.3 Required Power for Planned Tunnel

Category	Electric Energy (kW)
Tunnel Lighting	12.0
Emergency Facilities	3.0
Tunnel Electric Room	10.0
Total	**25.0**

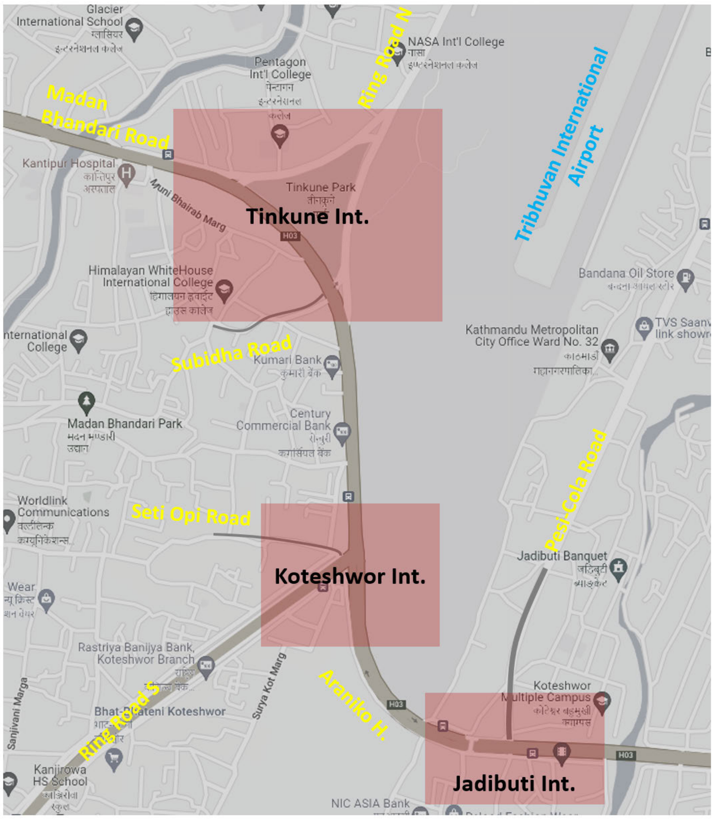
Source: JICA Survey Team

CHAPTER 11. MICROSCOPIC TRAFFIC SIMULATION

11.1 Methodology

11.1.1 Study Area

The Survey contains a microscopic traffic simulation (VISSIM) examining the traffic impact of "with" and "without" the introduction of an underpass which was recommended in the Survey. The study area includes the Araniko Highway, with high traffic volume on the three main intersections, Tinkune, Koteshwor, and Jadibuti. The Araniko Highway also passes the middle of the Tribhuvan International Airport (TIA). Figure 11.1.1 illustrates the study area.



Source: JICA Survey Team

Figure 11.1.1 Study Area of Microscopic Traffic Simulation

11.1.2 Microscopic Traffic Simulation

(1) About VISSIM

VISSIM is a microscopic time step and behavior-based traffic simulation software developed by PTV (Germany), widely used to assess traffic conditions. Evaluating various traffic management scenarios is essential to select the best optimization measures before project implementation. The key performance indicators (KPI) for traffic analysis, such as vehicle delay, travel time, queue length, and flow values of intersections, can be generated using VISSIM software.

In this study, VISSIM is used to evaluate the economic impact in the study area of two scenarios, “With Project” and “Without Project,” and the resulting congestion rate of the three alternatives for the Koteshwor intersection improvement in the at-grade level.

(2) Model Development by VISSIM

To develop the model in VISSIM, geometric data, traffic flows, vehicle composition, and turning movements were collected through the surveys. The section below outlines the methodology for developing the model.

Step 1: Import the scaled background map of the study area.

Step 2: Draw the road network, which consists of links and link connectors, using the network editor - nos. of lanes, lane widths, lane type (i.e., straight, right/left turn, u-turn, shared lane, bus lanes, etc.) were considered.

Step 3: Vehicle inputs and vehicle composition - Vehicle flows were input with the vehicle composition of each entry point featuring six vehicle categories, namely, motorbike, three-wheeler (3W), car, light goods vehicle, heavy goods vehicle, and bus.

S*tep 4:* Vehicle routing - Defining vehicle static routes for individual turning movements in the study area.

S*tep 5:* Traffic signal input – Adjustment of traffic signal phasing and timing for both With Project and Without Project scenarios through peak hours

Step 6: Define data collection points - Inputting settings for travel time, vehicle delay, vehicle flow, and traffic speed enables collecting data for evaluation.

Step 7: Run the simulation and generate results – The simulation period was 1 hour and 15 minutes. The first 15 minutes is for model preparation, and the last hour is for data collection for the evaluation replicating the scenarios' traffic situation.

Available references were instrumental in creating the road network conditions applied in the model, which include road drawings and satellite images provided by Google Earth.

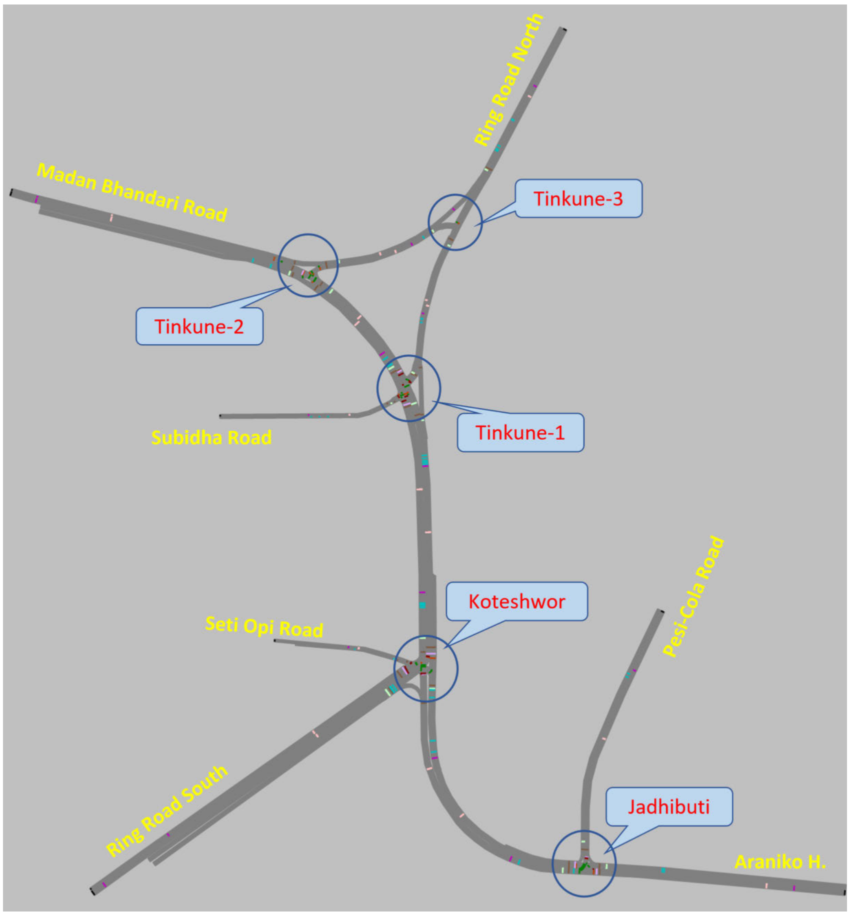
As for the vehicle input for each vehicle category and turning movements, the traffic demand for the current year, i.e., the traffic survey results from February 2019, were applicable. The traffic demand for 2033, after the underpass becomes operational, was estimated based on the future traffic demand forecast described in Chapter 4.

(3) Model Calibration and Validation

The calibration and validation cover the afternoon peak hour (17:00-18:00), comparing model results and the actual survey data, which checks in/out traffic volume at each entry (RRN, RRS, ARK Hwy North, and ARK Hwy South.) Directional traffic at each intersection is set in an acceptable range with the queue length over the network to replicate the current traffic situation.

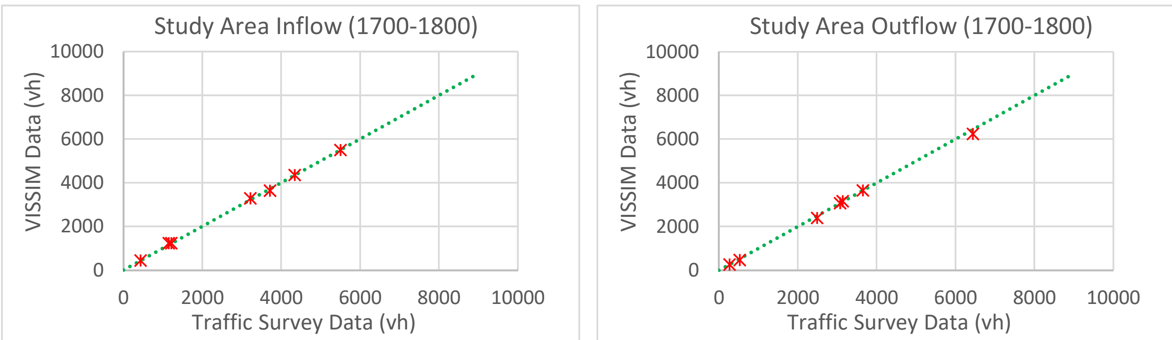
Driving behavior parameters are the key to calibrating the model. Two sets of behaviors, one for general traffic (4-wheel vehicles) and another for motorbike/3W were input to replicate the high composition of motorcycles and aggressive driving behavior in the study area.

A statistical test, namely the GEH, used in traffic engineering, traffic forecasting, and traffic modelling to compared two sets of traffic volume, is adopted to validate the inflow and outflow traffic volume for the whole study area and for each intersection. The GEH had results within an acceptable range of less than 5.0. GEH output for the whole network was between 0.8 and 1.2. The figures below show a snapshot of the measurement area by VISSIM under current conditions (Figure 11.1.2) and the comparison of validation results of the inflow and outflow traffic at the study area scale and single intersections (Figure 11.1.3, Figure 11.1.4).



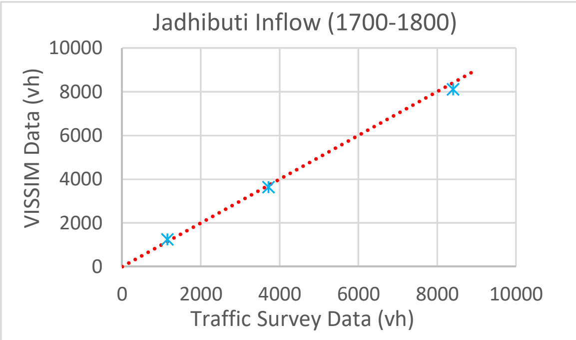
Source: JICA Survey Team

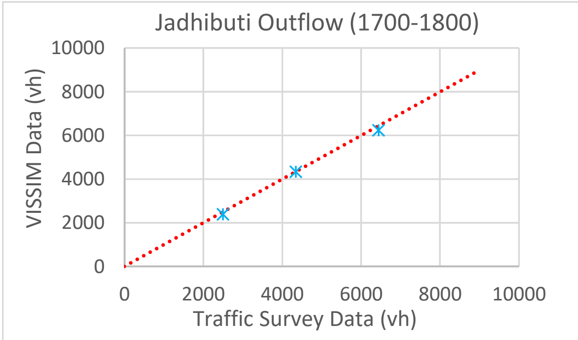
Figure 11.1.2 Measurement Area by VISSM (Existing condition)



Source: Study Team

Figure 11.1.3 Validation Results for In/Out Traffic Flow (whole study area)


Jadhibuti Inflow (1700-1800)
VISSIM Data (vh)
10000
8000
6000
4000
2000
0
0
2000
4000
6000
8000
10000
Traffic Survey Data (vh)


Jadhibuti Outflow (1700-1800)
VISSIM Data (vh)
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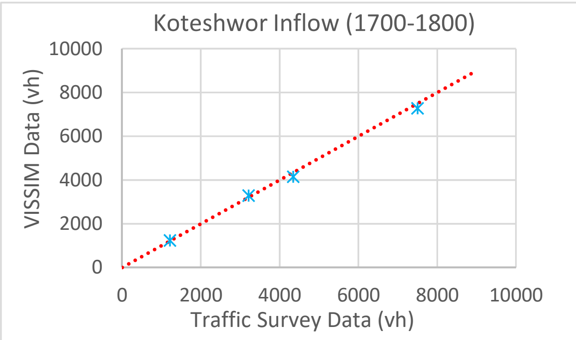
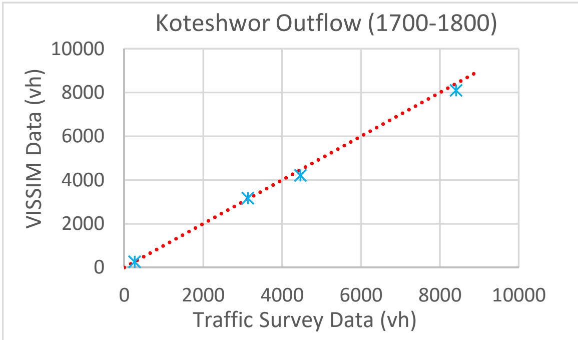
0
2000
4000
6000
8000
10000
Traffic Survey Data (vh)


Koteshwor Inflow (1700-1800)
VISSIM Data (vh)
10000
8000
6000
4000
2000
0
0
2000
4000
6000
8000
10000
Traffic Survey Data (vh)


Koteshwor Outflow (1700-1800)
VISSIM Data (vh)
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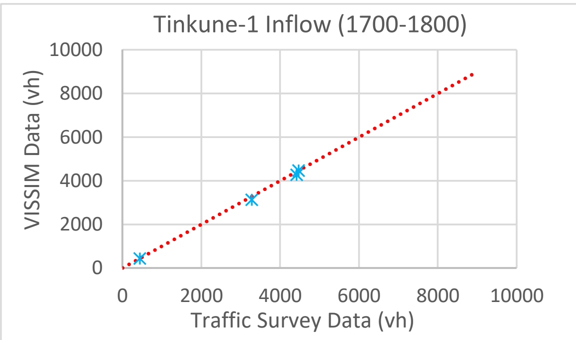
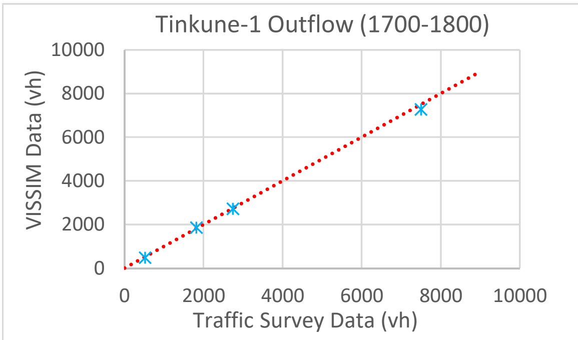
2000
4000
6000
8000
10000
Traffic Survey Data (vh)


Tinkune-1 Inflow (1700-1800)
VISSIM Data (vh)
10000
8000
6000
4000
2000
0
0
2000
4000
6000
8000
10000
Traffic Survey Data (vh)


Tinkune-1 Outflow (1700-1800)
VISSIM Data (vh)
10000
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2000
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2000
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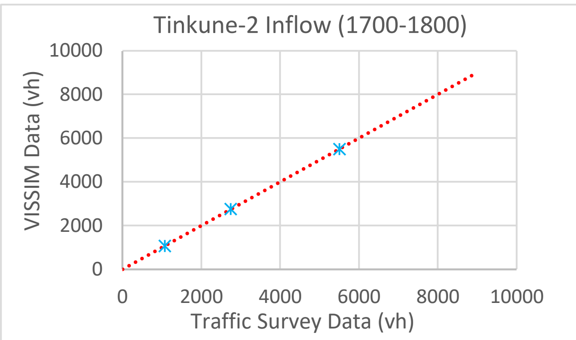
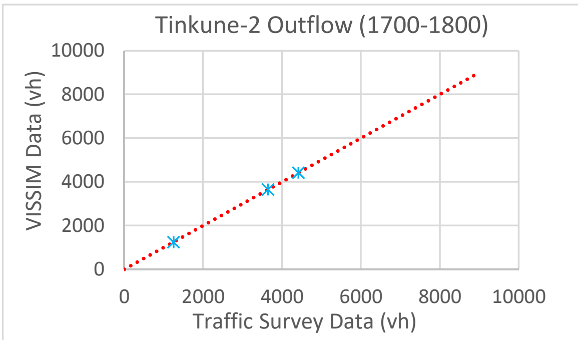
6000
8000
10000
Traffic Survey Data (vh)


Tinkune-2 Inflow (1700-1800)
VISSIM Data (vh)
10000
8000
6000
4000
2000
0
0
2000
4000
6000
8000
10000
Traffic Survey Data (vh)


Tinkune-2 Outflow (1700-1800)
VISSIM Data (vh)
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2000
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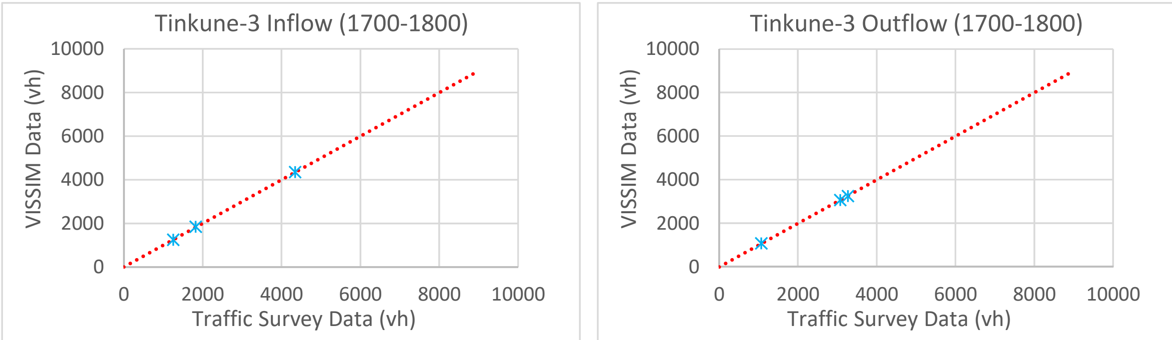
8000
10000
Traffic Survey Data (vh)



Source: JICA Survey Team

Figure 11.1.4 Validation Results for In/Out Traffic Flow at Each Intersection

11.1.3 Study Scenarios by VISSIM

This study utilized VISSIM models to examine different scenarios described in Table 11.1.1.

Table 11.1.1 Scenarios Studied by VISSIM

Scenario-1	Without Project (No implementation of intersection improvement) (2033)
Scenario-2	With Project (Implement intersection improvement with underpass) (2033)

Source: JICA Survey Team

Scenario-1 and scenario-2 were measured to compare economic savings from vehicle operation cost (VOC) and travel time cost (TTC) between the With- and Without-project scenarios outlined in Figure 11.1.5. The Without Project scenario assumes only at-grade improvements for each intersection. The With-project outline assumes the introduction of an underpass connecting the Jadibuti Intersection to the Tinkune-2 intersection.

The underpass will ease congestion due to high traffic generated by vehicles from and to Maitighar and Bhaktapur by reducing the burden share of the already saturated Jadibuti-Tinkune-2 road section. In addition, in both scenarios, the traffic approach in Seti Opi road at Koteshwor Intersection will be eliminated (see Figure 11.1.2).

Source: JICA Survey Team

Figure 11.1.5 With- and Without-Project Scenarios

11.2 Traffic Condition

11.2.1 Current Traffic Condition

1) Daily Traffic Volume and Peak Hour Traffic Volume

The current traffic volume in the study area is considered relatively high. According to the 2019 survey, the highest traffic volume passes over Koteshwor Intersection from 6:30 to 21:00. The study showed that Koteshwor Intersection hosts around 182,000 vehicles daily, and the peak-hour traffic volume was around 16,000 vehicles per hour.

The Tinkune-1 Intersection has the second-highest traffic volume, with around 145,000 vehicles per day and 13,000 vehicles per hour at peak. Details regarding daily traffic volume and hourly peak volume are in Table 11.2.1.

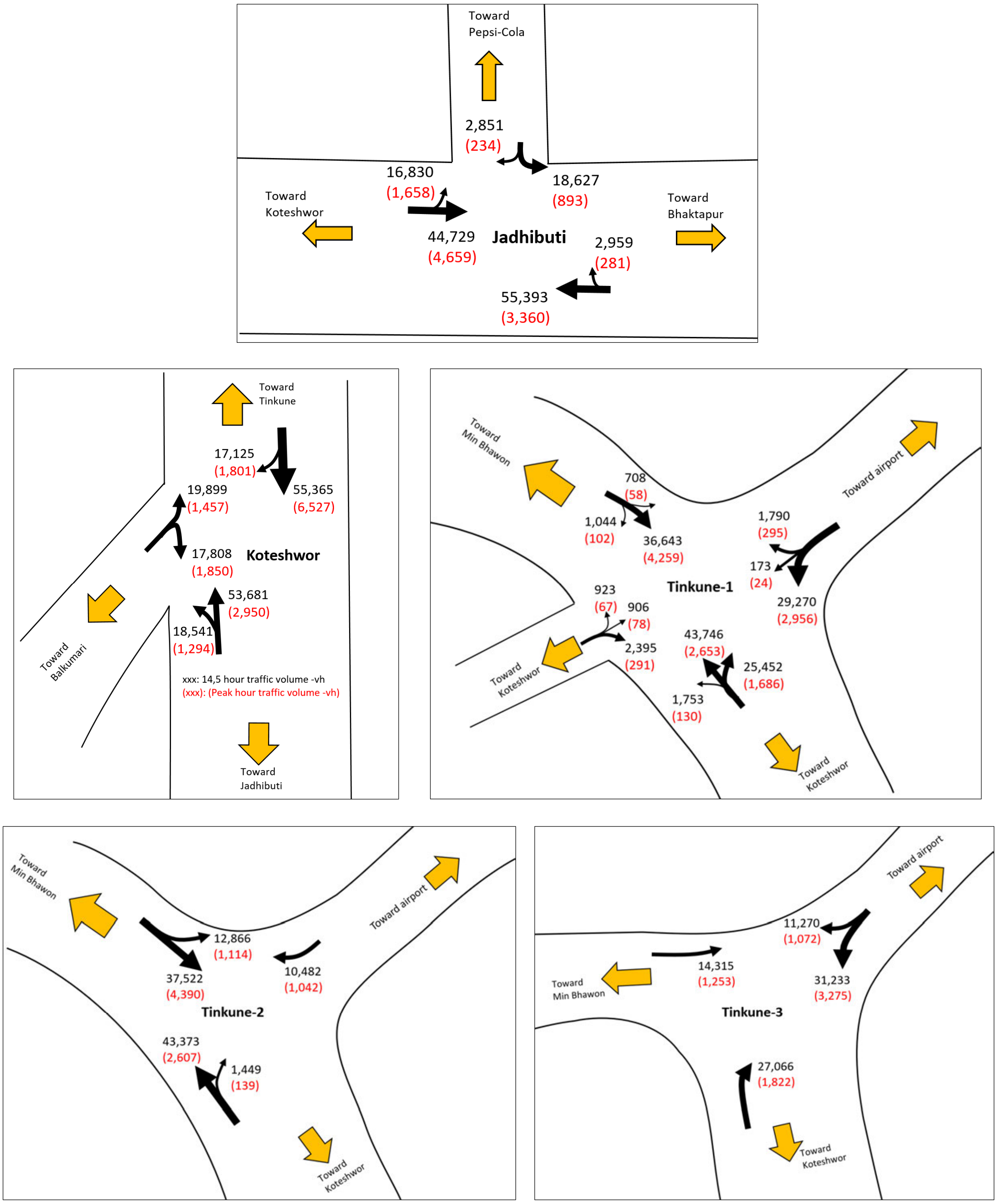
Table 11.2.1 Current Traffic Volume

Intersection	Daily volume 630~2100 (vehicle)	Hourly peak volume (vehicle/hour)
Jadibuti	141,398	11,085
Koteshwor	182,419	15,879
Tinkune-1	144,803	12,599
Tinkune-2	106,480	9,322
Tinkune-3	83,884	7,422

Source: JICA Survey Team

2) Turning Movement

Figure 11.2.1 describes the current turning movement traffic volume at the five intersections.



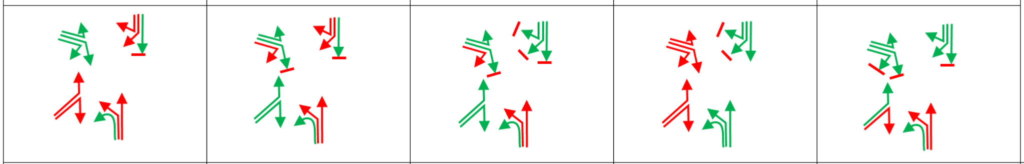
xxx: Total traffic volume (vehicle 6:30-21:00)
(xxx): (Peak hour traffic volume -vh)

Source: JICA Survey Team (Traffic Survey – 2019)

Figure 11.2.1 Current Traffic Turning Movement Volume

3) Current Traffic Control

The police manually manage the traffic at the Jadibuti, Koteshwor, and Tinkune-1 intersections with long cycle times. Traffic signal cycle times in this strudy come from recorded traffic video, showing an average of 420 seconds. Police coordinate traffic control between the three intersections with walky-talkies. The following figures outline average signal phasing times: Figure 11.2.2, Figure 11.2.3, and Figure 11.2.4

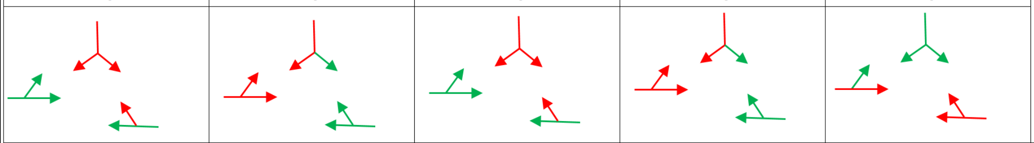


1ϕ	2ϕ	3ϕ	4ϕ	5ϕ	
G:36 Y:3 R1	G:25 Y:3 R1	G:72 Y:3 R1	G:164 Y:3 R1	G:103 Y:3 R1	Cycle Time: 420

Green arrow: go
Red arrow: stop
Green arrow with red bar: give way

Source: JICA Survey Team

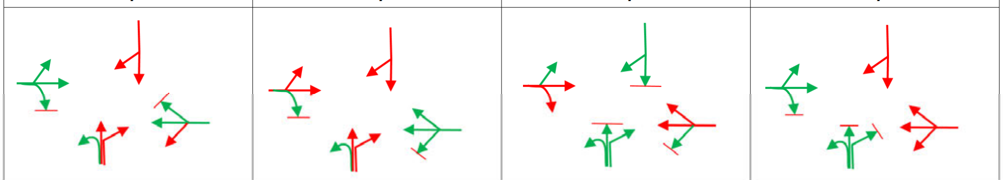
Figure 11.2.2 Koteshwor's Traffic Signal Phasing (current)



1ϕ	2ϕ	3ϕ	4ϕ	5ϕ	
G:153 Y:3 R1	G:24 Y:3 R1	G:108 Y:3 R1	G:18 Y:3 R1	G:97 Y:3 R1	Cycle Time: 420

Source: JICA Survey Team

Figure 11.2.3 Jadibuti's Traffic Signal Phasing (current)



1ϕ	2ϕ	3ϕ	4ϕ	
G:15 Y:3 R1	G:76 Y:3 R1	G:23 Y:3 R1	G:52 Y:3 R1	Cycle Time: 182

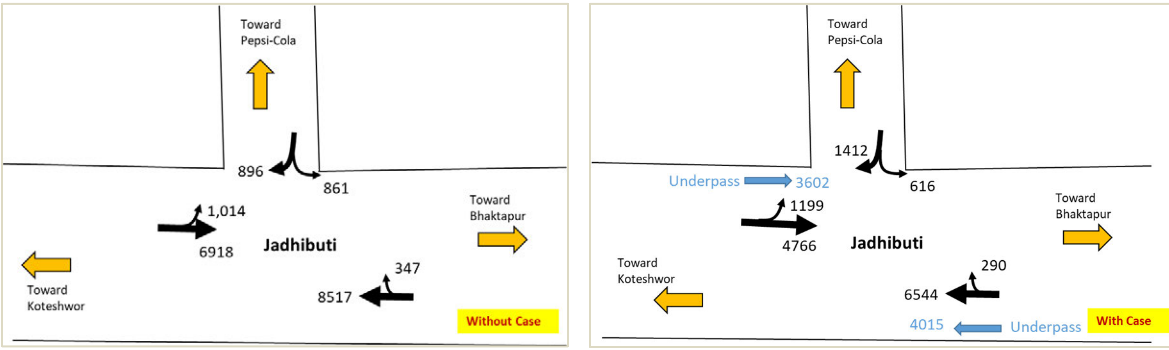
Source: JICA Survey Team

Figure 11.2.4 Tinkune-1's Traffic Signal Phasing (current)

11.2.2 Future Traffic Condition

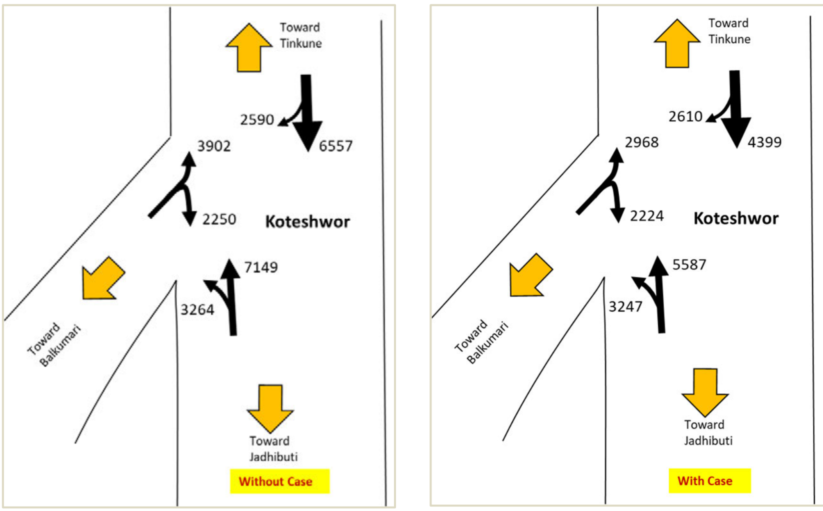
1) Peak Hour Traffic Volume (2033)

The traffic demand forecast in this survey predicted the future traffic volume in 2033 when the underpass become operational. Hourly turning movement traffic volume in 2033 for With-project and Without-project scenarios are in Figures 11.2.5 to 11.2.9.



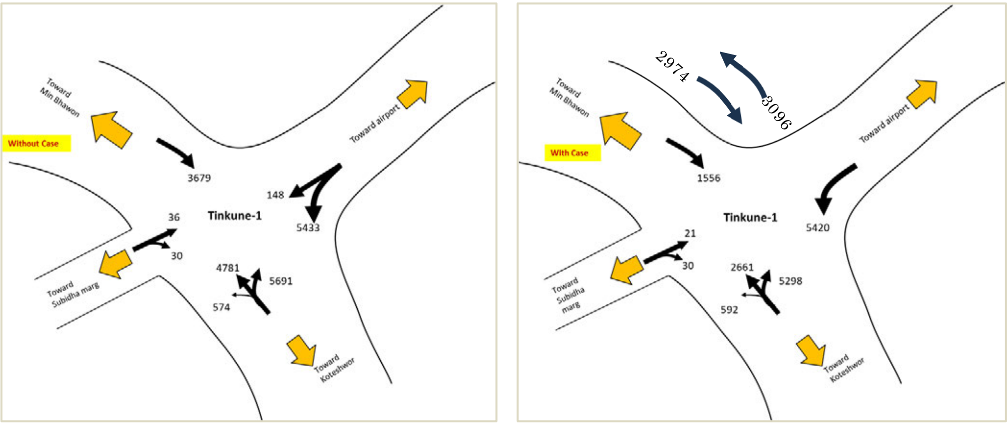
Source: JICA Survey Team

Figure 11.2.5 Jadhibuti's Future Traffic Volume (2033)



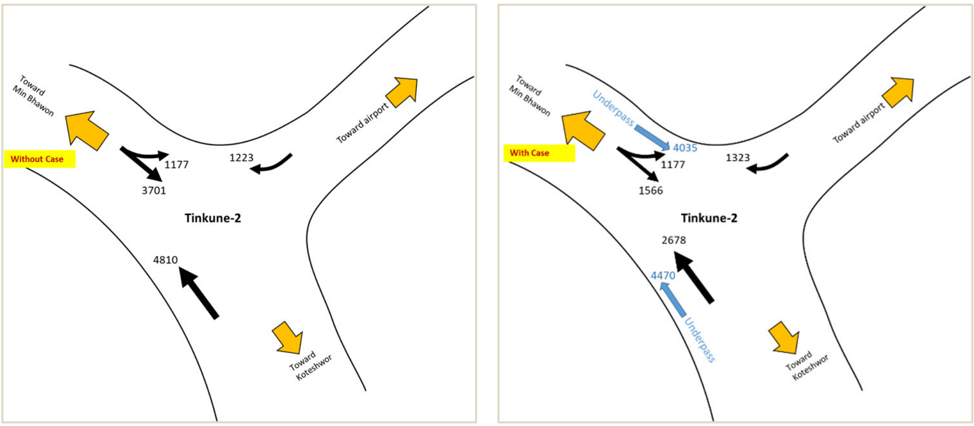
Source: JICA Survey Team

Figure 11.2.6 Koteshwor's Future Traffic Volume (2033)



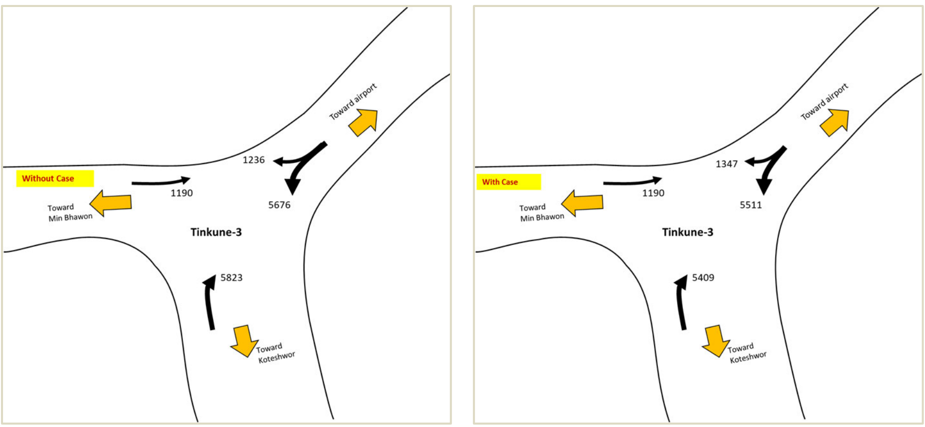
Source: JICA Survey Team

Figure 11.2.7 Tinkune-1's Future Traffic Volume (2033)



Source: JICA Survey Team

Figure 11.2.8 Tinkune-2's Future Traffic Volume (2033)

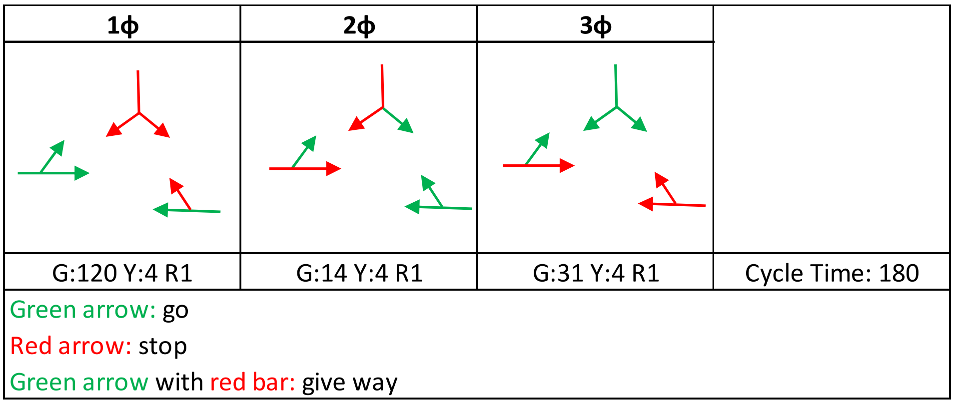


Source: JICA Survey Team

Figure 11.2.9 Tinkune-3's Future Traffic Volume (2033)

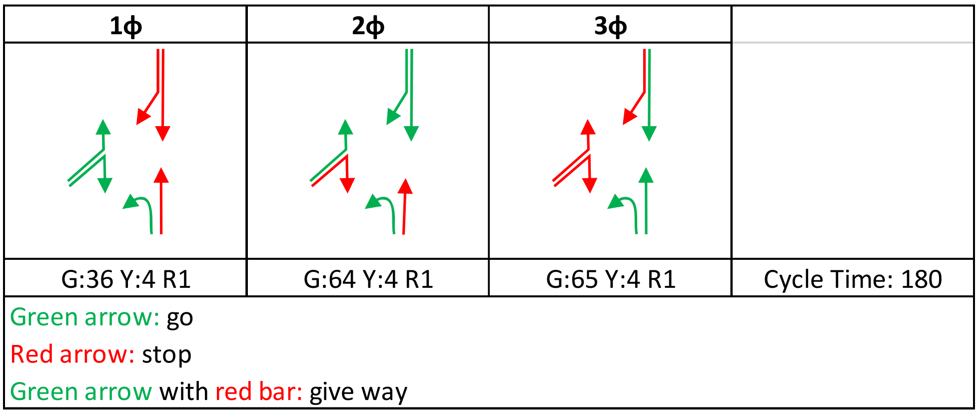
2) Future Traffic Control (Without Scenario, 2033)

New development considerations for the Jadibuti, Koteshwor, Tinkune-1, and Tinkune-3 intersections account for the tentative traffic signal settings for the Without Project scenario in 2033. Detailed signal settings are in the following figures: Figure 11.2.10, Figure 11.2.11, Figure 11.2.12, and Figure 11.2.13.



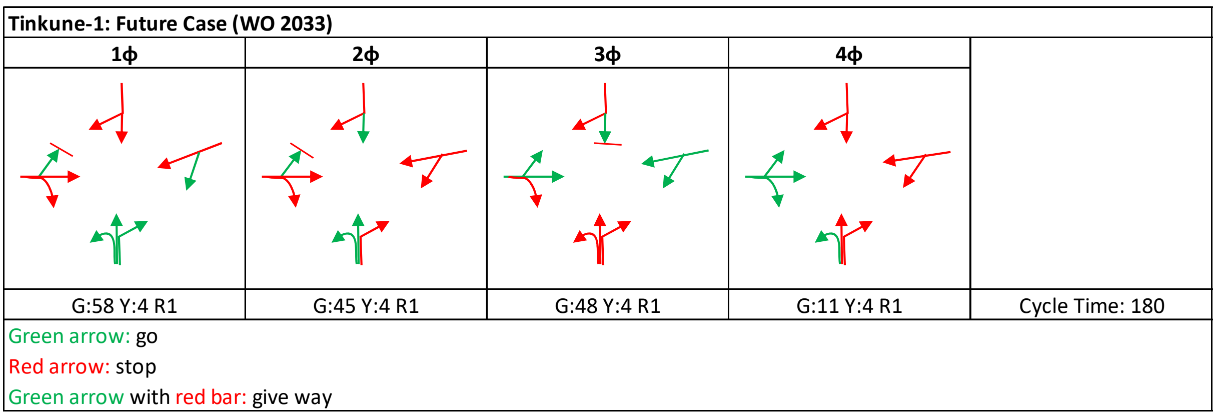
Source: JICA Survey Team

Figure 11.2.10 Jadibuti's Traffic Signal Phasing (WO scenario-2033)



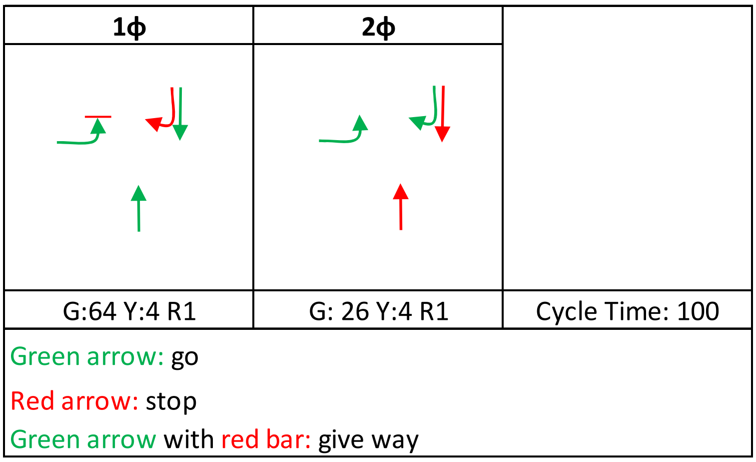
Source: JICA Survey Team

Figure 11.2.11 Koteshwor's Traffic Signal Phasing (WO scenario-2033)



Source: JICA Survey Team

Figure 11.2.12 Tinkune-1's Traffic Signal Phasing (WO scenario-2033)

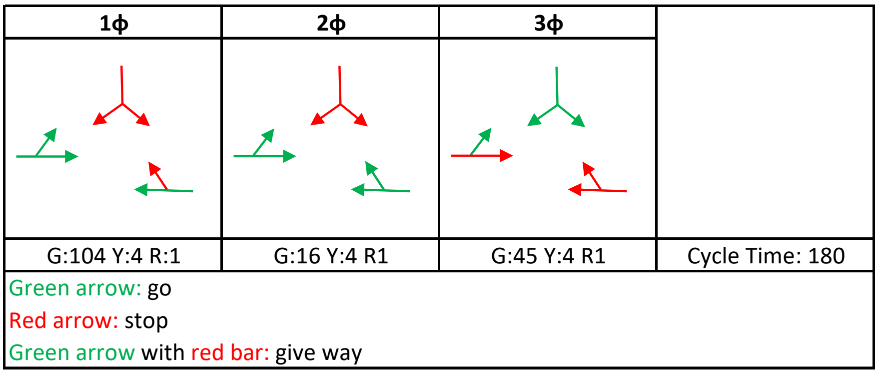


Source: JICA Survey Team

Figure 11.2.13 Tinkune-3's Traffic Signal Phasing (WO scenario-2033)

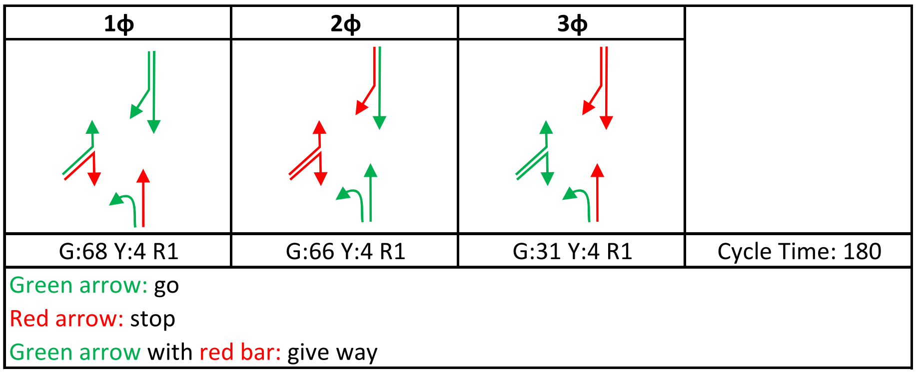
3) Future Traffic Control (With Scenario, 2033)

Considerations on traffic signal phasing for the With Project scenario in 2033 for the new development plans of Jadibuti, Koteshwor, Tinkune-1, and Tinkune -3 Intersections are in Figure 11.2.14, Figure 11.2.15, Figure 11.2.16, and Figure 11.2.17. The detailed contents of traffic signal phasing, including signal location, shall be examined and discussed among concerned organizations, such as DOR and Traffic Police, at the design detailing stage.



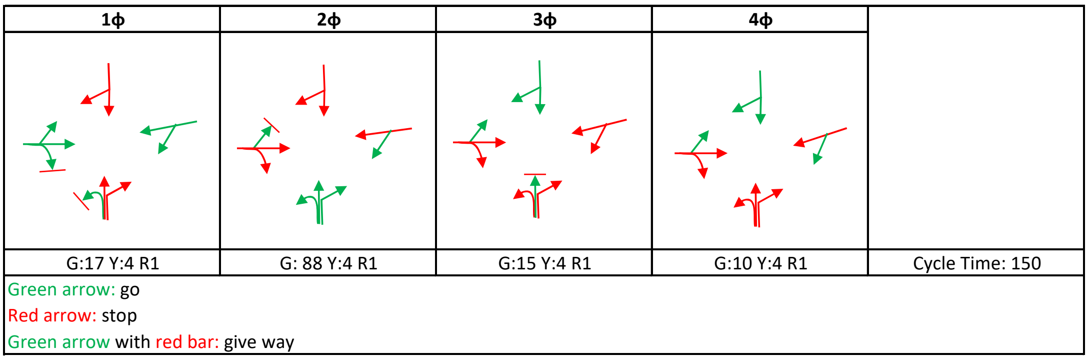
Source: JICA Survey Team

Figure 11.2.14 Jadhibuti's Traffic Signal Phasing (With scenario-2033)



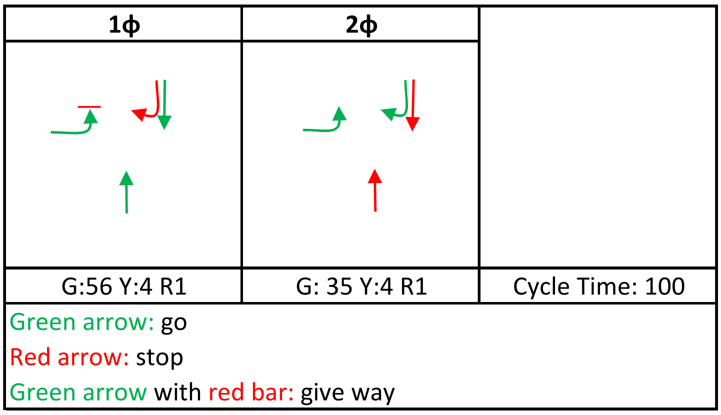
Source: JICA Survey Team

Figure 11.2.15 Koteshwor's Traffic Signal Phasing (With scenario-2033)



Source: JICA Survey Team

Figure 11.2.16 Tinkune-1's Traffic Signal Phasing (With scenario-2033)



Source: JICA Survey Team

Figure 11.2.17 Tinkune-3's Traffic Signal Phasing (With scenario-2033)

11.3 Evaluation Results (Economic Analysis)

An economic analysis to compare cost savings between With-project and Without-project (WO) scenarios was performed. Travel time cost (TTC) and vehicle operation cost (VOC) calculations account for vehicle delay and travel speed of each vehicle category within the study area.

- Vehicle delay (seconds): Difference between actual travel time and the travel time under ideal conditions (traveling with desired speed)
- Vehicle travel speed (km/h): Travel distance divided by travel time

Figure 11.3.1 shows the traffic congestion at the same time of day between With-project and Without-project scenarios.

The congestion level depicted in red color, shows the vehicles travelling with relatively low speeds in each of the scenarios. However, the With-project use case features faster vehicle travel when compared with the Without-project outline, especially within the road section between the Koteshwor and Tinkune 3 intersections.

Source: JICA Survey Team

Figure 11.3.1 Congestion Condition Comparison between With and Without Scenario-2033

The study utilizes unit values for calculating TTC and VOC in 2018 with an adjustment on bus unit value based on the percentage of bus types from the 2019 traffic survey data. Details are in Table 11.3.1 and Table 11.3.2.

Table 11.3.1 Unit Values of TTC

Unit Values of TTC by Vehicle Type, 2022 Prices [in NPR/hour/vehicle]

	Motorbike	Threewheels	car	LGV	HGV	Bus
Unit Values of TTC	54.47	372.87	107.59	139.26	165.00	*1100.29*

Source: JICA Survey Team

Table 11.3.2 Unit Values of VOC

Km/h	Motorbike	Threewheels	car	LGV	HGV	Bus
<5	8.95	34.19	49.90	69.62	111.41	*72.24*
10	8.73	32.78	48.07	66.25	106.05	*69.79*
15	8.47	31.23	45.99	62.81	100.52	*66.99*
20	8.19	29.56	43.66	59.31	94.82	*63.81*
25	7.86	27.76	41.08	55.72	88.94	*60.27*
30	7.50	25.84	38.24	52.03	82.88	*56.34*
35	7.10	23.79	35.13	48.22	76.66	*52.03*
40	6.64	21.64	31.76	44.25	70.26	*47.33*
45	6.13	19.40	28.14	40.07	63.69	*42.27*
50	5.54	17.16	24.32	35.56	56.96	*36.89*
>50	4.85	15.18	20.53	30.46	50.02	*31.35*

Source: JICA Survey Team

The calculation results for travel time and vehicle operation costs for With-project and Without-project scenarios are in Table 11.3.3.

Table 11.3.3 Comparison Results of TTC and VOC between With and WO Scenarios

Travel Time Cost_Hourly (NPR)

	Car	HGV	Threewheel	Ptv Bus	LGV	Motorbike	Total
With Case	63,991	1,569	3,507	163,362	11,902	69,322	313,652
WO Case	136,758	3,016	5,742	363,834	26,424	148,821	684,596
With - WO	-72,767	-1,447	-2,235	-200,473	-14,523	-79,500	-370,944

Travel Time Cost_Daily (NPR)

	Car	HGV	Threewheel	Ptv Bus	LGV	Motorbike	Total
With Case	873,292	21,409	47,861	2,229,410	162,423	946,035	4,280,429
WO Case	1,866,341	41,163	78,364	4,965,271	360,616	2,030,973	9,342,728
With - WO	-993,049	-19,754	-30,503	-2,735,861	-198,193	-1,084,938	-5,062,299

Vehicle Operation Cost_Hourly (NPR)

	Car	HGV	Threewheel	Ptv Bus	LGV	Motorbike	Total
With Case	481,599	21,503	3,996	180,996	110,378	239,022	1,037,495
WO Case	551,162	19,947	5,097	222,824	128,887	270,407	1,198,324
With - WO	-69,563	1,556	-1,101	-41,828	-18,508	-31,385	-160,830

Vehicle Operation Cost_Daily (NPR)

	Car	HGV	Threewheel	Ptv Bus	LGV	Motorbike	Total
With Case	6,572,411	293,449	54,533	2,470,068	1,506,338	3,261,952	14,158,753
WO Case	7,521,744	272,217	69,564	3,040,896	1,758,923	3,690,261	16,353,605
With - WO	-949,332	21,233	-15,031	-570,828	-252,585	-428,308	-2,194,851

Source: JICA Survey Team

11.4 Findings from the Traffic Microsimulation

The above studies produce several findings:

- **Economic impact**: Compared to the Without-project scenario, the project implementation could save about 5,062,000 NPR per day in TTC and around 2,195,000 NPR per day in VOC.
- Due to high traffic demand, it is suggested to also install a signal at the Tinkune-2 intersection for smoother traffic flow.

Because microsimulation can analyze detailed traffic movement at the project site, it is an excellent tool to study how to manage traffic during construction. Considering existing traffic conditions, examining traffic management plans during construction is essential for minimizing the Project’s impact on road users.

CHAPTER 12 STUDY ON MANOHARA RIVER BYPASS

12.1 Introduction

The pre-survey contains a preliminary study using reconnaissance data and a secondary one that explores the necessity of building the Manohara River Bypass, which connects Araniko Highway South to Ring Road South along the Manohara River through Right of River (RoR) space. The Appendix of the main report summarizes the effects of bypass construction and the improvement of the Koteshwor Intersection.

The preliminary study identified some easing of congestion at the Koteshwor Intersection. However, it also raised some issues with realizing the bypass, such as trouble with several control points, flooding along the river, and high construction costs.

This chapter will further elaborate on the pre-survey results, particularly the engineering study for the bypass, using the results of the topographical survey and the latest site reconnaissance data to assess its effects and necessity as a component of the Koteshwor-Tinkune Intersection improvement project.

12.2 Possible Impacts of New Arterial Road/Bypass Development along the Manohara River Corridor

The final pre-survey report found that the grade-separated road improvement at the Koteshwor-Tinkune Intersections will reduce the traffic congestion on the existing arterial roads: The Araniko Highway and the Ring Road.

On the other hand, it also found that even after the development of the grade-separated roads, the traffic conditions at the Koteshwor Intersection would remain severe. Also, the scale of the inflow section must increase.

For example, two left turn lanes must exist for Ring Road, hosting south-to-north traffic. Five right turn lanes are necessary for Ring Road South, connecting to Araniko Highway South. The expansion of the intersection area will require additional land acquisitions.

By diverting the traffic volume to the Manohara River Bypass, it will be possible to reduce the load on the intersection, particularly the traffic volume connecting Ring Road South and Araniko Highway South. It will also ensure high-speed and safe travel.

12.3 Objectives and Scope of the Pre-Feasibility Study on Manohara River BP

Given these precedents, the objective of the pre-feasibility study (Pre-FS) is to provide a possible upgrade plan for the ongoing Manohara River Corridor Development, which secures more traffic flow capacity for the corridor, contributing to the alleviation of traffic congestion at the Koteshwor Intersection.

The scope of the Pre-FS is as follows:

- To source updated information on the ongoing Manohara River Corridor Development, such as locations of the corridor and revetment, control points, like religious and educational facilities, through site surveillance and interviews with relevant authorities.
- To learn the present flow capacity of the Manohara and the Hanumante Rivers based on the information above.
- To review upgrading concepts/alternatives for the River Corridor provided in the pre-survey and select the most appropriate option for the Manohara River Bypass.
- To undertake preliminary designing for the identified alternatives, and future traffic passing through the BP after the upgrade.
- To judge the necessity of incorporating the Manohara River Bypass upgrade into the Koteshwor-Tinkune Intersection project.

12.4 Concept of the Ongoing Manohara River Corridor Development

12.4.1 Bagmati Area Physical Infrastructure Development Project

HPCIDBC has been promoting river improvement works in Kathmandu Valley according to the Bagmati Action Plan (2009-2014), which has the following components:

1. River training
2. River corridor development
3. Installing an interceptor along the rivers.

Although HPCIDBC has been responsible for finishing the bulk of the work, various agencies are involved in its implementation, as shown in Table 12.4.1.

Table 12.4.1 Work Section and Responsibility for Implementation

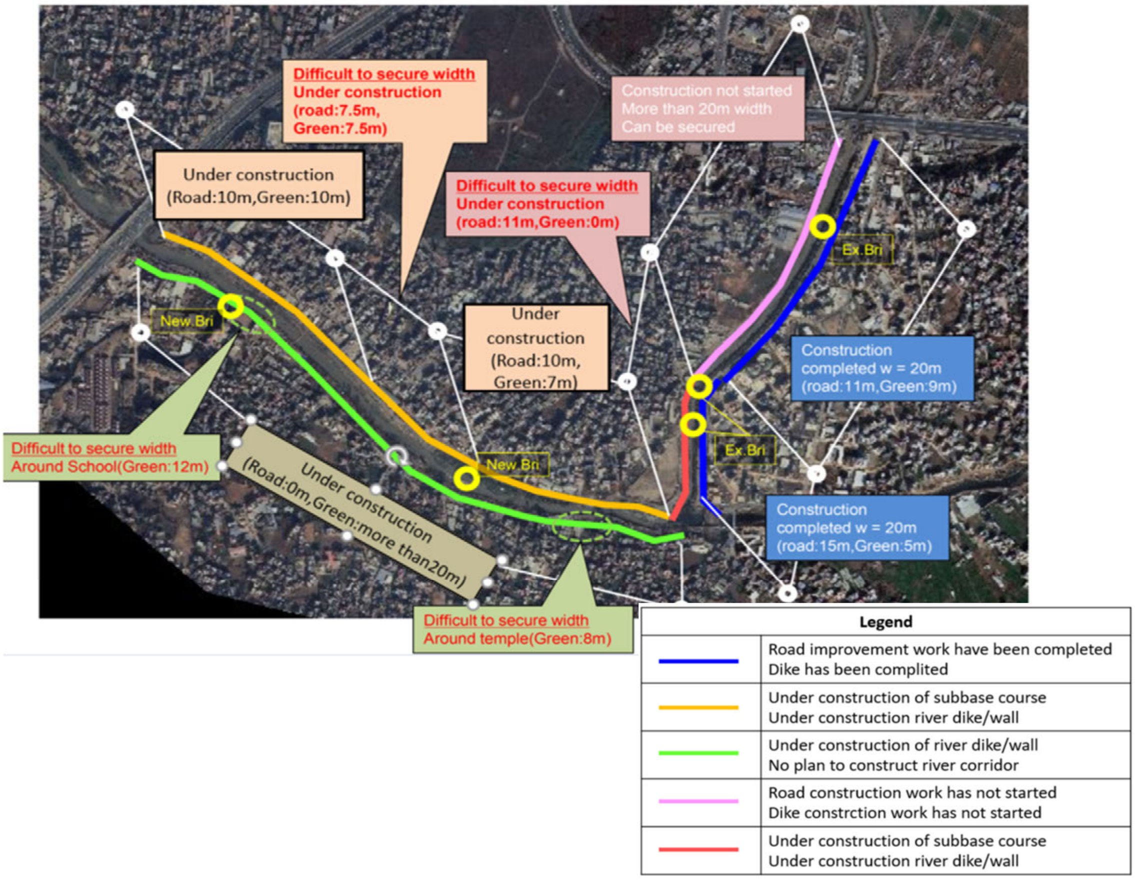
River Name	River Training	River Corridor	Interceptor
Bagmati River	HPCIDBC	HPCIDBC	HPCIDBC
Bishnumati River	HPCIDBC	DOR	HPCIDBC
Hanumante River	PID, KUKL	HPCIDBC	PID, KUKL
Dhobi River	KVDA	KVDA	HPCIDBC
Manohara River	PID, KUKL	HPCIDBC, DoR, Local Government, KVDA	PID, KUKL

Note: KUKL: Kathmandu Upatyaka Khanepani Limited, PID: Project Implementation Department
Source: JICA Survey Team

12.4.2 Basic Concept of Manohara River Corridor Development Plan

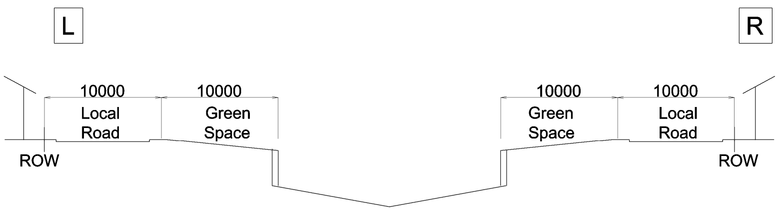
Figures 12.4.2 and 12.4.3 show the Manohara River Corridor Development concept based on an interview with DOR and HPCIDBC Division Chiefs. In Section-1, a two-lane road with footpaths (10m in width) at both sides and green spaces at the riversides (10m in width) exist on both banks of the Manohara River.

It is assumed that the Corridor concept is formulated on the basis of "Public Notice, Nov.2018", which stated to keep 20m as RoR for the Manohara River bank, and RoR varies depending on rivers, from 4m to 20m.



Source: JICA Survey Team

Figure 12.4.1 Work Progress of the Manohara River Corridor Development

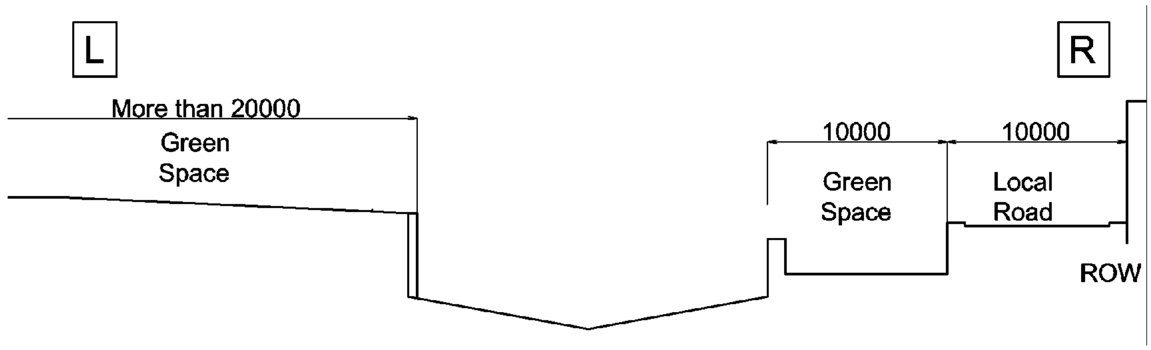


Source: JICA Survey Team

Figure 12.4.2 Basic Concept of Manohara River Corridor Development

(Section-1: Araniko Highway – Confluent Point with Hanumante River)

Division Chiefs apply a different concept for Section-2. A road and green space are only provided on the right bank of the Manohara River because the existing road runs almost parallel to the left riverbank.Figure 12.4.3. shows the typical cross-section of Section-2. However, as of August 2023, new road approch to Kodku Khol bridge is under construction.



Source: JICA Survey Team

Figure 12.4.3 Basic Concept of Manohara River Corridor Development

(Section-2: Confluent Point with Hanumante River – Ring Road South)

12.5 Current Progress of Manohara River Corridor Development

12.5.1 Progress of the River Corridor Development

The Manohara River runs along government-designated administrative boundaries in Kathmandu, Bhaktapur, and Lalitpur. Table 12.5.1 shows work sections of the river corridor with its progress in administrative territories. Although HPCIDBC is responsible for the river corridor development, various agencies play a role in project implementation. Project progress varies depending on the work section.

Table 12.5.1 Work Sections with Progress and Its Administrative Territory

Work Section	Administrative Territory	Progress of River Corridor Development
Section-1: Araniko Highway Bridge to Confluence Point with the Hanumante River	-	
- Left bank side	Bhaktapur	Completed
- Right bank side	Kathmandu	-Interceptor works are under progress in the first half without road work. Pavement work only remains for the latter half.
Section-2: Confluence Point with the Hanumante River to the Ring Road Bridge	-	
- Left bank side	Lalitpur	No corridor involvement planning
- Right bank side	Kathmandu	Completed

Source: JICA Survey Team

12.5.2 Features of Manohara River

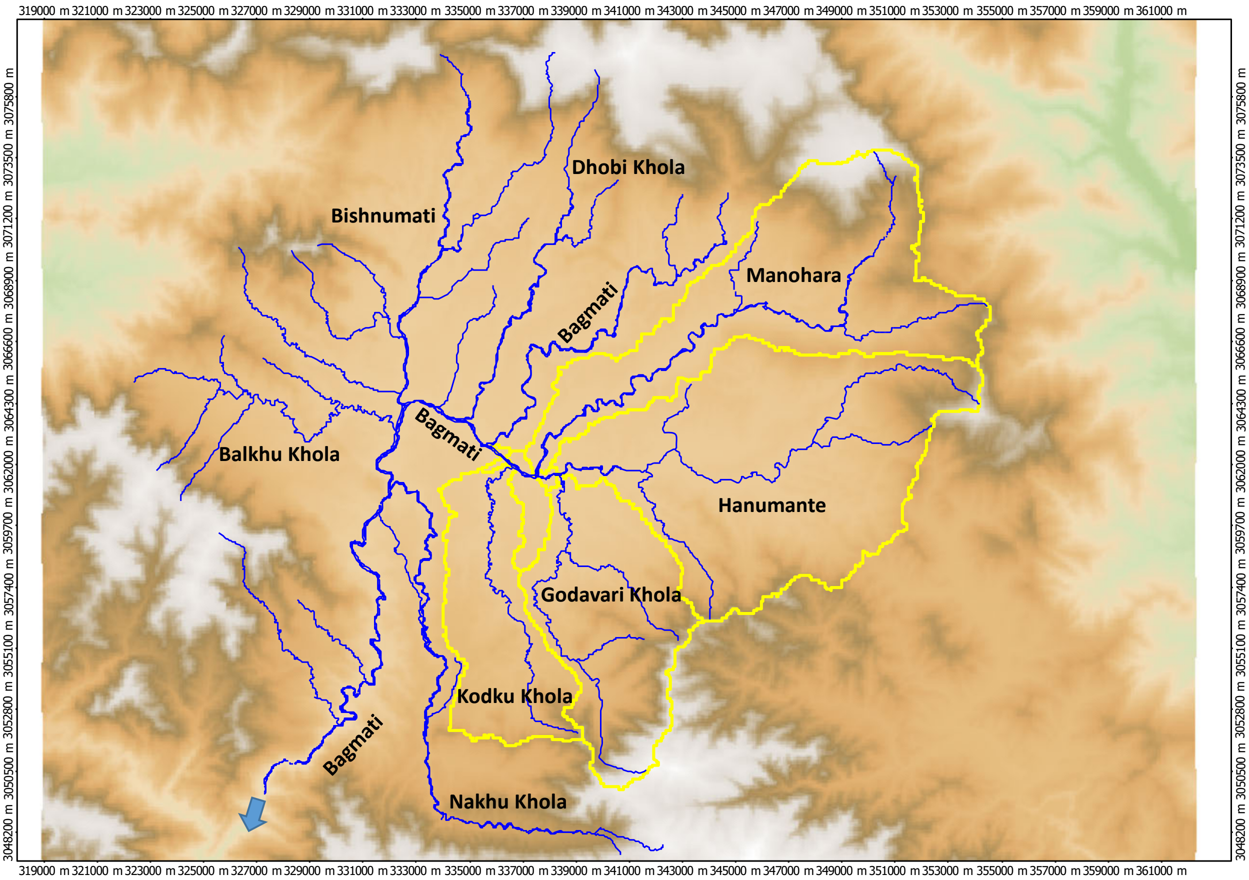
(1) Manohara River

The Manohara River belongs to the upper Bagmati River Basin, which consists of three parts: the Upper Bagmati (Kathmandu Valley), the Middle Bagmati, and the Lower Bagmati in the Terai Plain. The catchment area of the upper Bagmati River Basin is approximately 600 km^2, about 15% of the entire Bagmati River Basin.

The Manohara River is the largest tributary in the upper Bagmati River Basin in the Kathmandu Valley. Its catchment area is 260 km^2, subdivided into the sub-catchments shown in Figure 12.5.1, which are the following:

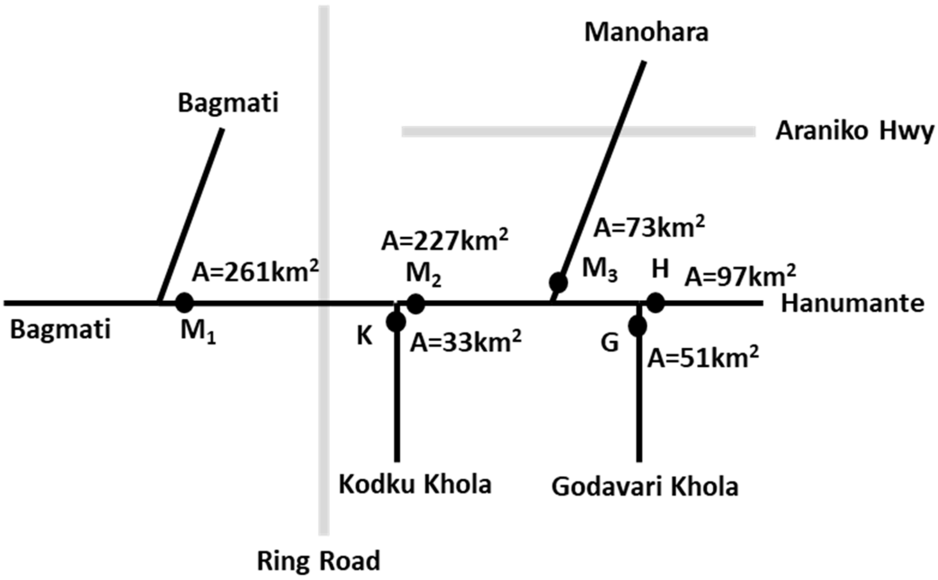
- Manohara (main channel)
- Hanumante
- Godavari Khola
- Kodku Khola

The schematic expression of the Manohara River system is in Figure 12.5.2.



Source: JICA Survey Team

Figure 12.5.1 Sub-Catchments of Manohara River Catchment

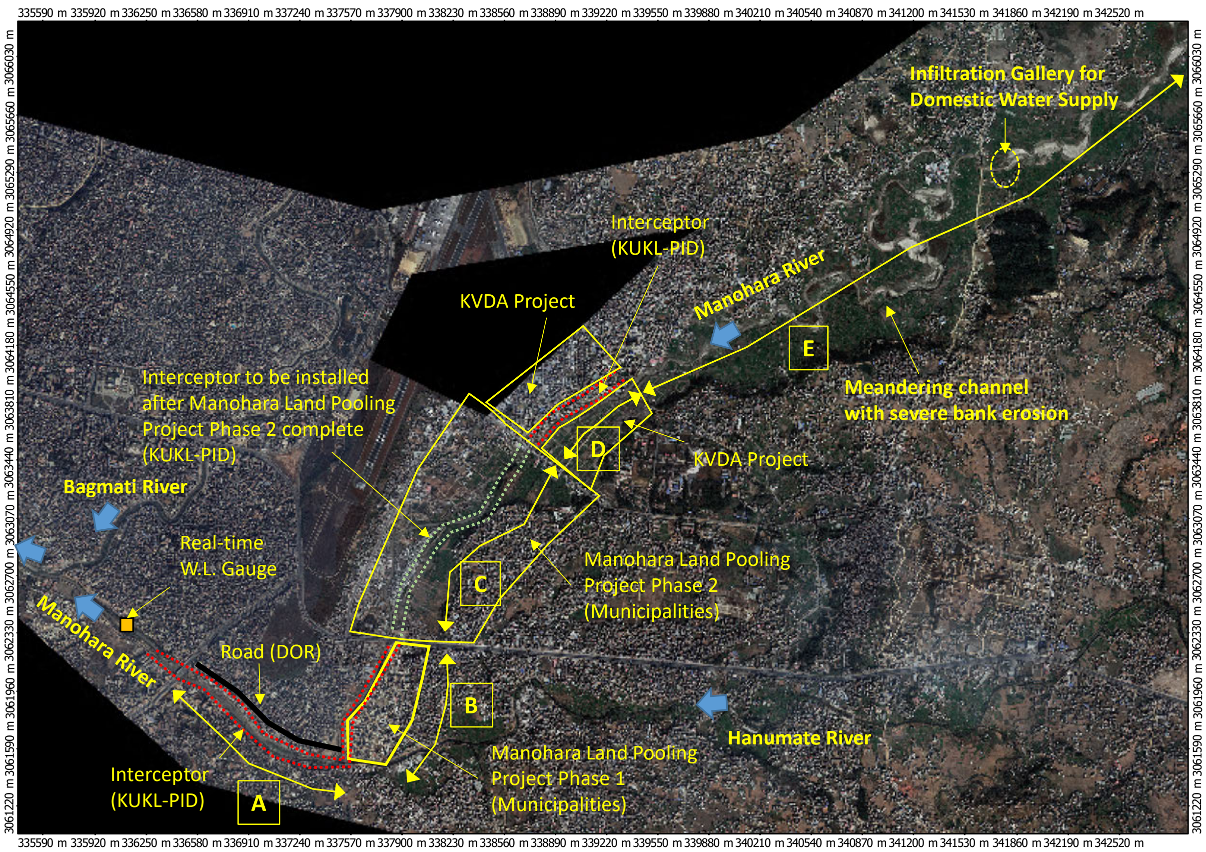


Source: JICA Survey Team

Figure 12.5.2 Schematic Expression of Manohara River System

(2) River Improvement Projects

The river improvement projects in/along the Manohara River have been implemented by various agencies, as shown in Figure 12.5.3 and Table 12.5.2.



Source: JICA Survey Team

Figure 12.5.3 River Improvement Projects in/along Manohara River

Table 12.5.2 River Improvement Projects in Manohara River

Reach		Bank Protection and River Training Works	Green Space and Road	Interceptor Sewerage Main
A	Confluence with Bagmati R. – Confluence with Hanumante R.	Right Bank: **DOR** Left Bank: **KUKL-PID**	Right Bank: **DOR** **(No Green Belt)** Left Bank: HPCIDBC	**KUKL-PID**
B	Confluence with Hanumante R. – Bridge on Araniko Hwy	Right Bank: **KUKL-PID** Left Bank: **Municipality[1]**	Right Bank: HPCIDBC* Left Bank: **Municipality[1]**	**KUKL-PID**
C	Bridge on Araniko Hwy – Pepsi Cola Bridge	**Municipality[2]**	**Municipality[2]**	KUKL-PID
D	Pepsi Cola Bridge – 1km upstream of Pepsi Cola Bridge	**KVDA**	**KVDA**	**KUKL-PID**
E	1km upstream of Pepsi Cola Bridge -	KVDA	KVDA	KVDA

Bold = Completed or ongoing
1=Manohara Land Pooling Project Phase 1, 2= Manohara Land Pooling Project Phase 2
Source: KUKL-PID, KVDA, HPCIBDC

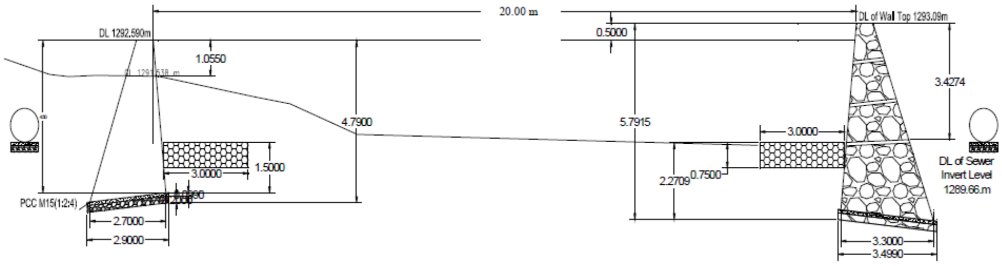
Many land-development projects related to the Kathmandu Valley Development Authority (KDVA) exist along the Manohara River. They are as follows:

- **Manohara Land Pooling Project Phase 1 in Reach B**
  The project targeted the left bank of the Manohara River. The Madhyapur Thimi Municipality implemented it with a loan from the KVDA. The project is almost complete after 22 years. It is responsible for constructing the bank protection, green space, and road on the left bank.

- **Manohara Land Pooling Project Phase 2 in Reach C**
  The project targeted both banks of the Manohara River with joint implementation by the Madhyapur Thimi Municipality and Kathmandu Metropolitan Municipality. The project was possible through a loan from KVDA.
  The project was once responsible for land development and building bank protection, green space, and roads along the river. However, there was difficulty in dealing with informal settlers in the project area. Also, forming a consensus between the two municipalities on a new river alignment was challenging.
  The river alignment eventually became the administrative border between the two municipalities. KUKL-PID will install the interceptor sewerage main after this project finishes.

- **KVDA Project in Reach D**
  The KVDA directly developed the area from the Pepsi Cola Bridge to about 1 km upstream. The right bank side is complete after eight years. The project is ongoing on the left bank, achieving 80% completion after three years. This project built bank protection, green space, and a road. KUKL-PID has already installed the interceptor sewerage main in this area.

- **1 Lakh Ropanies New Urban Expansion Area Development in Reach E**
  KVDA has been preparing a new town development plan in this area. KVDA will implement it shortly after conception. It proposes land development with a flood plan, building bank protection, green space, and a road along the river. HPCIDBC conducted a study to determine the necessary river width. They proposed a cross-section shown in Figure 12.5.4, which can accommodate floods with a 5-year return period. Its width is approximately 20 m, with retailing walls around 5 m high.



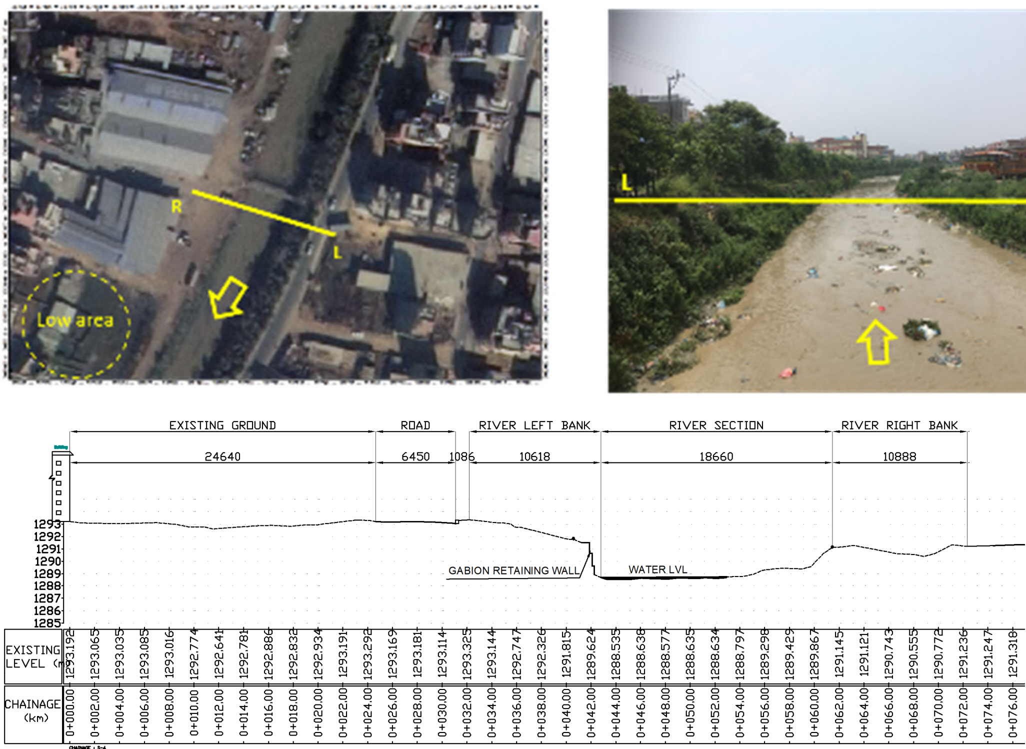
Source: HPCIBDC

Figure 12.5.4 Typical Cross-section HPCIDBC Proposed

12.5.3 Section-1: From Araniko Highway Bridge to Confluence Point with Hanumante River

<u>River Situation</u>

The river width varies from 16 m to 40 m in Section-1, and its depth from the bank to the bed ranges from 3 m to 5 m. Water depth of around 30-50 cm in the dry season and a flow velocity of about 1m/sec at normal flow is observed. Some riverbed protection works, or their remains are near the bridges in Section-1. A 2-3 m gabion mattress protects riverbanks on both sides.



Source: JICA Survey Team

Figure 12.5.5 Present Situation of the Manohara River (Section-1)

This section has an estimated discharge capacity of about 120m^3/s and 100m^3/s for the right and left riverbank, measuring the height from the top of the gabion mattress. It is equivalent to the probable discharge at a 5 –10-year return period. Refer to 12.6).

There are three bridges across the river in Section-1: One for a truss pedestrian bridge providing access to the market located at the right bank, approximately 200 m downstream from the Araniko Highway; a second one only passable for light vehicles, around 600 m downstream from the Araniko Highway; and a third one, which is a temporary bridge all vehicles can ply, providing access to Ring Road South.

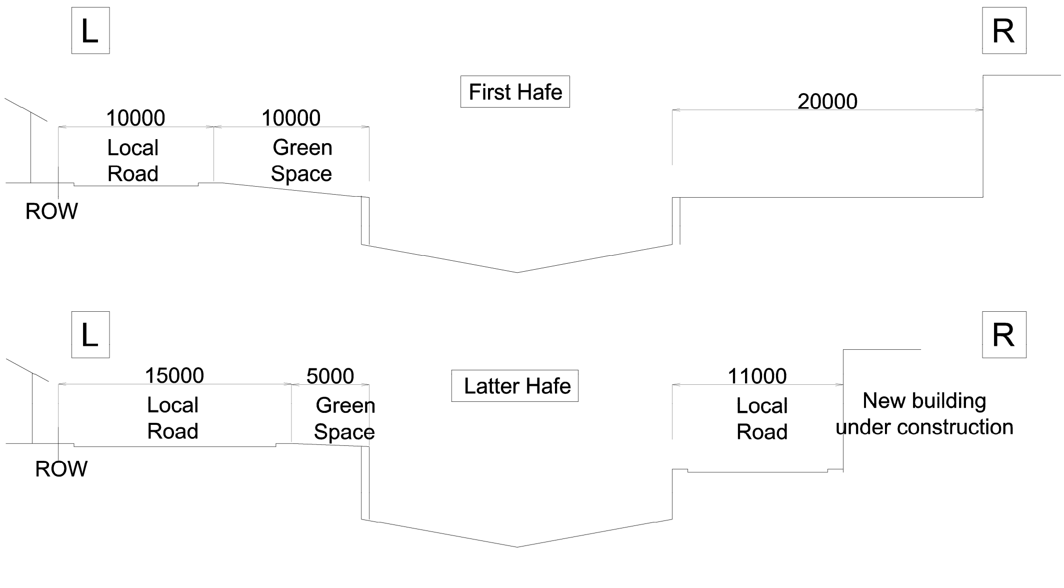
Left Bank Section

The Corridor development on the left bank section of the Manohara River has been completed with a setback width of 20 m, combining a 2-lane road with footpaths at both sides and a green space at the riverside.

It features two types of cross-sections: a 10 m-wide road portion with 10 m of green space and a 15 m-wide road portion with 5 m of green space, as shown in Figure 12.5.6. The reasons DOR engineers applied a wider road width of 15 m, unlike the road in the upper stream, are unclear. However, according to our site observation, a 15 m-wide road section might be for securing parking spaces for heavy vehicles owned by the residents and firms nearby.

Source: JICA Survey Team

Figure 12.5.6 Wider Road Section at Latter Half of Secion-1



Source: JICA Survey Team, based on the interview results from DoR and site reconnaissance

Figure 12.5.7 Completed Section of the River Corridor at Left Bank of Manohara River

Right Bank Section

On the right bank of Section-1, from the Araniko Highway to the second bridge mentioned above, the road construction work has not started yet, although interceptor installation works are underway. It is observed that sufficient space for 20m setback has been already secured except the area near by the existing bridge.

From the second bridge to the confluent point, houses and a new public facility construction site owned by the municipality are along the river. The limited space due to the occupation of both houses and construction sites suggests that, at present, it is for roads and not for green spaces in the Corridor. River training works and a retaining wall have been constructed in this section.

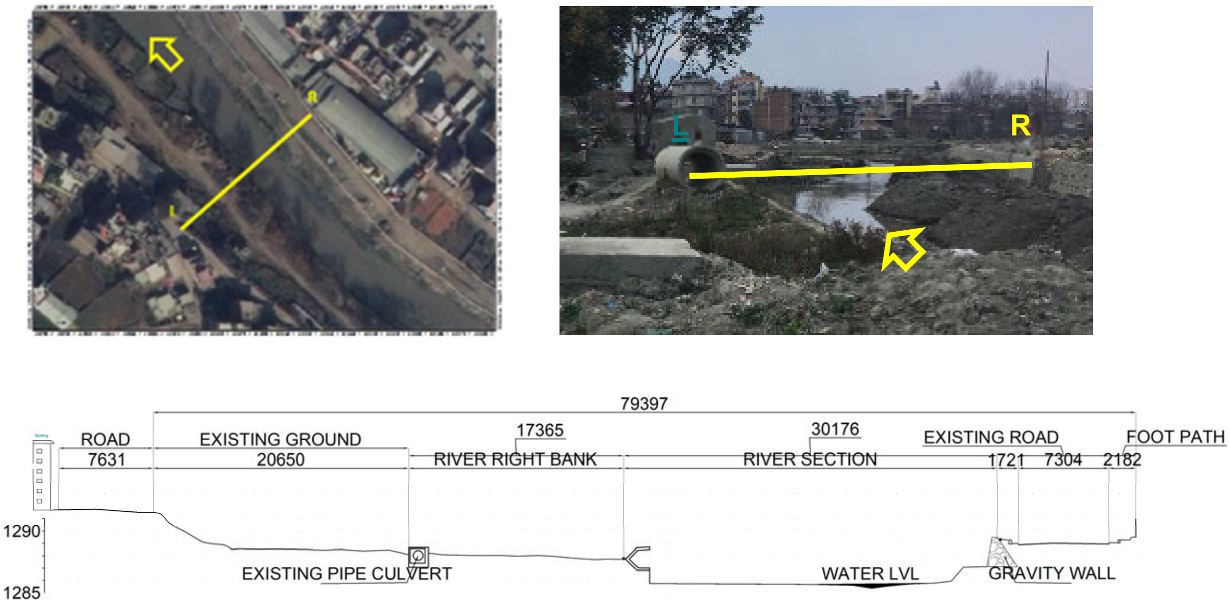
Source: JICA Survey Team

Figure 12.5.8 Latter Half of the Corridor at the Right Bank of Manohara River

12.5.4 Section-2: From Confluence Point with the Hanumante River to Ring Road Bridge

River Condition

After the confluent point in the Hanumante River, the river width widens from 20 m to 25 m between retaining walls constructed by the ongoing river training project. While the construction of green space is complete, the retaining wall works on the left bank are still under construction. Moreover, the river flow appears gentler than on the upstream side, and its water depth ranges from approximately 0.3 m to 0.5 m.



Source: JICA Survey Team

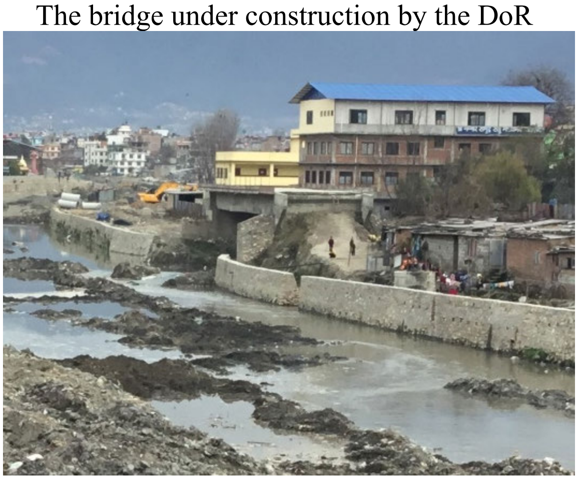
Figure 12.5.9 Section-2: After Confluent Point in the Hanumante River

The discharge capacity of this section is approximately 80m^3/s for a stone masonry bank height, equivalent to the probable discharge at less than a two-year return period.

At the middle point of the Section-2, the municipality is constructing a 35 m-long steel bridge across the river. Additionally, the DOR has completed another river bridge project across a branch of the Manohara River near the Ring Road Bridge, which runs parallel to the river. As per the DOR interview, the approch road for the second bridge will be constructed by HPCIDBD.

The bridge under construction by the municipality

The bridge under construction by the DoR



Source: JICA Survey Team

Figure 12.5.10 Bridges under Construction in Section-2

__Left Bank Section__

The river training works for retaining walls with construction works for the intercepting sewage system are almost complete at the left bank side. According to the latest information from HPCIDBC, there is no road corridor plan along Section-2 of the Manohara River. Instead, a 20 m-wide green space area is set within the setback space on the left bank side. However, as of August 2023, river corridor including approch to the bridge constructed by DOR is under construction.


Source: JICA Survey Team

Figure 12.5.11 After Confluent Point in the Hanumante River at the Left Bank of Section-2

By observation, it is evident that a setback space of 20 m from the river is nearly secured along Section-2, except for areas near the temple, technical college, and the constructed branch river bridge. Furthermore, The demolition of several houses along the riverbank near the Ring Road Bridge have already demolished toensures the setback space.

<u>Right Bank Section</u>

The river training works, securing the road space on the right bank, have been completed, and only pavement works are pending. Based on on-site observations, it appears that the line of the retaining wall defining the river edge, to maintain a distance of 11 m from the private land border. Consequently, the retaining wall line exhibits meandering characteristics rather than a smooth curve.

Additional river training works in front of the retaning walls are under construction. They secure green space based on the corridor development concept. This results in narrower river but ensures the setback space on the right bank side.

Source: JICA Survey Team

Figure 12.5.12 Meandering Retaining Wall Line at the Right Bank of Section-2

12.6 Flood Water Level Analysis on Manohara River

12.6.1 Probable Discharge

HPCIDBC conducted a hydrological and hydraulic study on the Hanumante River to determine necessary river width. They explored various methods to estimate the probable discharge, including empirical methods were attempted. Among these, Synder's Method, based on the rainfall-runoff model, for their study. Table 12.6.3 shows the probable discharge for return periods at every catchment area.

Table 12.6.1 Probable Discharge

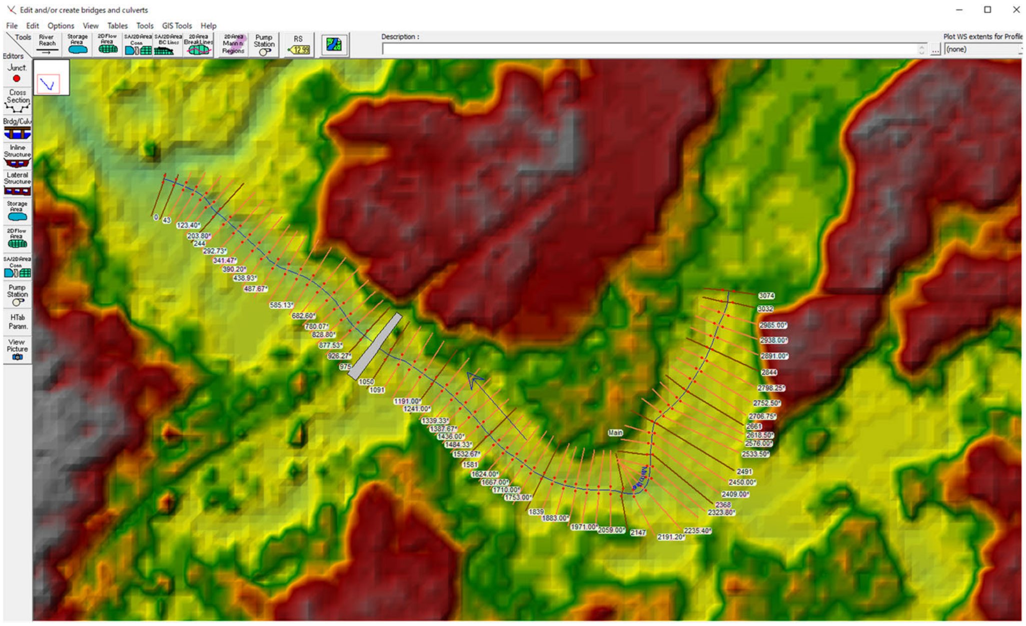
Location	Catchment Area (km^2)	Return Period					
		2 year	5 year	10 year	25 year	50 year	100 year
M1: Manohara	261	302	396	459	538	597	656
M2: Manohara*	227	254	318	360	411	451	488
M3: Manohara*	73	97	124	141	164	181	197
H: Hanumante	97	113	139	156	177	194	210
K: Kodku Khola	33	46	60	70	82	91	100
G: Godavari Khola	51	67	88	101	118	131	144

Note*: The HPCIDBC Report does not indicate the discharge at this location. The JICA Survey Team estimated the probable discharge at this location using the specific discharge curve derived from the discharge data collected by the HPCIDBC in the Hanumante River.
Source: HPCIDBC, JICA Survey Team

12.6.2 Non-Uniform Flow Calculation of the Manohara River

(1) Model Setup

A total reach length is approximately 3,000 m from the confluence with the Bagmati River to the Araniko Highway in the Manohara River. It was modeled for one-dimensional non-uniform flow calculation. Hydraulics modeling employed the HEC-RAS model, and Figure 12.6.1illustrates the model setup.



Source: JICA Survey Team

Figure 12.6.1 Model Setup for Non-Uniform Flow Calculation of the Manohara River

The model setup used the following information:

<u>Cross-Section Data</u>

- 9 cross sections (S3 - S12): Topographical survey conducted in 2020
- 3 cross sections (Sa1 - Sa3): Topographical survey conducted in 2018

<u>Digital Surface Model (DSM)</u>

- AW3D30[1] with about 30 m grid was employed for estimating floodplain elevation. The correction for the elevation bias used the cross-section data above.

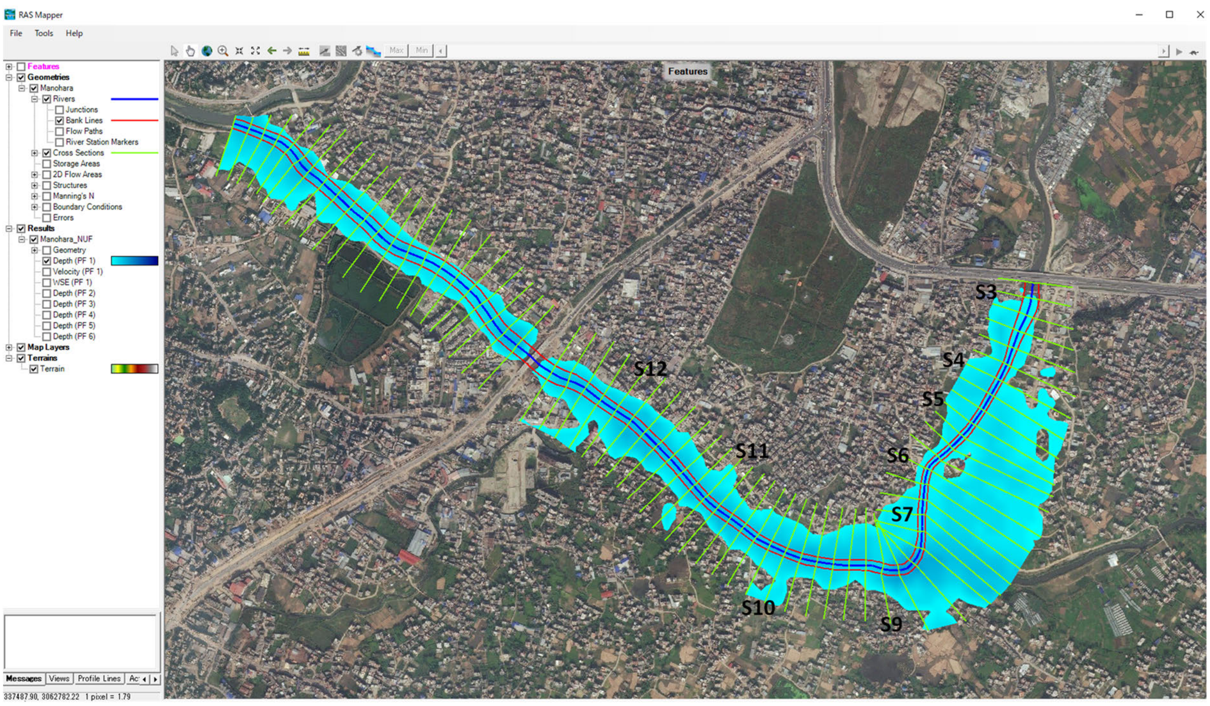
The number of actual cross-sections available for non-uniform calculation is limited. Therefore, the study used interpolated cross-sections.

The following roughness for hydraulic calculation was adopted:

- Main channel: 0.035
- Floodplain: 0.06

(2) Results

Figure 12.6.2 shows the expected inundated area for the flood in a 100-year return period based on the result of the non-uniform flow calculation. The width of the inundation is 100 m to 300 m, depending on the location. The result shows that the Balkumari Bridge on Ring Road and Araniko Highway are not submerged during the flood in a 100-year return period.

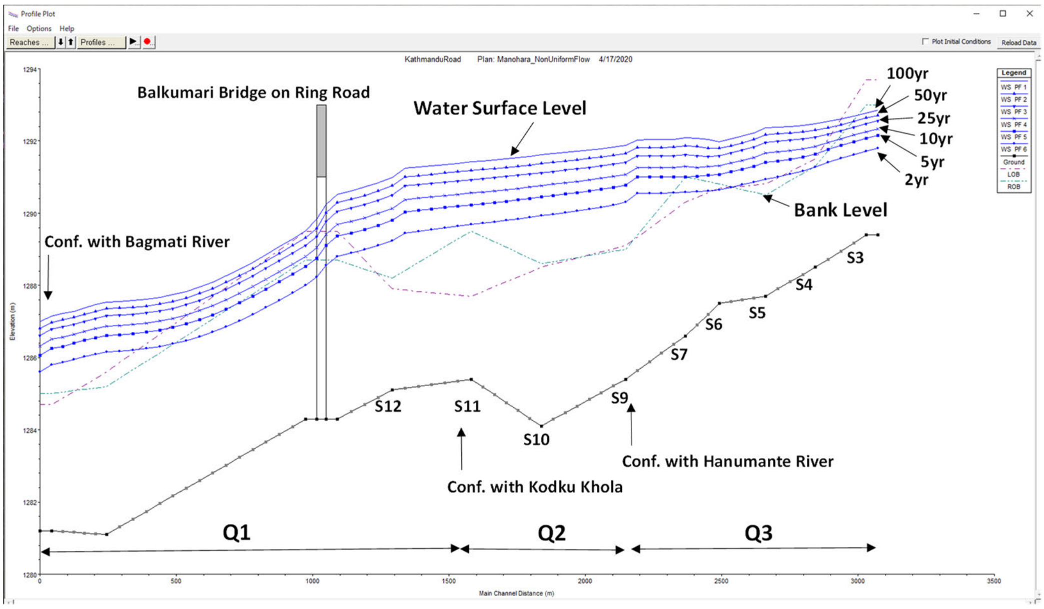


Source: JICA Survey Team

Figure 12.6.2 Expected Inundated Area during the Flood in a 100-Year Return Period

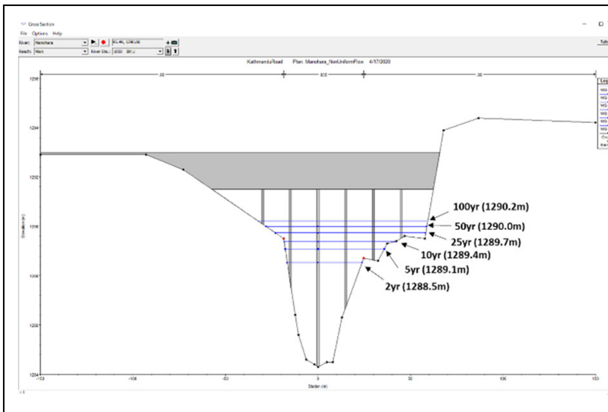
[1] ALOS Global Digital Surface Model "ALOS World 3D - 30m, https://www.eorc.jaxa.jp/ALOS/en/aw3d30/index.htm

Figure 12.6.3 presents the longitudinal profile of the calculated water surface levels for floods in 2, 5, 10, 25, 50 and 100-year return periods as well as lowest channel bottom level and bank levels. Figure 12.6.4 and Figure 12.6.5 illustrates the water surface levels with the cross-sections.

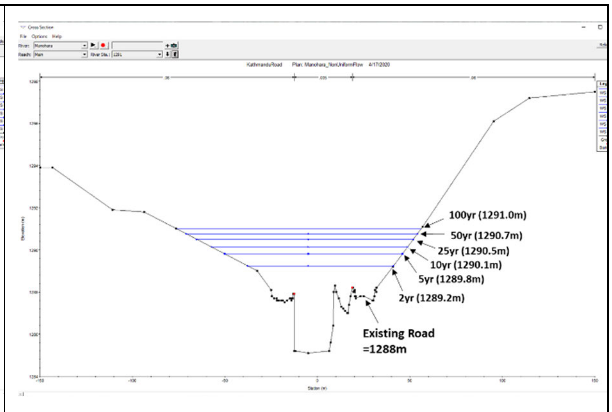


Source: JICA Survey Team

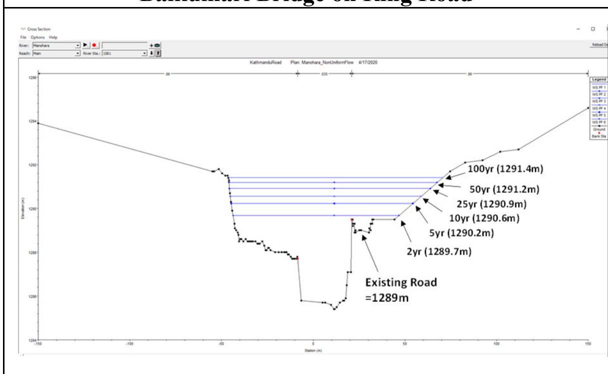
Figure 12.6.3 Longitudinal Profile of Calculated Water Surface Levels during Flood



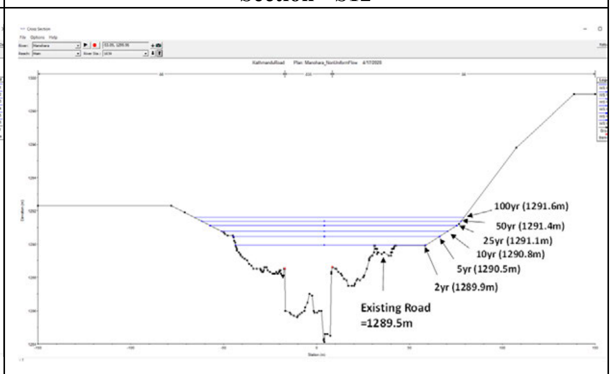
Balkumari Bridge on Ring Road



Section - S12



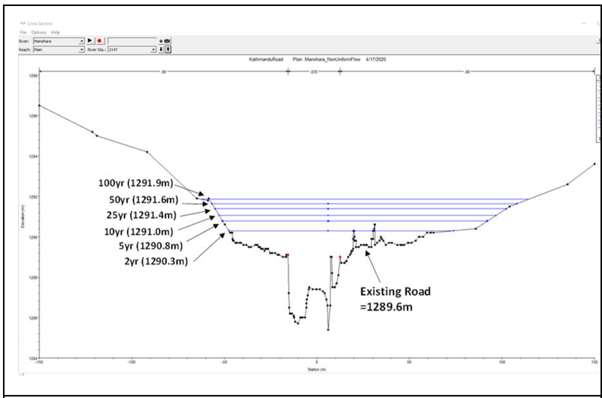
Section - S11



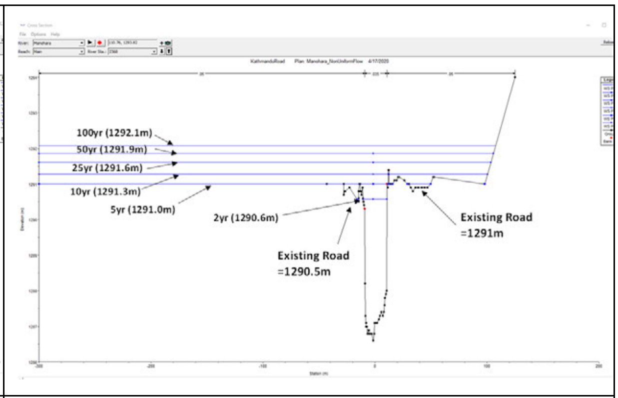
Section - S10

Source: JICA Survey Team

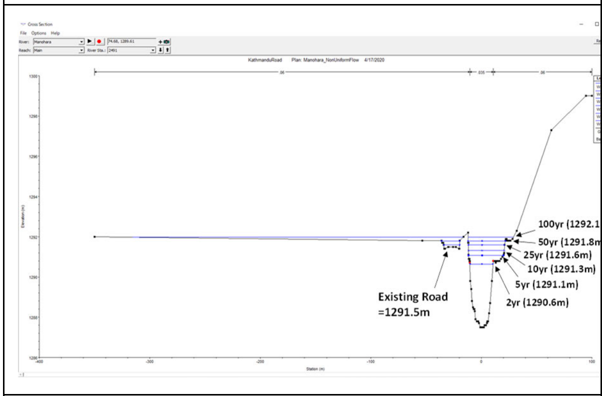
Figure 12.6.4 Calculated Water Surface Levels with Cross-Sections (1/2)



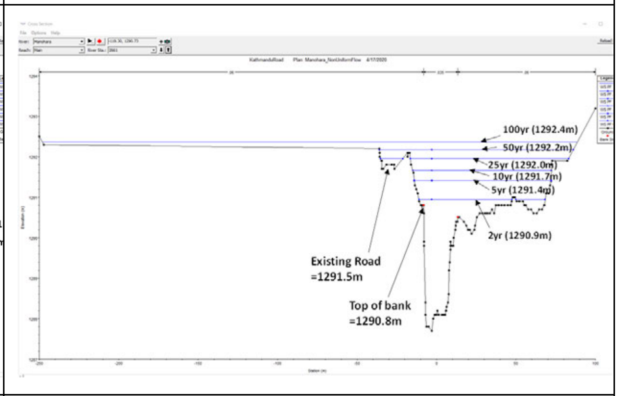
Section – S9



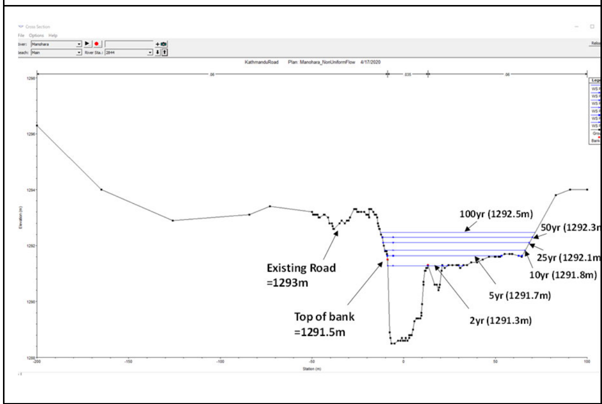
Section – S7



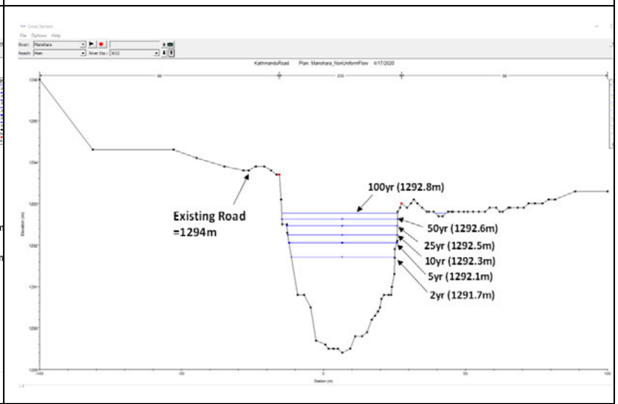
Section – S6



Section – S5



Section – S4



Section – S3

Source: JICA Survey Team

Figure 12.6.5 Calculated Water Surface Levels with Cross Sections (2/2)

Table 12.6.2 lists the calculated water surface levels for each cross-section.

Table 12.6.2 Calculated Water Surface Levels

(Unit: m)

Section	Return Period					
	2 year	5 year	10 year	25 year	50 year	100 year
S3	1291.7	1292.1	1292.3	1292.5	1292.6	1292.8
S4	1291.3	1291.7	1291.8	1292.1	1292.3	1292.5
S5	1290.9	1291.4	1291.7	1292.0	1292.2	1292.4
S6	1290.6	1291.1	1291.3	1291.6	1291.8	1292.1
S7	1290.6	1291.0	1291.3	1291.6	1291.9	1292.1
S9	1290.3	1290.8	1291.0	1291.4	1291.6	1291.9
S10	1289.9	1290.5	1290.8	1291.1	1291.4	1291.6

S11	1289.7	1290.2	1290.6	1290.9	1291.2	1291.4
S12	1289.2	1289.8	1290.1	1290.5	1290.7	1291.0
Balkumari Bridge	1288.5	1289.1	1289.4	1289.7	1290.0	1290.2

Source: JICA Survey Team

By varying the flow discharge along the reach, the flow capacity of the existing channel was assessed for the crest level of the existing revetment. Table 12.6.3 presents the results.

Table 12.6.3 Flow Capacity for Crest Level of Existing Revetment

Section	Flow Capacity （m^3/s）		Flow Capacity （Return Period (year)）	
	Left Bank	Right Bank	Left Bank	Right Bank
S3	400	250	100 <	100 <
S4	130	120	5 - 10	5
S5	120	100	5	2 - 5
S6	200	200	100 <	100 <
S7	200	370	100 <	100 <
S9	120	120	< 2	< 2
S10	130	130	< 2	< 2
S11	80	260	< 2	< 2
S12	140	170	< 2	< 2
Balkumari Bridge	480	330	10 - 25	2 - 5

Source: JICA Survey Team

Although Sections S6 and S7 have enough flow capacity for the flood in a 100-year return period, the calculated water surface level exceeds the bank level because of the backwater effect from the downstream reach after the confluence with the Hanumante River.

Control Points/Facility to be considered for Upgrade Plan

12.6.3 Relevant Ongoing and Completed Projects along the Manohara River

Table 12.6.4 shows the projects to the Manohara River Corridor Development.

Table 12.6.4 Relevant Ongoing and Completed Projects

Project Name	Fund	Referencing Points
(1) Kathmandu-Bhaktapur Road Improvement Project	JICA	-Completed project. Hydraulic analysis for the new Manohara River Bridge on Araniko Highway. Its bridge length and span arrangement can accommodate the discharge volume of a 50-year return period.
(2) Construction of Intercepting Sewage System along the Hanumante River	ADB	- Ongoing project, including river training works and installation of interceptors along the assumed river corridor but excluding the river corridor provision, works.
(3) Construction of Manohara Khola Steel Girder Bridge	Local Fund	-Ongoing project. River cross-section plan when determining the bridge length. Connection between the Corridor and this bridge should be considered.
(4) Construction of Kodku Khola Bridge in parallel to the Manohara River	DOR	-Completed project but no approach roads. 7m in width. Crossing the river ranch of the Manohara River, Kodku Khola. It is observed

		that it considers the discharge volume of a 50-year return period.
(5) Ring Road Upgrade Project	China	-Widening to a 4-lane main road plus 2-lane frontage roads at both sides, including bridge sections. There is no design report for additional bridges across the Manohara River, but it assumes a design of 100 years against flood frequency.

Source: JICA Survey Team

12.6.4 Control Points/Facilities for the Manohara River Bypass Planning

As a result of the site reconnaissance by the study team, the following points/facilities, described in Table 12.6.5, are control points for route selection of the bypass.

Table 12.6.5 Control Points for Route Selection


1.Market


2.Exixiting Bridge


5.Exisiting Bridge


6.Exisiting Bridge


7.New building under construction


8&9.School


10.Temple


11.New bridge under constrction


12. Temple


13. Temple


15.School &16.New bridge under constrction


17. Religious place


18. Religious place

Source: JICA Survey Team

12.7 Upgrade Concept for Manohara River Bypass

12.7.1 Upgrade Concept/Design Policy for Bypass

Although the pre-survey report discussed the major upgrade concepts for the bypass, the study team again consulted with the Nepal side on the primary policy of the bypass below in the study, which significantly affects construction costs of the bypass.

(1) Road Function

There are two ideas on the road function for the bypass; one is to separate local traffic from the throughway one, and another is to provide multifunction to the bypass, allowing both local traffic and throughway one on the same road. Considering the prime purpose of the bypass, which secures smooth traffic on the bypass from/to Araniko Highway to Ring Road South and lowers the risk of traffic accidents on the bypass, the former concept was recommended by the study team and appraised by the Nepal side.

(2) Road Elevation

As stated in Section 12.6, the Section-2 area along the Manohara River has experienced frequent inundations. An analysis indicated that the planned river cross-section in Section-2 can only accommodate floods at 2 to 5 years, designating this area as flood prone. Notably, the Manohara River Section-2 area faced flooding in July 2018.

Considering the current situation along the Manohara River, there are two arguments regarding the road elevation of the bypass. The first proposes setting the road elevation against a flood with a 50 to 100-year probability, given that the bypass holds the same importance as Araniko Highway and Ring Road. The second suggests allowing the inundation of the bypass since it occurs only a few days within a 2 to 5-year period, with the remaining period time being dry, resulting in lower construction costs. However, an access issue arises at the existing bridge in the Section-1, as shown in Figure 12.7.1.

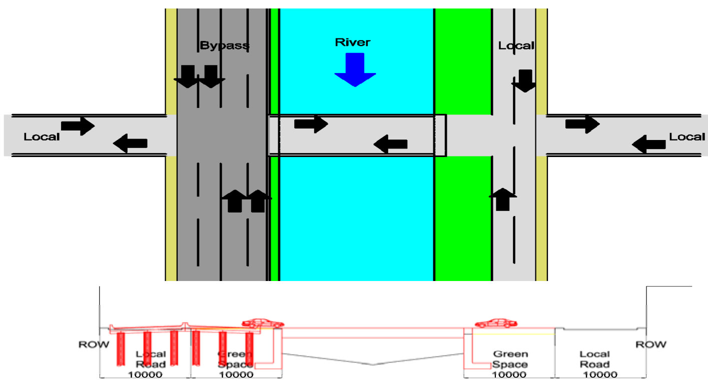


Figure 12.7.1 Access Issue at the Existing Bridge

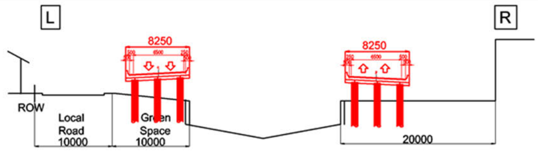
The bypass should be constructed with an elevated structure that remains passable in the event of a flood to realize the first concept, ensuring it does not cause adverse flooding effects in other areas along the river. It implies avoiding the use of a high embankment bank.

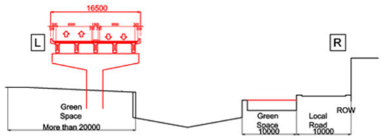
Accordingly, the study team recommended the first concept, considering the road class of the connecting roads and difficulty in the road maintenance against frequent inundation.

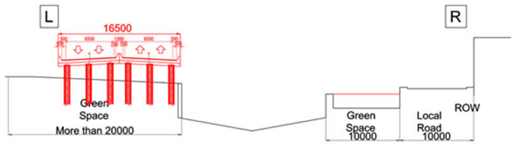
(3) Structural Option for the Bypass

A discussion in (2) Road Elevation clarified the necessity of the elevated structure for the bypass. Two structure types are considered: a flyover type and a pile-bent one. The pile-bent type is economical and by rapid construction but is only applicable up to an elevation of 3 m from the ground level. On the other hand, the flyover type has no elevation limitations but involves higher costs. Table 12.7.1 provides the comparison of both types.

Table 12.7.1 Structural Type for Elevated Bypass

<table>
<tr><th colspan="2"></th><th>Flyover</th><th>Pile Slab</th></tr>
<tr><td rowspan="2">Cross-section</td><td>Separated</td><td>Not considering because of high cost</td><td>


</td></tr>
<tr><td>Integrated</td><td>


</td><td>


</td></tr>
<tr><td colspan="2">Applicability</td><td>Applicable elevation is unlimited.</td><td>Applicable elevation is limited(Up to approx.3m).</td></tr>
<tr><td colspan="2">Advantage</td><td>• Over Passing existing river cross bridge is possible. Enable both to secure existing river cross traffic and to regulate local traffic access.
• Utilized land at grade is smaller.</td><td>• Low project cost</td></tr>
<tr><td colspan="2">Dis-advantage</td><td>• High project cost</td><td>• Over Passing existing river cross bridge is impossible. Intersection should be provided at existing bridges. Its operation is very complicated
• Utilized land at grade is larger.</td></tr>
</table>

Source: JICA Survey Team

Another aspect to consider regarding the elevated bypass structure is whether to opt that superstructure of each direction is a combined or separated. The combined structure design is preferred due to construction cost considerations, offering savings in foundation and substructure volume when sufficient space is available. Following the site reconnaissance, Tge space for installing the combined elevated bypass structure along the river is existed.

(4) Summary of the Upgrade Concept: Minimum Requirements of the Bypass

To summarize the upgrade concepts for the bypass mentioned above, the minimum requirements are as follows:

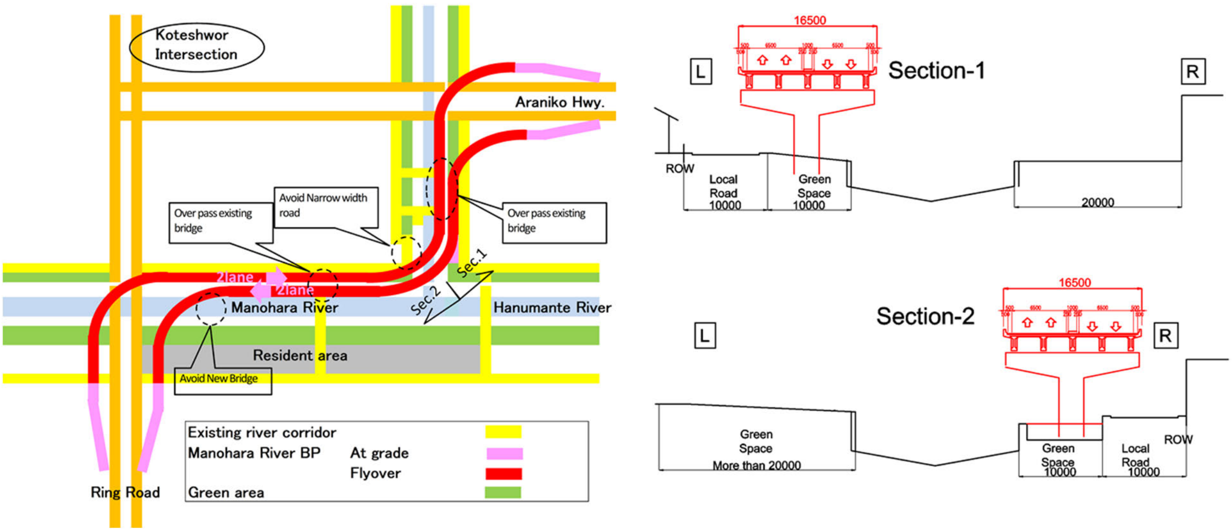
- Separate the throughway traffic for the bypass from the local one, which utilize the present river corridors, by application of the elevated structure to secure both smooth passage of the bypass and reducing the risk of traffic accidents
- Secure the road elevation of the bypass against the flood at 100 years probability and necessary geometry to ensure the road functions as a trunk road
- When setting its route, avoid the religious and educational facilities as much as possible not to relocate them

12.7.2 Alternatives for the Bypass Plan

The following alternatives are considered for the concept of route selection and road structure of the bypass based on the upgrade concepts mentioned above.

(1) Alternative-1: Two-way Single Elevated Structure, Left Bank in Sec-1 and Right Bank in Sec-2

Alternative-1 is to provide a new elevated throughway with a two-way single structure passable when the flood occurs at 100-year probability at the left bank of the Section-1and at the right bank of the Section-2 next to the existing frontage road by using the green space.



Source: JICA Survey Team

Figure 12.7.2 Plan & Cross-Section for Alternative-1

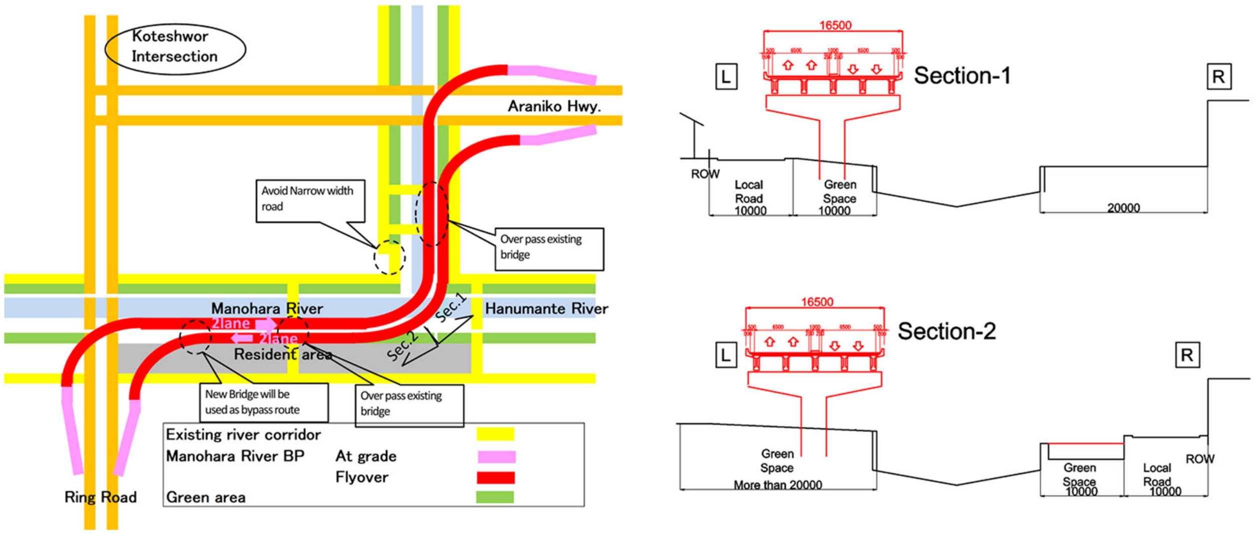
Table 12.7.2 summarizes the major features of Alternative-1.

Table 12.7.2 Major Features of Alternative-1

Outline	• Provide a new elevated throughway with two-way single structure passable when the flood occurs at 100 year probability at the left bank of Section-1and at the right bank of Section-2 next to the existing frontage road using the green space.
Advantages	• Preservation of large green space at the left bank of Section-2 shall be preserved. • Avoid major control points/facilities such as the new bridge in parallel to the river, school and religious facility located at the left bank of Section-2
Dis-advantages	• Green space is partially distracted, and it deprives the rest/amenity space from the surrounding residents • Less construction space/yard, particularly in Section-2 during construction • Nose barriers shall be required not only near the religious and education facilities but also the remaining areas of Section-2 because of its vicinity of the residences

(2) Alternative-2: Two-way Single Elevated Structure, Left Bank in Sec-1 and Left Bank in Sec.2

Alternative-2 is to provide a new elevated throughway with a two-way single structure passable when the flood occurs at a 100-year probability at the left bank of Section-1and at the left bank of Section-2 next to the existing frontage road by using the green space.



Source: JICA Survey Team

Figure 12.7.3 Plan and Cross-Sections for Alternative-2

Table 12.7.3 summarizes the major features of Alternative-2.

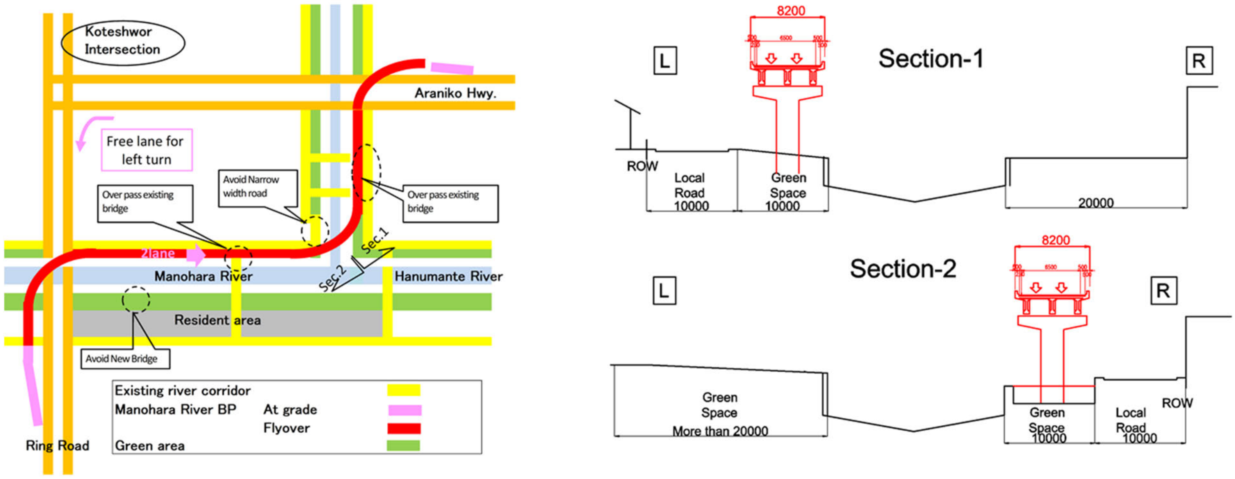
Table 12.7.3 Major Features of Alternative-2

Outline	• Provide a new elevated throughway with a two-way single structure passable when the flood occurs at 100-year probability at the left bank of Section-1and at the left bank of Section-2 next to the existing frontage road by using the green space.
Advantages	• Wide construction space and yard are available at the left bank of the Section-2 • Less number of houses to be considered the anti-noise measures along the Bypass than Alt-1
Dis-advantages	• Necessity of relocating religious facility and land acquisition of school yards and usage of the completed new bridge

Source: JICA Survey Team

(3) Altenative-3: One-way Elevated Bypass from Ring Road to Araniko Highway

Alternative-3 is to provide a new one-way elevated throughway along the Manohara River to traffic from Ring Road South to Araniko Highway because free-left turn lanes are at Koteshwor Intersection for the traffic directing from Araniko Highway to Ring Road South, which means less delay in passing through the Koteshwor Intersection.



Source: JICA Survey Team

Figure 12.7.4 Plan and Cross-Sections for Alternative-3

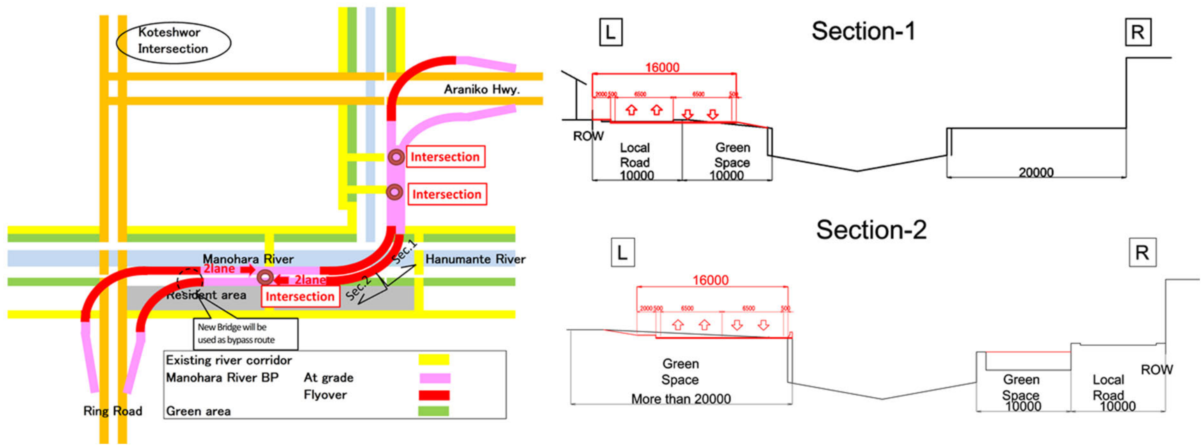
Table 12.7.4 Major Features of Alternative-3

Outline	• Provide a new one-way elevated throughway along the Manohara River to traffic from the Ring Road South to the Araniko Highway because free-left turn lanes are at the Koteshwor Intersection for the traffic directing from Araniko Highway to Ring Road South
Advantages	• Approximately a half of construction cost than other alternatives • Short construction time
Dis-advantages	• Total construction cost, including future provision of the bypass for opposite bound, shall be higher than Alternative 1&2.

Source: JICA Survey Team

(4) Alternative-4: At-grade Throughway Section with Grade Separation at Both Ends (Reference)

Alternative-4 is to provide at-grade throughway sections with grade separation at both ends connecting with Ring Road South and Araniko Highway, although this alternative does not fulfill the minimum requirements stated in 12.7 for reference.



Source: JICA Survey Team

Figure 12.7.5 Plan & Cross-Sections for Alternative-4

Table 12.7.5 summarizes the major features of Alternative-4.

Table 12.7.5 Major Features of Alternative -4

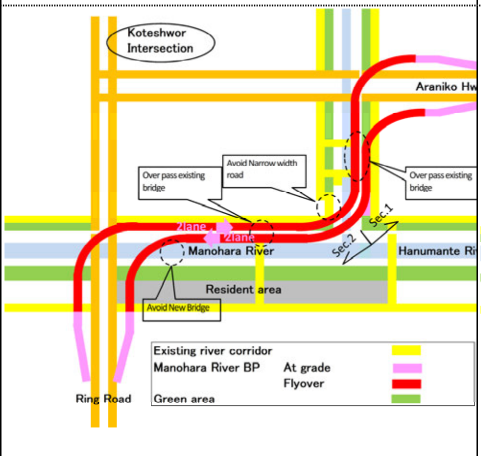
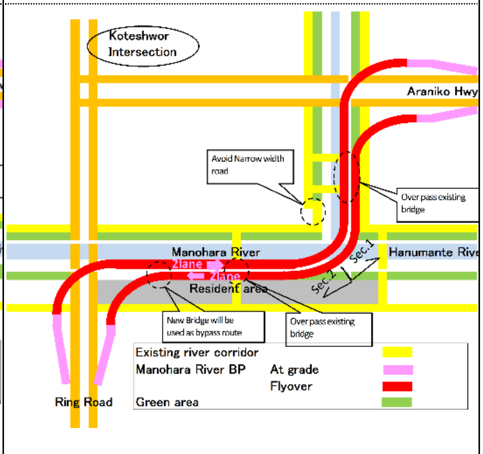
Outline	• Provide at-grade throughway sections with grade separation at both ends connecting with Ring Road South and Araniko Highway,
Advantages	• Low construction costs • Short construction period
Dis-advantages	• Road closure in case of flooding of the Manohara River • Risks of traffic accidents due to a mixture of throughway traffic and local ones on the same road • Lower road capacity as the bypass road due to the mix of throughway traffic and local ones

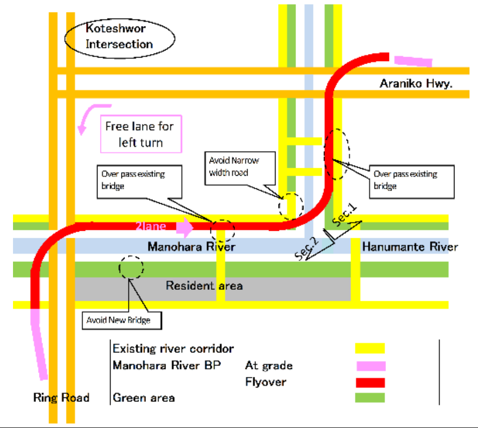
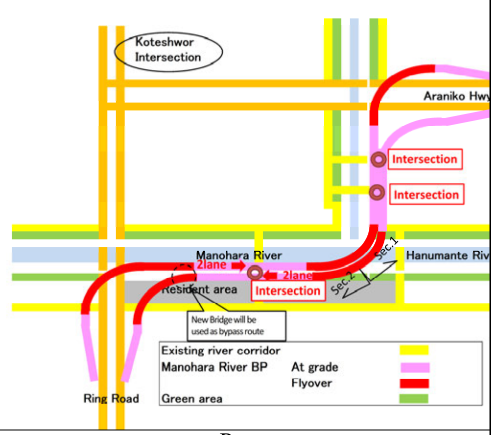
Source: JICA Survey Team

12.7.3 Comparison of Upgrade Concepts

The comparison for route alternatives is show in Table 12.7.6. Alternative-2 is selected as optimal plan, although Alternative-3 can be recommended considering cost saving.

Table 12.7.6 Comparison for Route Alternative

Alternative Plan	Alternative-1 (Alt-1)	Alternative-2 (Alt-2)
Outline View	Seciton1 : Left bank Section2 : Right bank 	Seciton1 : Left bank Section2 : Left bank 
Traffic flow Improvement	Excellent No. of lanes Bypass : 4 Local road : Same as existing High Service Level because throughway traffic is separated by local traffic.	Excellent No. of lanes Bypass : 4, Local road : Same as existing High Service Level because throughway traffic is separated by local traffic.
Constructability	Poor An adequate construction yard cannot be secured in Section-2. Temporary platform for the yard should be provided on the river due to the girder erection.	Good Green space can be utilized as a construction yard.
Construction Cost	Poor Bridge cost(rate) : 1.00 The design road elevation should be higher than Alt-2 in Section 2 due to securing the vertical clearance above the local road. In addition, temporary platform is necessary.	Good -Bridge cost(rate) : 1.00 The design road elevation should be lower than Alt-1 in Section 2. In addition, temporary platform is not necessary.
Land Acquisition	Poor No. of affected houses : 31 Land acquisition is required around the ramp terminal at both ends.	Poor No. of affected houses : 31 Land acquisition is required around the ramp terminal at both ends.
Suitability to the Ongoing Development Plan	Good In Section 1, small portion of river dike should be reconstructed for install substructure.	Good In section 1, small portion of dike should be reconstructed for install substructure.
Environmental Impact	Good Minor impact because throughway traffic pass through FO structure.	Good Minor impact because throughway traffic pass through FO structure.
Effect of inundation	Good A flood at 100-year probability can be accommodated.	Poor A flood at a 100-year return period probability can be accommodated. However in case the Kodku Khola Bridge should be used as a bypass (see remarks), it cannot be accommodate.
Remarks		A new bridge on the Kodku Khola River should be used as a part of BP. However, this depends on geometric and structural conditions. Reconstruction may be necessary.
Recommendation	Inferior to Alt-2 in economic performance.	Recommendable Superior to Alt-1 in economic performance.

Alternative Plan	Alt-3	Alt-4
Outline View	Flyover through the bypass Seciton1 : Left bank Section2 : Right bank 	At-grade except at both ends and middle Seciton1 : Left bank Section2 : Left bank 
Traffic Flow Improvement	Good No. of lanes BP : 2 Local road : Same as the existing A plan only focusing on the bottleneck at Koteshwor Intersection. However, provide smooth traffic flow from RRS to Araniko Hwy.	Poor No. of lanes: 4 (upgrade existing local road) Poor service level: Throughway traffic is mixed with local traffic. There are many traffic conflict points at the existing bridge/ feeder roads so that project effect might not be demonstrated.
Constructability	Poor Adequate construction yard can't be secured in Section-2. Temporally platform should be provided on the river due to girder election.	Poor Construction speed might be good because bridge length is shorter than other alternatives. However, if thick, soft soil layer exists, large scale of soil improvement works are necessary.
Construction Cost	Excellent Bridge cost (rate) : 0.50 The bridge area is almost a half of Atl-1 and 2.	Excellent Bridge cost (rate) : 0.40 Minimum bridge area is required
Land Acquisition	Good No. of affected houses : 23 Land acquisition for direction Araniko highway to RRS is not necessary.	Poor No. of affected houses : 31 Land acquisition is required around the ramp terminal.
Correspondence of the Ongoing Development Plan	Good In section 1, small portion of dike should be reconstructed for install substructure.	Poor For all section, reconstruction of dyke might be necessary due to additional Traffic load.
Environmental Impact	Good Throughway traffic pass through flyover structure.	Poor Traffic volume on local road extremely increased.
Effect of inundation	Good A flood at 100-year probability can be accommodated.	Bad In Section-1, only a flood at 25-year return period can be accommodated. In Section-2, only a flood at 2-year probability can be accommodated.
Note	Step wise development from Araniko highway to Ring Road South is difficult because there are no spaces to install additional substructure in Section-1.	If the at grade section is elevated in the future, it will be necessary to demolish a part of the flyover in order to connect vertical alignment
Recommendation	(Recommendable) If cost reduction is required, this plan can be considered.	Many disadvantages

Source: JICA Survey Team

12.8 Preliminary Design of the Manohara River Bypass

12.8.1 Design Condition for the Bypass

Preliminary design for the bypass shall be carried out based on Alt-2 as described in Section 12.7.3. Since the function of the Manohara River Bypass is to provide an alternative route between Ring Road South and Araniko Highway, the same design conditions of Araniko Highway should be applied. The details of the design conditions are in Section 6.1.

12.8.2 Control Points of Horizontal/Vertical Alignments Setting

(1) For Horizontal Alignment

Control points for horizontal alignment and policies for its setting are shown in Table 12.8.1.

Table 12.8.1 Control Points and Policies for Horizontal Alignment Setting

Control points/Policy	Location: River bank	Station
Min. curve radius is to be adopted in order to minimalize the crossing length over Araniko Highway.	Right	No.-1+80
Avoid new building construction site	Right	No.7+00
Avoid the existing temple	Left	No.9+40
Avoid the existing temple	Left	No.12+0
Connect with the new bridge under construction	Left	No.16+80
Min. curve radius is to be adopted in order to minimalize the crossing length over Ring Road	Right	No.19+0

Source: JICA Survey Team

(2) For Vertical Alignment

The control points and policies for vertical alignment setting are shown in Table 12.8.2.

Table 12.8.2 Control Points for Vertical Alignment

Control points/Policy	Location: River Bank	Station
Secure the vertical clearance over the existing highway	Right	No.-1+60
Secure the vertical clearance over the existing bridge	Left	No.0+80
Secure the vertical clearance over the existing bridge	Left	No.4+80
Secure the vertical clearance over the existing bridge	Left	No.5+60
Securing the vertical clearance over the planned bridge	Left	No.9+60
Securing the vertical clearance over H.W.L.	Left	No.12+60
Connect with the new bridge under construction	Left	No.16+80
Secure the vertical clearance over the existing bridge	Left	No.19+0

Source: JICA Survey Team

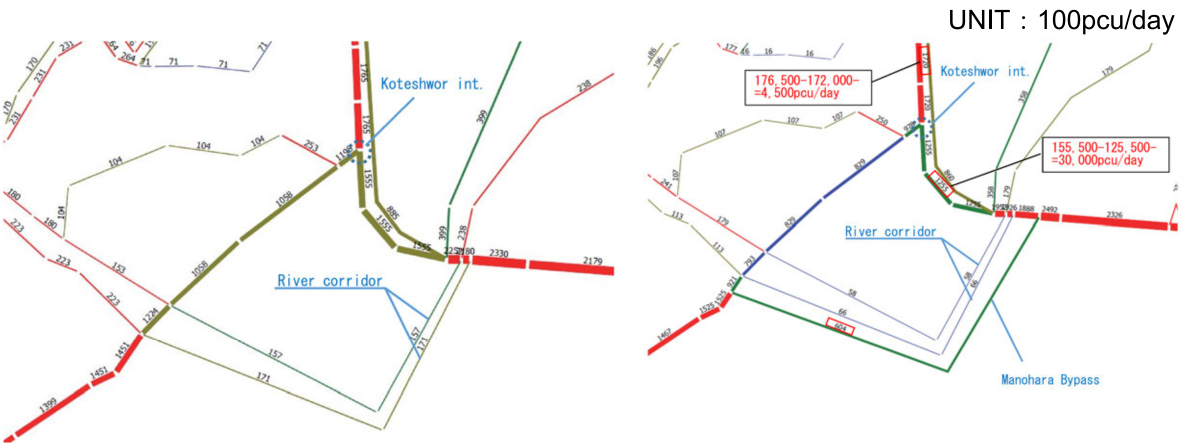
12.8.3 Output of the Bypass Alignments

Based on the design conditions, control points, and policies for the alignment settling, the plan and profile for the bypass are provided and shown in Appendix 6.

12.9 Necessity of Manohara River Bypass

12.9.1 Effects of the Manohara River Bypass on Koteshwor Intersection Improvement

Figure 12.9.1 presents the results of the updated traffic demand forecast in the study. If the Manohara River Bypass is coupled with the improvement alternative passing through the airport land by underpass structure (Alt-4-2 UP using TIA land use)), which would produce the highest congestion improvement effect at the Koteshwor Intersection, approximately 60,400 pcu/day traffic will use the bypass according to the revised traffic volume forecast in 2033, and its effect results in the reduction of traffic entering/existing to/from the Koteshwor Intersection from/to both RRN and Araniko Highway south, 4,500pcu/day and 30,000 pcu/day, respectively.



With Alt-4-2 UP(TIA use)　　　With Alt-4-2 + the Bypass

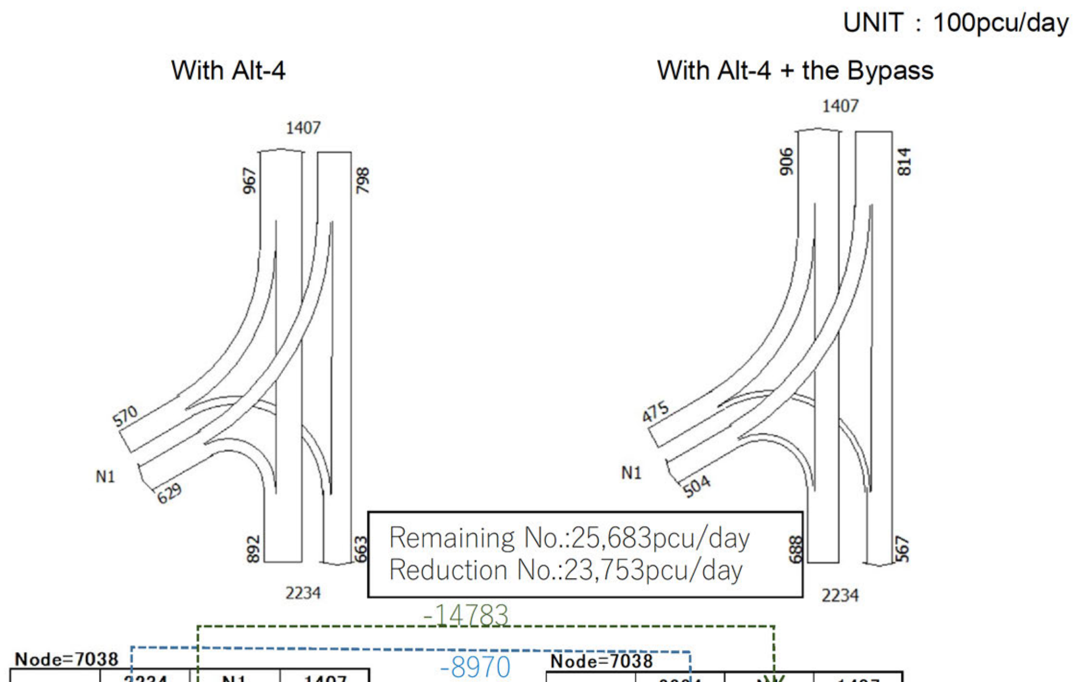
Source: JICA Survey Team

Figure 12.9.1 Results of Updated Traffic Demand Forecast

For the further detailed analysis, the traffic volume by each direction at the Koteshwor Intersection is analyzed and shown in Figure 12.10.2.

According to the analysis, although the traffic volume from/to RRS~Araniko Highway south reduces by approximately 23,753pcu/day for both directions, 25,685 pcu/day of traffic volume from/to RRS to/from Araniko Highway south still remains. This phenomenon implies that there is a large volume of traffic heading to Pepsi Cola Road from RRS through Koteshwor Intersection.

In addition, the total traffic volume at Koteshwor Intersection of 193,700 pcu/day still remains even though 28,300 pcu/day of traffic volume is reduced from the case without the Manohara River Bypass.



Node=7038

	2234	N1	1407	
2234	0	29,626	59,541	892
N1	19,812	0	37,144	570
1407	46,506	33,267	0	798
	663	629	967	2260

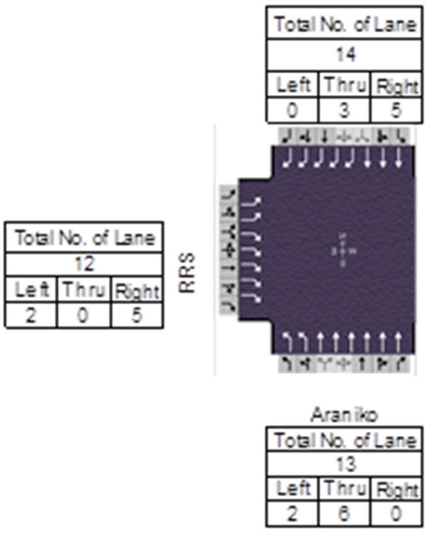
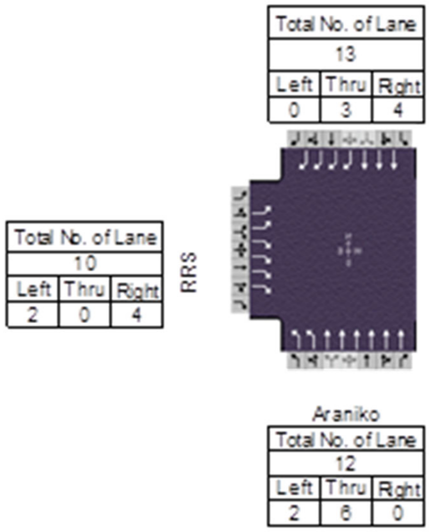
Node=7038

	2234	N1	1407	
2234	0	14,843	53,980	688
N1	10,842	0	36,632	475
1407	45,848	35,518	0	814
	567	504	906	1977

Figure 12.9.2 Traffic Volume for Each Direction at Koteshwor Intersection

Intersection analysis based on the revised traffic volumes forecasts show Table 12.9.1. The results suggested that the number of the right-turn lanes at the intersection can be reduced by one lane on RRS, from five to four lanes, due to the impact of the bypass, as explained earlier. However, the scale of the intersection remains nearly unchanged with or without the bypass.

Table 12.9.1 Comparison of Analysis Results of Alternatives for Koteshwor Intersection

Alt.	Alt 4-2 (Design year:2033)	Alt 4-2 with Manohara Bypass (Design year:2033)
Lane Layout		

12.10 Conclusion and Recommendation

Through the pre-study of the Manohara River Bypass has the following conclusions regarding its outline and necessity:

- The Manohara River Bypass route is flood-prone area, especially from the confluent point with the Hanumante River to the bridge on Ring Road South, which can only withstand floods at two to five years return period. Due to its significance as a road connecting Ring Road South and Araniko Highway South, as well as the need to enhance traffic safety by separating the throughway traffic from local traffic, the construction of the bypass with an elevated bridge structure across the entire section was recommend.
- Recommend selecting Alt-2, wherein the route passes through the left bank in Section-1 and the right bank in Section-2, considering the available space for flyover structures and their construction. However, Alt-3 can be applicable when the investment cost is limited.
- Construction for Alt-2 primarily consists of PC-I girder with spans ranging from 30 m to 40 m. Additionally, a partially steel box girder with a span length of 100 m, is used where longer spans are necessary.
- By developing the bypass, a significant portion of the traffic between RRS and Araniko Highway South would divert to the bypass, avoiding the need to pass through Koteshwor

Intersection. However, despite the attraction of traffic from other directions and improvement made to the intersection through grade separation, along with the substantial volume of traffic moving to and from Pepsi Cola Road through the intersection, the impact of reducing the scale of the Koteshwor Intersection concerning future traffic is limited. Consequently, the bypass's effectiveness in alleviating traffic congestion at the Koteshwor Intersection is limited.

- However, the road network improvement, especially the connection between the Bhaktapur area and the Kathmandu center, can serve as an alternative to alleviate traffic congestion at the Koteshwor Intersection, based on the study's confirmation of a certain level of traffic reduction at the intersection with the implementation of the bypass.

Based on the conclusions and the study results, the following is recommended:

- Incorporating the bypass construction into the current project, which focuses on constructing the grade-separated structure for the Koteshwor Intersection, is not recommended because it has limited impact on reducing the intersection scale concerning future traffic.
- A lack of road network in the area, particularly the Bhaktapur area, including the Eastern New City Development area to the Kathmandu center, increases the traffic volume at the intersection from other directions. Accordingly, Transport Master Plan/Development Plan in Kathmandu Valley should be revised and updated, considering the progress of the Eastern City Development Project, including transport mode and other satellite city ones along ORR.

CHAPTER 13. PROCUREMENT CONDITION IN NEPAL

13.1 Procurement Plan

13.1.1 Construction Materials

Commonly used materials for civil construction, including natural and imported materials from India, are readily available in the Nepalese market. However, steel materials for bridge construction and other specialized projects are not locally accessible. Consequently, they come from the third-party countries like India, Thailand, and Japan. Table 13.1.1 presents the procurement plan outlining primary construction materials for the project.

Table 13.1.1 Procurement Plan for Major Construction Materials

NO	Materials	Procurement Country		Note
		Nepal	Japan/ 3rd Country	
1	Cement	PA		Imported and domestic products are both distributed
2	Gravel, Sand, Aggregate	PA		Available from quarry in the suburbs of Kathmandu
3	Concrete admixtures	PA		Imported products (generally distributed)
4	Reinforcing bar	PA		Imported and domestic products are both distributed
5	Concrete form	PA		Imported and domestic products are both distributed
6	Bituminous materials for pavement	PA		Imported products (generally distributed)
7	Precast-concrete products (Curb stones, Drainage, etc.)	PA		Imported and domestic products are both distributed
8	Fuel(Gasoline/Diesel)	PA		Imported products (generally distributed)
9	H-shaped steel beam		PA	Procurement in Japan for quality assurance
10	U-shaped steel sheet pile		PA	Procurement in Japan for quality assurance
11	Pipe scaffolding materials		PA	Procurement in Japan for quality assurance
12	PC strands		PA	Local procurement is impossible
13	Paint (Fluorine/Modified epoxy resin)		PA	Local procurement is impossible
14	Steel Products for Bridge		PA	Procurement in Japan for quality assurance
15	Secondary Products for Bridge (Bearing, Expansion Joint, etc.)		PA	Procurement in Japan for quality assurance
16	Mechanical Electricity Equipment for Tunnel		PA	Procurement in Japan for quality assurance

Note: PA: Possible to procure
Source: JICA Survey Team

13.1.2 Construction Equipment

The construction equipment commonly used by civil construction works, such as bulldozers, backhoes, wheel loaders, and dump trucks, are locally available. On the other hand, large-sized cranes for girder erection and specific machinery for underpass construction must be procured from the third-party country like India. Table 13.1.2 shows the supplier of typical construction machinery. Large cranes (50 tones or more), which is used in flyover and underpass constructions for the project, will be procured from outside the country as they are virtually non-existent in Nepal.

Table 13.1.2 Supplier of Major Construction Equipment

NO	Machine	Specification	Procurement Country		Note
			Nepal	Japan/ 3rd Country	
1	Bulldozer	15ton, 21ton	PA		
2	Excavator	$0.2m^3$, $0.34m^3$, $0.6m^3$	PA		
3	Wheel Loader	$2.1m^3$	PA		
4	Dump Truck	10ton	PA		
5	Semi-trailer	20ton		PA	Procurement in India for import
6	Truck Crane	4.9ton, 20ton, 25ton	PA		
7	Road Roller, Macadam	10-12ton	PA		
8	Tire Roller	8-20ton	PA		
9	Vibration Roller, Combined	3-4ton	PA		
10	Concrete Plant	$45m^3$/hr	PA	PA	To be arranged by the contractor in Nepal or procurement from India
11	Generator	100-200kVA	PA		
12	Air Compressor	$5.0m^3$/min	PA		
13	Rough Terrain Crane	Less than 35ton	PA		
14	Rough Terrain Crane	Above 35ton		PA	Procurement in India for import
15	Truck Crane	More than 35ton		PA	Procurement in India for import
16	Foundation Earth Drilling rigs			PA	Procurement in India for import
17	Sheet-pile Driver			PA	Procurement in Japan
18	Concrete Mixer Truck	$4.5m^3$	PA		
19	Concrete Pump Vehicle	$90m^3$/hr	PA		

Note: PA: Possible to procure
Source: JICA Survey Team

13.2 Contractor Camp and Temporary Yard

The project site encompasses the existing roads and surrounding areas from the Tinkune Intersection to Jadibuti Intersection via Koteshwor Intersection. The estimated land area for the contractor camp and temporary yard is more than 20,000 m^2, where the following facilities will lie:

- Concrete plant
- Asphalt plant
- Precast girder production yard
- Material storage
- Construction equipment yard/workshop
- Fuel tank and water tank
- Office and accommodation

The proposed site for the contractor camp and the temporary yard for the project are selected based on the following conditions:

- Present land use
- Relocation challenges
- Mobilization of large vehicles

Source: JICA Survey Team and Google Map

Figure 13.2.1 Proposed Site for Contractor Camp and Temporary Yard

Figure 13.2.1 illustrates the proposed locations for the contractor camp and temporary yard. Landowners and relevant organizations, such as DOR and the Kathmandu Metropolitan City Government, determine the land use of the proposed location. For instance, since the previous landowners of Site -1 have opposed its use for construction due to unresolved compensation disputes, as expressed in the second consultation meeting held in June 2023, it is anticipated that the Nepalese authorities will exert maximum effort to resolve the issue and make the site available to the contractor prior to the initiation of construction works.

1) Tinkune Park (Site-1)

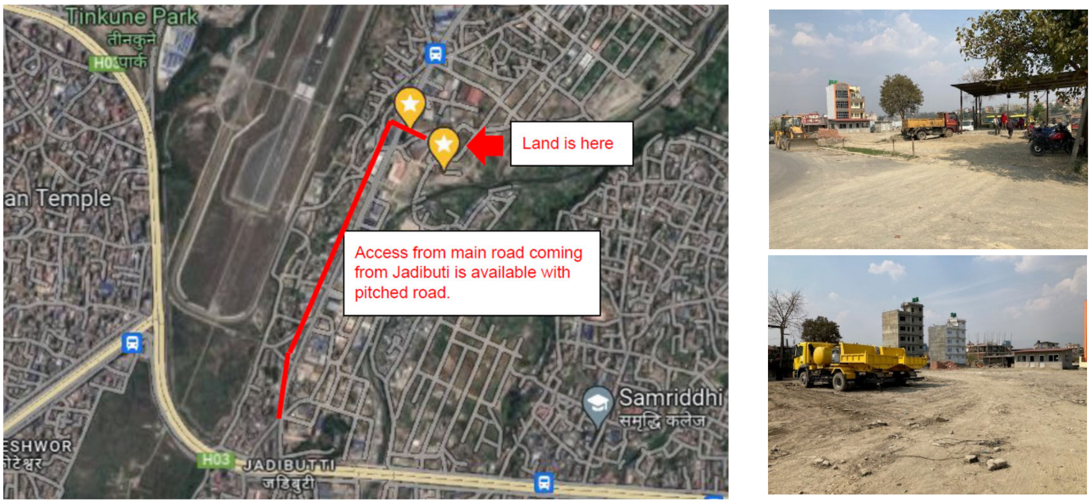
The inner land of the Tinkune Intersection, as shown in Figure 13.2.2, is a potential site for the contractor's main camp and construction yard due to its proximity to the project site. The area spans approximately 16,000 m^2, with a portion designated for diversion space during construction. While there have been disputes overcompensation for land acquisition in some lots of this area, the DOR has committed to making the best effort to resolve the issues to facilitate the project utilization of the land.

Source: JICA Survey Team

Figure 13.2.2 Location and Present Condition of Site-1

2) DOR Land (Site-2)

The land owned by the DOR Maintenance Branch is another potential site for the contractor's main camp and construction yard. The site is 700 m from the Jadibuti Intersection on Pepsi-Cola Road, near the Manohara River, as shown in Figure 13.2.3. The land is approximately 7,000 m^2 and will be officially under the name of the DOR upon the completion of the land pooling project in the vicinity. It can be inferred that the area is sufficiently large for the camp and a standard construction yard if the contractor agrees to utilize both Site-1 and Site-2.



Source: JICA Survey Team

Figure 13.2.3 Location and Present Condition of Site-2

3) TIA Land (Site-3, 4)

If Site-1 cannot be used as the main camp, consideration will be given to using a portion of the TIA site under the jurisdiction of CAAN. Since Site-3 currently has been used as a construction yard for airport taxiway project, the availability of the site will be discussed with the relevant parties prior to the start of this Project, In addition, if Site-4 is used, careful consultation on the location of the yard will be required due to the presence of high voltage power and fiber optic cables connecting the airport power plant and sensitive VOR/DME via the Araniko Highway, as well as the height limitation by OLS

Source: JICA Survey Team

Figure 13.2.4 Location and Present Status of Site-3 and Site-4

13.3 Borrow Pit, Quarry, and Spoil Disposal Site

13.3.1 Borrow Pit

Since the surplus soil generated by the construction works will be the embankment material for the TIA land filling in the future, it is unnecessary to transport additional materials from the borrow pit for the project at this time.

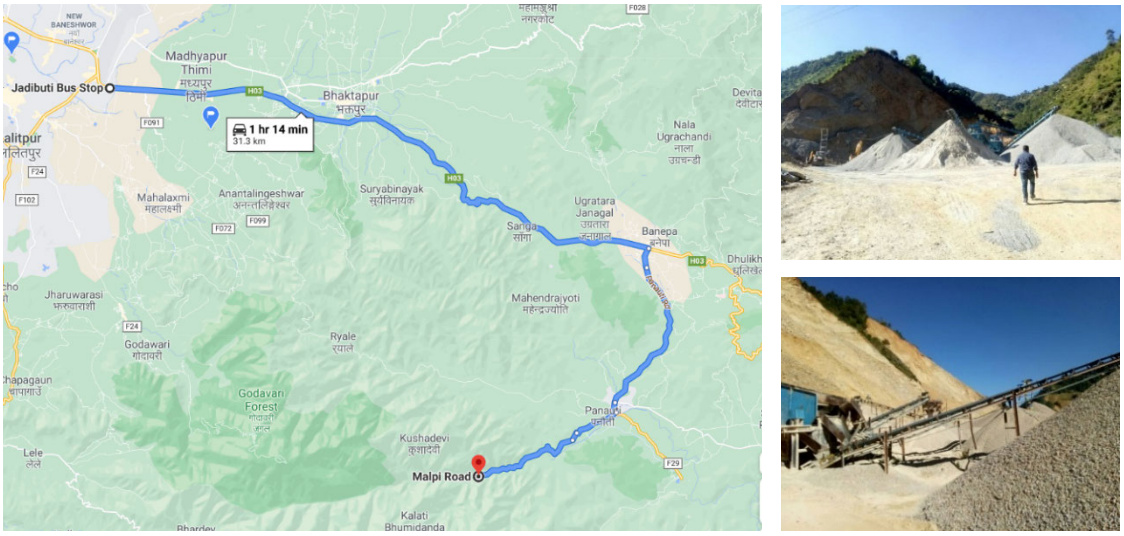
13.3.2 Quarry Site

Kalati Bhumidanda, situated in the Kavrepalanchowk District to the southeast, approximately 30 km from the project site, is among the proposed quarry sites. It can supply aggregates, powdered limestone, and sub-base course materials, as listed in Figure 13.3.1. Samples were collected from the quarry sites, and laboratory tests were conducted. The results confirmed that there are no issues with its use.

Table 13.3.1 Proposed Quarry Site

Location	Material Available	Ownership	Distance and Time to the Construction Site	Estimated Yearly Production
Kavrepalanchowk District Kalati Bhumidanda	Huge volume of hill quarry materials available • Aggregates • Stones • Base/Subbase	Private	32km (One way- 1h 15min.)	315, 000m^3 from 9 crusher plants

Source: JICA Survey Team



Source: Google Map (Left), JICA Survey Team (Right)

Figure 13.3.1 Transportation Route and On-site Condition of Kalati Bhumidanda

13.3.3 Disposal of Surplus Materials

The removal of asphalt pavement and concrete structures will generate construction waste, with an estimated volume of at least 10,000 m^3. Additionally, the underpass construction will excavate approximately 300,000m^3 of soil. As previously mentioned, some areas within the TIA territory have depressed land, and TIA intends to fill these areas to ensure airplane safety.

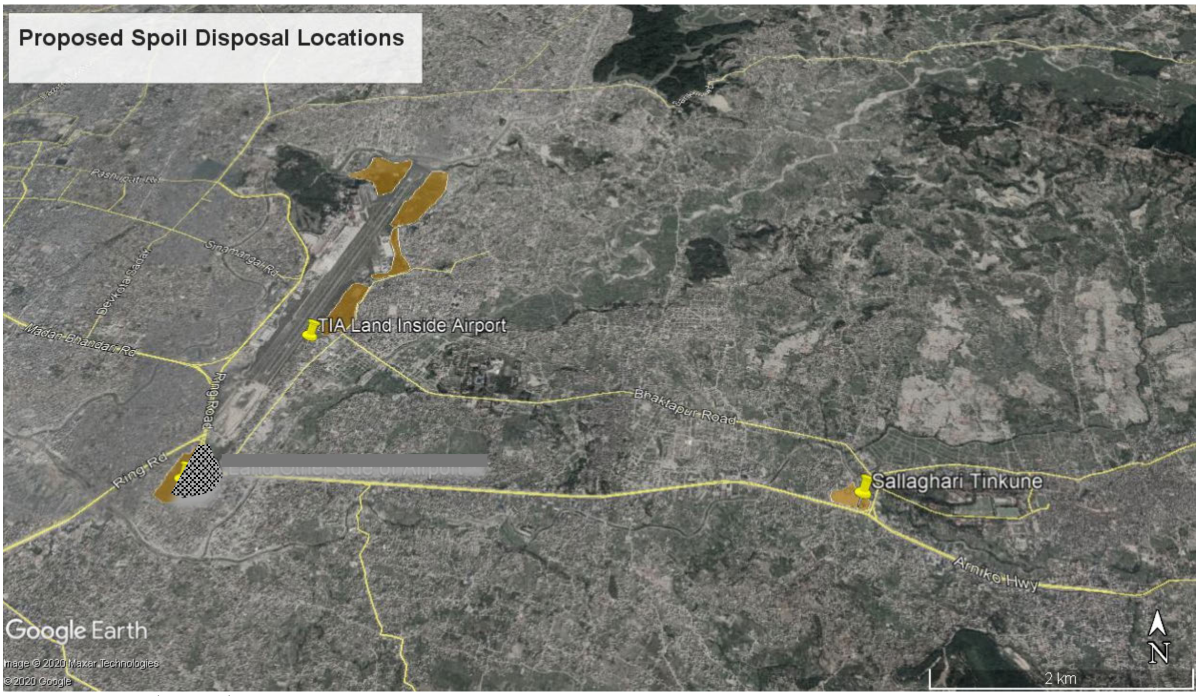
Furthermore, within the TIA territory, the VOR/DME has been installed in an open area on the opposite side of the Araniko Highway, which could serve as a potential disposal site. Alternatively, another land, approximately 5.5 km east along the Araniko Highway, is a potential disposal site.

Determining the use of the lands for disposal will involve consultations with landowners and pertinent organizations, such as CAAN, Kathmandu Metropolitan City Government, and the DOR. Table 13.3.2 provides a summary of the proposed locations and volumes for disposal.

Table 13.3.2 Proposed Location for Construction Waste Disposal

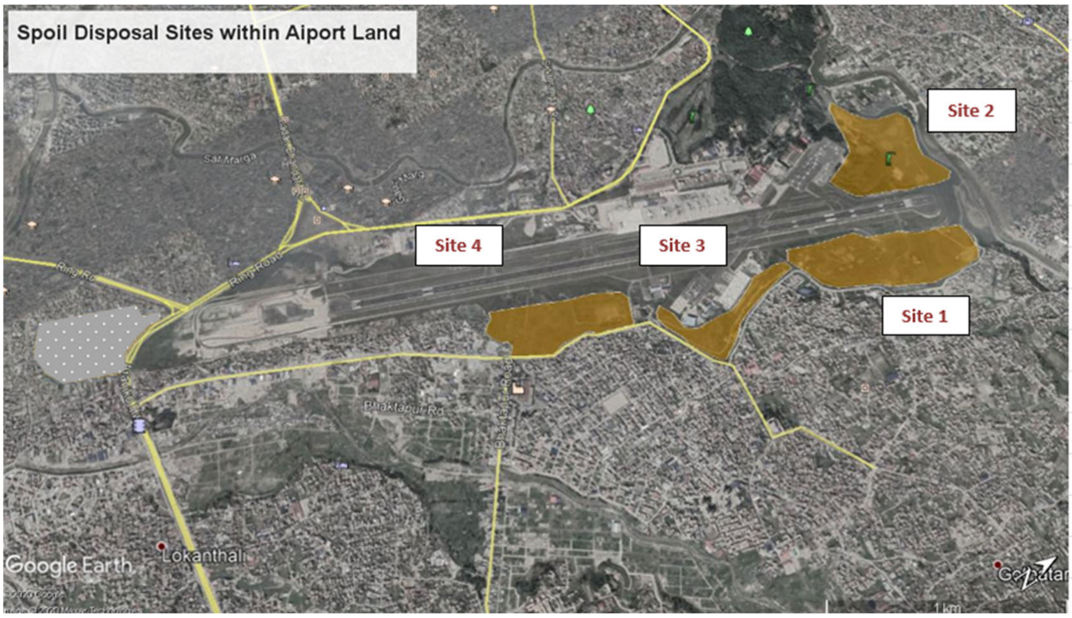
No.	Location	Area Available	Estimated Fill Volume	Land Ownership	Distance and Time to the Project Site
1	TI Airport	640,000m^2	384,000m^3	Public (TIA/CAAN)	Average 2km inside TIA
	Site-1	220,000m^2	132,000m^3		
	Site-2	200,000m^2	120,000m^3		
	Site-3	80,000m^2	48,000m^3		
	Site-4	140,000m^2	84,000m^3		
2	Bhaktapur District, Tinkune, Sallaghari	50,000m^2	30,000m^3	Public (Nepal Trust)	5.5km through Araniko Hwy
	Total	**690,000m^2**	**414,000m^3**		

Note: The computation of possible fill volume assumes that 0.6 m filling height can be applied to each site.
Source: JICA Survey Team



Source: Google Earth

Figure 13.3.2 Proposed Construction Waste Disposal Site



Source: Google Earth

Figure 13.3.3 Proposed Construction Waste Disposal Site in TIA Land (No. 1 and 2)

Source: Google Earth (Left), JICA Survey Team (Right)

Figure 13.3.4 Proposed Construction Waste Disposal Site in Bhaktapur District (No. 3)

13.4 Production Plant

13.4.1 Concrete Batching Plant

In Nepal, the prevalent practice among contractors involves purchasing cement, sand, and aggregates, and they subsequently mix them on-site to produce concrete. It is uncommon for contractors to buy ready-mix concrete from suppliers and rent batching plants from other contractors.

Despite the emergence of a ready-mixed concrete supplier in the market, the supply volume is insufficient for large-scale projects, as per the latest information.

Considering that the project necessitates over 80,000 m^3 of concrete, with some of it required for nighttime construction, it is advisable for the contractor to install a concrete production plant on-site.

13.4.2 Asphalt Plant

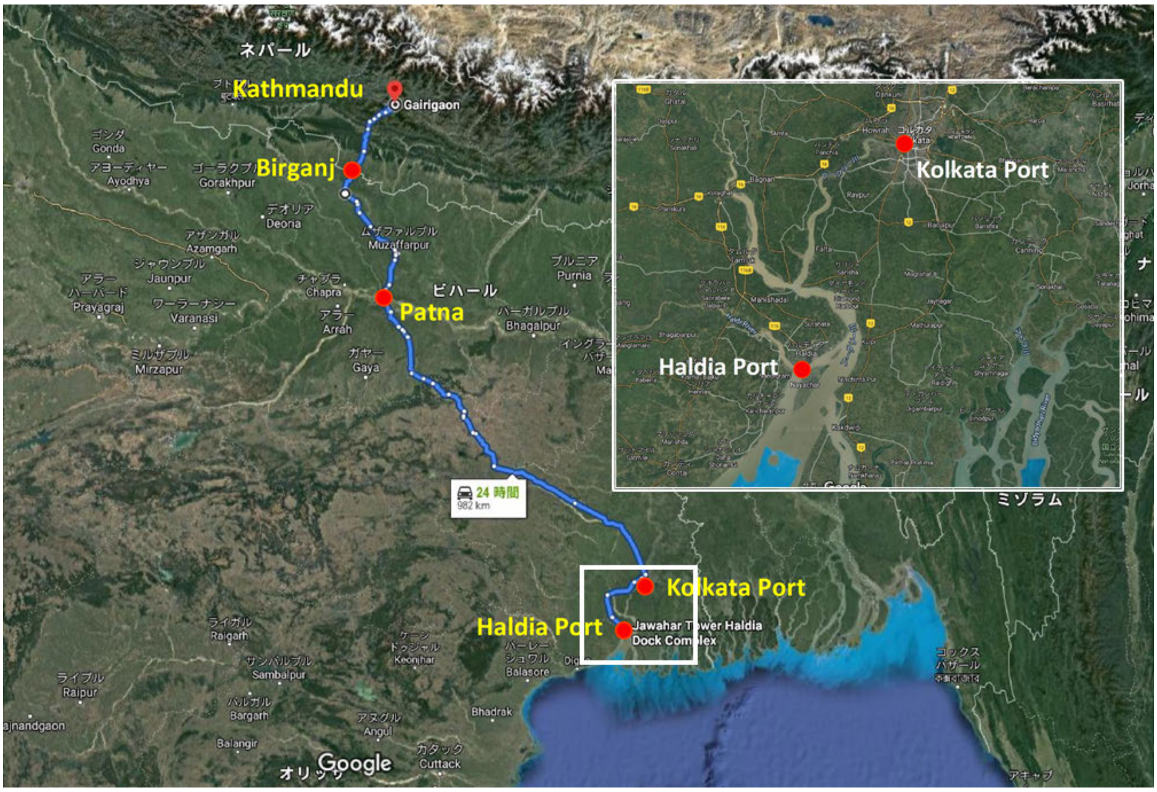
In Nepal, only major contractors own asphalt plants, utilizing them exclusively for their projects. After project completion, these contractors relocate the plant from one project site to another. Additionally, there is currently no supplier in the market offering mixed-asphalt concrete.

Given the existing market conditions, it is iperative for the project to establish its own on-site asphalt plant.

13.5 Transport Route for the Mobilization

13.5.1 Inland Transportation

As a landlocked country, Nepal imports the materials and machinery necessary for construction work from other countries. These imports are transported overland from Indian Port of Kolkata or Haldia, approximately 100 km south of Kolkata Port, passing through Patna and reaching Kathmandu, as illustrated in Figure 13.5.1.



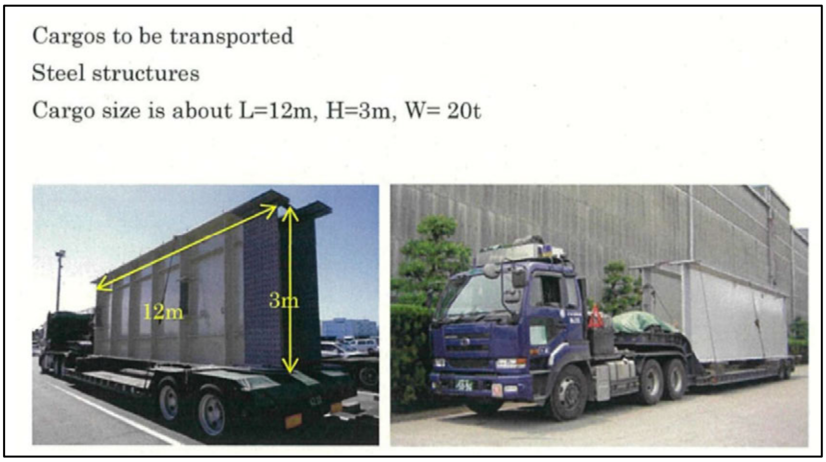
Source: Google Map

Figure 13.5.1 Inland Transportation Route from Kolkata to Kathmandu

While Kolkota Port primarily deals with container cargo, Haldia Port specializes in handling bulk cargo. When importing construction materials and equipment from third countries, either port is the starting point for inland transportation. The imported products from India or other third countries, including Japan, undergo customs clearance in Birgunj, Nepal.

13.5.2 Transport Vehicle

Mobilized materials and construction equipment from India and other third countries are transported by 40 ft-size trailers, as illustrated in Figure 13.5.2. An interview with a Japanese logistics provider in India confirmed the ability to transport these materials from Kolkata Port to Kathmandu under the current road conditions.

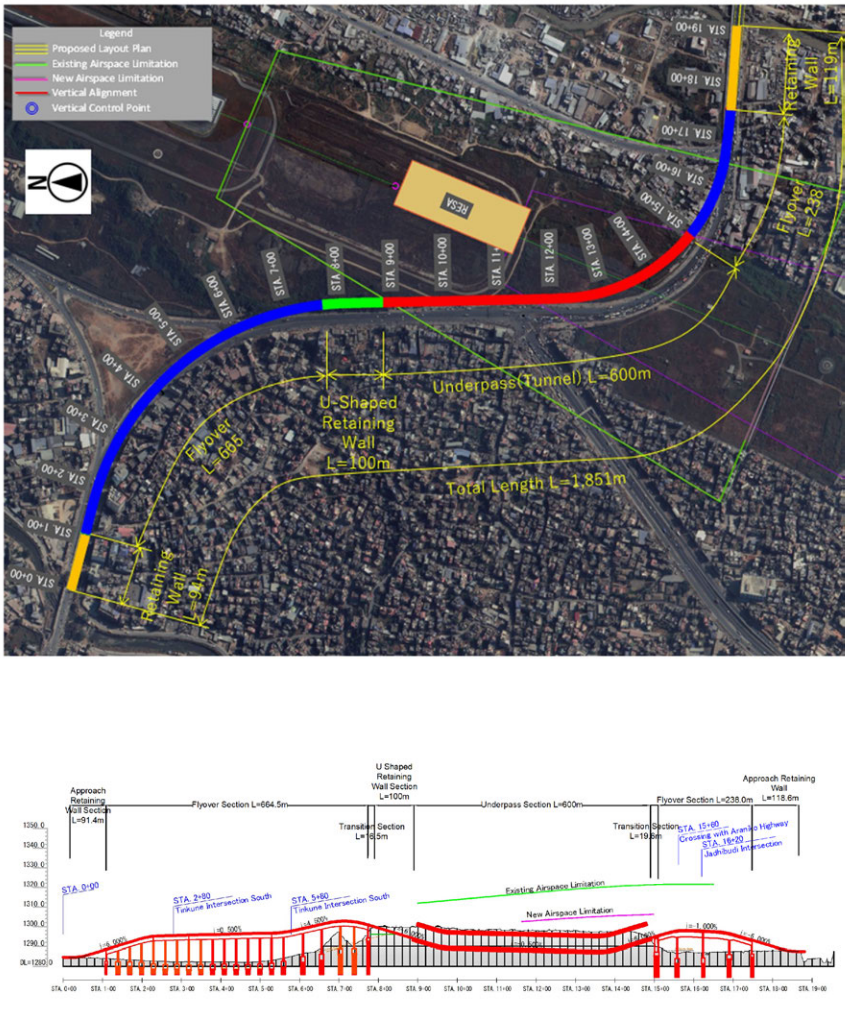


Source: JICA Survey Team

Figure 13.5.2 Semi-Trailer for Inland Transportation (reference)

CHAPTER 14. CONSTRUCTION PLANNING

14.1 General



Source: JICA Survey Team

Figure 14.1.1 Construction Plan Overview

14.2 Planning Policy

The construction plan for the Project must optimize economic efficiency and construction time based on site conditions and procurement circumstances.

Firstly, to understand the overall construction process, it is necessary to determine the possible construction period for every method under consideration, accounting for natural conditions such as rainy and dry seasons and the location of the Project relative to neighboring airports and existing roads.

In addition, a list of possible safety measures for the entire construction project will be compiled, and the fabrication/material yard, construction access road (temporary road), soil dumping site, etc. will be considered based on the surrounding facilities/buildings, topographical conditions, current road conditions, and various other factors. The underpass construction should carefully account for the operating airport nearby.

Based on the above, the following considerations must be present in the design stage of construction planning:

- Construction schedule
- Temporary road plan
- Construction method for the underpass section (U-shaped retaining wall and Tunnel)
- Construction method for the flyover section (Steel/PC bridge)
- Construction method for improvement of the AG road section

14.3 Construction Schedule for the Project

Table 14.3.1 contains the overall construction process. It itemizes work for the Project period, following the results of the construction planning in this chapter. The TK-2R alignment option will have a construction period (Secret). The following sub-chapters itemize the construction method and describes workloads in detail. Note that comments on this TK-2R construction plan were received from CANN on June 15, 2023, and the revised plan was resubmitted on September 1, 2023.

(Secret)

Source: JICA Survey Team

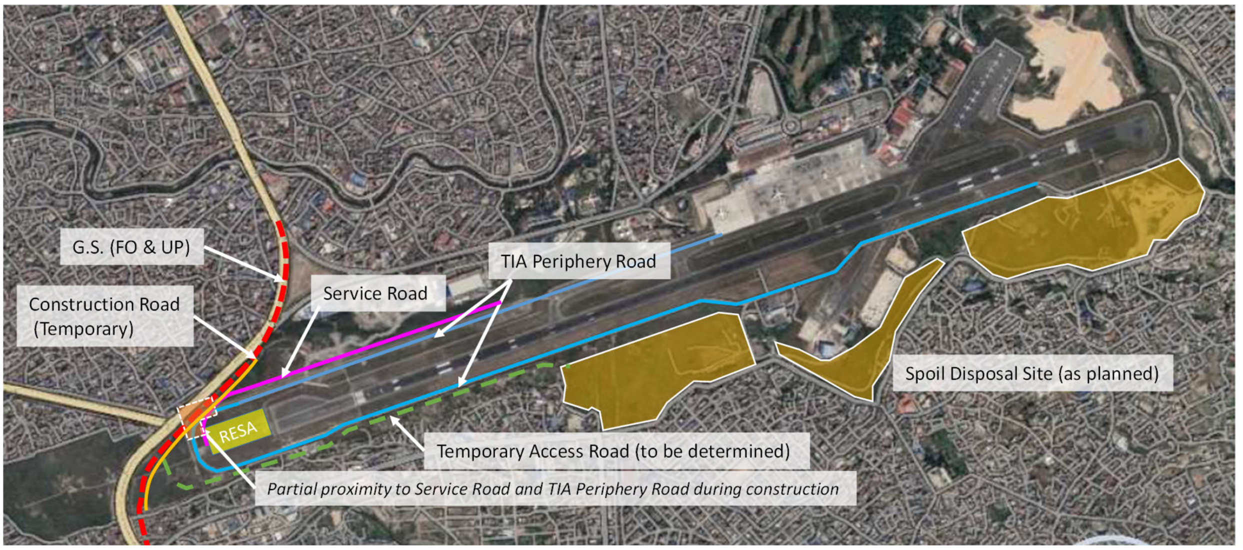
Table 14.3.1 Complete Construction Schedule

14.4 Construction Road and Temporary Access Road Plan

Figure 14.4.1 shows a temporary access road plan containing construction roads for the Project. The contractor must complete the installation of construction roads before the primary excavation of the box culvert construction for the Project underpass.

During box culvert construction, since the TIA Periphery Road or planned Service Road shall be cut partially with fences at the border between the construction area and TIA territory, the contractor must provide temporary detour roads. Implementors must prohibit construction vehicles from accessing RESA and other TIA territories.

CAAN provided information on the landfilling plan for the lower areas on the southeastern section of the airport runway, which secure airplane safety during landing. The agency considered placing excavated soils for the designated area via a temporary access road on the southeast side of the runway.



Source: JICA Survey Team

Figure 14.4.1 Flow Lines in the Construction Area

14.5 Underpass Section

14.5.1 Construction Conditions

(1) Construction Zone

In TIA, OLSs are classified into the following four types.

i. Inner Horizontal Surface: The surface at an altitude of 45 m within a circle of radius 4000 m centered on the reference point at each airport.

ii. Approach Surface: Trapezoidal surface with divergence 15% extending up to 3,000 m in the direction of runway extension (both sides) with a slope of 2% starting from 60 m end of the runway strip (i.e., distance from threshold)

iii. Take-off Surface: Trapezoidal surface with divergence 12.5% extending up to 15,000 m in the direction of runway extension (both sides) at each airport with a slope of 2% starting from 60 m end of the runway strip or end of clearway, whichever is greater (i.e., distance from threshold)

iv. Transitional Surface: The surface with a slope of one-seventh (14.3%) of the runway perimeter between the inner horizontal surface and the approach surface.

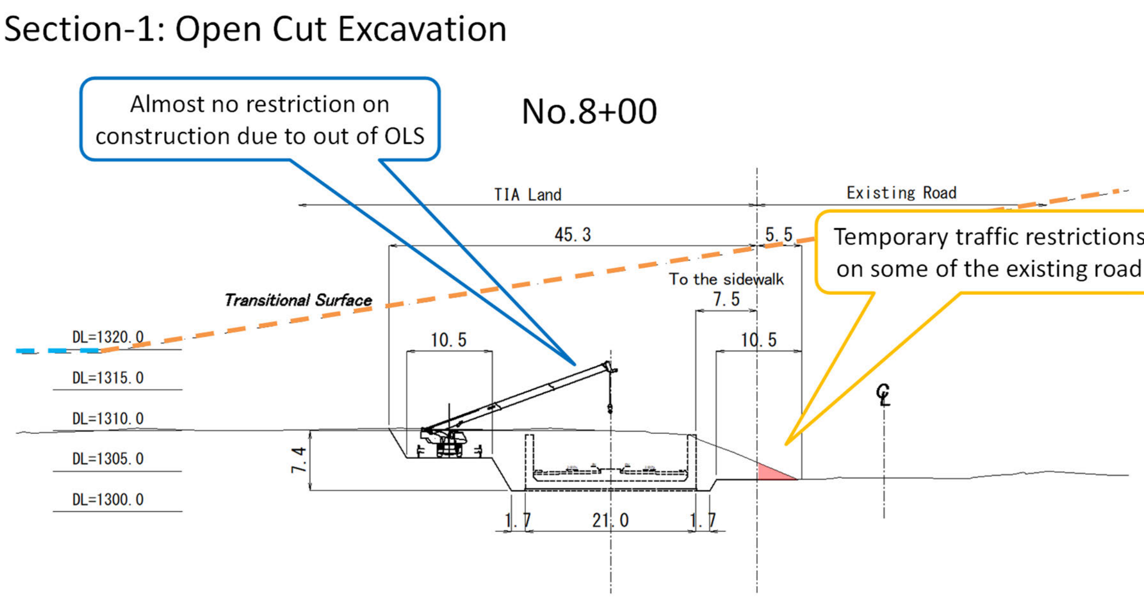
Depending on the height of the OLSs, the construction zone within the TIA land will be divided into three sections, as shown in Figure 14.5.1. The areas subject to the OLS comprises Zone-1 and Zone-2. In particular, Zone-1 is required severe restrictions for construction activities by requirements from the airport operation, which the height of Take-off Surface is quite low from the ground level. In addition, the underpass section of the Project shall be also divided into five sub-sections based on the proximity level to the existing road.

		Structure Type	Construction Method Type	Conditions		
				Under the OLS	Limited working time	Road restrictions
Zone-3: Outside of OLS Approach (Under Transitional Surface)	Sect.-1 L=120	U-shaped R.W	OC			✓ Temporary
Zone-2: Under OLS Approach	Sect.-2 L=270	Tunnel	ER	✓		✓ All day long
Zone-1: Under OLS Take-off and Approach	Sect.-3 L=140	Tunnel	ER	✓	✓ Low clearance to the OLS	✓ All day long
	Sect.-4 L=40	Tunnel	ER	✓	✓ Low clearance to the OLS	✓ Temporary
	Sect.-5 L=160	Tunnel	OC	✓		

Source: JICA Survey Team

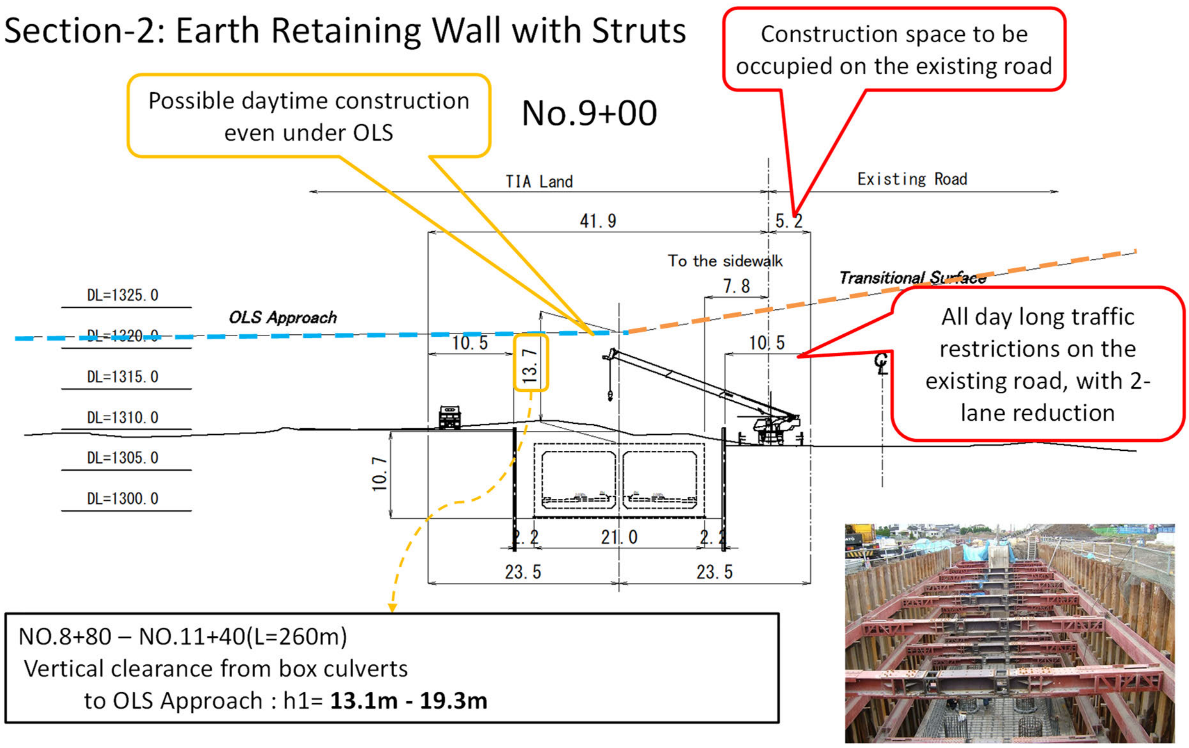
Figure 14.5.1 Construction Zones with Site Conditions

Typical cross-sections for each sub-section are in Figure 14.5.2 through Figure 14.5.6.



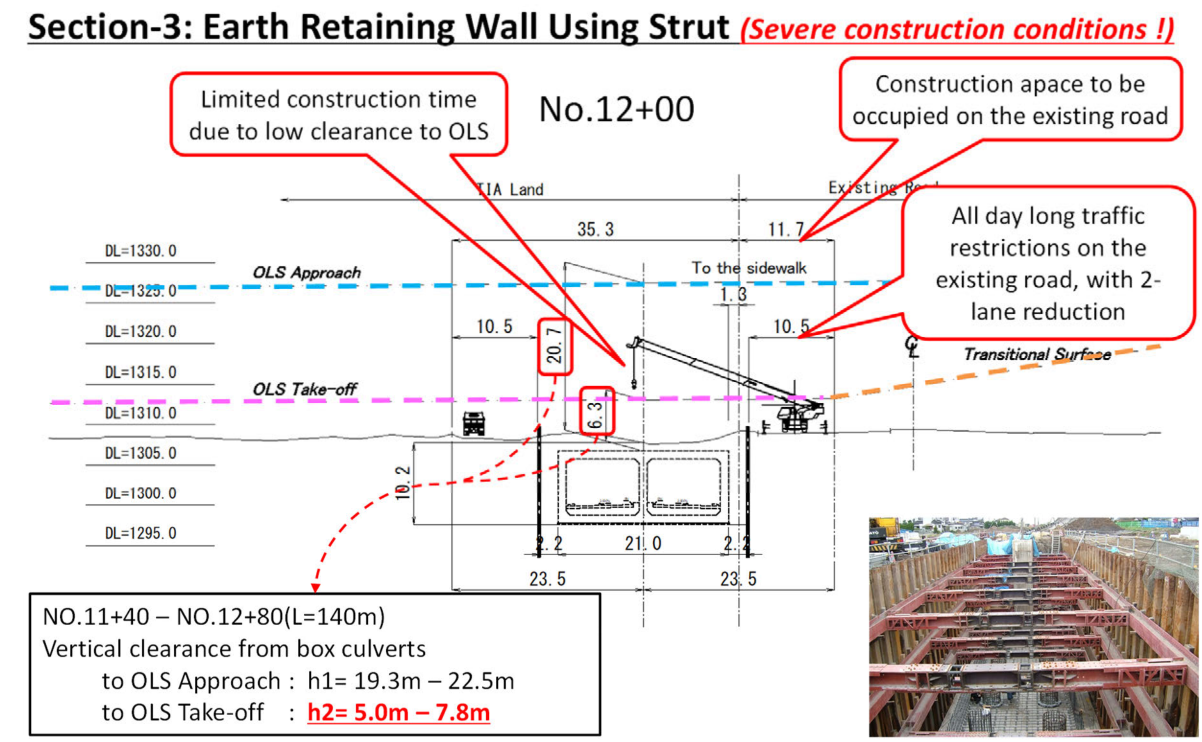
Source: JICA Survey Team

Figure 14.5.2 Section-1(Zone-3) U-shaped retaining wall



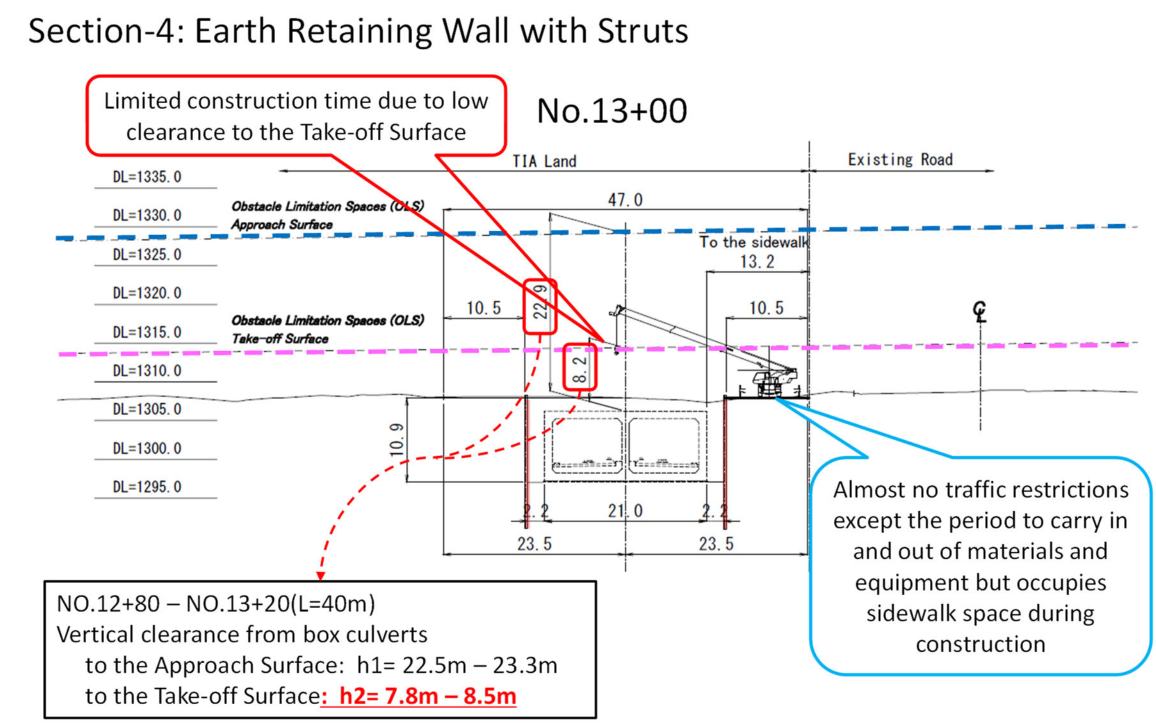
Source: JICA Survey Team

Figure 14.5.3 Section-2(Zone-2) Tunnel



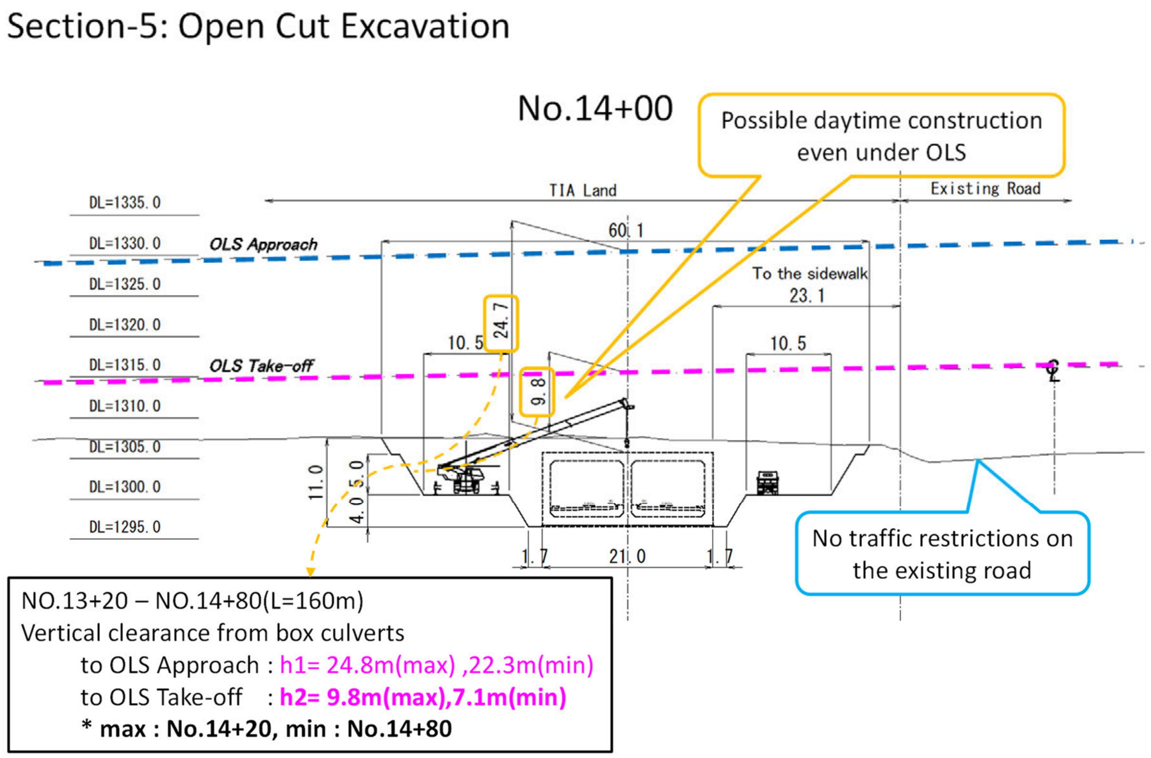
Source: JICA Survey Team

Figure 14.5.4 Section-3 (Zone-1) Tunnel



Source: JICA Survey Team

Figure 14.5.5 Section-4 (Zone-1) Tunnel



Source: JICA Survey Team

Figure 14.5.6 Section-5 (Zone-1) Tunnel

(2) Obstacles Limitation Spaces (OLS)

Table 14.5.1 shows the allowable heights under OLS for construction activities. Table 14.5.1indicates that the construction activity in Zone-1 and Zone-2 requires attentive consideration for safety works that will not disturb airport operations.

Table 14.5.1 Allowable Heights for Construction Activities Restricted by OLS

		Height from G.L. to OLS	
		Approach Surface	**Take-off Surface**
Zone-3: Outside of OLS Approach (Under Transitional Surface)	Sect.-1: OC (L=120)	N/A	N/A
Zone-2: Under OLS Approach	Sect.-2: ER (L=270)	11.8m – 18.1m	N/A
Zone-1: Under OLS Take-off and Approach	Sect.-3: ER (L=140)	18.1m – 22.1m	3.9m - 7.3m
	Sect.-4: ER (L=40)		
	Sect.-5: OC (L=160)	22,1m – 27.4m	7.3m – 12.3m

OC: Open Cut Excavation, ER Earth Retaining Wall

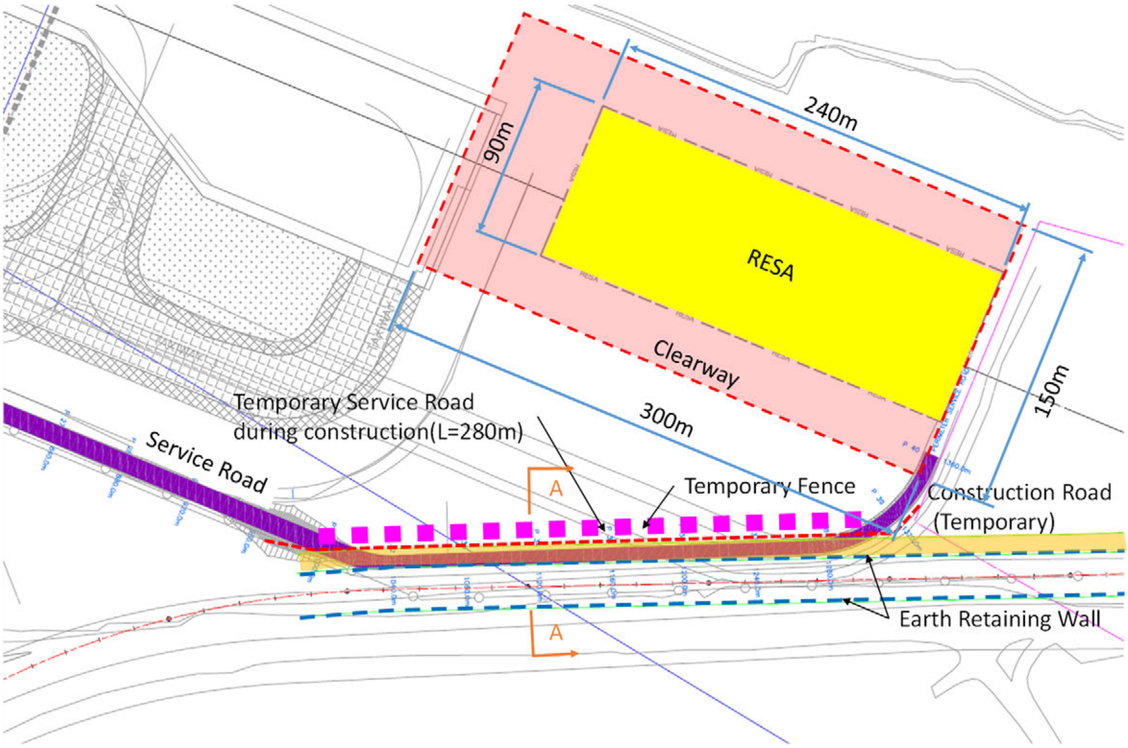
Source; JICA Survey Team

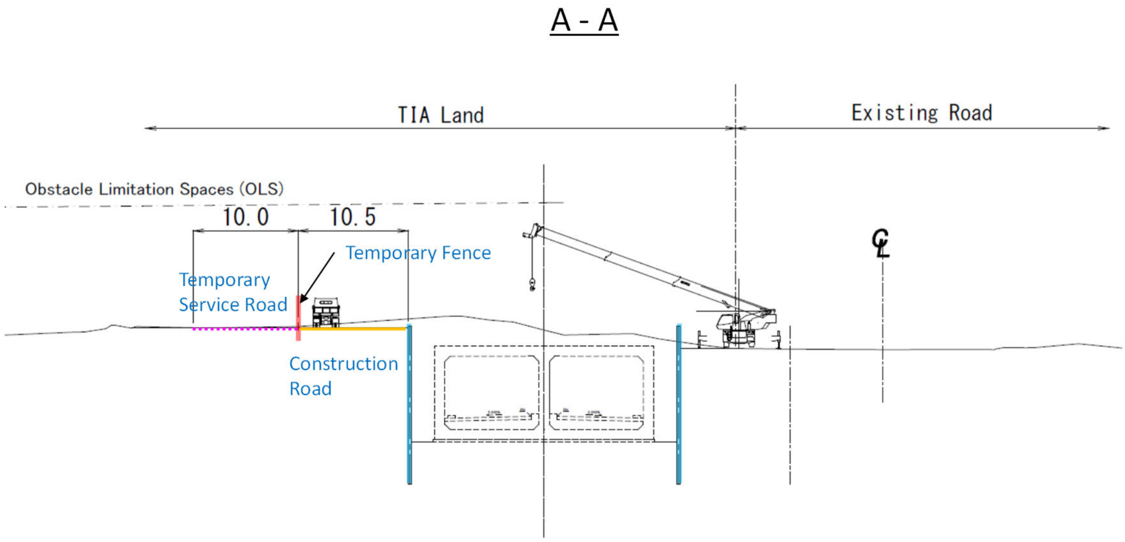
(3) Clearway and Runway End Safety Area (RESA)

According to the answers to the Questionnaire from JST by CAAN, dated September 14, 2022, “Clearway,” which has a 150 m width and 300 m length from the edge of the runway, shall be required to provide an obstruction-free space to complete take-off safely. Implementors shall maintain it during the Project construction period.

Furthermore, to provide an area long enough to contain overruns and undershoots resulting from a reasonably probable combination of adverse operational factors, RESA is required to set a clearway following the said answers to the Questionnaire, with a width of 90 m and a length of 240 m, 60 m from the edge of the runway. In the RESA area, a contractor for the Project is not allowed to temporarily store or keep materials, devices, equipment, machinery, and facilities during the entire construction period.

As shown in Figure 14.5.7, the Service Road for the airport will have to be moved approximately 280 m to the side during construction. Temporary fences will separate the construction area from the temporary Service Road. The construction area will not interfere with RESA.





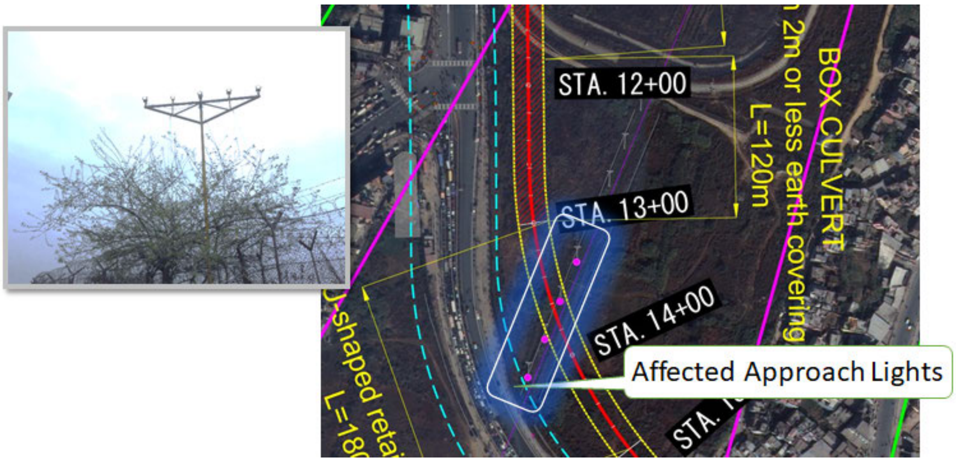
Source: JICA Survey Team

Figure 14.5.7 Location of Excavation Line and RESA

(4) Special Consideration for Airport Incidental Facilities during Construction

1) Guide Lights

As shown in Figure 14.5.8, the guide lights in TIA are affected during box culvert construction. Temporary electrical and communication paths are necessary to replace them. The guide lights must maintain the same positions as the current ones during construction.

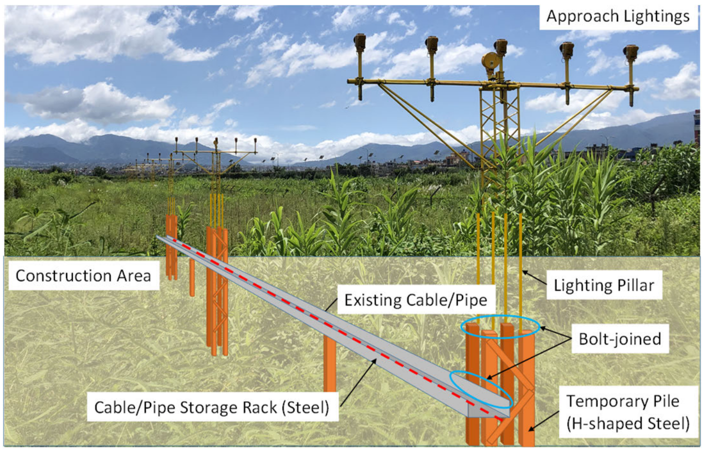


Source: JICA Survey Team

Figure 14.5.8 Location Map of Guide Lightings

Figure 14.5.9 shows how the temporary guide lights will operate during construction.

- Contractors will fix guide lights in the excavated area by embedding H-shaped steel into the ground for temporary piles and bolting them to the existing support pillar.
- They will place electrical piping on a temporary steel rack across the excavation face, and the H-shaped steel embedded in the ground will be used as a support material and cut around.
- Support materials will replace shoring and scaffolding materials during the box culvert construction.



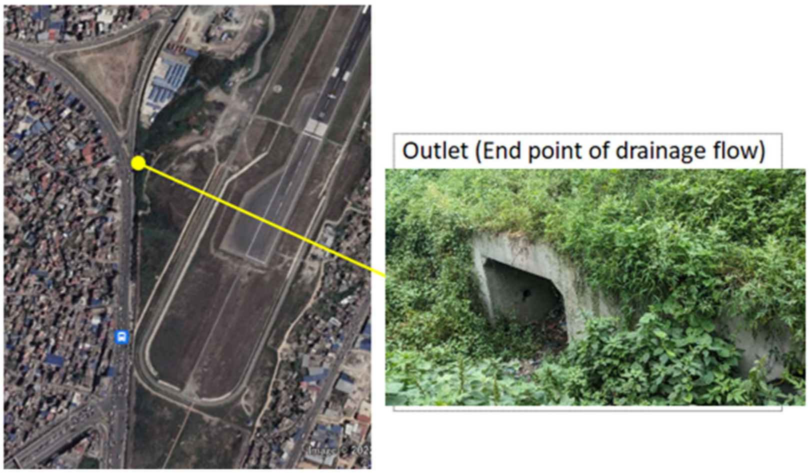
Source: JICA Survey Team

Figure 14.5.9 Example of Temporary Guide Lighting Operation

CAAN requested DOR to install an additional guide light at the median of the existing Araniko Highway to fulfill the standard total installation length of 900 m.

2) It has a present length of 870 m and does not fulfill the standard. A fact-finding mission from JICA will examine the request from CAAN. Drainage Facility

The August 2022 joint site reconnaissance from JST and CAAN found that the drainage outlet on the Tinkune intersection side drains water from the areas outside the TIA Periphery Road. The agencies will reinvestigate the location of the drainage outlet relative to the planned Project road during the detailed designing phase. Discussions will be held with the airport administrator if the route will impact the existing facilities.



Source: JICA Survey Team

Figure 14.5.10 Outlet on the Tinkune Intersection

There is a drainage system within the TIA Periphery Road to collects water surrounding the runway center. to the Manohara River using new drainage facilities from the recent runway expansion works.

3) High Voltage Power Cables and Optical Fiber Cables

High-voltage electrical and optical fiber cables have been laid between the airport powerhouses, reaching the sensitive VOR/DME equipment, placed southward the highway through the Project construction area in various routes. Any damage to these cables may harm the landing/takeoff operation of aircraft, resulting in airport closure. Hence, the design and construction will be conducted with utmost precaution against disturbing these cables.

(5) Security and Safety Facility: Double fencing

Construction work within TIA land needs to ensure airport security and construction safety. The contractor must install double fences to form construction area boundaries at the preparation stage of the Project.

The new taxiway construction, including construction for the TIA Service Road parallel to the runway on the southwest side with its work area of 1200 m x 250 m, is planned to commence in Dec. 2022, lasting three years. This taxiway project would duplicate the Project construction period and work area, necessitating attentive coordination with CAAN, the TIA operator, and the taxiway contractor to maintain airport security and safety within TIA territory.

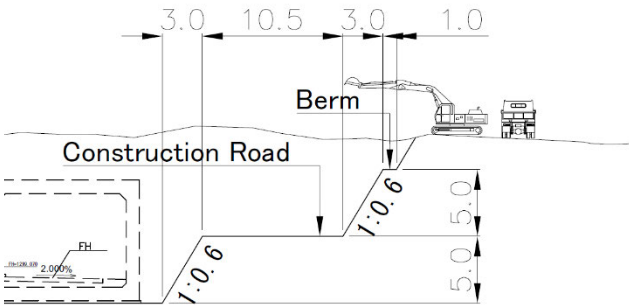
(6) Excavation Gradient

The excavation gradients by excavation height for this construction area of the Project, where applicable, are shown in Table 14.5.2 and Figure 14.5.11.

Table 14.5.2 Excavation Gradient

Soil Classification	Excavation Height	Excavation Gradient	Berm Width
Gravelly soil, Sandy soil, Clay, Rocky boulders	Less than 1m	Straight	-
	1m or more but less than 5m	1:0.5	-
	Total height 5m or more	1:0.6	Installed 1m wide every H=5m from bottom at minimum

Source: Ministry of Land, Infrastructure, Transport and Tourism, Japan



Source: JICA Survey Team

Figure 14.5.11 Cross-Sectional View of Excavation

(7) Working Time

Construction for the Project must finish during the daytime, as a general rule. Works shall be conducted during nighttime hours if construction activities risk exceeding or violating OLS because of equipment and machinery. Nighttime working hours are assumed to be 4 hours between 2:00 a.m. and 6:00 a.m.[1] when aircraft are not taking off or landing.

Light pollution control is mandatory for nighttime construction, especially during aircraft take-off and landing hours. Reflections from lighting and metal may adversely affect a pilot's ability to land.

[1] This timeframe is an assumption at this stage. It may be possible to extend the working hours in the future, depending on discussions with airport officials. In case of the on-going project for taxiway extension, 6-hours of nighttime works have been allowed from CAAN

Table 14.5.3 Working Time by Construction Work Type

	Type of Construction Work			
	Earth Works	Earth Retaining Wall	Concrete Structures	Pavement
Zone-1: Under OLS Take-off and Approach	D/N	N*	D/N	D/N
Zone-2: Under OLS Approach	D	N*	D	D/N
Zone-3: Outside of OLS Approach (Under Transitional Surface)	D	-	D	D/N

D : Daytime
N* : Nighttime *when aircrafts are not operating only
D/N : Daytime or Nighttime (No restriction)

Source: JICA Survey Team

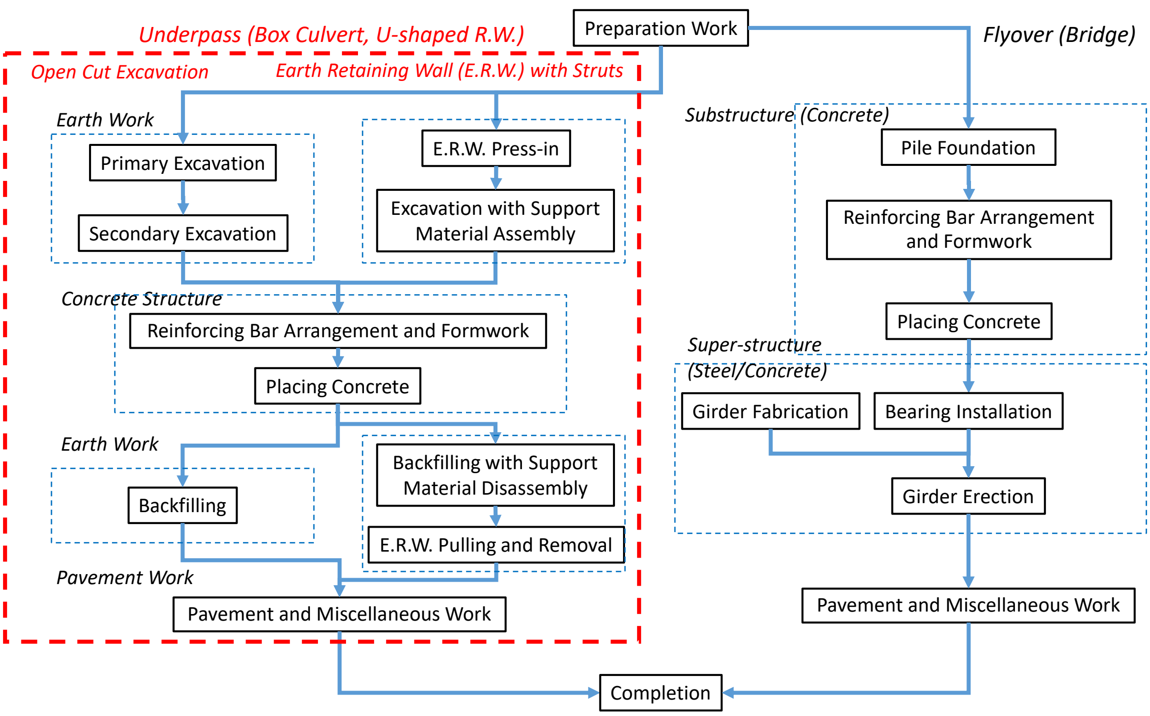
Note that pavement works within the box culvert do not affect the aircrafts operation because it will be done in the closed area within the box culvert.

14.5.2 Construction Process

(1) Construction Flow

The construction flow of the underpass section in TIA territory for the Project is in Figure 14.5.12 through the red boxed line.

Depending on construction conditions for each section, the underpass is to be constructed using one of two methods: Earth Retaining Wall with Struts or Open-Cut Excavation. The GS route section will be constructed near the existing road with Earth Retaining Wall with Struts. However, as much of this section is under OLS, construction shall be affected by height restrictions.



Source: JICA Survey Team

Figure 14.5.12 Underpass Construction Flow

Points common to all construction processes are listed below.

- Check height restrictions and workspace prior to work and follow air traffic control instructions during work to ensure the work area can be evacuated at all times.
- For work involving heavy equipment, check height restrictions and workspace in advance and install aircraft warning lights on construction equipment as necessary.
- For construction at night, consult with the airport manager/operator as the use of lights and reflections from metallic objects may interfere with aircraft operations.

(2) Earth Retaining Wall with Struts

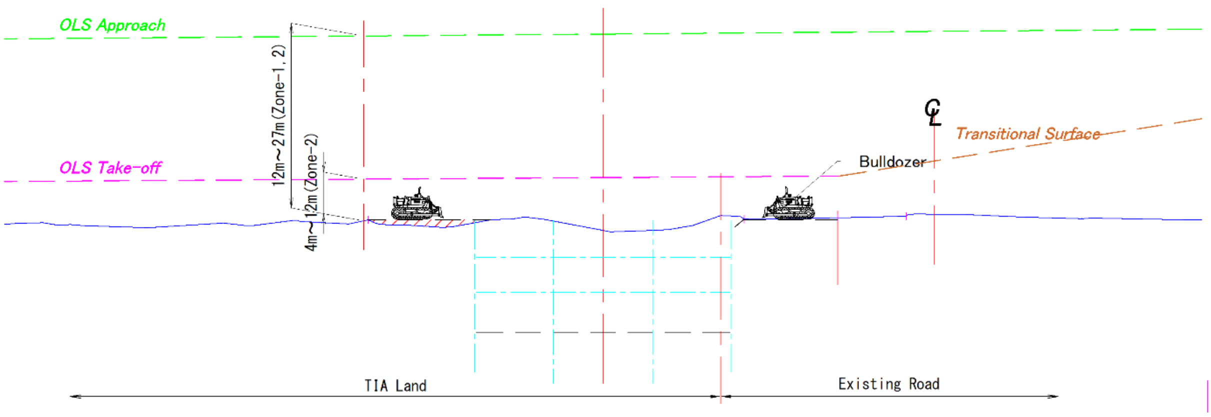
Installing sheet piles for the earth retaining walls under the OLS will be at night, outside aircraft operating hours. The "Vibratory Hammer method" will be applied, which is faster and does not require special construction machinery.

The process of earth retaining wall method is as follows.

1) Preparation Work for Earth Retaining Works

i. Areas under the Take-off Surface (Section-3, 4) *Partial nighttime working

Preparation works such as surface clearing and excavation from the ground level may be temporarily constrained by the height of construction equipment and workspaces exceeding one meter from the Take-off Surface, as shown in Figure 14.5.13. Workers and equipment in this area must always be ready for evacuation under air traffic control instructions. For excavation, equipment height limits and working spaces require checking prior to operation, and an aircraft warning light shall be attached to the construction machinery as necessary.



Source: JICA Survey Team

Figure 14.5.13 Preparation Work

ii. Outside the areas under the Take-off Surface (Section-2) *No time restrictions on construction

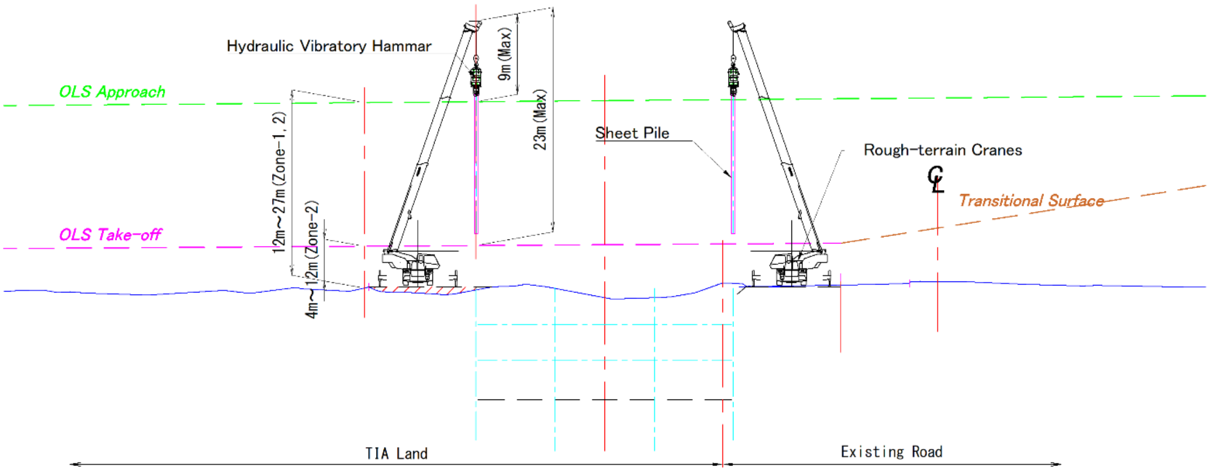
Construction can proceed during the daytime without any restrictions. For nighttime construction, the lighting and reflections of metal objects may interfere with aircraft operations, so a consultation with airport administrators/operators is necessary.

2) Earth Retaining Wall Press-in

i. Areas under the Take-off Surface (Section-3, 4) *Full nighttime working

ii. Outside the areas under the Take-off Surface (Section-2) * Full nighttime working

Press-in steel sheet piles shall be carried out at night when aircrafts have no operation in the section-2 through the section-4 area, as the tip of the crane boom exceeds the maximum of nine meters from the Approach Surface and 23 meters from the Take-off Surface, as shown in Figure 14.5.14Earth Retaining Wall Press-inFigure 14.1.1. In addition, operational construction machinery must feature an aircraft warning light.



Source: JICA Survey Team

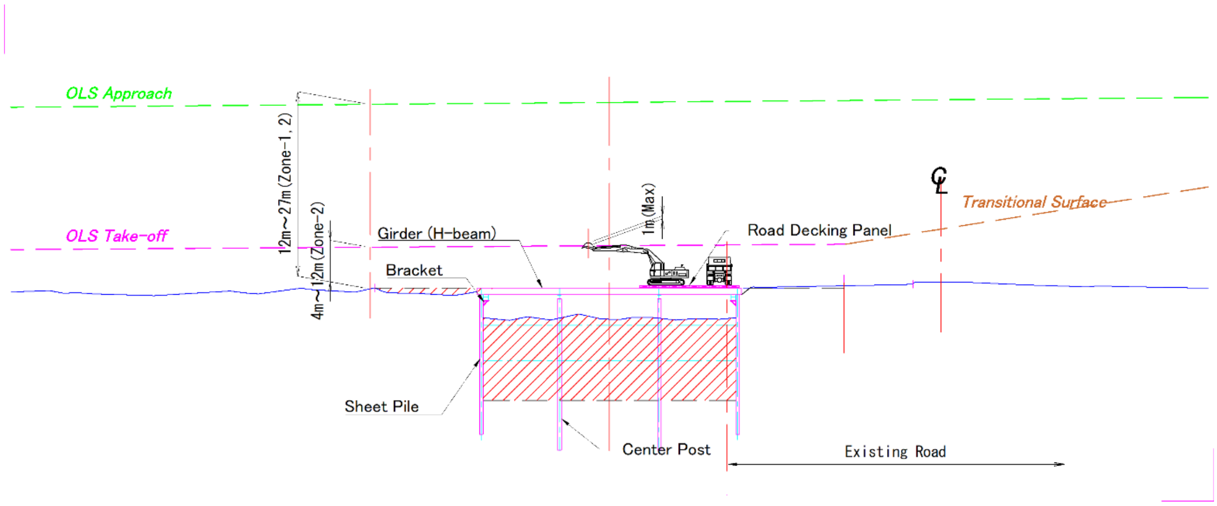
Figure 14.5.14Earth Retaining Wall Press-in

3) Excavation with Support Material Assembly

i. Areas under the Take-off Surface (Section-3, 4) * Partial nighttime working

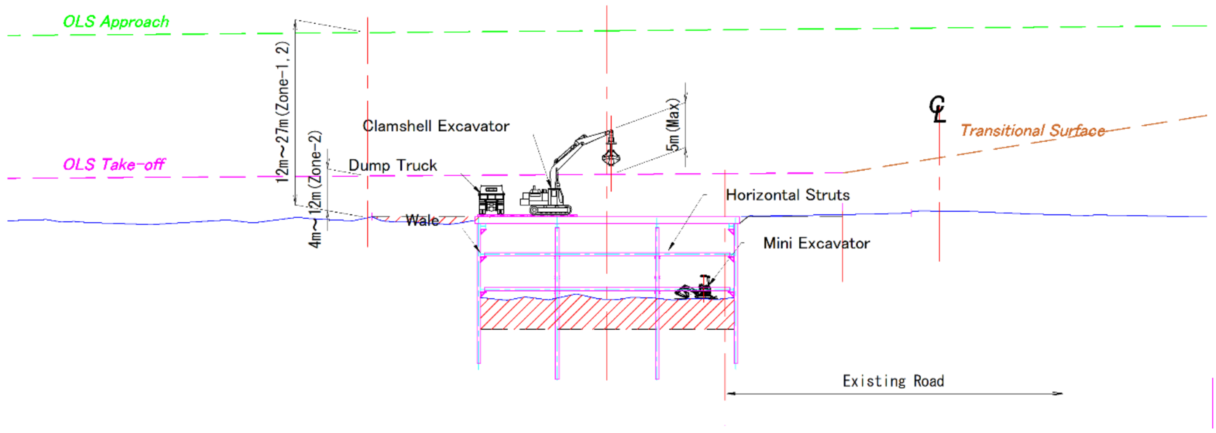
Excavation work and assembly for support materials inside the earth retaining wall by excavators or crane may temporarily exceed the maximum five meters from the Take-off Surface, as shown in Figure 14.5.15 and Figure 14.5.16. Works in this area must always be ready for evacuation to comply with air traffic control instructions.

The heigh limit and working space for excavation require checking before work starts, and an aircraft warning light shall be attached to the construction machinery as necessary.



Source: JICA Survey Team

Figure 14.5.15 Excavation Inside the Earth Retaining Wall (1)



Source: JICA Survey Team

Figure 14.5.16 Excavation Inside the Earth Retaining Wall (2)

ii. Outside the areas under the Take-off Surface (Section-2) *No time restriction for construction work

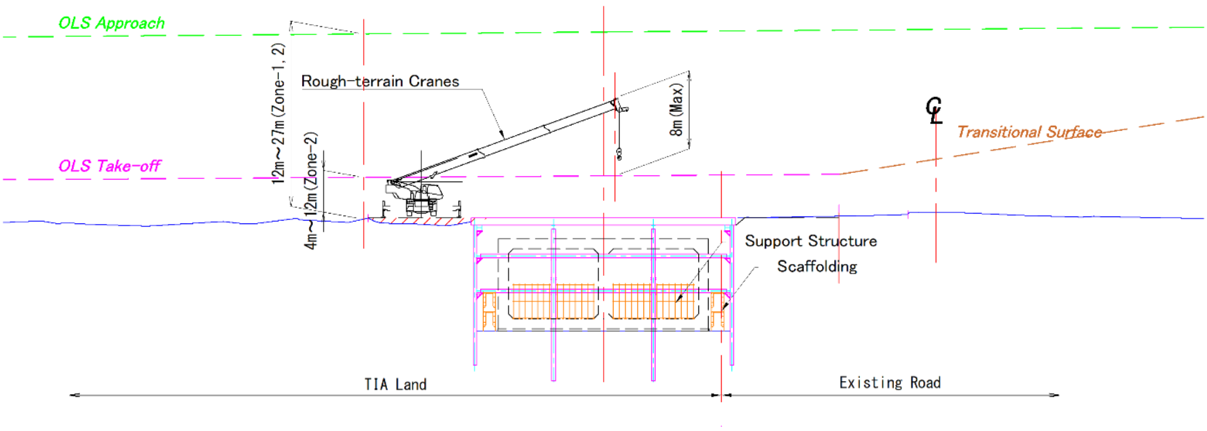
Construction can be proceeded during the daytime without any restrictions.

4) Reinforcing Bar Arrangement and Formwork

i. Areas under the Take-off Surface (Section-3, 4) * Partial nighttime work

During the scaffolding, formwork, supports, and rebar setting inside the earth retaining wall, a crane boom tip may temporarily exceed the maximum eight meters from the Take-off Surface, as shown in Figure 14.5.17. The work in this area must always be ready for temporary suspension to follow air traffic control instructions.

In such cases, the work should be suspended and carried out at a time when aircraft are not taking off, in accordance with the instructions of the airport control.



Source: JICA Survey Team

Figure 14.5.17 Crane Operation for Box Culvert Construction

ii. Outside the Areas under the Take-off Surface (Section-2) *No time restriction for construction work

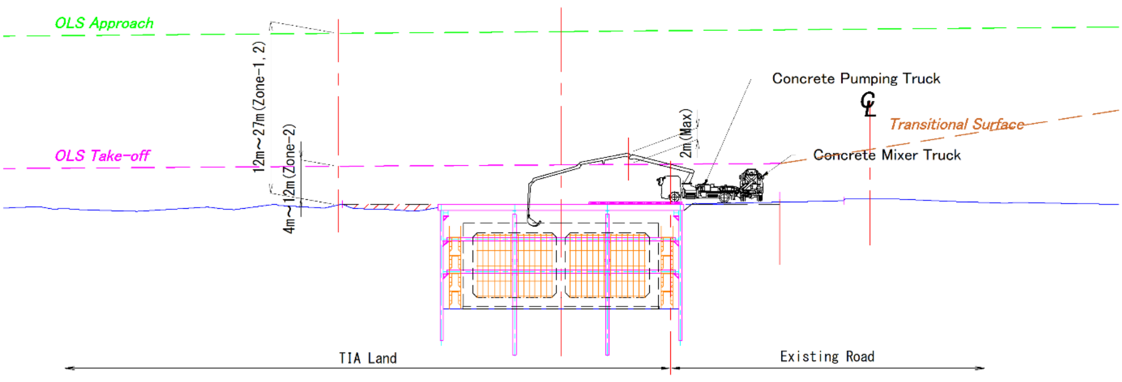
Construction can be proceed during the daytime without any restrictions. However, they must continuously observe height restrictions when operating cranes or handling long components.

5) Placing Concrete

i. Areas under the Take-off Surface (Section-3, 4) * Partial nighttime working

The boom of concrete pumping truck may temporarily exceed the maximum two meters from OLS Take-off during concrete pumping operations, as shown in Figure 14.5.18.

In such cases, the work should be suspended and carried out at a time when aircraft are not taking off, in accordance with the instructions of the airport control.



Source: JICA Survey Team

Figure 14.5.18 Concrete Placing for Box Culvert Construction

i. Outside the areas under the Take-off Surface (Section-2) *No time restriction on construction time

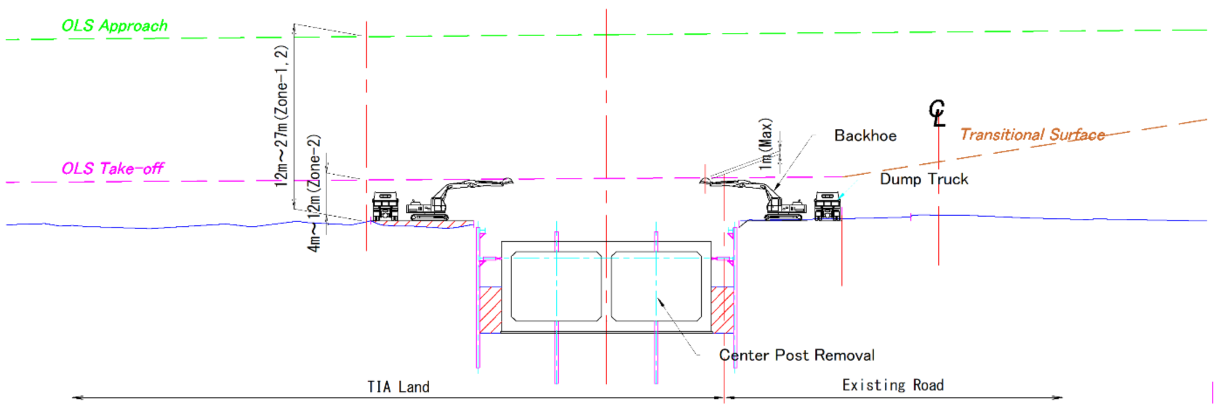
Construct can be proceed during the daytime without restrictions. However, they must continuously observe height restrictions when placing concrete.

6) Backfilling with Support Material Disassembly

i. Areas under the Take-off Surface (Section-3, 4) * Partial nighttime work

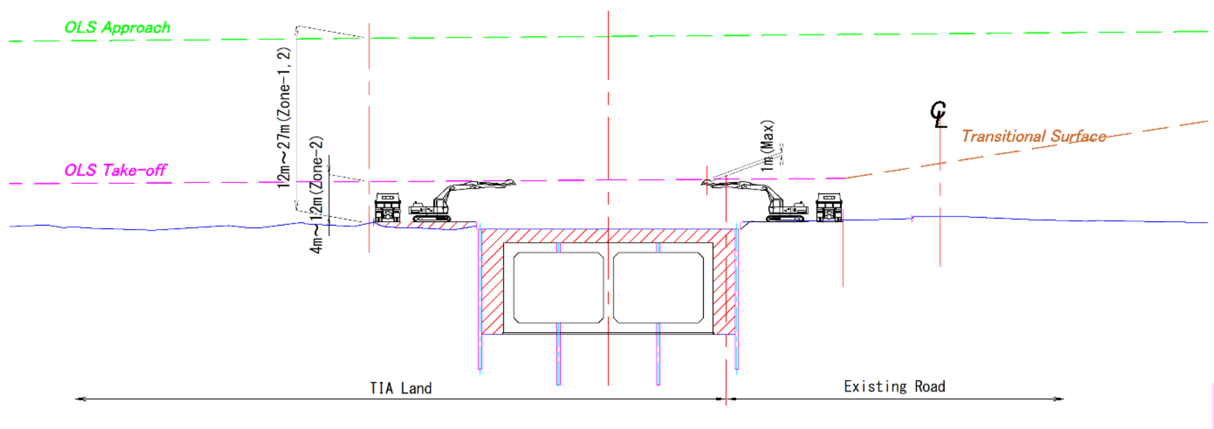
Construction equipment heights and workspace restrictions may be temporarily constrain support material disassembling and backfilling inside the earth retaining wall if they exceed one meter from the Take-off Surface, as shown in Figure 14.5.19 and Figure 14.5.20.

The center posts for the box culvert construction that cannot be removed will be left in place.



Source: JICA Survey Team

Figure 14.5.19 Backfilling Outside Box Culvert (1)



Source: JICA Survey Team

Figure 14.5.20 Backfilling Outside Box Bulvert (2)

ii. Outside the areas under the Take-off Surface (Section-2) *No time restrictions on construction

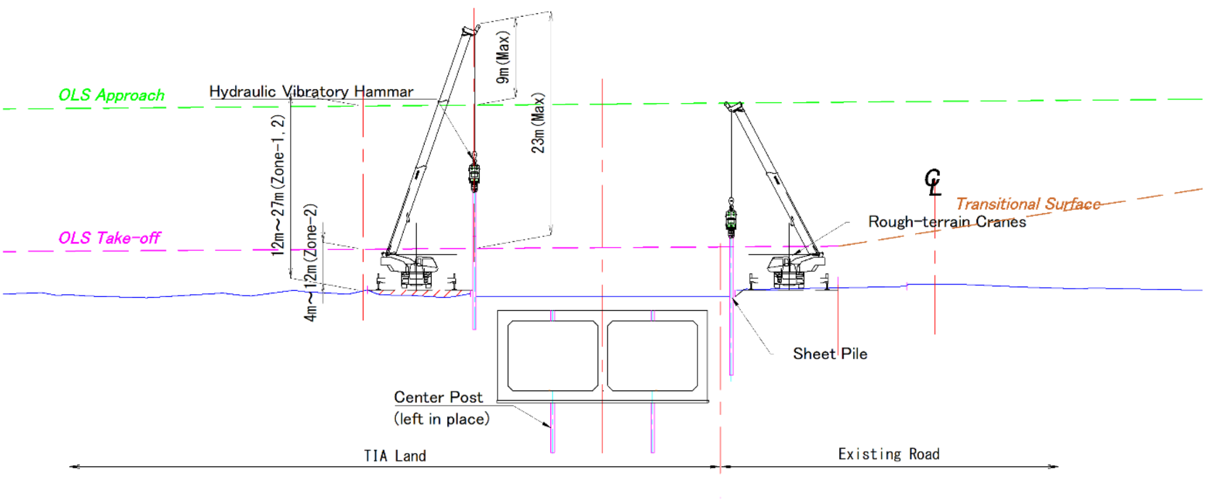
Construction can be proceed during the daytime without any restrictions. However, they must continuously observe height restrictions continuously observed when operating cranes or handling long components.

7) Earth Retaining Wall Pulling and Removal

i. Areas under the Take-off Surface (Section-3, 4) *Full nighttime work

ii. Outside the areas under the Take-off Surface (Section-2) * Full nighttime work

As shown in Figure 14.5.21, pulling and removal of steel sheet piles for the earth retaining walls shall be carried out at night when aircraft operations are nonexistent for section-2 through section-4, as the tip of the crane boom will exceed the maximum of nine meters from the Approach Surface and 23 meters from the Take-off Surface, and the center posts for culvert construction must remain in place. In addition, construction machinery must feature an aircraft warning light.



Source: JICA Survey Team

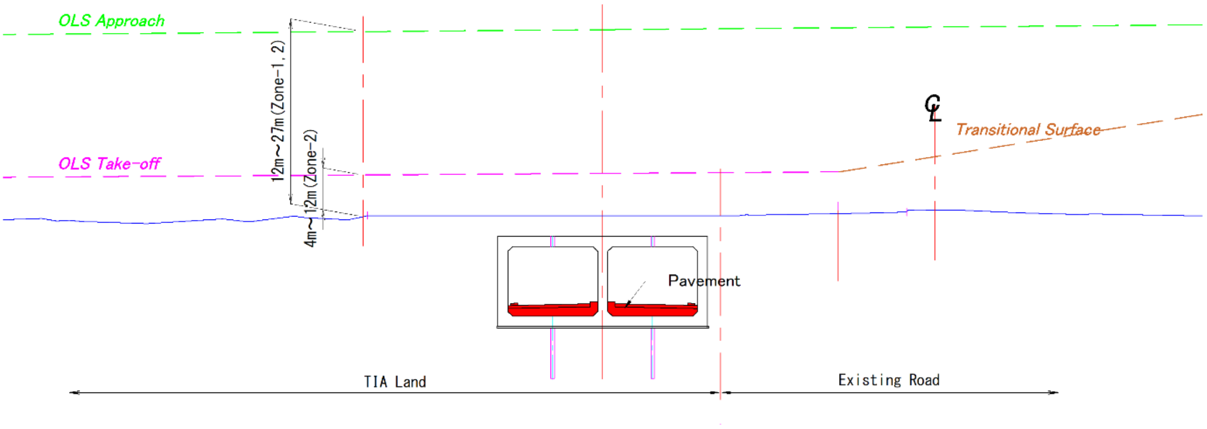
Figure 14.5.21 Earth Retaining Wall Pulling and Removal

8) Pavement and Miscellaneous Work

i. Areas under the Take-off Surface (Section-3, 4) *No time restrictions on construction

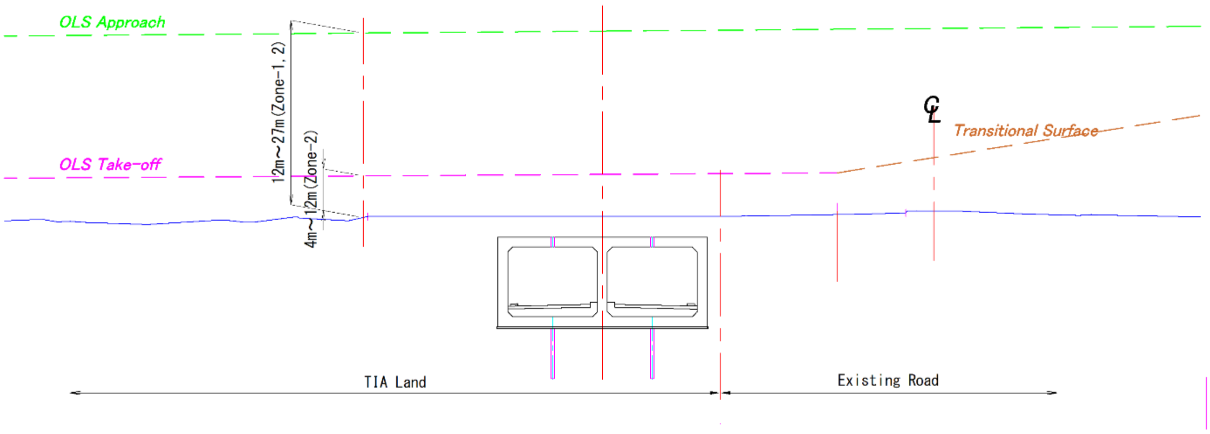
ii. Outside the areas under the Take-off Surface (Section-2) *No time restrictions on construction

Pavement work inside the box culvert in the UP section will be performed without time constraints in all sections, as shown in Figure 14.5.22.



Source: JICA Survey Team

Figure 14.5.22 Pavement Work and Miscellaneous Work Inside the Box Culvert



Source: JICA Survey Team

Figure 14.5.23 Completion Shape

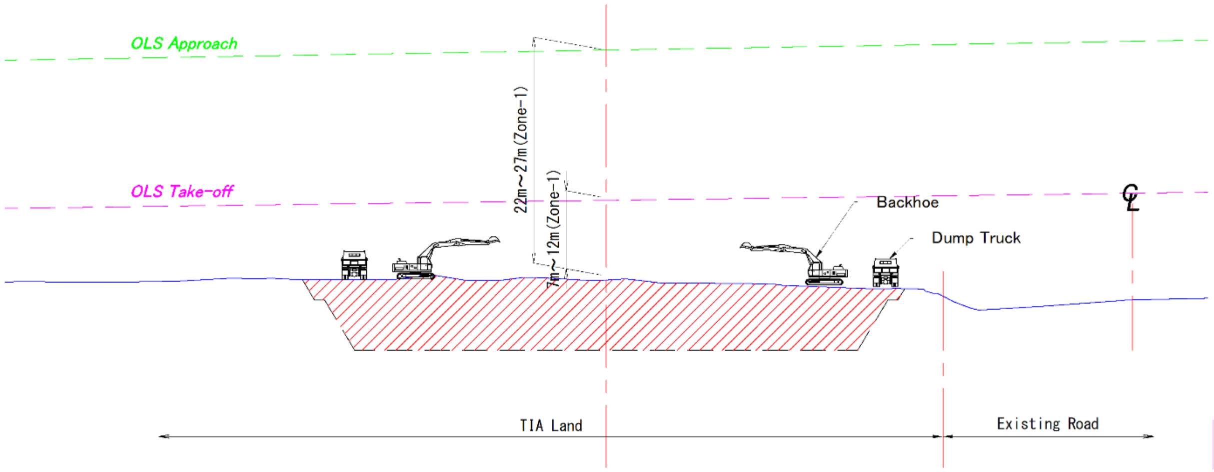
(3) Open-Cut Excavation

The process of open cut excavation method is as follows.

1) Preparation Work for Primary Excavation

i. Areas under the Take-off Surface: Section-5(Zone-1) *No time restrictions on work

Preparation work, including surface clearing and all excavation, may be temporarily constrained by construction equipment heights and workspaces when exceeding the Take-off Surface limits, as shown in Figure 14.5.24. The work in this area must always be ready for evacuation to follow air traffic control instructions. For excavation, the height limits and working space require checking before work starts, and an aircraft warning light shall be attached to the construction machinery as necessary.



Source: JICA Survey Team

Figure 14.5.24 Preparation Work

ii. Outside of the Approach Surface (Section-1) *No time restrictions on construction

Construct can be proceeded during the daytime without any restrictions.

2) Primary Excavation

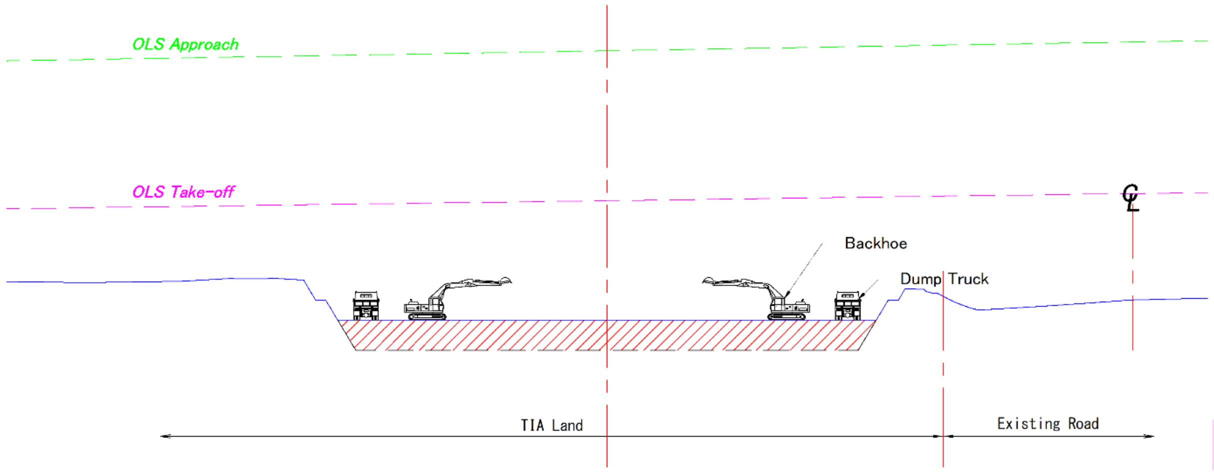
i. Areas under the Take-off Surface (Section-5) *No time restrictions on construction

Primary excavation plans must set temporary construction roads and work yards at both sides of the Project structures, allowing cranes to perform necessary activities, like carrying materials such as rebars.

As shown in Figure 14.5.25, since the workspace for the Project structures have more distant from the Take-off Surface after preparatory work, construction can be proceeded during the daytime without any restrictions.

Excavated soils shall be hauled to a designated area in the TIA compound. After the primary excavation, they will compact the revealed bottom surface to create a construction road.

For the nighttime construction, a consultation with airport management and operators is necessary for setting construction guidelines. The same applies to subsequent processes.



Source: JICA Survey Team

Figure 14.5.25 Primary Excavation

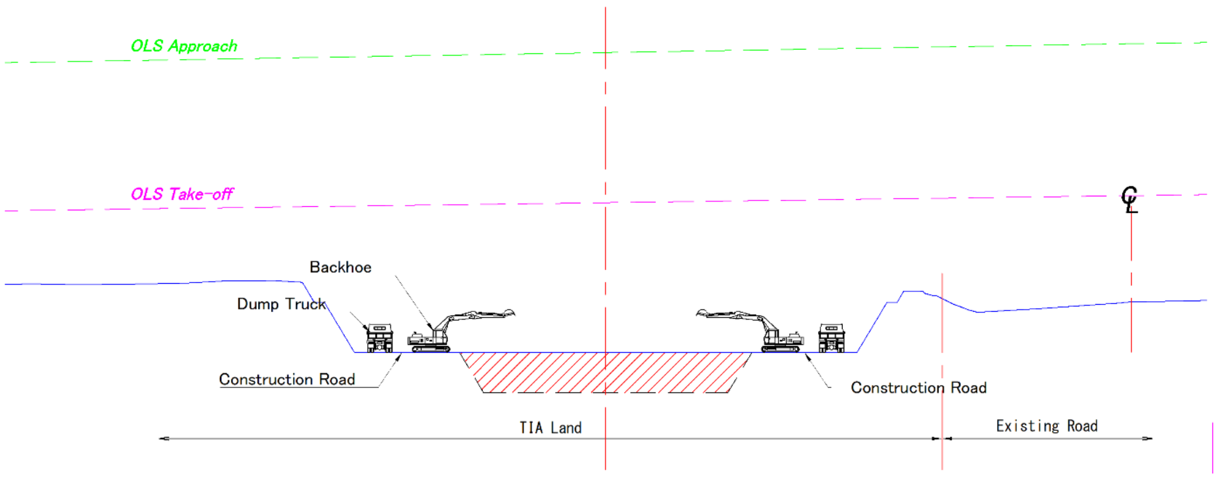
ii. Outside of the Approach Surface (Section-1) *No time restrictions on construction

Construction can be proceeded during the daytime without any restrictions.

3) Secondary Excavation

i. Areas under the Take-off Surface (Section-5) *No time restrictions on construction

The secondary excavation will dig up to the bottom lines of the Project structures. Construction can proceed without any restrictions during daytime, as the bottom lines are below the Take-off Surface in Figure 14.5.26. After shaping the construction roads, excavation commences on the construction bases of the Project structures.



Source: JICA Survey Team

Figure 14.5.26 Secondary Excavation

ii. Outside of the Approach Surface (Section-1) *No time restrictions on construction

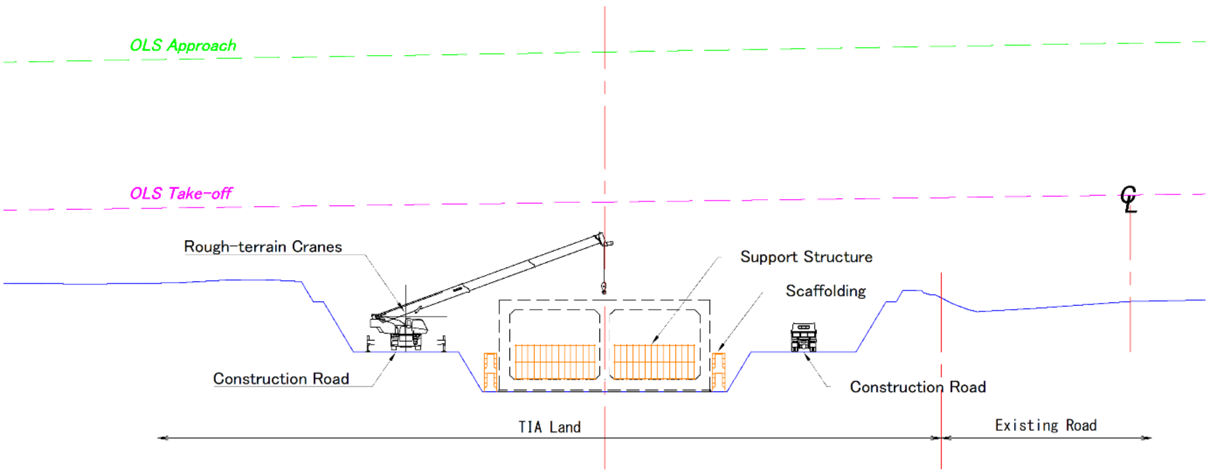
Construction can proceed during the daytime without any restrictions.

4) Reinforcing Bar Arrangement and Formwork Setting

i. Areas under the Take-off Surface (Section-5) *No time restrictions on construction

Lifting heights and workspaces exceeding the Take-off Surface might temporarily constrain crane operations, as shown in Figure 14.5.27. The work in this area must always remain ready for temporary suspension to follow air traffic control instructions.

For crane operations, height limits and working space require checking prior to operation, and an aircraft warning light shall be attached to the crane boom.



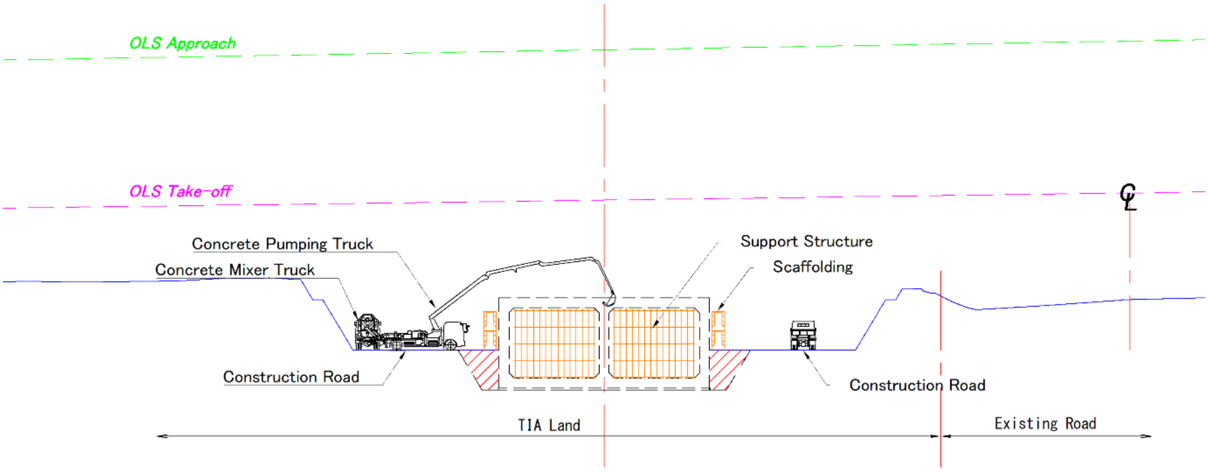
Source: JICA Survey Team

Figure 14.5.27 Crane operation for box culvert construction

ii. Outside of the Approach Surface (Section-1) *No time restrictions on construction

Construction can be proceed during the daytime without any restrictions.

5) Placing Concrete



Source: JICA Survey Team

Figure 14.5.28 Concrete Placing for Box Culvert Construction

i. Areas under the Take-off Surface (Section-5) *No time restrictions on construction

Lifting heights and workspaces exceeding the Take-off Surface might temporarily constrain concrete pumping operations, as shown in Figure 14.5.28. The work in this area must always remain ready for temporary suspension to follow air traffic control instructions.

Height limits and working space require checking prior to operation, and an aircraft warning light shall be attached to the concrete pump boom

ii. Outside of the Approach Surface (Section-1) *No time restrictions on construction

Construction can be proceed during the daytime without any restrictions.

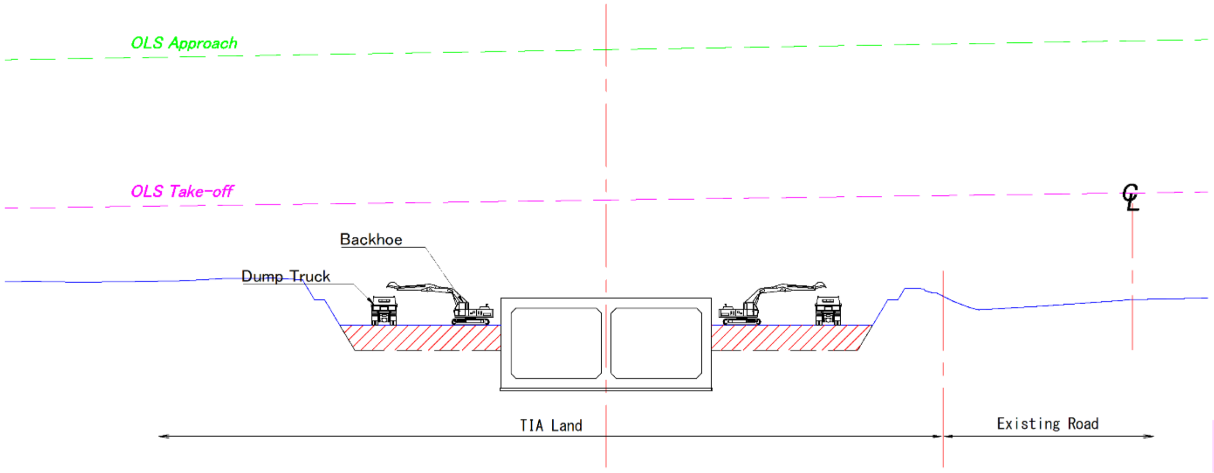
6) Backfilling

i. Areas under the Take-off Surface (Section-5) *No time restrictions on construction

Initial backfilling works can be constructed without any restrictions during daytime, as shown in Figure 14.5.29.

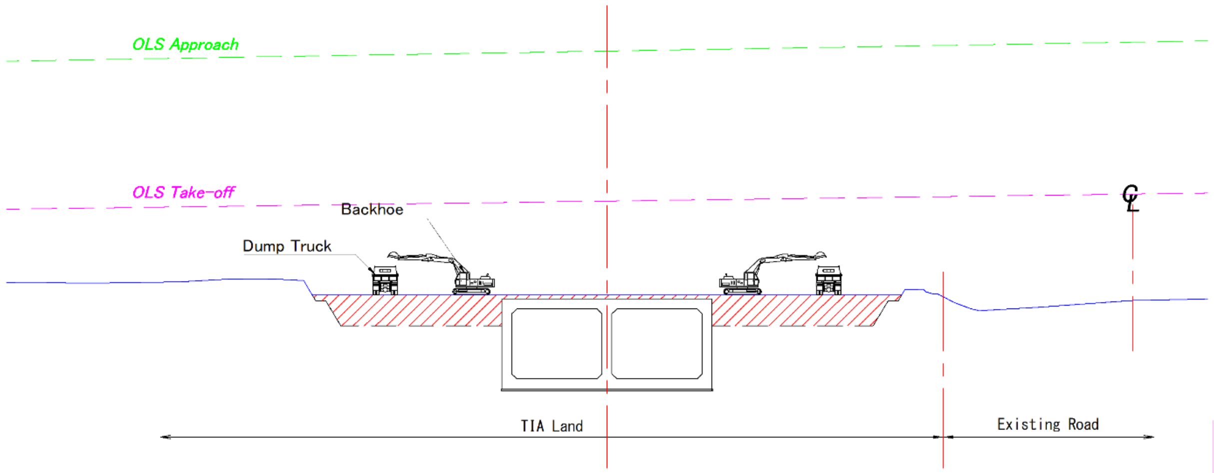
During the latter part of backfilling, the workspace will be in close proximity to the OLS take-off, which may temporarily constrain the height and workspace for construction equipment, as shown in Figure 14.5.30.

The minimum earth covering thickness of the box culvert shall be basically 2 meters.



Source: JICA Survey Team

Figure 14.5.29 Backfilling (1)



Source: JICA Survey Team

Figure 14.5.30 Backfilling (2)

ii. Outside of the Approach Surface (Section-1) *No time restrictions on construction

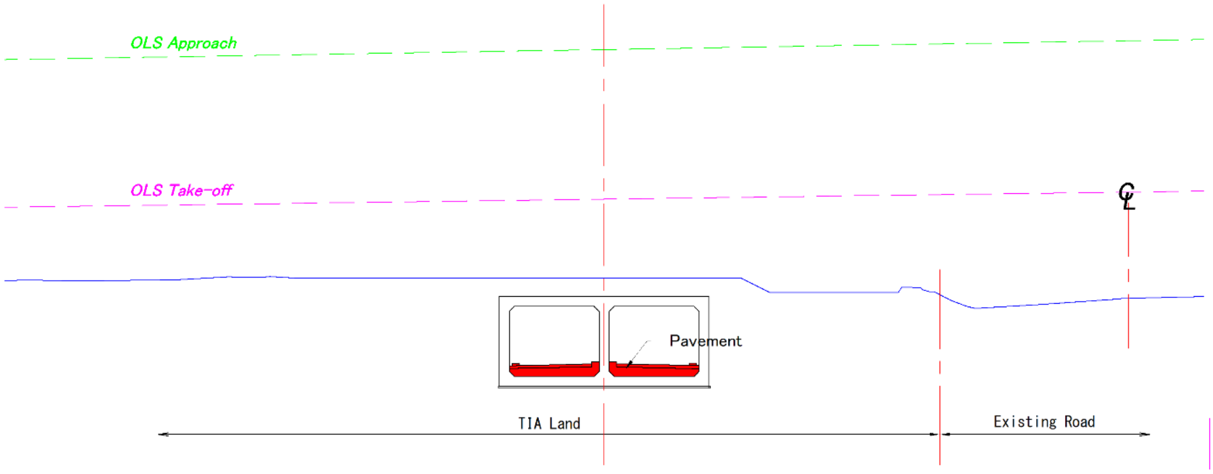
Construction can proceed during the daytime without any restrictions.

7) Pavement and Miscellaneous Work

i. Areas under the Take-off Surface (Section-5) *No time restrictions on construction

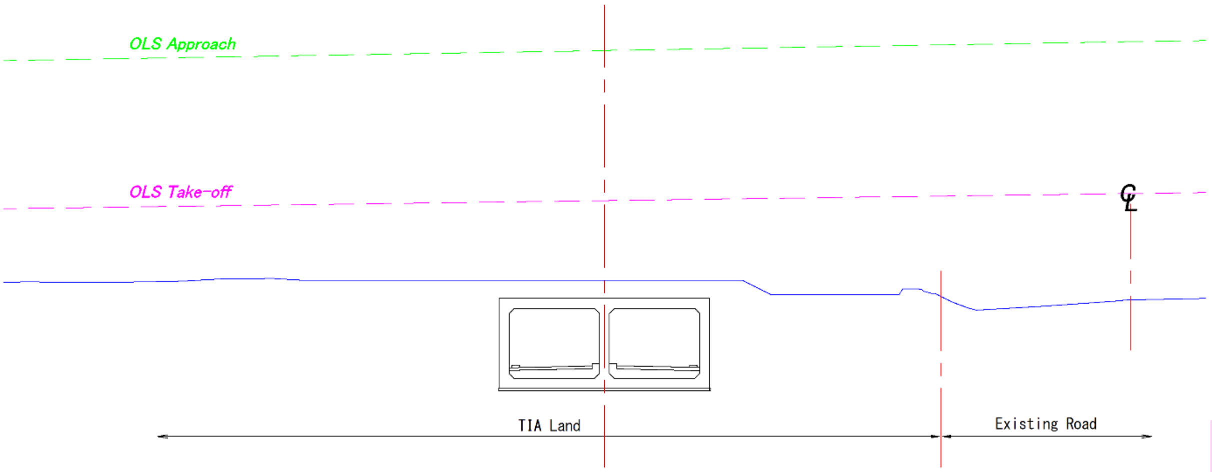
ii. Outside of the Approach Surface (Section-1) *No time restrictions on construction

Pavement work inside the box culvert in the UP section will be performed without time constraints in all sections, as shown in Figure 14.5.31.



Source: JICA Survey Team

Figure 14.5.31 Pavement Work and Miscellaneous Work



Source: JICA Survey Team

Figure 14.5.32 Completion

14.5.3 Construction Machinery and Equipment

The main machineries and equipment to be used in the construction of the underpass section is listed in Table 14.5.4. Self-propelled construction equipment can allow evacuation from areas as directed by airport management.

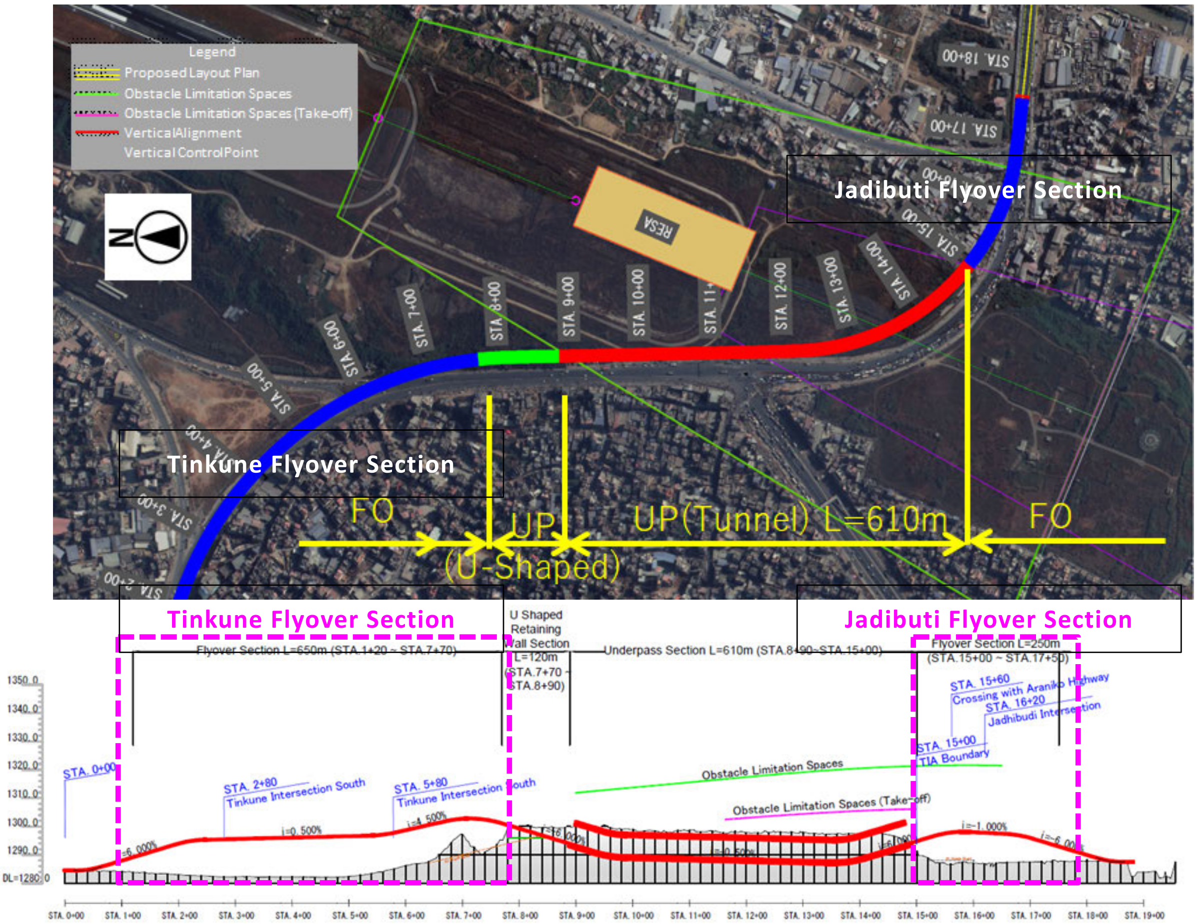
Table 14.5.4 Main machinery and equipment list

NO	Machine	Specification	Height (m)		Types of Construction Work			Note
			Max	Min	Earth Works	Concrete Structures	Pavement	
1	Bulldozer	15ton, 21ton	3.2	3.0	✓			
2	Excavator	$0.2m^3$, $0.34m^3$, $0.6m^3$	8.6	2.6	✓			
3	Wheel Loader	$2.1m^3$	5.3	3.4	✓			
4	Dump Truck	10ton	3.3		✓			
5	Semi-trailer	20ton	N/A*1	2.8		✓		*1 Depends on the size of the load
6	Truck Crane	4.9ton, 20ton	10.0*2	3.3		✓		*2 Boom Length 12.4m Operating Radius 8.0m
7	Road Roller, Macadam	10-12ton	3.1		✓		✓	
8	Tire Roller	8-20ton	3.1		✓		✓	
9	Vibration Roller, Combined	3-4ton	3.1		✓		✓	
10	Generator	100-200kVA	1.7	1.4		✓	✓	
11	Air Compressor	$5.0m^3/min$	1.3			✓	✓	
12	Rough Terrain Crane	Less than 35ton (35t)	22.0*3	3.5		✓		*3 Boom Length 22.2m Operating Radius 11.0m
13	Rough Terrain Crane	Above 35ton (65t)	22.0*4	3.7		✓		*4 Boom Length 23.8m Operating Radius 14.0m
14	Truck Crane	More than 35ton (100t)	22.0*5	4.0		✓		*5 Boom Length 28.3m Operating Radius 20.0m
15	Concrete Mixer Truck	$4.5m^3$ (10t*6)	3.7			✓	✓	*6 Max Carrying Capacity
16	Concrete Pump Vehicle	$90m^3/hr$	16.6*7	3.0		✓	✓	*7 Boom Length 13.8m

Source: JICA Survey Team

14.6 Flyover Section

14.6.1 Construction Conditions and Requirements



Source: JICA Survey Team

Figure 14.6.1 Construction Planning Overall View

The work items and construction method for the FO section of the Project structures are in Table 14.6.1 and Table 14.6.2.

Table 14.6.1 Work Items and Construction Method for the Tinkune Flyover

Work Item	Outlie of Structures	Construction Method
Superstructure	PC-Girder (L=420m): Span length l=30m, Girder height h=2.0m	Truck Crane Erection
	Steel Box Girder (L=244.5m): Span length l=30.0m-49.5m Girder height h=2.0m	Truck Crane Bent Erection
Substructure	RC Abutment/Pier (in part PC beam): n=19, h=7.5m-15.0m	Cast-in-situ Concrete
	Steel-rigid Frame Pier: n=2, h=14.0m-15.0m	Beam and Column: Truck Crane Bent Erection Pile Cap: Cast-in-situ Concrete
Pile Foundation	Bored Pile: ϕ 1.2m, l=50m-58m	Earth Drill Method

*Design assumptions

Source: JICA Survey Team

Table 14.6.2 Work Items and Construction Method for the Jadibuti Flyover

	Structural Specification	Construction Method
Superstructure	Steel Box Girder (L=238.0m): Span length l=48.0m-66.0m, Girder height h=2.7m	Truck Crane Bent Erection
Substructure	RC Abutment/Pier: n=4, h=8.5m-12.5m	Cast-in-situ Concrete
	Steel-rigid Frame Pier: n=1, h=13.0m	Beam and Column: Truck Crane Bent Erection Pile Cap: Cast-in-situ Concrete
Pile Foundation	Bored Pile: ϕ 1.2m, l=50m-58m	Earth Drill Method

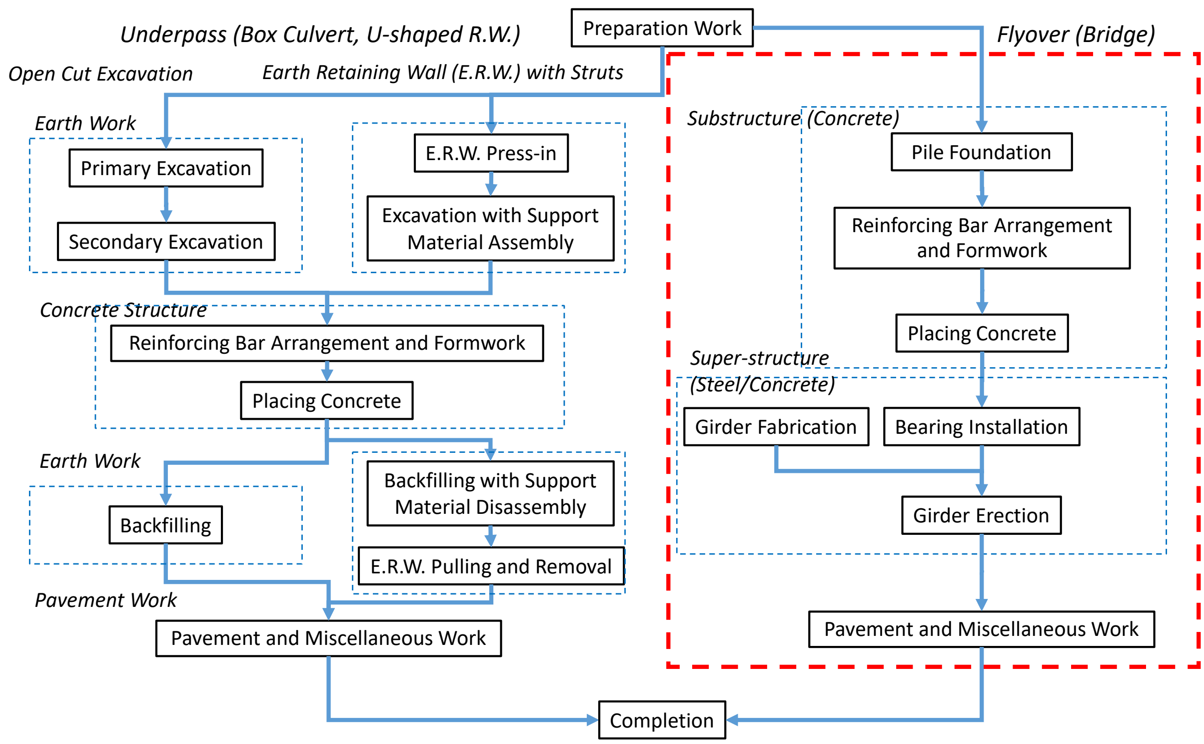
*Design assumptions

Source: JICA Survey Team

14.6.2 Construction Process

(1) Construction Flow

The planned construction flow of the flyover section of the Project road is in Figure 14.6.2 by the red boxed line.

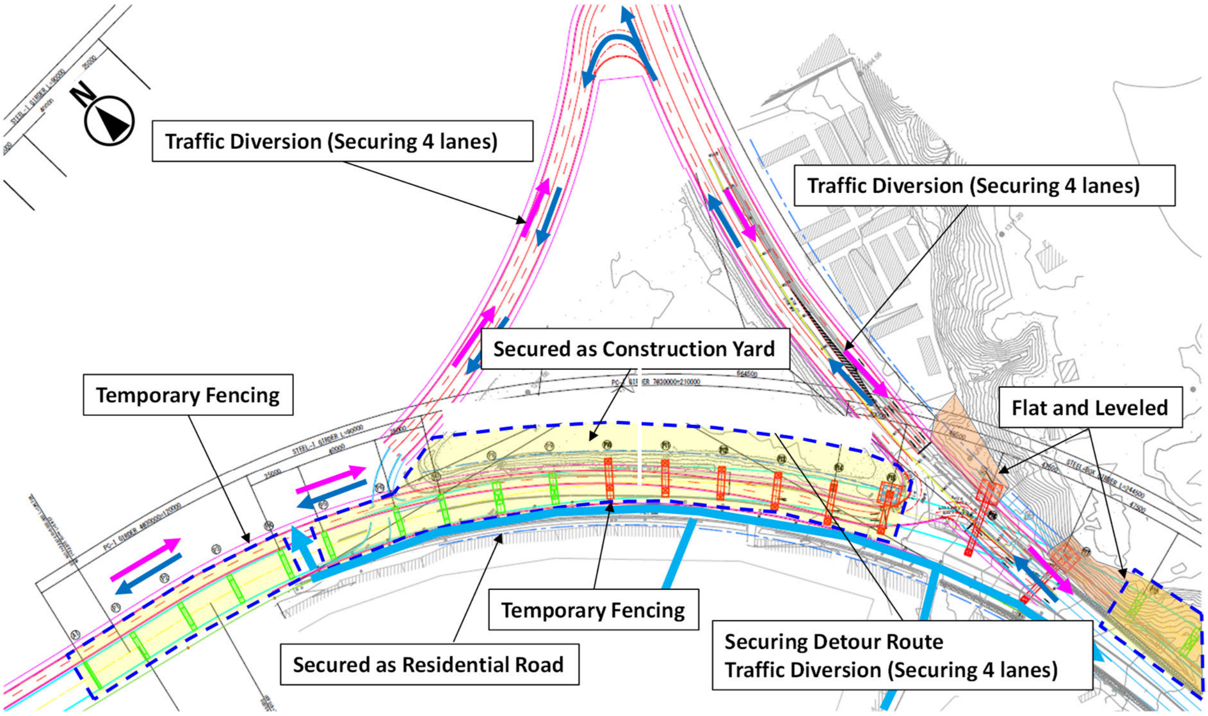


Source: JICA Survey Team

Figure 14.6.2 Flyover Construction Flow

(2) Tinkune Flyover

1) Preparation Work



Source: JICA Survey Team

Figure 14.6.3 Preparation Work

i. Secured as Construction Yard

The inner land area of the Tinkune Intersection will be a temporary reserved yard for the FO construction. The temporary fencing will be installed within the yard to prevent third parties from entering to the construction site.

ii. Provision of Detour Road during Construction

Since the FO construction works, including foundation, substructure and superstructures are to be constructed along the west ramp of the intersection, the existing road should be closed. General road users require a temporary detour route in the park, as shown in Figure 14.6.3.

Therefore, as shown in Figure 14.6.3, general road users are to be detoured by using other two ramp road of the intersection during construction.

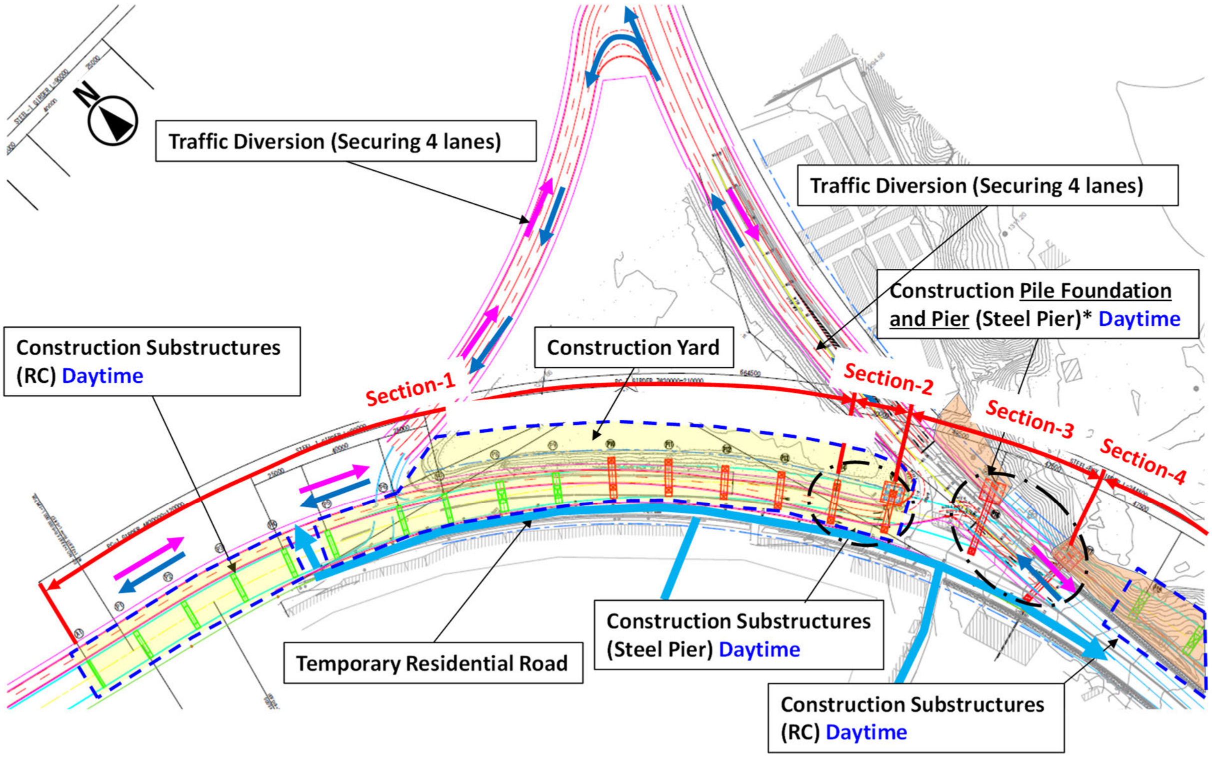
iii. Securing Access to Residents along the Existing Road during Construction

Since the existing road on the opposite side of the inner land of the Tinkune Intersection has a dense population, present access for the residents should be secured during construction, as shown in Figure 14.6.3. Installing fences from the construction site and the existing road is necessary.

iv. Flat and Leveled

Piers near the TIA land boundary in the south vertex of the intersection are to be constructed on the uneven ground under the cliff. Accordingly, the area will be leveled before its construction work.

2) Pile Foundation and Substructure



Source: JICA Survey Team

Figure 14.6.4 Pile Foundation and Substructure

The substructure work in Section-1 and 2, indicated in Figure 14.6.4, will commence in the daytime without time and construction constraints. However, the substructure work in Section-3 will start at nighttime because it is on a busy existing road. The working time and construction location for each section are in Table 14.6.3.

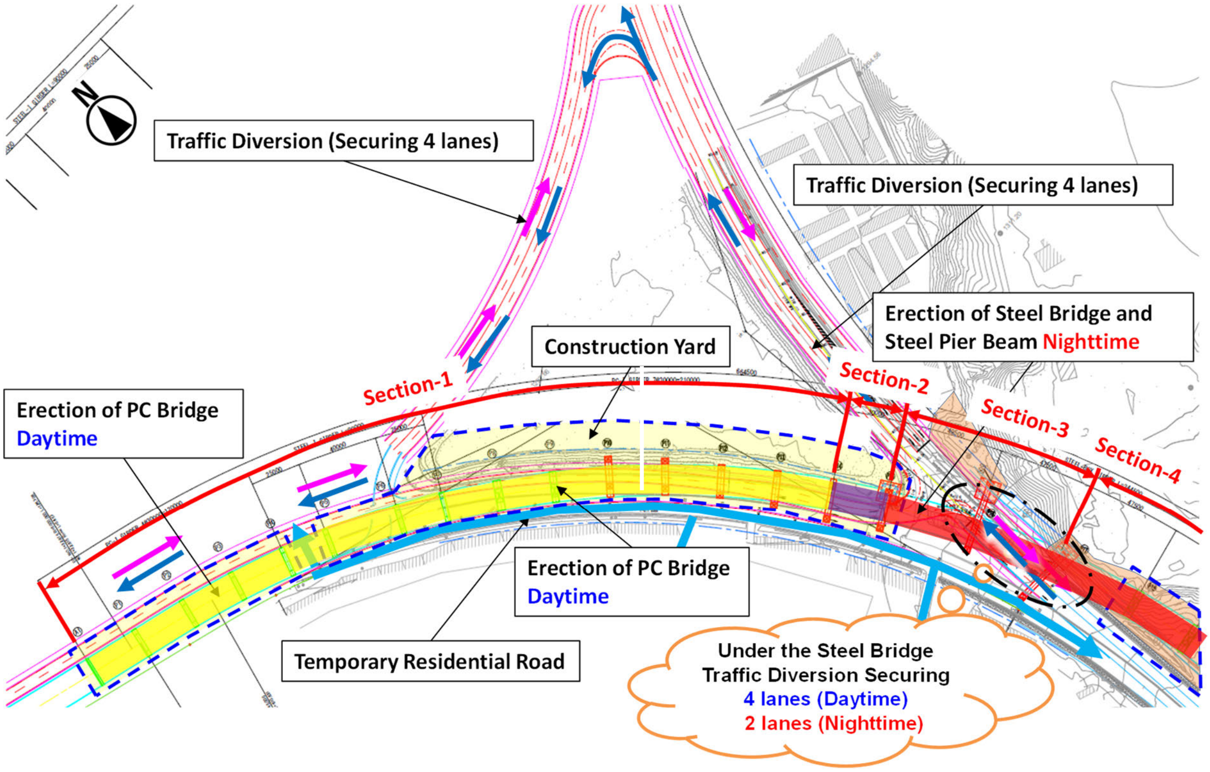
Table 14.6.3 Working Time

	NO. Structures	Construction Location	Working Time	
			Pile Foundation	Abutment/Pier
Sect. -1: PC-T Girder (A1-P14)	15	Within the yard	D	D
Sect. -2: Steel Box Girder (P15)	1	Within the yard	D	D*
Sect. -3: Steel Box Girder (P16, P17)	2	On the road	D/N	D*
Sect. -4: Steel Box Girder (P18, 19, A2)	3	Within the yard	D	D

D : Daytime
N : Nighttime
D/N : Daytime or Nighttime (Undecided)
* Excluding steel beam section

Source: JICA Survey Team

3) Superstructure and Steel Pier Beam Work



Source: JICA Survey Team

Figure 14.6.5 Superstructure and Steel Pier Beam

As shown in Figure 14.6.5, steel girders and beams for Section-3 work will be erected in nighttime because the works shall be performed on the busy existing road. For this purpose, whereas two lanes of the existing road will be restricted to traffic during nighttime construction, four lanes will be opened during daytime construction. The Section-4 work is to be done in close proximity to the existing road, accordingly it will be constructed at nighttime if the prescribed clearance required for the girder erection cannot be maintained.

The working time and construction location for each section are summarized in Table 14.6.4.

Table 14.6.4 Working Time

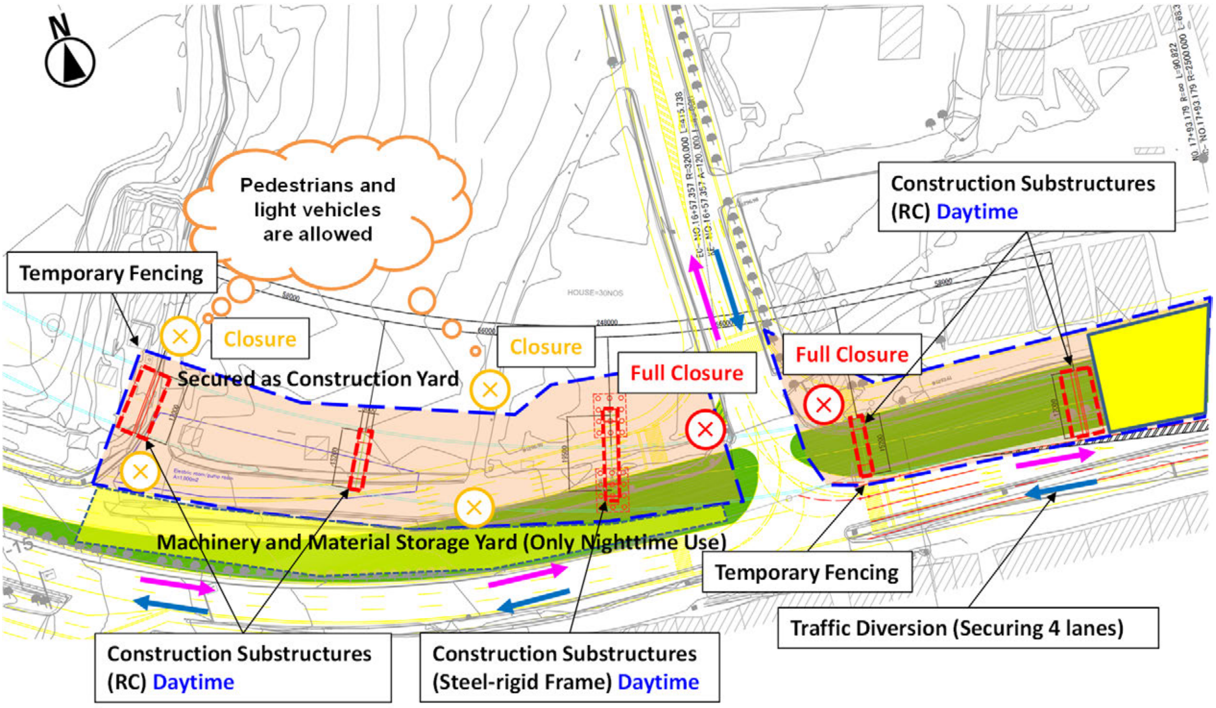
		Length	Construction Location	Working Time	
				Superstructure	Steel Pier Beam
Sect. -1: PC-T Girder	(A1-P14)	420.0m	Within the yard	D	–
Sect. -2: Steel Box Girder	(P15)	30.0m	Within the yard	D	D
Sect. -3: Steel Box Girder	(P16, P17)	97.0m	On the road	N	N
Sect. -4: Steel Box Girder	(P18, 19, A2)	117.5m	Within the yard /On the Road	D/N	–

D : Daytime
N : Nighttime
D/N : Daytime or Nighttime (Undecided)

Source: JICA Survey Team

(3) Jadibuti Flyover

1) Preparation Work, Foundation and Substructure Works



Source: JICA Survey Team

Figure 14.6.6 Preparation Work and Substructure

Preparation work, foundation building, and substructure works for the FO section across the Jadibuti Intersection will be carried out mainly within the temporary construction yard during the daytime, as shown in Figure 14.6.6. See the areas enclosed with blue dotted lines. There will be no significant disruption to traffic on the existing road. In addition, although this area is under the OLSs (for Approach Surface), there would be no obstruction because the margin height to the OLS is 30 meters more from the existing road.

i. Secured as Construction Yard

The area along the existing road near the Jadibuti Intersection will be reserved as a construction yard during construction. The temporary fencing will be installed enclosing the yard to prevent third parties from entering. A section of the temporary fencing will be partially open to allow pedestrians and small vehicles to pass through as a residential road, as indicated in Figure 14.6.6.

ii. Traffic Diversion

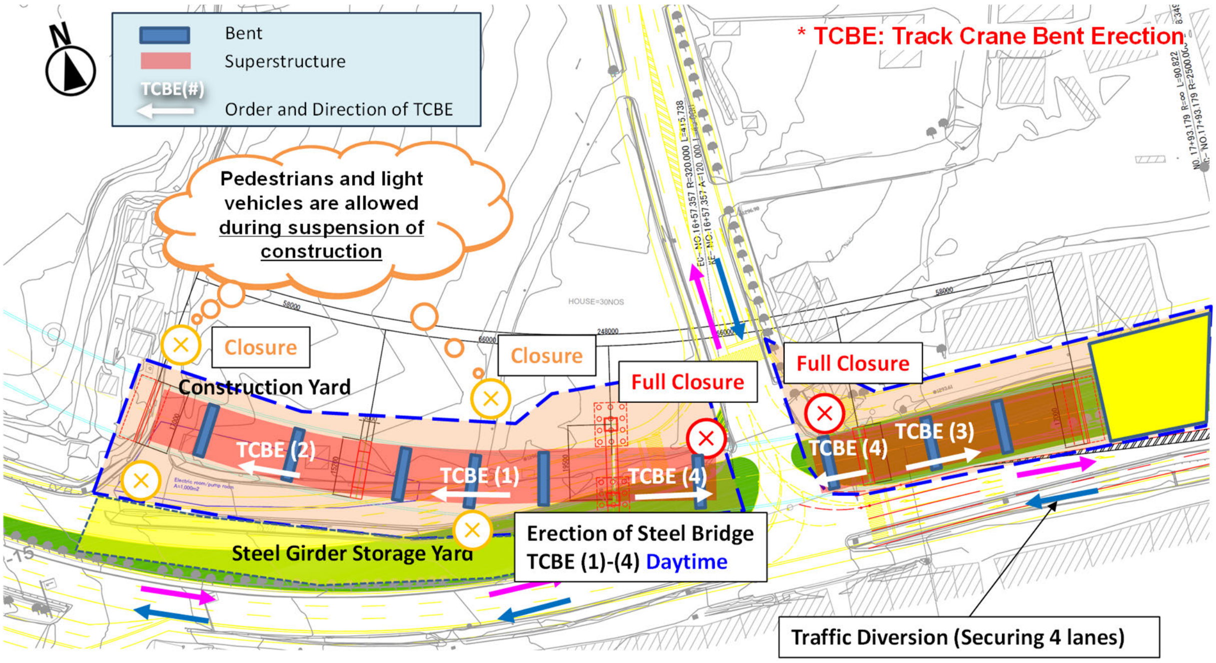
A minimum of four lanes will be restored during construction for open to traffic.

iii. Storage Yard

Personnel will use the storage yard on the west side of the intersection only at nighttime due to its location on the existing road. During the daytime, materials and equipment will be transported from the DOR-owned yard to the construction site, as shown in Figure 14.6.7.


Figure 14.6.7 Proposed Site for the Contractor Camps and Construction Yard

2) Superstructure (Truck crane bent erection within the construction yard)

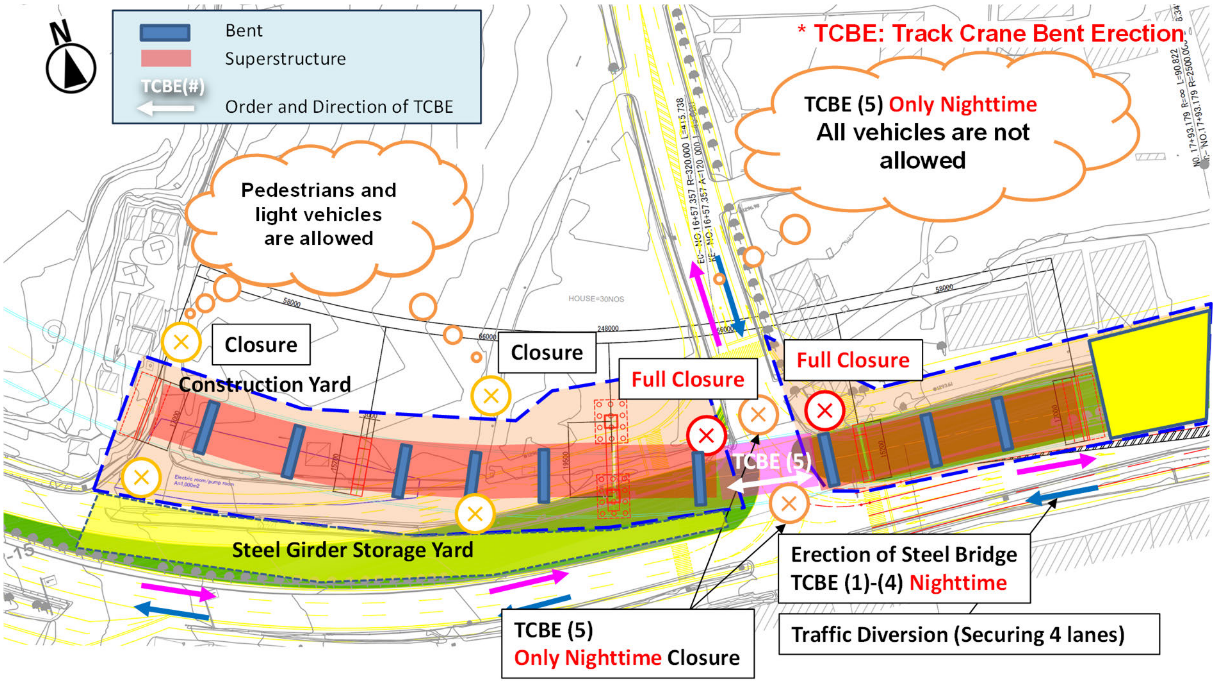


Source: JICA Survey Team

Figure 14.6.8 Superstructure (1)

The superstructure work will occur within the yard during the daytime because there will be no significant disruption to the traffic on the existing road, as shown in Figure 14.6.8.

3) Superstructure (Truck crane bent erection on the existing road)



Source: JICA Survey Team

Figure 14.6.9 Superstructure (2)

The superstructure constrction above the intersection will commence during nighttime. One line of the intersection will close during construction and reopen to traffic during the daytime.

14.6.3 Construction Machinery and Equipment

The machinery and equipment for constructing the Project structures are in Table 14.6.5.

Table 14.6.5 Main Machinery and Equipment List

NO	Machine	Specification	Height (m)		Types of Construction Work			Note
			Max	Min	Earth Works	Concrete Structures	Pavement	
1	Bulldozer	15ton, 21ton	3.2	3.0	✓			
2	Excavator	$0.2m^3$, $0.34m^3$, $0.6m^3$	8.6	2.6	✓			
3	Wheel Loader	$2.1m^3$	5.3	3.4	✓			
4	Dump Truck	10ton	3.3		✓			
5	Semi-trailer	20ton	N/A*1	2.8		✓		*1 Depends on the size of the load
6	Truck Crane	4.9ton, 20ton	10.0*2	3.3		✓		*2 Boom Length 12.4m Operating Radius 8.0m
7	Road Roller, Macadam	10-12ton	3.1		✓		✓	
8	Tire Roller	8-20ton	3.1		✓		✓	
9	Vibration Roller, Combined	3-4ton	3.1		✓		✓	
10	Generator	100-200kVA	1.7	1.4		✓	✓	
11	Air Compressor	$5.0m^3$/min	1.3			✓	✓	
12	Rough Terrain Crane	Less than 35ton (35t)	22.0*3	3.5		✓		*3 Boom Length 22.2m Operating Radius 11.0m
13	Rough Terrain Crane	Above 35ton (65t)	22.0*4	3.7		✓		*4 Boom Length 23.8m Operating Radius 14.0m
14	Truck Crane	More than 35ton (100t)	22.0*5	4.0		✓		*5 Boom Length 28.3m Operating Radius 20.0m
15	Concrete Mixer Truck	$4.5m^3$ (10t*6)	3.7			✓	✓	*6 Max Carrying Capacity
16	Concrete Pump Vehicle	$90m^3$/hr	16.6*7	3.0		✓	✓	*7 Boom Length 13.8m

Source: JICA Survey Team

CHAPTER 15. COST ESTIMATION

15.1 Basic Policy for Cost Estimation

15.1.1 Project Cost

Table 15.1.1 shows a summary of the Project costs.

Table 15.1.1 Project Cost

(Secret)

(1) Costs to Nepal

The following costs are Nepal's portion.

- Land Acquisition
- Resettlement of Houses and Industrial Structures
- Relocation of Public Utilities
- Protection of Public Utilities

(2) Construction Cost

Construction costs include direct and indirect construction costs.

The direct construction cost shall be estimated based on the BQ (Bill of Quantities) method in Table 15.2.1 through Table 15.2.5. The indirect costs (Common Temporary Cost, Site Management Cost, and General and Administrative Cost) are fixed charge rates for each category based on Japanese norms, proportional to the direct construction costs, with some items listed for separate collation and recording.

The quoted prices for fabrication, transportation, and installation of materials necessary for the steel bridge, including electromechanical equipment for the underpass, are adopted by a specialized Japanese company due to the unique nature of the work.

A summary of the total base construction cost is in Table 15.1.2.

Table 15.1.2 Total Base Construction Cost

(Secret)

(3) Engineering Cost

The consulting service fee consists of the items below. It is calculate by multiplying the cost per engineer by the required man-month (MM).

The following costs were estimated based on past data from similar projects:

- Detailed design cost
- Engineering survey costs
- Tender assistance Cost
- Construction supervision cost

(4) Operation and Maintenance Costs

Post-completion operation and maintenance costs for the Project are in Chapter 18. It is not included as the Project cost.

15.2 Conditions of Cost Estimate for the Project

(1) Unit Price Setting

The unit prices of materials, equipment, and labor for this cost estimation are based on market prices as follows:

1) General unit prices for materials, machinery, and labor

- Quoted unit prices by a local contractor in September 2022
- DOR Road Division Kathmandu, 2079, Analysis of Rates (Fiscal Year 079/80) District: Kathmandu

Unit prices for the Project construction cost estimate originate from unit prices published by the DOR for the Kathmandu area and ones from several local contractors.

Since some DOR-published unit prices are significantly lower than others, most unit prices are based on the ones collected from local contractors.

2) Unit prices for materials and equipment that are unavailable in Nepal market

- Published construction price list in Japan as of March 2022

3) Special work items such as structure (steel) and electrical and mechanical facilities for tunnel construction

- Quoted prices by a Japanese specialized company in May 2023

(2) Indirect Costs

The indirect cost calculation for Project construction shall follow the Japanese Civil Engineering Cost Estimating Standards, which apply the lowest cost rates in the criteria as the construction category.

(3) Exchange Rates

JICA used September 2023 exchange rates for the Project cost estimate:

- 1 Nepal Rupee (NPR) = 1.11 JPY
- 1 US Doller (US$) = 145.00 JPY
- 1 US$ =131.00 NPR

(4) Price Escalation

JICA used September 2023 price escalation rates for the Project cost estimate:

- Foreign currency portion: 2.71% per annum
- Domestic currency portion: 6.13% per annum

(5) Physical Contingency

JICA used September 2023 physical contingency rates for the Project cost estimate:

- Construction: 10.0%
- Consultant: 10.0%

(6) Tax Rate

JICA used September 2023 tax rates for the Project cost estimate:

- VAT: 13%
- Import tax: 1.0%

Table 15.2.1 Bill of Quantity (1)

(Secret)

Table 15.2.2 Bill of Quantity (2)

(Secret)

Table 15.2.3 Bill of Quantity (3)

(Secret)

Table 15.2.4 Bill of Quantity (4)

(Secret)

Table 15.2.5 Bill of Quantity (5)

(Secret)

CHAPTER 16. IMPLEMENTATION SCHEDULE

16.1 Project Components

The components of the project are listed below.

(1) Civil Work Components

The major civil work components of the project are as follows. Chapters 8 and 9 further discuss them.

Grade-separated Facility

- Total Length : 1,851 m
- Construction of the Underpass within TIA Territory
  - U-shaped Retaining Wall --------------------- L=100 m
  - Tunnel (Box Culvert) ------------------------- L=600 m
- Construction of the Flyover at Tinkune and Jadibuti Intersections
  - Steel Box Girder Bridges ----------------------- L = 245 m (Tinkune), 238 m (Jadibuti)
  - PC-I Girder Bridges ---------------------------- L = 420 m (Tinkune)
- Construction of Earth Section (Approach to Flyover)
  - Tinkune side----------------------- L = 110 m
  - Jadibuti side -----------------------L = 138 m
- Installation of Electrical and Mechanical Facilities for the Underpass
- Pavement for Flyover and Underpass -------------- A = 26,000 m^2
- Miscellaneous Works

At-Grade Road and Intersection Improvement

- Road Improvement for Existing At-Grade Roads ------------- A= 66,000m2
- Construction of Footbridge -------------------------- 1 location
- Miscellaneous Works

(2) Consulting Services

- Detailed Designs
- Tender Assistance
- Construction Supervision

(3) Procurements of Operation and Maintenance Equipment

- O&M Office Building and Tunnel Electric Room, etc.

16.2 Implementation Schedule

The project implementation schedule with the alignment option of TK-2R is estimated as shown in Table 16.2.1 and Table 16.2.2. Major assumptions for setting the implementation schedule are as follows:

- An international contractor with substantial experience of road and bridge projects of a similar nature will perform all construction works.
- The project will procure an international consultant with substantial experience of road and bridge projects of a similar nature to provide close support to the DOR.
- (Secret)
- The works conducted under OLSs may be subject to limitations on their working hours, especially if there is a risk of violating the OLSs area using construction machinery such as cranes for lifting materials, concrete pumping, and sheet pile installation (see Chapter 14 for more details).

Table 16.2.1 Summary of Project Implementation Schedule (Tentative)

Item	Assumed start and duration
Loan Agreement	(Secret)
Procurement of the Consultant	
Detailed Design	
Procurement of the Contractor	
Construction Works	
Defect Notification Period	

Source: JICA Survey Team

Table 16.2.2 Breakdown of Project Implementation Schedule (Tentative)

(Secret)

16.3 Remarks on the Process of Project Implementation

(1) Traffic Regulation and Safety Management during Construction

1) Traffic Safety Management on Existing Roads

The project includes the construction of grade-separated facilities within the existing road spaces along with improvements of the existing roads. The existing roads will have a mix of general traffic and construction vehicles. To ensure traffic safety on the existing roads, the contractor must implement careful traffic management, including placing flagmen at points with an increased risk of accidents.

2) Safety Risk Assessment (SRA)

The project will conduct an SRA form the detailed phase with the support of the consultant to secure safe airport operation during construction works within the TIA land. Its implementation schedule and contents will be determined in coordination with the airport authorities using the following manuals:

- CAAN, Guidance Manual for Conducting Safety Risk Management Activities in Air Traffic Management, July 2018 (1st Edition)

The SRA implementation requires close coordination between the DOR and CAAN/TIA operators.

(2) Compliance of Labor law

The contractor for the project must comply with the Nepal Labor Act, 2074 (2017) (Rule and Regulation for Workers and Employees to the Private Institution and Factory in Nepal) and respect suitable working conditions and local customs when employing workers. Since some underpass works are conducted at night when the airport is not in operation, the contractor must provide carful overtime management for workers while the contractor monitors to prevent accidents at the construction site.

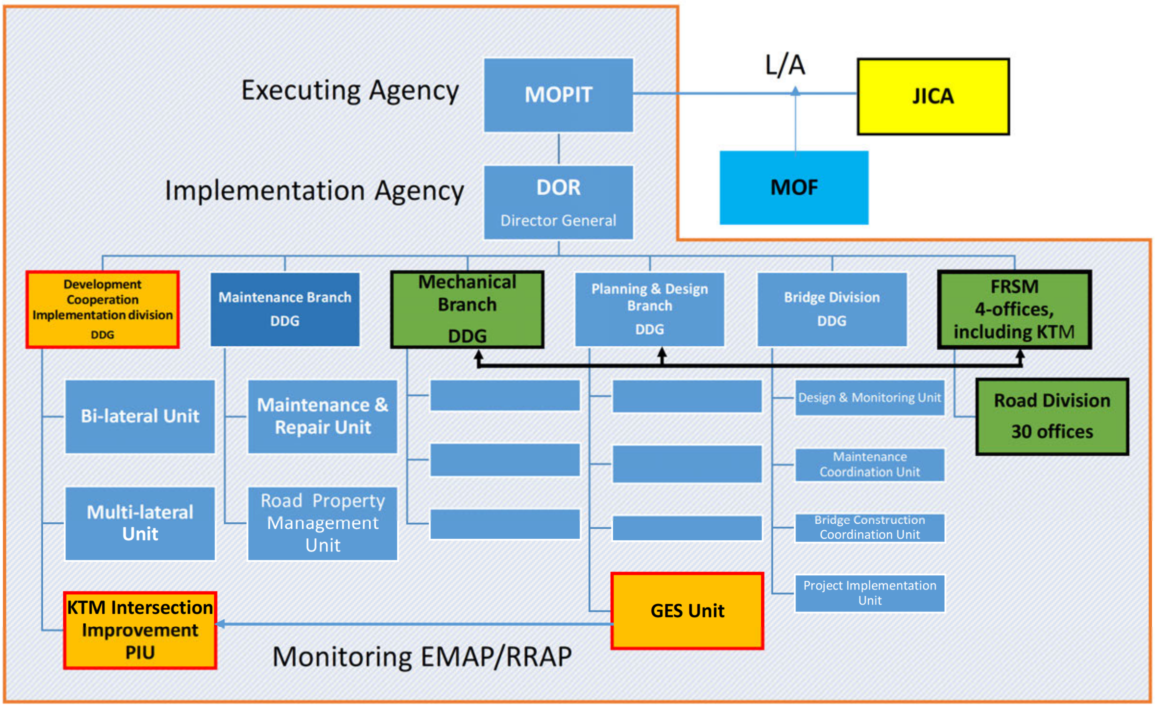
(3) Timely Actions and Coordination of the Nepal Side

The successful and timely implementation of the project depends on proactive actions and coordination by the Nepal side, particularly in securing necessary sites such as land acquisition and compensation for the project roads, the main camp of the contractor, and the machinery and material storage sites. The DOR's initiative is crucial for maintaining the project's implementation timeline to meet the original schedule.

CHAPTER 17. PROJECT IMPLEMENTATION SYSTEM

17.1 Outline of Project Implementation System

The Ministry of Physical Infrastructure and Transportation (MOPIT) will be the executing agency (EA), and the Department of Road (DOR) will be the Implementing Agency (IA) for the project. The DOR will establish a Project Directorate Project Implementation Unit (PIU) under the Development Cooperation Implementation Division in Kathmandu, which is responsible for donor-funded projects except one by ADB and will recruit a consultant for the detailed design and construction supervision for the project in order to support the implementation activities of the DOR smoothly. Figure 17.1.1 shows the proposed implementation organization structure for the project.



Notes : GESU: Geo-Environment and Social Unit,
Source: JICA Survey Team

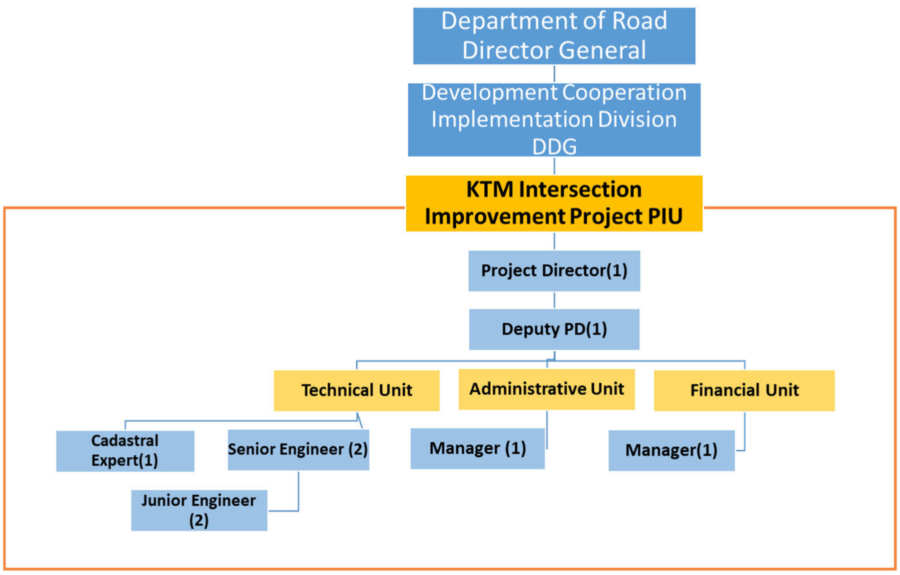
Figure 17.1.1 Proposed Implementation Organization for the Project

The objective of the PIU is to implement the project smoothly and effectively and maintain smooth and timely coordination with project stakeholders to fulfill the responsibilities listed below. Thus, the PIU shall be organized by the internal staff of the DOR, as proposed in Figure 17.1.2. The PIU for the on-going Nagdhunga Tunnel Project financed by JICA has no staff for the environmental and social consideration from the DOR. According to the explanation of the PIU, environmental and social consideration works rely on the consultant staff due to the lack of experienced DOR staff in this field.

As explained, the DOR has implemented many road and bridge improvement, rehabilitation, and construction projects financed by various foreign bilateral and multi-lateral donors, including JICA, which implies that they have sufficient capacity to implement the project. Assigning a well-experienced staff will contribute more to smooth project management and implementation.

Key Responsibilities of PIU

- Procurement of Consultants and Contractors
- Financial management
- Contract administration
- Pre-construction works, comprising a detailed design work, land acquisition within ROW, relocation/resettlement, and acquisition of environmental approval from the responsible agency
- Construction management (traffic safety management, quality and schedule monitoring for contractors and consultant, monitoring of EMP etc.
- Coordination with relevant authorities and stakeholders
- Project evaluation



Note: PIU organization was planned based on ongoing Nagdhunga Tunnel Project

Figure 17.1.2 Proposed Organization Structure of the PIU

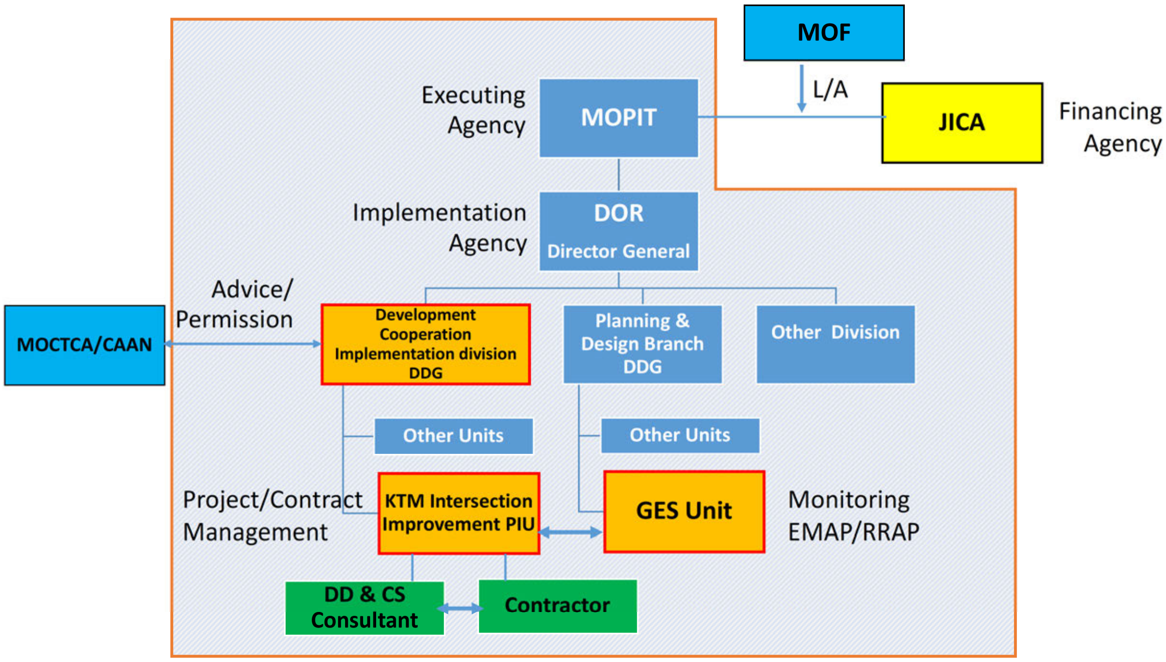
17.2 Method for Project Implementation

As mentioned above, the DOR will recruit an international consultant team for conducting a detailed design, tender assistance, and construction supervision for the project under

International Competitive Bidding (ICB), a common practice in Nepal under Japanese Yen Loan projects. Furthermore, DOR will procure an international contractor or joint venture to construct the project facilities supported by the selected consultant and the bid committee.

Through the detailed design and construction stages, GESU will provide advice on environmental and social issues to both the DOR and the consultant while monitoring the construction activities through reports from the consultant.

During the detailed design and construction stage, the DOR will consult with CAAN under MOCTCA to get permission for the works and their conditions within TIA territory in order to secure the safety of airport operations.



Note: PIU organization was planned based on on-going Nagdhunga Tunnel Project

Figure 17.2.1 Proposed Organization Structure of the PIU

17.3 Project Implementation Schedule

The project implementation schedule is provided in Chapter 14: Construction Planning according to the project implementation method mentioned above and the assumptions listed in Table 17.3.1. Figure 17.3.1 shows the project implementation schedule.

Table 17.3.1 Assumptions for Implementation Schedule(Tentative)

Item	Assumptions
Loan Agreement	(Secret)
Procurement of the Consultant	
Detailed Design	
Procurement of the Contractor	
Construction Works	
Defect Notification Period	

Source: JICA Survey Team

(Secret)

Source: JICA Survey Team

Figure 17.3.1 Project Implementation Schedule

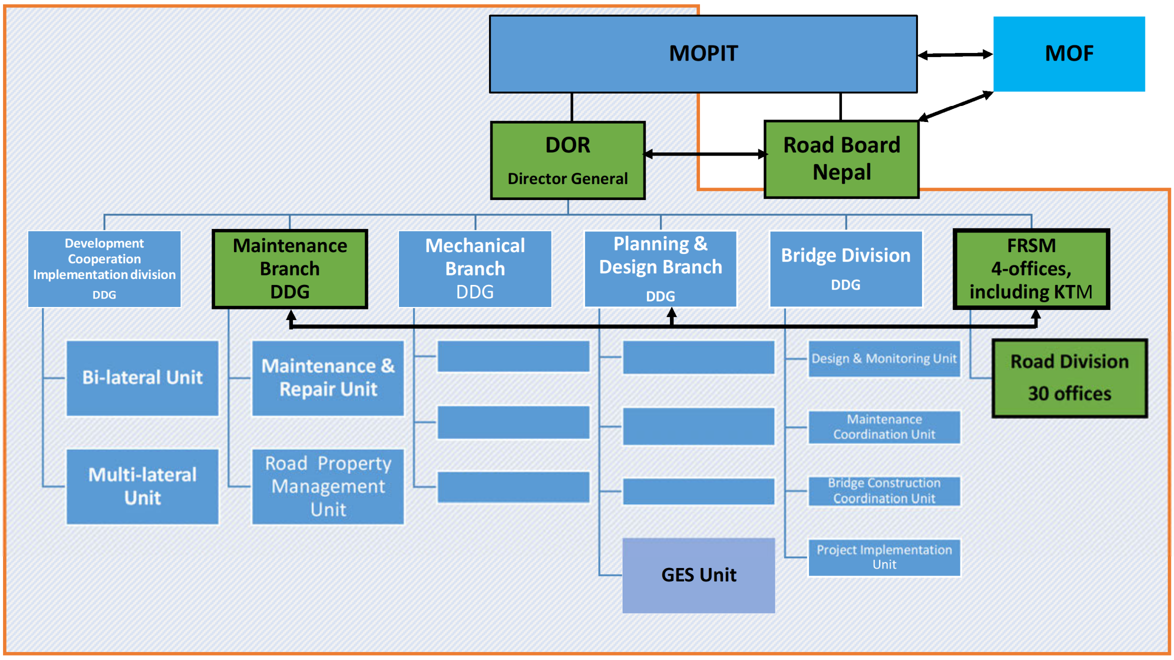
CHAPTER 18. OPERATION AND MAINTENANCE

18.1 Capability of DOR for Operation and Maintenance of the Project Road

18.1.1 Current Practice of Road Operation and Maintenance for SRN

(1) Maintenance System for SRNs in Nepal

Roads and bridges on SRN under DOR have been maintained mainly through the DOR's support capacity for planning and carrying out routine, recurrent, periodic and emergency maintenance using the maintenance budget allocated by Road Board Nepal (see Section 16.1.3 for further details). 33 Division Roads Offices (DRO) conduct these maintenance activities under the monitoring of four Federal Roads Supervision and Monitoring Offices (FRSMO) of the DOR. On the one hand, the role of the Maintenance Branch of DOR is to facilitate the process through policy-level support and overall monitoring. Figure 18.1.1 shows the relation among the players mentioned above and primary roles of each player in the road maintenance work for SRN.



Source: JICA Survey team

Figure 18.1.1 Relation among the Players in Road and Bridge Maintenance for SRNs

DOR Maintenance Branch

- Formulate policies and programs for road and bridge maintenance and send it to the Planning Division of the DOR;
- Prepare the priority list of road and bridge maintenance and make a program, including the Integrated Annual Road Maintenance Program, to implement it;
- Give policy instructions to the FRSMOs to carry out the tasks entrusted to them;
- Coordinate, supervise, monitor and evaluate the activities of the FRSMOs and the DROs in road and bridge maintenance;
- Review the progress reports of road and bridge maintenance projects submitted from the FRSMOs and send them to the Planning Division after checking the targets and the progress;
- Arrange trainings for engineers, oversees and length workers related road and bridge maintenance works.

DOR FRSMOs

- Formulate an annual budget, short-term plan for five years, and long-term plan for 20 years for the road and bridge maintenance plans under its jurisdiction to submit to the Maintenance Branch;
- Monitor the ongoing plans and projects conducted by the DROs under its jurisdiction and prepare the consolidated report after reviewing the reports submitted by each DRO and submit it to the Maintenance Branch;
- Prepare suggestions on the specifications and norms related to the road and bridge maintenance works to recommend them to the Maintenance Branch.

DOR DROs

- Implement and supervise the routine, recurrent, emergency, and periodic maintenance of roads and bridges after procurement of the contractors;
- Conduct laboratory tests for road and bridge maintenance works.

In Kathmandu, there is one FRSMO, named as FRSMO Kathmandu, and 10 DROs belonging to the FRSMO Kathmandu.

The human resources held by both the Division Office and FRSMO Kathmandu are as follows:

FRSMO Kathmandu (total of 13 staffs)

- 1- Superintendent Engineer/Highway Engineer (SDE) as Chief
- 1- Senior Divisional Engineer/Highway Engineer and 2-Junor Engineer
- 4-Administrative and Financial Officer and Assistants

- 1-Computor Operator, 2-Dirvers and 4-Office Keepers

Division Road Office in Kathmandu (total of 13 staffs)

- 1- Senior Divisional Engineer/Highway Engineer as Chief
- 5-Highway Engineer, 10-Junior Engineer, 1-Lab Officer and 1-Lab Technician
- 4-Administrative and Financial Officer and Assistants
- 1-Computor Operator, 3-Dirvers and 3-Office Keepers

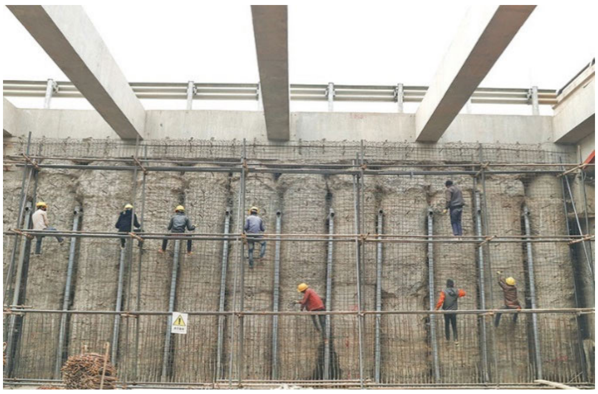
Although the practice of the performance-based road maintenance scheme was introduced in Nepal in 2003 and has been implemented alongside road improvement and rehabilitation projects, the maintenance period has been limited to only five years after the completion of the improvement and rehabilitation works. Currently, no roads in Kathmandu have had the performance-based road maintenance method applied.

18.1.2 Technical Capability

(1) Operation and Maintenance of Underpass and Tunnels

In Nepal, there is only one underpass road at Kalanki on the Ring Road, opened in 2018 and funded by China. As shown in Figure 18.1.2, this underpass consists of a short box culvert section of approximately 20 m in length, with U-shaped retaining wall. The remaining section, totaling 800 m, has retaining walls either with or without ribs.Interestingly, the underpass was constructed using a cast-in-place pile wall, and the surface walls do not serve as structural members.

Because the box culvert section in the underpass is relatively short, it lacks facilities such as lighting, firefighting, and smoke exhaust, as do the U-shaped wall sections. Consequently, the maintenance requirements for this underpass are similar to those of regular national highways.



Source: JICA Survey Team

Figure 18.1.2 Overview of the Kalanki Underpass

Furthermore, Nepal's first road tunnel, the Nagdhunga Tunnel, which spans two lanes and is 2.69 km long, is currently under construction with the assistance of the Japanese Yen Loan.

Given that the Nagdhunga Tunnel will be equipped with i) jet fan, ii) lighting system, iii) power supply and distribution system, and iv) communication system, all of which are the same as those for installation in the underpass of the project road, the technical expertise of the DOR involved in the operation and maintenance of the Nagdhunga Tunnel can be leveraged for the operation and maintenance of the project's underpass.

(2) Operation and Maintenance of Bridges

In Nepal, while there are numerous concrete bridges across the country, the number of steel bridges is limited. These steel bridges are used for long-span sections over intersections in the project, particularly at the crossing points of large rivers in rural areas. As a result, the DOR has limited experience and knowledges regarding the maintenance of steel bridges, including inspection and repairing methods, and ensuring safe maintenance practices under heavy traffic conditions. Therefore, it is recommend that incorporating a capacity development program to inspect, evaluate, and repair steel bridges as part of the project. This program may include the preparation of a manual for steel bridge maintenance.

18.1.3 Financial Capability

(1) Budgeting Process and Disbursement Results

As described in Chapter 2, the primary funding source for road and bridge maintenance is the RBN. However, the current funding sources are a combination of the annual government budget allocation and grants and loans from development partners. Table 18.1.1 shows the fund allocations for road and bridge maintenance to the responsible agencies. In recent years, an annual fund of approximately 36 to 55 million USD per year has been made for the SRN.

In order to receive the maintenance fund, Responsible Agencies (RAs) present an annual program on maintenance of the roads that plans to repaired and maintained each year, setting out the necessary funds needed according to the board's pre-approved criteria. The Executive Committee of RBN reviews the annual programs and prepares an Integrated Annual Program for road network maintenance. After receiving an integrated annual program from the DOR and the municipalities, RBN integrated a program specifying the nature of RAs' responsibilities. The process of finalization of maintenance fund has been changed based on the long experience of maintenance funding.

Table 18.1.1 Fund Allocation for Road Maintenance to Responsible Agencies from 2016/17 to 2019/20

FY	RAs	Program Approved (NPR)	Fund Disbursement		Spending Rate
			(NPR)	(USD)	
2016/17	DOR	5,636,651,269	4,505,336,219	38,449,744	80%
	DDC	273,533,590	233,340,420	1,991,390	85%
	MUS	668,373,674	519,410,312	4,432,786	78%
	Sub-total	6,578,558,532.71	5,258,086,951	44,873,920	80%
2017/18	DOR	5,099,363,710	4,588,537,331	37,571,555	90%
	DOLIDAR	14,860,000	10,575,405	86,593	71%
	MUS	782,705,666	640,077,874	5,241,043	82%
	RMUS	14,606,043	12,089,856	98,993	83%
	Sub-total	5,911,535,419	5,251,280,466	42,998,184	89%
2018/19	DOR	4,893,494,145	4,564,174,051	36,705,366	93%
	DOLI	5,000,000	956,664	7,694	19%
	MUS	1,032,416,256	858,608,334	6,904,980	83%
	RMUS	99,081,800	91,911,776	739,160	93%
	Sub-total	6,029,992,201	5,515,650,825	44,357,200	91%
2019/20	DOR	6,862,228,080	6,488,039,015	54,730,027	95%
	DOLI	80,000,000	1,170,675	9,875	1%
	MUS	493,327,783	257,638,786	2,173,319	52%
	RMUS	56,280,139	40,249,147	339,523	72%
	Sub-total	7,491,836,002	6,787,097,623	57,252,744	91%

Source: Annual Progress Report, FY76/77, RBN
Note: DDC: District Development Committees, MUS: Municipalities, RMUS: Rural Municipalities

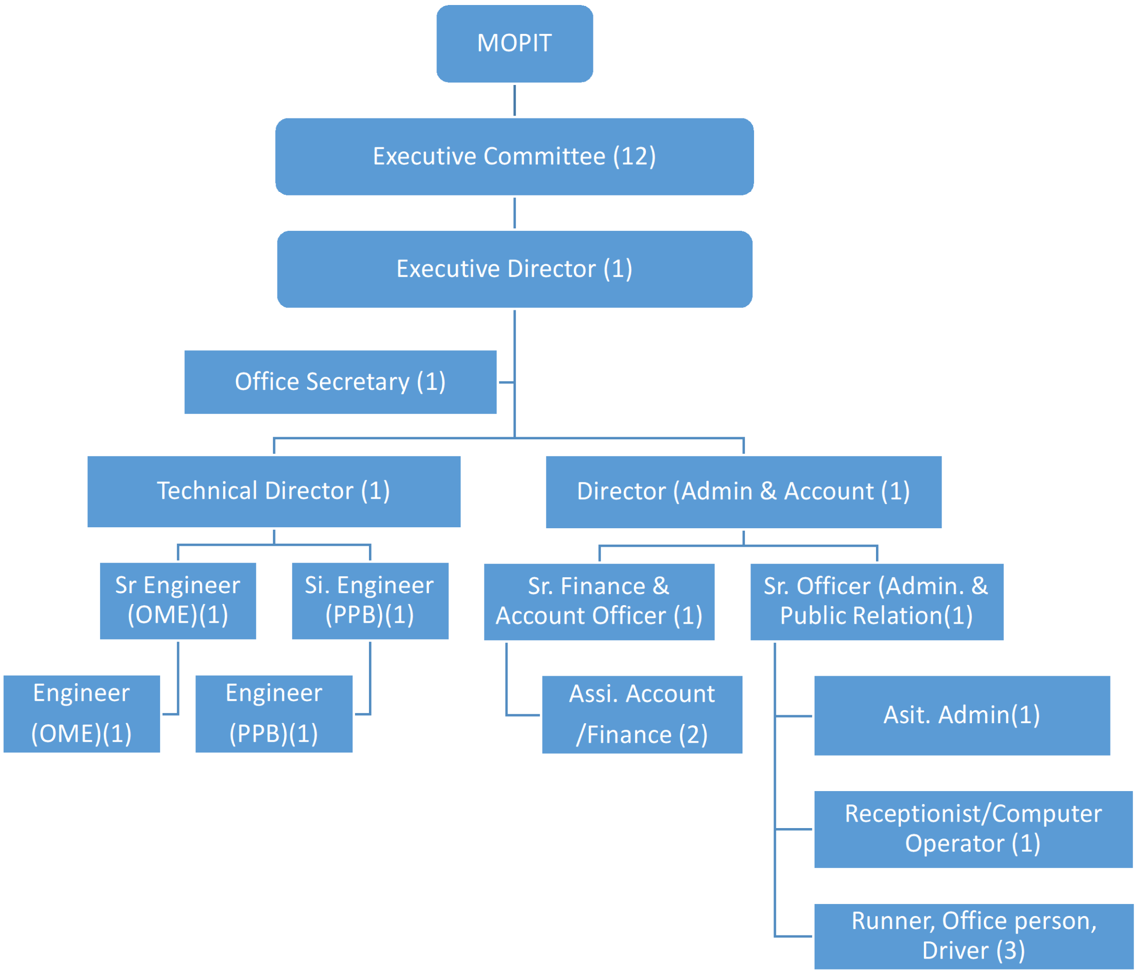
(2) Issues on Maintenance Fund

While the total financing for road maintenance has been increasing in Nepalese Rupees (NRP) and has risen by 29% from 2016/17 to 2019/20, there are still some issues with road maintenance funding in Nepal.

Firstly, there is a significant funding gap between the estimated requirements based on road conditions and length and the actual funds allocated. For example, the annual funding allocation for SRN maintenance has fallen short of the annual requirements in the past five years by an average of 60%. In contrast to the average annual requirement of NPR 14 billion, the available funding has average NPR 4 billion annulaly. Therefore, the RBN and the MOPIT need to explore additional sources of finance to support road maintenance.

Secondly, there is a need to enhance the spending efficiency for maintenance by responsible agencies. Of the budget allocated, the actual disbursement by the RBN averaged 88% between 2016/17 and 2019/20 for all road network, representing an improvement from the average 81% from 2012/13 to 2017/18. As analyzed in the Nepal Infrastructure Sector Assessment by the World Bank in 2019, this improvement is due to the weak procurement capacity, contract management, and implementation. However, the DOR appears to be the most capable one for road maintenance implementation among the RAs.

Thirdly, insufficient staff members totaling to 17 hinder the effective and efficient works by the RNB, as shown in Figure 18.1.3.



Source: Annual Progress Report, FY76/77, RBN

Figure 18.1.3 Organizational Chart of RBN

(3) Affordability of Maintenance Budgets for the Project Roads and Facilities

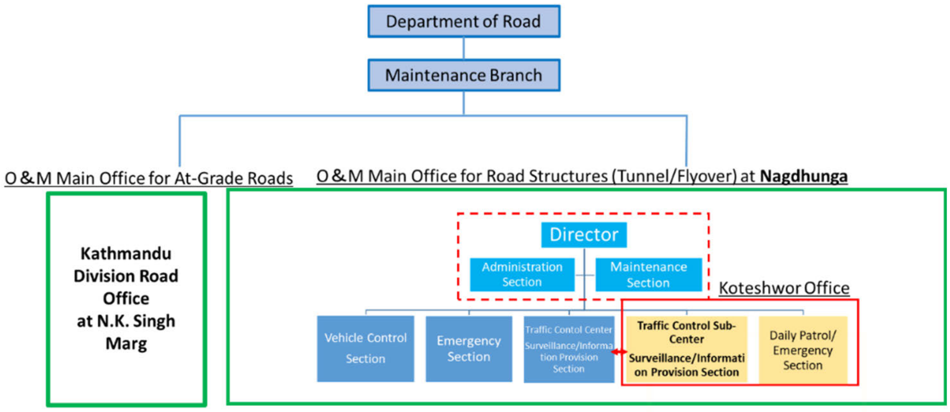
According to the most recent data on the maintenance fund allocated to the DOR, as shown in Table 18.1.1, approximately 6.5 billion NPR was allocated to the DOR in the 2018/19 period. On the other hand, the operations and maintenance cost for the project roads is estimated at (Secret), which accounts for (Secret) of the total budget. Therefore, the newly required O&M cost for the new project facility is considered affordable.

18.2 Proposed Operation and Maintenance System for the Project Facilities and Roads

Considering the difference in the commencement time of operation between the Nagdhunga Tunnel operation and maintenance (O&M) office, expected in 2025, within the Kathmandu Valley, and the project roads, expected in 2028, it is valid to assume that the O&M team for the Nagdhunga Tunnel has already gained some experience in tunnel O&M, which are of a similar nature to the works required for the project's underpass road.

In addition, given the scale and length of the Nugdhunga Tunnel, a relatively large O&M team is being planned there, as per the interview with the DoR. Considering the proximity of both road sections, it is proposed that the O&M team for the project roads should be integrated into the Nagdhunga Tunnel O&M organization, as shown in Figure 18.2.1. The delienation of the roles for the Nagdhunga Tunnle Mail Office, Koteshwor Office, and Kathmandu Division Road Office are as follows:

- The Maintenance Section is responsible for inspection and maintenance activities for both the Nagdhunga Tunnel and the Project grade-separated facilities comprising underpass and flyovers because of the similarity of the works, and its main office shall be located in the Nagdhunga Tunnel office together with necessary equipment and devices.
- The Koteshwor sub-office will be constructed near the project grade-separated facilities with functions of only surveillance and information provision to the road users passing through the underpass and flyovers, as well as in preparedness of emergency case while coordinating with traffic police and fire station, such as road accidents and fires in the tunnel section. In addition, the Koteshwor sub-office should be equipped with a traffic monitor room along the grade-separated facilities, sharing the vehicle behaviors with the Nagdhunga main office in order to send the necessary resources in case of emergency to the project roads.
- The Koteshwor sub-office will establish close coordination with traffic police, the fire-fighting office, and hospitals with nearby ambulances to request the dispatchment of resources and equipment during an emergency. Coordinating with the TIA, who owns ambulances and fire-fighting vehicles, is a good idea.
- Kathmandu Division Road office is in charge of operation and maintenance for the at-grade road sections of the project roads, same as other national highways and within the Kathmandu Valley, considering the organization.



Source: JICA Survey Team

Figure 18.2.1 Proposed O&M Organization for the Project Roads

18.2.1 O&M Activities for Tunnel Section

(1) General

Major operation and maintenance activities for the tunnel section are classified as follows:

1) Tunnel inspection
2) Maintenance of the tunnel structure and facilities
3) Monitoring of traffic movement, traffic accident, and fire incident within the tunnel
4) Emergency actions in the event of accidents or incidents

(2) Tunnel Inspection

Inspection of the tunnel section must be undertaken on a daily or periodically basis by an O&M team in order to check the following items:

- Tunnel facilities (lighting and emergency facilities etc.)
- Obstacles on road surface
- Cleanliness/damages of the tunnel wall, lighting facility and emergency facility
- Damages/deformations of the tunnel wall (cracks, water leakage and deformation etc.)
- Drainage facility
- Any other problem

Table 18.2.1 shows the details of the tunnel inspection items.

Table 18.2.1 Tunnel Inspection Items

Component		Inspection Items
Tunnel structure	Concrete structure	(1) Cracks, (2) Water leakage, (3) Free lime, (4) Deformation/damage
	Drainage	(1) Clogging, (2) Damage
Tunnel facilities	Lighting facilities	(1) Lighting intensity/conditions, (2) Heating of distribution board, (3) Looseness and damages of wire
	Emergency facilities	(1) Facility Conditions (Dirt/damages), (2) Facility performance, (3) Signal reception status, (4) Heating/noise of control panel

Source: JICA Survey Team

(3) Tunnel Maintenance

Table 18.2.2 lists the tunnel maintenance activities. These activities should be implemented based on the results of tunnel inspection.

Table 18.2.2 Tunnel Maintenance Works

Component		Maintenance Works
Tunnel Structure	Concrete Structure	(1) Wall cleaning, (2) Crack sealing, (3) Water leakage prevention, (4) Joint repair, etc.
	Drainage	(1) Cleaning, (2) Repair, etc.
Tunnel Facilities	Lighting Facilities	(1) Cleaning, (2) Lamp replacement, (3) Stability check (Lamp condition), etc.
	Emergency Facilities	(1) Cleaning, (2) Operation check, (3) Parts replacement, etc.

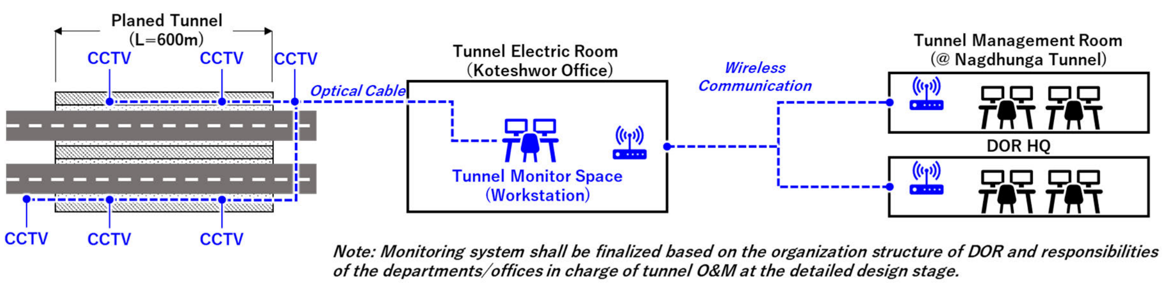
Source: JICA Study Team

(4) Tunnel Monitoring

According to the Japanese Standard, the planned tunnel section in the project is Class-A based on the traffic volume and tunnel length. Since the tunnel section has a heavy traffic flow, CCTVs along the tunnel is desirable to monitor the traffic flow and the status of accidents and disasters. The information on the CCTVs is transmitted to a monitoring PC (workstation) installed in the tunnel electrical room, and the O&M team must monitor the situation in the tunnel shall for 24 hours. In addition, the information on the CCTVs can be shared wirelessly with the tunnel management office of the Nagdhunga Tunnel or the DOR HQ so that necessary responses and actions can be taken quickly and appropriately in the event of accidents or disasters in the tunnel (see Figure 18.2.2).

Tunnel monitoring shall focus on the following items:

- Reckless driving, overtaking, over speed, traffic jam
- Stopped vehicles, broken-down vehicles
- Obstacles
- Traffic accidents, fire incidents



Source: JICA Survey Team

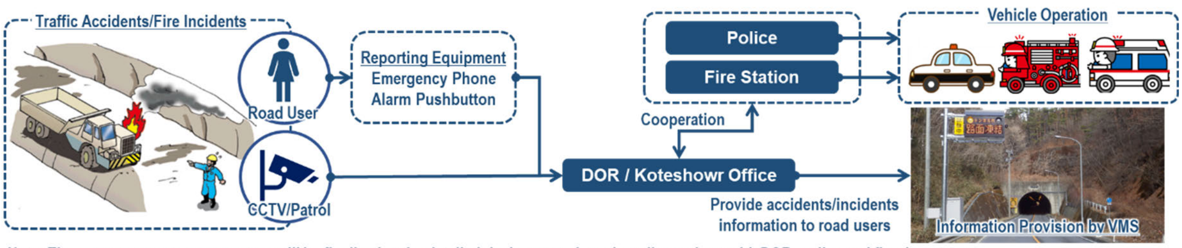
Figure 18.2.2 Tunnel Monitoring System

(5) Emergency Actions in the Event of Accidents/Incidents

The O&M team at the Koteshwor Office must promptly respond to any accidents or incidents discovered by the O&M team or reported by road users, including assessing whether it is necessary to inform the nearby fire station and/or police. Major potential accidents and incidents in the tunnel section are as follows:

- Traffic accidents
- Fire incidents
- Break-down vehicles
- Obstacles

Figure 18.2.3 shows the emergency response in the event of accident or incident.



Note: The emergency response system will be finalized at the detailed design stage based on discussions with DOR, police and fire department.
Location map of the Koteshowr Office (O&M Team Office) is shown in Chapter 10.

Source: JICA Survey Team

Figure 18.2.3 Emergency Actions in the Event of Accident or Incident

(6) Human Resources and Equipment/Devices for Tunnel O&M

Table 18.2.3 Table 18.2.2and Table 18.2.4 list the human resources and equipment and devices required for tunnel O&M at the Koteshwor Office. The nearby fire station and hospital will provide the emergency equipment and devices, such as fire trucks and ambulances. To ensure this, the DOR should make prior arrangements with these organizations. It is advisable for the DOR to consult with CAAN/TIA regarding the deployment of fire trucks and ambulances owned by these organizations.

Table 18.2.3 Human Resources for Tunnel O&M

Responsibilities	Number of Staff	Remarks
Tunnel Maintenance	5 staff (Conducted by O&M Team of Nagdhunga Tunnel)	- Civil Engineer: 2 staff - Electrical Engineer: 1 staff - Mechanical Engineer: 1 staff - Communication Engineer: 1 staff
Tunnel Patrol	4 staff × 3 team = 12 staff	including for emergency actions in the event of accidents/incidents
Tunnel Monitoring /Information Provision	2 staff × 3 team = 6 staff	
Vehicle Control	2 staff × 3 team = 6 staff	

Source: JICA Survey Team

Table 18.2.4 Equipment/Devices for Tunnel O&M

Category	Equipment/Devices	No. of Unit	Remarks
Tunnel Maintenance	Road Sweeper	1	To use the equipment owned by the Nagdhunga Tunnel management office.
	Wall Cleaning Vehicle	1	
	Water Supply Equipment for Cleaning	1	
	Aerial Work Platform	1	
	Station Wagon	1	
	Inspection Machinery and Tools	1 set	
Tunnel Patrol	Patrol Car	2	
Tunnel Monitoring /Information Provision	CCTV	6	
	Monitoring Device (Workstation + Monitor)	1 set	
	VMS	2	
Emergency Actions	Towing Vehicle	2	
	Trucks with Air Jack	2	
	Fire Trucks	―	Arranged by fire station
	Ambulances	―	Arranged by fire station
	Police Vehicles	―	Arranged by police station

Source: JICA Survey Team

(7) Traffic Regulations in Tunnel

In accordance with Article 46, Paragraph 3 of the Road Law in Japan, road administrators have the authority to prohibit or restrict the passage of vehicles carrying hazardous materials in undersea tunnels and similar tunnels (long tunnels with a length of 5,000 m or more). This operation measure aims to reduce the impact (risk) on tunnel users and the surrounding environment resulting from accidents and disasters inside the tunnel. Road administrators are required to consider and implement measures for safe tunnel operation.

Since the planned tunnel of the project passes through the land within the airport, accidents and disasters inside tunnel might affect to airport operation. In order to reduce the impact (risk) on road users and the surrounding environment due to accidents and disasters in the tunnel, it is necessary to discuss the importance of traffic restrictions for vehicles carrying hazardous materials with the DOR and related organizations during detailed design.

18.3 Operation and Maintenance Costs Estimate for the Project Roads

The cost estimate for future operation and maintenance will only cover the new road structures and facilities, including the underpass and flyover structures. This is due to the fact that there are minimal changes in specifications and facilities for the at-grade road sections to be improved in the project, as compared to the existing situation.

Table 18.3.1 shows the operation and maintenance costs for the underpass section of the project roads for 20 years after starting its operation, including the average O&M expense per year.

Table 18.3.1 Tunnel O&M Costs

Items	
Staff Cost working for O&M office	(Secret)
Electricity Cost	
Tunnel Maintenance Cost	
Total (20 years)	
O&M expense per year	

Source: JICA Survey Team

The O&M cost for the FO section can be estimated using the past O&M expense data from Japan[1]. Considering the difference in the labor cost, the average FO O&M cost can be estimated as follows:

(Secret)

The estimated average FO O&M expense per year is at (Secret) .

As a result, the total O&M cost for the GS section per year shall be:

(Secret)

[1] Analysis on maintenance cost and case studies of urban expressways in Japan and USA, 2015, JSCE

CHAPTER 19. ENVIRONMENTAL AND SOCIAL CONSIDERATIONS

19.1 Environmental and Social Considerations

19.1.1 Project Overview

(1) Project Overview

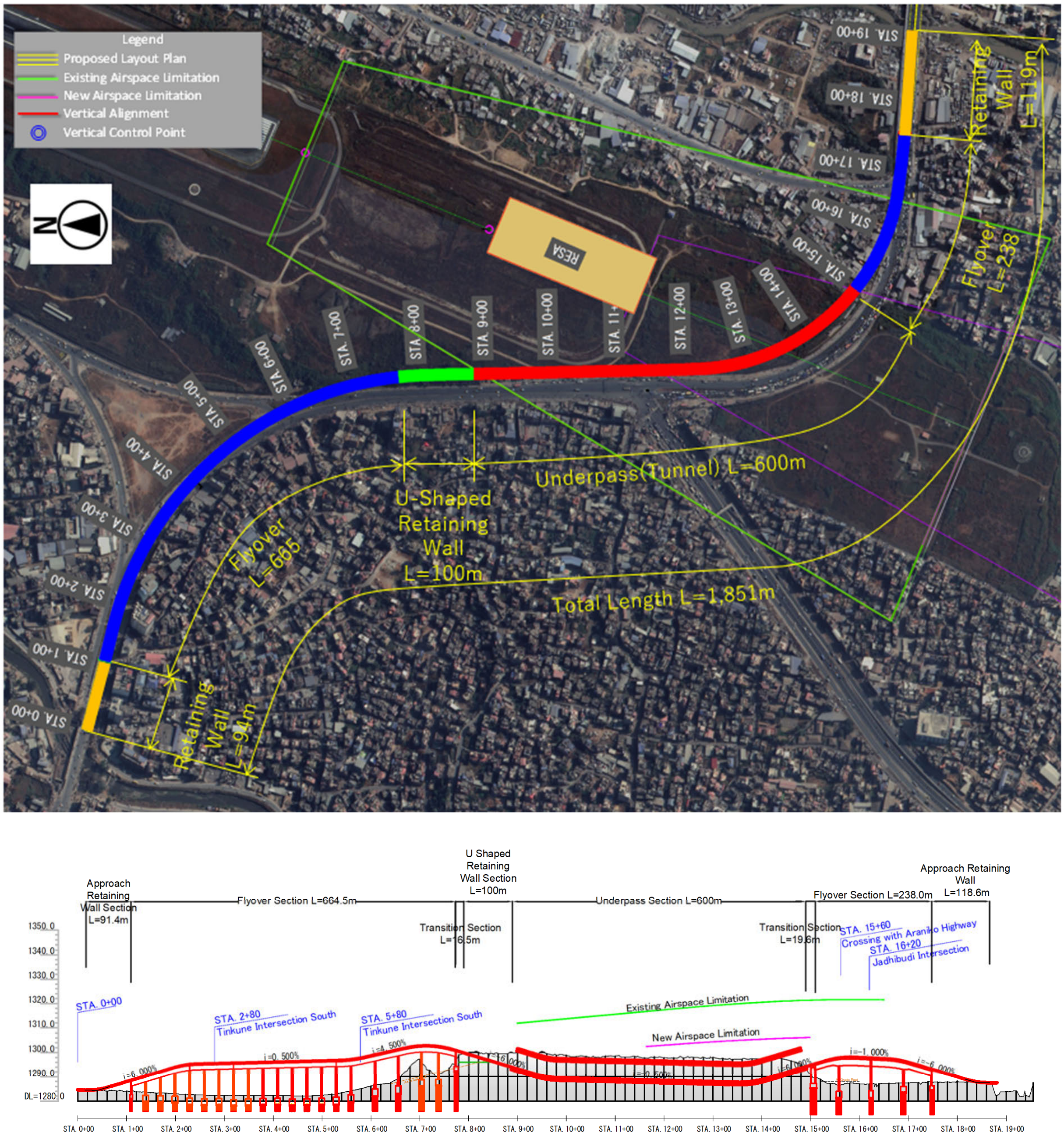
Table 19.1.1 Project Overview

Project name	Koteshwor Intersection Improvement Project
The purpose of project	By improvement of the intersections Tinkune, Koteshwor and Jadibuti, by grade separated structures, the Project enhances traffic flow improvement and mitigates traffic congestion in Kathmandu city (especially in the eastern part of Kathmandu valley and the inner city), which consequently contributes to regional economic growth and environmental improvement.
Target Area	Kathmandu District, Bhaktapur District, and Lalitpur District
Stakeholders	• Department of Roads (DOR), Ministry of Physical Infrastructure and Transport (MOPIT) • Civil Aviation Authority of Nepal (CAAN), Ministry of Culture, Tourism and Civil Aviation (MOCTCA) • Traffic Police • Kathmandu Valley Development Authority (KVDA), Ministry of Urban Development • Kathmandu Metropolitan Municipality
Province, District, Municipality, Ward No.	Bagmati Province, Kathmandu District, Kathmandu Metropolitan Municipality, Ward No. 32
Total Length	1851.2m
Type of Work	New Construction of the Grade Separated Structure and Improvement of the At-grade existing roads
Number of Lanes	4 lanes (2 lanes for each direction) for the GS section
Design Speed	50 km/hour
Surface Type	Concrete for UP and Asphalt Concrete for the GS and AG roads
Improvement of Intersections	3 locations (Jadibuti, Koteshwor, Tinkune)
Design Traffic	Future traffic demand on the GS structure: 88,486 pcu/day in 2033
Underpass Section	TIA Land
Underpass Length	700m at underground of Airport premises at Koteshwor
Road lanes inside Underpass	3.25 m x 2 lanes at each direction
Type of Underpass	U-shaped Retaining Wall and Box Culvert type 9.5m x 2 with 1.5 to 2.0m median
Pedestrian Allowance	No
Flyover Section – 1	Jadibuti side
Flyover Length	238m from Manohara River Bridge
Road lanes in Flyover	3.25 m x 2 lanes at each direction
Type of Flyover	Steel Narrow Box Girder with 15.5m of the total width
Flyover Section – 2:	Tinkune side
Flyover Length	664.5m
Road lanes in Flyover	3.25 m x 2 lanes at each direction
Type of Flyover	Steel Narrow Box Girder and PC-I Girder with 15.5m of the total width

Source: JICA Survey Team

Source: JICA Survey Team

Figure 19.1.1 Location of the Project



Source: JICA Survey Team

Figure 19.1.2 The Alignment to be Improved

(2) Impacts to be Investigated and Considered

In addition to the direct and immediate impacts of the preparation, construction and operation of the improved road and intersections under the Project, the derivative, secondary, and cumulative impacts as well as impacts associated with indivisible projects are also to be examined and assessed, so far as it is rational. The impacts through a project life cycle are also considered.

Planned road-widening work with mounding is scheduled for the stretch between Jadibuti intersection and Manohara River. This work is led by DOR and is independent of any assistance from JICA. The road-widening by DOR is required for the Project but would proceed even if the Project funded by JICA were not in place. Therefore, according to the JICA Guidelines, the road-widening by DOR is not considered as an "indivisible project" of the JICA-funded Project, and its impacts do not need examination and assessment under the Project.

However, there is a slight chance that the road-widening work may be carried out under the JICA-funded project, especially if there are delays in DOR's road-widening. In such instances, the report will also examine the impacts of DOR's road-widening activities, including land acquisition and resettlement on the northern side of the alignment section (see Section 19.2.4(2) for reference).

(3) Indivisible Projects and Projects with Derivative, Secondary, and Cumulative Impacts

As shown in "2.4 Relevant Development Plan and Program,"

19.1.2 Status of Natural and Social Environment

(1) Natural Environment

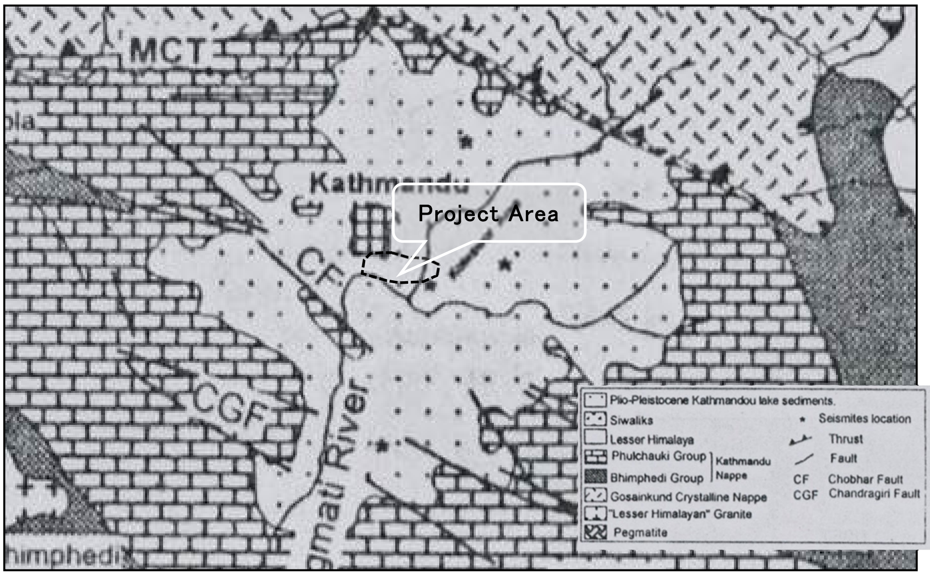
1) Topography

The proposed Project area is located in Kathmandu valley. The present road runs from Tinkune of Kathmandu Metropolitan Municipality's Ward No. 32 and ends at the Manohara River, which is the boundary river between Kathmandu and Bhaktapur districts. The total stretch of the Project road is 1.8512 km in length. The general topography of the area is more or less plain terrain. There are no unique, fragile or difficult topography, elevations and slope characteristic to this area. The road alignment passes through plain lake deposit of the valley.

2) Geology & Soil

The geology of the Study area represents the Kathmandu complex of the lesser Himalayas. Whole study area lies in Lake deposit alluvium unconsolidated ordinary soil. Alluvium deposits are found in some stretches. The road, in most of the sections, passes through the cultivated farmland with deeper thickness of colluvium soil. The geology of this area indicates the existence of slate, phyllite, schist, quartzite, limestone, dolomite, etc.

The Project area consists of recent river terrace deposit. The deposit consists of fine-medium sand and gravels. The cut face of the soil, hence, seems to be stable. The area consists of gneiss and schist of argillaceous formation. (Refer Figure 19.1.3).



Source: Engineering, Environmental and Geological Map of Kathmandu Valley, Scale 1:50,000, 1996b

Figure 19.1.3 Geological Map of Project Area

3) Natural Hazards

Earthquakes, landslides and river flooding are some of the natural hazards that can be expected within the Project area. The Kathmandu Valley lies within the seismically active Himalayan belt and has witnessed a number of catastrophic earthquakes. The risk of earthquake for infrastructure development is unavoidable. The risk of landslides within the Project area is not very high since the road lies within the flat terrain.

4) Climate

The climate of the Project area is sub-tropical. The Climatological data of nearby station, Kathmandu Airport (Index No.1030), shows that the average mean annual temperature is 18.67 °C. The average means annual maximum temperature recorded is 25.04°C and average mean annual minimum temperature is 11.83°C, for the year 2020.

5) Hydrology

Two distinct seasons, rainy and dry seasons, exists within Kathmandu Valley and also within the Project area. The hydrology of the Project is strongly affected by the monsoon climate. Usually more than 80 percent of precipitation falls during the monsoon period. The rainfall data recorded by meteorological station Kathmandu Airport (Index No.1030) shows the annual precipitation is 1755.35 mm for the year 2022.

6) River system

The major rivers systems that come across the Project area are the Manohara and Bagmati river systems. The general features are as below:

Table 19.1.2 Major Rivers in the Vicinity of the Project Area

SN	Name of River	General Features	Catchment Area
1	Manohara River	-Seasonal river -Dry season min. discharge ~ 0.7 m^3/sec -Wet season discharge ~ $5m^3$/sec.	Approx. 25 km^2 including Project site
2	Bagmati River	-Seasonal river with many tributaries -Dry season min. discharge ~ 0.5 m^3/sec -Wet season discharge ~ $9m^3$/sec.	Approx. 35 Km^2 including Project site

Source: Field Study, August 2022, JICA Survey Team

7) Protected Areas and Rare and Endangered Species

No protected areas exist along the project alignment, and no habitats for rare or endangered species are found there either.

8) Social Environment

The project-affected area along the project alignment includes various types of land ownership and usage. This includes land owned by DOR, which is used as the ROW for existing roads. Additionally, the Civil Aviation Authority of Nepal (CAAN) owns land that is part of Tribhuvan International Airport. The government owns the plots in the triangular-shaped area at the Tinkune intersection, which serves as an open area for gatherings and sports activities; it doesn't have any permanent structures. In Jadibuti and Tinkune, land plots adjacent to the existing ROW are owned by both private owners and government agencies. These plots contain buildings with single and multiple stories, serving various purposes such as residences, offices, shops, and factories.

No cultural or historical heritage sites, nor indigenous communities, are found in or around the planned alignment of the Project.

2,444m^2 (0.2444ha) of privately owned land needs to be acquired for the Project. Seventy-nine people of 18 families in the Jadibuti area will be involuntarily resettled/affected by the Project with acquisition of the land plots they reside. Details of the land acquisition, involuntary resettlement and socio-economic status of the project affected people are described below in Section 19.2 (Abbreviated Resettlement Action Plan).

19.1.3 Legal Framework and Institution for Environmental and Social Considerations in Nepal

(1) Nepali Legal Framework for Environmental and Social Considerations

Government of Nepal has developed a range of environmental policy & legal frameworks. Most of the national policies and laws of the Government of Nepal (GON) are in favor of environmentally sound economic development and growth. Essential laws and regulations for the proposed Projects are summarized in Table 19.1.3.

Table 19.1.3 Overview of Environmental Management Legal Frameworks in Nepal

Category	Topic	Laws and Regulations	Authority
Constitution	Protection of environment Property rights Human rights	Constitution of Nepal, 2072 (2015)	Gov. Nepal
Principal environmental law	EIA / IEE	Environmental Protection Act, 2076 (2019) Environmental Protection Rules, 2077 (2020)	MOFE
		Environmental and Social Management Framework, 2064 (2007)	GESU(DOR)
Pollution prevention	Environmental Standards	Nepal Gazette, B.S. 2060/4/19 (4 August 2003) (Air), Nepal Gazette, B.S. 2054/9/8 (Gas emission from vehicles) Motor Vehicle and Transportation Management Act, 2050 (1993)	MOFE, MOPIT
	Soil disposal	Environmental and Social Management Framework, 2064 (2007)	DOR/GESU
	Waste control	Environmental and Social Management Framework, 2064 (2007)	DOR/GESU
Natural environment	Forest clearance, Biodiversity conservation	Nepal Forest Guidelines, 2063 (2006) Forest Products Collection & Sales Distribution Guidelines, 2058 (2001) Watershed Conservation Rule, 2042 (1985) Local Self-Governance Act, 2056 (1999)	MOFE, Local Government
	Underground water	None	N/A
	Rivers	Water Resources Act, 2049 (1992) Local Self-Governance Act, 2056 (1999)	MOWS, Local Government
	Nature conservation	National Parks and Wildlife Conservation Act, 2030 (1973) Soil and Watershed Conservation Act, 2039 (1982)	MOFE
Cultural heritage	Conservation of cultural heritage	Ancient Monument Protection Act, 2013 (1956) Ancient Monuments Preservation Rules, 2046 (1989)	MOCTCA

Source: JICA Survey Team

1) Constitution of Nepal

In the Constitution of Nepal, Article 16 (1) human rights related to environment and health; Article 27 related to right to information,; Article 35 (5) related to priority to the prevention of adverse impacts in the environment from physical development activities, protection of the environment and special safeguard of the rare wildlife, protection and sustainable use flora/ fauna and biological diversity; Section 13, Part 3 related to equal treatment of citizens and provisions by law for the protection, empowerment or advancement of women, Dalits, indigenous people (Adivasi/ Janajati); Article 19 related to Rights to Property, compensation to acquired property.

2) Environmental Protection Act, 2076 (2019)

Environmental Protection Act, 2053 (1997) (EPA1997) was amended by the Environmental Protection Act (EPA), 2076 (2019) (EPA2019), which requires a proponent to undertake, either (i) Brief Environmental Study, (ii) IEE or (iii) EIA of the proposed project and have the Reports approved by the concerned sector agency, respectively, prior to its implementation. EPA2019 stresses following points:

- Set out the review and approval process of IEE and EIA Reports that involve informing and consulting stakeholders.
- Stipulate that no one is to create pollution that would cause significant adverse impacts on the environment or harm to public life and health, or to generate pollution beyond the prescribed standards.
- Specify the Ministry in charge of environment (currently the MOFE) to conduct inspection of approved projects to ensure that pollution prevention, control or mitigation is carried out according to the approved IEE or EIA Report.
- Provide for the protection of objects and places of national heritage and places with rare plants, wildlife and biological diversity.
- State that any person/party affected by pollution or adverse environmental impact caused by anybody may apply to the prescribed authority for compensation to be recovered from the polluter/pollution generator.
- The Act mandates several compliances to Project Developers while developing a Proposal of a Project, to ensure that the implementation of the Project does not harm the environment.
- The Act has also redefined certain terms so that the definitions are more comprehensive. For instance, “Pollution” has been redefined so as to include waste, chemical, heat, sound, electronic, electronic magnet or radioactive radiation that significantly degrade, damage the environment or harm the 40 beneficial or useful purposes of the environment by changing the environment directly or indirectly.
- Further, the Act explicitly authorizes the Government of Nepal to set standards to reduce and regulate emission, hazardous waste, and pollution emitted by vehicles, equipment, industries, hotels, restaurants and other institutions or activities.

3) Environmental Protection Rules, 2077 (2020)

After the enforcement of the EPA2019, the environmental protection rules (EPR2020) accordingly repealed previous EPR1997 as per the EPA1997. EPR2020 became effective from 15th June 2020 and obliges the project proponents to perform environmental assessments as per Schedules 1, 2 and 3. Rules have defined thresholds for environmental assessment under 3 categories; Brief Environmental Study, IEE and EIA.

It has defined the roles of the provincial government and the local government as well in the process of environmental assessment of development projects. The legal regime on the environment makes every effort to integrate environmental aspects in the Projects and programs.

As per the criteria specified under Schedule 2 and Schedule 3, of the EPR, 2020, the following threshold criteria have been set for the construction of transportation related infrastructure.

Table 19.1.4 IEE and EIA Project Category Defined by EPR2020

Roads Sector	IEE Provision (Schedule 2)	EIA Provision (Schedule 3)
New Road Construction	(1) Up to 25 km	(1) Above 25 km
Ropeway Construction	(2) Above 5 km and up to 50 km	(2) Above 50 km
Cable Car Construction	(3) Above 1 km and up to 5 km	(3) Above 5 km
Bridge Construction	(4) Over 100m	NOT MENTIONED in EPR
Road Tunnel Construction	(5) Above 1 km and up to 3 km	(4) Above 3 km
Road Flyover Construction	(6) Length not mentioned	NOT MENTIONED in EPR
Public Monorail Construction	(7) Length not mentioned	NOT MENTIONED in EPR
Public Railway Construction	NOT MENTIONED in EPR	(5) Length not mentioned
National Highway Improvement, widening, reconstruction and rehabilitation	(8) Above 10 km and up to 50 km	(6) Above 50 km

Source: EPR2020

4) Soil and Watershed Conservation Act, 2039 (1982)

In order to properly manage the watersheds of Nepal, the Soil and Watershed Conservation Act 1982 was enacted. Section 3 of the Act empowers GON to declare any area as a protected watershed area. Section 4 of the Act provides that a watershed conservation officer has the authority to implement the following works in protected watershed areas.

Construct and maintain dams, embankments, terrace improvements, diversion channels and retaining walls. Protect vegetation in landslide-prone areas and undertake afforestation programs and regulate agricultural practices pertinent to soil and watershed conservation.

Under Section 10 of the Act, power is extended to the Watershed Conservation Officer to grant permission to construct dams, drainage ditches, canals, cut privately owned trees, excavate sand, boulders and soil, discharge solid waste, and establish industry or residential areas within any protected watershed. The Act outlines the essential parameters necessary for proper watershed management (including rivers and lakes). The Act is applicable to protected watersheds.

(2) Environmental Related Plans and Policies

1) National Environmental Policy, 2076 (2019)

The policy has versioned for the management of pollution, waste maintenance of greenery to ensure people's right to live in hygienic and healthy environment. Similarly, the policy has the objective of mainstreaming the environmental concerns in developmental activities. It has emphasized the promotion of reusing and recycling the waste. To prevent, control and minimize the pollution the following policies and strategies have been proposed:

- Efficient structures will be formed to prevent, control and minimize the pollution.
- Promotion of environmentally friendly vehicles.
- Waste segregation as well as promotion of reuse and recycle techniques and proper disposal of the remaining solid waste has to be ensured.
- To maintain the hygienic aquatic environment direct release of polluted water, sewage and solid waste to the water body will be prevented.

While managing the solid and liquid waste, appropriate mitigation measures will be imposed to the source and minimize the potential adverse impacts on downstream areas.

2) National Climate Change Policy, 2076 (2019)

National Climate Change Policy, 2076 has focused its area to comply the development areas coping with climate change as well as protecting the biodiversity and livelihood together with ecosystem persistence at a holistic approach. Its target is to develop forest as degraded land as well as riverbanks through plantation. Generation of greenhouse gases shall be mitigated with proper measures. Similarly, road design should include climate change risk mitigation measures.

3) National Environment Policy and Action Plan (NEPAP), 2050 (1993)

The NEPAP is a part of the government's endeavour to incorporate environmental concern into Nepal's development process. NEPAP reviews current government policies on environment, formulates new policies where needed and suggests an action agenda to address environmental problems. NEPAP also identifies alternation of ecology from riverine to lake interventions and deals with the destruction of forest and wildlife, threats to survival of migratory aquatic species, climate changes and the risk of dam failure due to seismic activities, loss of agricultural land and displacement of local population as significant environmental impacts of hydropower projects.

(3) Land Related Plans and Policies

1) Land Acquisition, Resettlement and Rehabilitation Policy, 2072 (2015)

The Policy contributes to the overall development of the nation and its citizens by creating a conducive environment for the implementation of infrastructure development projects. The Policy supports timely execution (Completion) of development projects, minimizing adverse impacts on economic, social and cultural aspects of affected families/people and the project area.

The Policy aims to improve the social and economic status of project affected families by providing fair and adequate compensation, appropriate resettlement and rehabilitation assistance/allowances while acquiring land for infrastructure development projects and projects of public interests.

The Policy's objectives are:

i. To avoid displacement wherever possible and if not, explore alternatives to minimize adverse impacts as much as possible.

ii. To provide adequate compensation, rehabilitation assistance, and opportunities of social and economic benefit to the affected person, family, and the community

To create a conducive environment for timely completion of project by making land acquisition, valuation, compensation, resettlement, and rehabilitation process simple, easy, transparent and fair.

2) Land Use Policy 2072 (2015)

The strategy 3 of Policy 2 has taken into account how to maintain a balance between physical infrastructure development and environment. The strategy 3 of Policy 10 focuses on adoption of principles of sustainable development in view of the impact of climate change during any construction and/or development works in order to keep balance between land, environment and development.

(4) Environmental Clearance Process for Proposed project

As per the categorization of the EPR2020, the proposed projects would be categorized as Road Tunnel Construction (5) Above 1 km and up to 3 km (IEE) or Road Flyover Construction (6) no scale criteria (IEE), or both tunnel and flyover, which requires at least initial environmental examination (IEE) approval from competent authority, MOPIT, before the commencement of the work.

As per EPR2020, major processes for IEE are given below.

i. 7 Days written notice for collection of suggestions and opinions regarding the Project from the concerned local stakeholders.

ii. Prepare terms of reference (TOR) for IEE, incorporating suggestions received.

iii. Submit TOR to its concerned Ministry for its Approval. (Get approval of TOR from the concerned Ministry within 15 days of submission if no change needed)

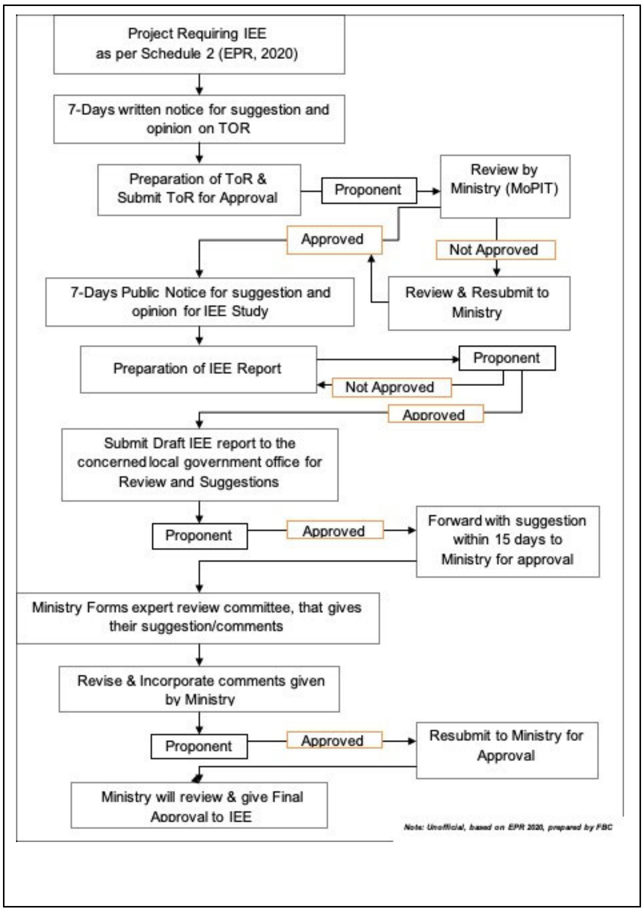
iv. If further change is required, the document is revised and resubmitted. (get approval of TOR from concerned Ministry within 15 days of resubmission)

v. Public Notice for IEE (7 Days) asking for written suggestions and recommendations from all the concerned stakeholders, public entities and concerned people and agencies.

vi. Preparation of IEE Reports

vii. Public consultation, stakeholders meeting and public sharing

viii. Submit the Draft IEE report to the concerned local government office for their review and suggestions, if any, for its approval from the concerned Ministry



Source: JICA Survey Team based on EPR2020

Figure 19.1.4 IEE Approval Process

ix. Ministry will make an expert review committee who will review the report and give suggestion/comments to the proponent for review, if needed, or forward for approval with their suggestions.

x. Incorporate the given comments by the expert panels under Ministry.

xi. Resubmit the revised IEE to Ministry for Approval and they will approve within 15 days of re-submission.

(5) Review of Relevant Standards of Nepal

The following Relevant Standards are reviewed and relevant Standards.

1) National Ambient Air Quality Standards for Nepal, 2012, GON

The new National Ambient Air Quality Standard (NAAQS) 2012 that came into effect requires effective monitoring and collection of eight-hour and 24-hour samples of air pollutants like Total Suspended Particulates (TSP), Particulate Matter (PM10 and PM2.5), carbon monoxide, lead and ozone levels for at least 347 days out of a 365-day year. The NAAQS further states that no particular place should fail to monitor air samples for two consecutive days.

2) **National Drinking Water Quality Standard 2079 (2022 A.D.)**

Major tasks during monitoring to be performed by water suppliers are cited as follows:

i. Regularly Control the quality to ascertain that the water supplied complies with the NDWQS.

ii. Periodic monitoring of all the components of the water supply system from the perspective of sanitation and risk to health.

iii. Proper supervision, inspection and maintenance as part of operation of the water supply systems.

iv. Development of necessary infrastructure such as a water quality testing laboratory and quality control.

Following factors should be considered while monitoring:

i. Type and quality of water sources i.e., surface water, springs, dug-wells, shallow wells, deep wells

ii. Type and size of the water supply system (pipe system, treatment facilities)

iii. Local environmental settings (physical infrastructure, geography, etc.)

iv. Sanitation and hygienic conditions surrounding the water supply system.

v. Socio-economic environment at the local level.

vi. Site specific conditions for complying with the standards.

vii. User’s opinion and suggestions regarding water quality

viii. Health and Hygiene Information (information on water related diseases)

3) **National Noise Standards, 2012, GON**

The National Noise Standard 2012 that came into effect as per the rule 15 of Nepal Government Environmental Protection Regulation 1997 that requires effective monitoring and collection of Daytime and Night-time noise level permitted limits as in the following table.

4) **Other Standards and Guidelines**

Other applicable Standards and Guidelines are:

- Standard on Emission of Smoke in Air by New Diesel Generator (Import)
- Nepal Water Quality Guidelines for the Protection of Aquatic Ecosystem, 2065 (2008)
- Tolerance Limits for Effluent Standards Discharged into Inland Surface Water from Combined Wastewater Treatment Plants

(6) JICA Guidelines for Environmental and Social Considerations, 2010

1) Categorization of the project (Citation from the JICA Guidelines)

Based on the project concept by the Pre-survey[1], the proposed project has been considered as category "B" project and stated on JICA disclosed website[2]. However, in case of notable impacts on "Sensitive characteristics" and "Sensitive areas" as per Appendix 3 of the JICA E&S GL due to the proposed projects components as well as related activities, the category shall be reconsidered. Citations of JICA E&S GL categorization and illustrative sensitive sectors, characteristics, and areas are shown in the following boxes.

> 2.2 Categorization
>
> 1. JICA classifies projects into four categories according to the extent of environmental and social impacts, taking into account an outline of project, scale, site condition, etc.
>
> 2. Category A: Proposed projects are classified as Category A if they are likely to have significant adverse impacts on the environment and society. Projects with complicated or unprecedented impacts that are difficult to assess, or projects with a wide range of impacts or irreversible impacts, are also classified as Category A. These impacts may affect an area broader than the sites or facilities subject to physical construction. Category A, in principle, includes projects in sensitive sectors, projects that have characteristics that are liable to cause adverse environmental impacts, and projects located in or near sensitive areas. An illustrative list of sensitive sectors, characteristics, and areas is provided in Appendix 3.
>
> 3. Category B: Proposed projects are classified as Category B if their potential adverse impacts on the environment and society are less adverse than those of Category A projects. Generally, they are site-specific; few if any are irreversible; and in most cases, normal mitigation measures can be designed more readily.
>
> 6. When necessary, JICA can change a category even after screening. This might occur such as when a new significant impact has come to light as a result of the cooperation project process, or in other specific situations.
>
> 7. Projects may not be clearly specified at an early stage of a Master Plan Study. In such cases, the study is categorized based on its likely significant impacts. At that time, derivative, secondary, and cumulative impacts are also considered. When considering plural alternatives, projects are classified in the category of the alternative that has the most significant impact. JICA reviews the categorization accordingly after projects have been identified with a progression of studies.

> Appendix 3. Illustrative List of Sensitive Sectors, Characteristics, and Areas
>
> The project of sensitive sectors, characteristics, and areas shown in this illustrative list are those that will likely have a significant adverse impact on the environment and society. Each individual project is categorized in accordance with the standards for "Category A" indicated in the categorization section of the guidelines, depending on the impacts of the individual projects. Consequently, projects that are likely to have a significant adverse impact on the environment and society are categorized as "Category A" even if they are not included in the sectors, characteristic, or areas on the list.

Criteria <Extraction related to the proposed projects>	proposed project

[1] Data Collection Survey on Urban Transport in Kathmandu Valley in Federal Democratic Republic of Nepal, JICA, 2019

[2] "The project is not considered to be a large-scale road project, is not located in a sensitive area, and has none of the sensitive characteristics under the JICA guidelines for environmental and social considerations (April 2010), it is not likely to have a significant adverse impact on the environment."
https://www.jica.go.jp/english/our_work/social_environmental/id/asia/south/nepal/c8h0vm0000f71x73.html

19. Sensitive Sectors Large-scale projects in the following sectors: (8) Roads, railways, and bridges	not considered to be a large-scale road project
2. Sensitive Characteristics (1) Large-scale involuntary resettlement (2) Large-scale groundwater pumping (3) Large-scale land reclamation, land development, and land clearing (4) Large-scale logging	has none of the sensitive characteristics
3. Sensitive Areas Projects in the following areas or their vicinity: (1) National parks, nationally-designated protected areas (coastal areas, wetlands, areas for ethnic minorities or indigenous peoples and cultural heritage, etc., designated by national governments) (2) Areas that are thought to require careful consideration by the country or locality Natural Environment a) Primary forests or natural forests in tropical areas b) Habitats with important ecological value (coral reefs, mangrove wetlands, tidal flats, etc.) c) Habitats of rare species that require protection under domestic legislation, international treaties, etc. d) Areas in danger of large-scale salt accumulation or soil erosion e) Areas with a remarkable tendency towards desertification Social Environment a) Areas with unique archaeological, historical, or cultural value b) Areas inhabited by ethnic minorities, indigenous peoples, or nomadic peoples with traditional ways of life, and other areas with special social value	not located in a sensitive area

1.3 Definitions

17. An “Initial Environmental Examination (IEE) level study” is a study that includes an analysis of alternative plans, a prediction and assessment of environmental impacts, and a preparation of mitigation measures and monitoring plans based on easily available information including existing data and simple field surveys.

2) JICA E&S review process (Citation from JICA E&S GL)

Citation from JICA E&S GL

3.1 Preparatory Survey

3.1.2 Project Formation (Loan aid, Grant aid (excluding projects executed through international organizations), and technical cooperation projects)

The following stipulations specify the procedure for the implementation of Feasibility Studies.

4. JICA applies a SEA when the preparatory surveys include not only project-level but also upper-stream-level studies, which are called Master Plan Studies. For Category A projects, JICA encourages project proponents etc., to disclose related information, hold local stakeholder meetings based on stakeholder analysis, and make efforts to avoid and minimize environmental and social impacts while scoping and alternative scenario analyses are being conducted. Such actions are also taken for Category B projects if necessary.

5. JICA ensures sufficient survey periods and assigns an expert(s) on environmental and social considerations to missions to prepare scoping drafts by collecting related information, conducting field surveys, and consulting with project proponents, etc.

6. Project proponents etc., disclose scoping drafts, which consist of project name, countries, locations, project outlines, categorizations and the reasons behind them, alternatives, impacts, and contents. Project proponents etc., also consult with local stakeholders reflecting stakeholder analysis for Category A projects and, if necessary, for Category B projects. JICA supports project proponents etc., in doing so in order that they incorporate the results of such consultations into their environmental and social considerations surveys. Consultations broadly cover the needs of cooperation projects and alternative analyses, including “without project” scenarios.

7. JICA conducts environmental and social surveys at the EIA level for Category A projects and at the IEE level for Category B projects and Master Plan Studies, in accordance with TOR. JICA prepares drafts of mitigation measures—including avoidance, minimization, and compensation—as well as drafts of monitoring plans and of institutional arrangements for environmental and social considerations.

8. Project proponents etc., consult with local stakeholders after information disclosure when considering the rough outline of environmental and social considerations, as needed. JICA supports this process and incorporates the results of such consultations into survey results.

9. Project proponents etc., consult with local stakeholders on draft reports for Category A projects and also, if necessary, for Category B projects, after the information disclosure. JICA supports this process and incorporates the results of such consultations into final reports.

10. JICA discloses final reports on its website promptly upon their completion.

11. If, for technical cooperation projects, a preparatory survey is not conducted but a detailed planning survey is conducted, the aforementioned procedures are followed for the detailed planning survey.

12. In the case of supplementary types of preparatory surveys, the necessary procedures mentioned in items 5 through 10 are followed according to the contents of the survey after the completion of the procedures in items 1 and 2.

(7) Gaps between the JICA Guidelines and Laws and Regulations in Nepal

The table shows the result of the gap analysis between the JICA Guidelines for Environmental and Social Considerations and the laws and regulations in Nepal.

Table 19.1.5 Gap Analysis between JICA Guidelines and Nepali Legal System

(A) JICA Guidelines for Environmental and Social Considerations with World Bank Safeguard Policy	(B) Nepali Law & Regulations	Gaps between (A) and (B)	Countermeasures for filling gaps
Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.	The adverse impacts can be minimized or avoided or dealt with in positive and constructive ways (Sectin1.1.1, Environmental and Social Management Framework, DOR, 2007, hereinafter referred to as the "ESMF")	No significant gaps are observed. This item is not clearly mentioned in domestic laws, however, ESMF covered it.	Based on ESMF, Land Acquisition Act, and the JICA's Environmental Guidelines, land acquisition and resettlement shall be avoided and/or minimized during the alignment decision process, structure planning, and any other discussion related to resettlement impact in the Project.
When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.	The adverse impacts can be minimized or avoided or dealt with in positive and constructive ways (1.1.1, ESMF) - Government of Nepal may, if it so deems necessary, acquire any land at anyplace for any public purpose, subject to compensation under this Act (Article 3, Land Acquisition Act)	No significant gaps are observed.	
People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.	Thus, the affected persons in the project will be entitled to various types of compensation and resettlement assistance that will help in the restoration of their livelihoods, at least, to the pre-project standards (7.3.1, ESMF)	No significant gaps are observed. This item is not clearly mentioned in domestic laws, however, ESMF covered it.	Based on ESMF and the JICA's Environmental Guidelines, RAP secures "improve or at least restore their standard of living, income opportunities and production levels to pre-project levels" by using the appropriate entitlement matrix.
Compensation must be based on the full replacement cost as much as possible.	When GON requires assets, national law does not specify about the provision of mandatory replacement cost. Therefore, ESMF strongly recommended that: Practical provisions must be made for the compensation for all lost assets to be made at replacement cost without depreciation or reductions for salvage materials. Efforts must be made to assess the real replacement costs of land to the extent possible. A procedure should be established for determining compensation rates accurately plus rigorous efforts to assess	There might be gaps on the determination of the compensation rate between the Nepali side and the JICA Environment Guidelines. In the past cases, deduction and/or using government fixed rate lower than market price are common.	Replacement Cost Survey (RCS) was conducted based on the standard of the JICA's Environmental Guidelines (the World Bank's definition and level of standards). The result is compared with the government's official unit price for determining validity. The result'shall be respected for future determination

(A) JICA Guidelines for Environmental and Social Considerations with World Bank Safeguard Policy	(B) Nepali Law & Regulations	Gaps between (A) and (B)	Countermeasures for filling gaps
	the replacement costs and market rates for all assets, including labor costs for construction.		process by CDC. Additional monitoring to support bridging from RAP to CDC's determination is required.
Compensation and other kinds of assistance must be provided prior to displacement.	ESMF referred OP 4.12: The measures (i.e., the RP) include the provision of compensation and of other assistance required for relocation, prior to displacement, and preparation and provision of resettlement sites with adequate facilities, where required.	No significant gaps are observed. This item is not clearly mentioned in domestic laws, however, ESMF covered it.	Based on the JICA's Environmental Guidelines, compensation, assistance, and relocation site have to be done and prepared prior to displacement.
For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public.	ESMF regulated RAP preparation.	No significant gaps are observed. This item is not clearly mentioned in domestic laws, however, ESMF covered it.	The RAP is developed with sufficient adherence to the JICA's Environmental Guidelines.
In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people Appropriate participation of affected people must be promoted in the planning, implementation, and monitoring of resettlement action plans.	In Chapter 5, the section of 2.2.1: The Procedural Steps in Road IEEs and EIAs of ESMF, and other sections covers all conditions concerning public participation/consultation. - Domestic EIA procedure supported by some conditions in ESMF requires public consultation meeting	No significant gaps are observed. This item is not clearly mentioned in domestic laws, however, ESMF covered it.	Based on the JICA's Environmental Guidelines, in case of the Category A projects, stakeholder meetings should be organized at least two times, at the time of the draft scoping and at the time of draft reporting, supplemented by focus group meetings. In addition to the above mentioned meetings, the RAP proposed promotion of public participation in the monitoring stage as well as implementation stage.
Appropriate and accessible grievance mechanisms must be established for the	5.1 and 7.5 of ESMF stipulated the establishment of grievance redressal mechanism (GRM)	No significant gaps are observed. This item is not clearly mentioned in	Based on the JICA's Environmental Guidelines, GRM is planned in the RAP.

(A) JICA Guidelines for Environmental and Social Considerations with World Bank Safeguard Policy	(B) Nepali Law & Regulations	Gaps between (A) and (B)	Countermeasures for filling gaps
affected people and their communities.		domestic laws, however, ESMF covered it.	
Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.	N/A *Cut-off date is recommended to set as the date of Census survey (7.2.3, ESMF)	There is no direct regulation of recommendation regarding the item.	Based on the JICA's Environmental Guidelines, the cut-off date is explained at the first stakeholder meetings. In the case that a certain time, e.g., two years, will have passed since the cut-off-date declaration before land acquisition is commenced, Census and other relevant field surveys shall be updated and revised with the latest situation.
Eligibility of benefits includes, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.	In the proposed project, the absence of formal titles will not be able to resettlement assistance and rehabilitation. (7.3.1, ESMF)	No significant gaps are observed. This item is not clearly mentioned in domestic laws, however, ESMF covered it.	Based on the JICA's Environmental Guidelines, appropriate entitlements are discussed in the RAP for both formal and informal cases. In principle, both formal and informal settlers are eligible for compensation and other conditions, including assistances, rights to relocate to the resettlement site, etc.
Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.	N/A * ESMF just referred OP 4.12	Cash for land is the common way of compensation for both formal and informal land cases in Nepal, and PAPs also prefer to cash compensation generally.	PAPs shall be given compensation options based on the RAP to select "land for land" or "cash for land" as much as possible.
Provide support for the transition period (between displacement and livelihood restoration).	N/A	The item is not clearly mentioned even in ESMF. Some kinds of assistance have a function to support such transition periods.	The RAP may cover the non-registered cases and compensation for temporary business disturbance, income restoration at the early stage, or any other allowance are considered.

(A) JICA Guidelines for Environmental and Social Considerations with World Bank Safeguard Policy	(B) Nepali Law & Regulations	Gaps between (A) and (B)	Countermeasures for filling gaps
Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities, etc.	8.3 of ESMF or the part of Entitlement Matrix stipulated the considerations scheme for such vulnerable groups	No significant gaps are observed. This item is not clearly mentioned in domestic laws, however, ESMF covered it.	Based on needs assessment through stakeholder meetings, socio-economic surveys, focus group meetings etc., special considerations for vulnerable groups are discussed and reflected in the RAP.
For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, an abbreviated resettlement plan is to be prepared.	7.10 of ESMF stipulated the abbreviated RAP under the condition of fewer than 200 people	No significant gaps are observed. This item is not clearly mentioned in domestic laws, however, ESMF covered it.	Based on the JICA's Environmental Guidelines, the abbreviated RAP shall be prepared under the stipulated conditions
Internal and external monitoring system must be established and implemented properly	8.8 of ESMF covers monitoring and evaluation	No significant gaps are observed. This item is not clearly mentioned in domestic laws, however, ESMF covered it.	Based on the JICA's Environmental Guidelines, a monitoring framework composed by internal monitoring, external monitoring, and evaluation is established in the RAP.

Source: JICA Survey Team

19.1.4 Alternatives Analysis

(1) Guidance on Alternative Study in JICA Guidelines for Environmental and Social Considerations (Citation from the Guidelines)

Analysis of alternatives: This systematically compares feasible alternatives to the proposed project site, technology, design, and operation including the "without project" situation in terms of the following: the potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional training and monitoring requirements. For each of the alternatives, it quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. It also states the basis for selecting the particular proposed project design and offers justification for recommended emission levels and approaches to pollution prevention and abatement.

(2) Guidance on Alternative Study in EPR2020

According to the Environment Protection Rules, 2020 (last amendment 2021)[3], Section-6, Schedule 12 (pertaining to Rule 7), Clause 5, Sub-Clause No. 5, Section C, "Template for Environment Assessment Report," it is required to conduct an alternative analysis of the proposed project during the environmental assessment stage. Even if there are no other alternatives for the project's implementation, a study or analysis of potential alternatives within the proposed project should be carried out. Additionally, a comparative assessment of the possible beneficial and adverse environmental impacts that may arise from the implementation of these alternatives should be conducted, considering the following aspects.

(3) Alternative Study for Proposed Projects

An alternative study focusing on environmental and social consideration matters is given below. The full coverage of alternative study for the proposed Project, including environmental and social consideration, is given in Chapter 7 of This Report.

Environmental and social impacts of the three alternatives, such as Alternative 1, Alternative 3-2 (via TIA land) and Alternative 4-2 (via TIA land) were evaluated equally with the score "6" for each. While Alternative 1 would not generate any involuntary resettlement, it would cause noise and vibration during both construction and operation phases. On the other hand, the other two options would generate involuntary resettlement at Jadibuti intersection, while their noise, vibration and other pollution would be less than Alternative 1 as it has a major part of alignment as underpass in the airport. Further details of comparison among the "Without-Project Option" and the three alternatives are presented in Table 19.1.6.

As discussed in Chapter 7, In conclusion of the alternatives analysis including the environmental and social consideration and the other evaluation criteria, Alt-4-2, which runs from Araniko Highway North to Araniko Highway South via TIA land with combination of underpass and flyover structure is highly recommend for the improvement of the three study intersections.

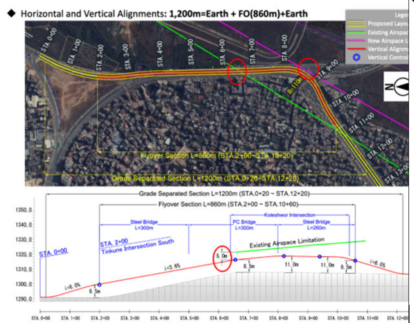
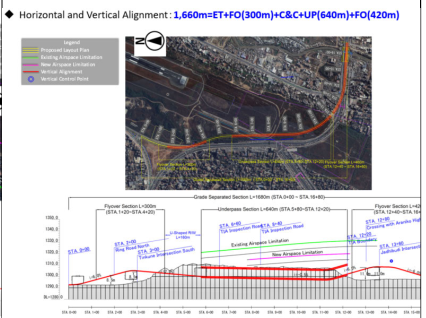
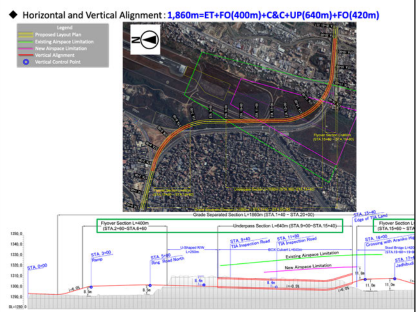
[3] As of now, EPR2020 is only available in Nepali, and there is no official English translation of EPR2020 provided by the government yet.

Table 19.1.6 Comparisons of With-Project and Without-Project Options

	Without-Project Option	With-Project Option	
		Construction Phase	Operation Phase
Physical Environment	• Existing condition of air and noise pollution, will continue.	• During Construction, increase in air pollution (construction related dust) and traffic jam will occur at/along this section	• About 70 % of the traffic will use the road section. • Air and noise condition along the existing highway will be made better by smooth and traffic jam-less, easier drive through improved intersection.
	• Existing road alignment and ROW of road will remain as they are.	• Existing road alignment and ROW will be changed due to the intersection improvement and new road alignment	• Overall road capacity will be improved
Socio-Economic and Cultural Environment	• Urbanization will spread in the Project area by high demand for housing, office and commercial space in the Jadibuti, Koteshwor, and Tinkune areas.	• Local material suppliers, engineering firms, contractors and workers will get benefit from the Project construction work and duration	• Urbanization, land use change from farmland to housing and commerce, will occur faster than 'No-Project Option' in the Project Area, especially along the Project roads.
General	• Traffic Congestion at Koteshwor intersection is expected to increase rapidly with the development of the Eastern City Development Program	• Technical skills and capacity enhancement of local engineering and construction companies • Technical skills and capacity enhancement of workers	• Application as a model case of grade-separated intersection design in urban areas of Nepal Reduction of traffic jam occurrence on this section of Araniko Highway – Ring Road intersection • Provision of an alternative route to/from Kathmandu Valley to the eastern area (Bhaktapur area) in case of catastrophic disasters such as a big earthquake (Disaster Preparedness) • Increase of road capacity to accommodate increased traffic volume up to at least year 2033 • Shortening of travel time due to no congestion waiting time • Saving of vehicle running cost

Source: JICA Survey Team

Table 19.1.7 Comparisons of Alternatives and the Evaluation

Option	Without Project Option	Option 1:Alt-4-1	Option 2:Alt-3-2	Option 3:Alt4-2
	Existing Road	Ring Road North to Ring Road South (Flyover Only)	Ring Road North to Araniko Hwy South, Underpass via TIA land (Underpass & Flyover)	Araniko Hwy North to Araniko Hwy South, Underpass via TIA Land (Underpass & Flyover)
Plan				
Infrastructure Type and Size	At Grade (AG) Surface Road No change in road width	Project Total Length: 1,200 m GS: 4 lanes AG: 8 lanes Flyover Length: 860 m Ventilation: no Drainage pumping: no Noise barrier: required for entire sec.	Project Total Length: 1,680 m GS: 4 lanes AG: 8 lanes Underpass Length: 800 m Flyover: 720 m Ventilation: no Drainage pumping: possibly required Nose barrier: partially required	Project Total Length: 1,860 m GS: 4 lanes AG: 8 lanes Underpass Length: 890 m Flyover: 800 m Ventilation: no Drainage pumping: possibly required Noise barrier: partially required
Additional Land Requirements	No Land Acquisition	No Land Acquisition Within ROW of RR	▪ Minimal land requirment inside Tinkune Intersection ▪ Some land requirment at Jadibuti Intersection ▪ Government Coordination between MoPIT/DoR and MoTCA/CAAN needed for land use under TIA	▪ Some land requirment inside the Tinkune Intersection ▪ Some land requirment at Jadibuti Intersection ▪ Government Coordination between MoPIT/DoR and MoTCA/CAAN needed for land use under TIA

Option	Without Project Option	Option 1:Alt-4-1	Option 2:Alt-3-2	Option 3:Alt4-2
Resettlement Requirements	No resettlement required	No resettlement required	▪ No resettlement at Tinkune intersection ▪ Approximately 30 households /businesses at Jadibudi intersection	▪ No resettlement at Tinkune intersection ▪ Approximately 30 households /businesses at Jadibudi intersection
Traffic management During Construction	No road closure	Jadibudi intersection: No road closure	Jadibuti intersection: Limited traffic management difficulty during construction of pier columns and their foundations along/outside of the existing road at the intersection	Jadibuti intersection: Limited traffic management difficulty during construction of pier columns and their foundations along/outside of the existing road at the intersection
		Tinkune-Koteshwor section: Significant traffic management difficulty during construction of piers and their foundations	Tinkune-Koteshwor section: 1) a few difficulties for underpass construction due to major works within TIA area, 2) limited traffic difficulties during construction of the flyover between TIA boarder and Tinkune intersection	Tinkune-Koteshwor section: 1) a few difficulties for underpass construction due to major works within TIA area, 2) limited traffic difficulties during construction of the flyover between TIA boarder and Tinkune intersection
Construction Related Noise & Vibration	No additional noise and vibration	Notable but typical noise and vibration impact by construction of flyover, in particular, foundation and pier construction, along the existing communities	1) Limited noise and vibration impact by flyover construction along the existing communities and 2) Neglegible impacts by underpass construction due to activities within ristricted TIA area	1) Limited noise and vibration impact by flyover construction along the existing communities and 2) Neglegible impacts by underpass construction due to activities within ristricted TIA area
Road Safety Concerns	Serious issues of vechicle collisions and road accident injury and/or death	▪ Serious issues of vechicle collisions and road accident injury and/or kill ▪ Pedestrian crossing will be an issue due to the extension of its length because of the intersection widening	▪ Serious issues of vechicle collisions and road accident injury and/or death ▪ Pedestrian crossing will be an issue due to extension of its length because of the intersection widening ▪ Evacuation facility shall be needed in the tunnel section in case of underpass closure by fire or other accidents	▪ Serious issues of vechicle collisions and road accident injury and/or death ▪ Pedestrian crossing will be an issue due to extension of its length because of the intersection widening ▪ Evacuation facility shall be needed in the tunnel section in case of underpass closure by fire or other accidents

Option	Without Project Option	Option 1:Alt-4-1	Option 2:Alt-3-2	Option 3:Alt4-2
Air Pollution and noise during operation	▪ Further degradation of air quality noise level due to continuous increase of traffic volumes along the roads	▪ Some improvement of air quality due to fewer traffic jams along the community ▪ Some degradation of noise level without noise barriers due to additional traffic noise from higher flyover in addition to the existing at grade level noise	▪ Some improvement of air quality due to fewer traffic jams along the community ▪ Some improvement of noise due to the least exposure of vechicles bypassed by the underpass along the Tinkune-Koteshwor section ▪ Limited degradation of noise level at Jadibuti area without noise barriers due to additional traffic noise from higher flyover in addition to the existing at grade level noise ▪ No ventilation required for the underpass due to enough natural ventilation	▪ Major improvement of air quality and noise due to fewer traffic jams along the community and the least exposure of vechicles passing by TIA area ▪ No ventilation required for the underpass due to enough natural ventilation
Impact on social environment	• Due to the heavy traffic jams, travel time increases, and economic development opportunities would be continuously lost and worsen. • Each year as traffic from eastern town development will aggravate traffic congestion situation.	• Additional job opportunities and skill up possibilities during construction, and limited job opportunities to maintain the flyover • Further development and commercial opportunities from the project area development and further eastern town development	• Additional job opportunities and skill up possibilities during construction, and some job opportunities to maintain the flyover and underpass with pumping and ventilation systems • Further development and commercial opportunities from project area development and further eastern town development	• Additional job opportunities and skill up possibilities during construction, and some job opportunities to maintain the flyover and underpass with pumping systems • Further development and commercial opportunities from project area development and further eastern town development
Project Duration	(Secret)			
Evaluation (Ranking)	**4**	**1** (at the initial desk review stage, no comparative advantage against option 2&3)	**1** (at the initial desk review stage, no comparative advantage against option 1&3)	**1** (at the initial desk review stage, no comparative advantage against option 1&2)
Remarks	• Further increased traffic is expected continuously along the Araniko highway, which only causes degradation of environment, health and safety along the communities. • Further congestion will negatively affect the further	• Due to the positive and negative characteristics against option 2 and 3, no comparative advantages are identified among project options, except no project option. • Lowest negative impacts on social impacts are expected due	• Due to the positive and negative characteristics against option 1 and 3, no comparative advantages are identified among project options, except no project option. • Modest negative impacts on social impacts are expected due	• Due to the positive and negative characteristics against option 1 and 2, no comparative advantages are identified among project options, except no project option. • Highest negative impacts on social impacts are expected due

Option	Without Project Option	Option 1:Alt-4-1	Option 2:Alt-3-2	Option 3:Alt4-2
	development of the Kathmandu Valley and eastern area development.	to the no land acquisition and resettlement. • Highest negative impacts on environmental and health impacts are expected due to the longest exposure of the construction impacts and potentially additional noise impacts from the proposed flyover along the dense residential and commercial area between the Tinkune-Koteshwor section.	to the smaller land acquisition and 20-30 household/business resettlement. • Lowest negative impacts on environmental and health impacts are expected due to the lowest exposure of the construction impacts by bypassing the alignment in TIA area. Also, modest impacts are expected from additional noise impacts from the proposed flyover along Jadibuti area.	to the largest land acquisition and 20-30 household/business resettlement. • Lowest negative impacts on environmental and health impacts are expected due to the lowest exposure of the construction impacts by bypassing the alignment in TIA area. Also, modest impacts are expected from additional noise impacts from the proposed flyover along Jadibuti area.

Source: JICA Survey Team

19.1.5 Scoping

(1) Scoping

The scoping matrix of the anticipated environmental and social impacts of the Project is displayed in Table 19.1.8.

Table 19.1.8 Scoping Matrix for Jadibuti – Koteshwor – Tinkune Intersection Improvement Project

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	Construction Stage	Operation	Rationales of the Assessment
Physical Environment				
Air Pollution		✓	✓	P: There is no activity causing air pollution during pre-construction stage.
				C: Some negative impacts are expected due to operation of construction equipment and heavy construction vehicles. One of these is the dust incidental to earthwork especially during the dry season.
				O: Air pollution is expected to increase due to increased traffic volume on the road.
Water Quality and Resources		✓	✓	P: There is no activity causing water pollution during pre-construction stage.
				C: Turbid water due to the earthworks, pier construction work, surface run-off and wastewater effluents from construction site, workers' camps/yards are expected to pollute the Manohara River and the Bagmati River to some extent.
				O: Some impacts on water quality in surrounding water bodies are expected due to water discharge from road users and wastewater from maintenance activities.
Bottom Sediment		✓	✓	P: There is no activity causing impact on bottom sediment during pre-construction stage.
				C: Some construction materials such as cement, chemical such as epoxy, sulphur, additives, admixtures, cements and sand are expected to be washed out mainly by rain to the Manohara River and the Bagmati River to some extent. However, the impact on bottom sediment is negligible and for a short time.
				O: Some wastewater will be generated from maintenance activities along the Project Road, the impact on bottom sediment from the wastewater will be negligible.
Land and Soil		✓		P: There is no activity causing impact on Land and soil during pre-construction stage.
				C: Impacts on soil from deposition of pollutants from construction materials in the construction site are expected to be small. Since there is no major industrial activity along the road, it is unlikely that soil along the Project Road is already polluted.
				O: Road traffic and maintenance work cause minimal impact on land and soil.
Noise and Vibration		✓	✓	P: There is no activity causing noise and vibration during pre-construction stage.

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	Construction Stage	Operation	Rationales of the Assessment
				C: Noise and vibrations are generated by operation of construction equipment and heavy vehicles, such as sheet pile driving machines, although they are temporary. Especially in Tinkune Jintersection, as an alignment option TK-2R is taken, it is necessary to install a steel sheet pile earth retaining structure between the existing road and the underpass construction section. At that time, late-night work is required in certain sections to ensure airport safety. The construction schedule should take into account the location of schools, hospitals and religious facilities that require silence in part of the day.
				O: Noise and vibration levels are likely to increase due to greater traffic volume along the Project Road. Specific measures may be required to minimize impacts on schools, hospitals and religious facilities.
Solid Waste		✓	✓	P: There is no activity generating solid waste during pre-construction stage.
				C: Waste from construction workers' camps is expected to be generated. Waste generated from construction and demolition work may include hazardous materials that must be treated before final disposal from the stock yard, concrete mixing plant, storage, etc.
				O: Waste will be generated from road users and workers of maintenance works.
Soil Waste		✓		P: There is no activity generating soil waste during pre-construction stage.
				C: Impact due to spoil disposal during construction of the Underpass, Construction of the Project Road with Flyover
				O: Road traffic and maintenance of the improved road do not generate soil waste.
Liquid Waste		✓		P: There is no activity generating liquid waste during pre-construction stage.
				C: Waste is expected from Construction, use of the Workers' Camp, including septic tanks, and Construction of the Underpass
				O: Road traffic and maintenance of the improved road do generate minimal liquid waste.
Ground Subsidence				P, C, O: There is no activity under the project causing ground subsidence
Sunshine rights				P, C, O: There is no activity under the project causing ground subsidence
Natural Environment				
Topography /Geology		✓		P: There is no activity causing such an impact during pre-construction stage.
				C: Changes in topographic conditions over the Project area takes place due to the requirement of cutting and filling work in some parts.
				O: Topographic conditions should become stable after the completion of construction works, which include slope protection and stabilization works.

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	Construction Stage	Operation	Rationales of the Assessment
Hydrology		✓	✓	P: There is no activity causing such impact during the pre-construction stage.
				C: Construction work may cause minor and temporary impacts on hydrology because of cutting and filling. No major river systems are directly affected.
				O: No impact is expected.
Climate/ Meteorological Phenomena		✓	✓	P: There is no activity causing such impact during the pre-construction stage.
				C/O: Impact on the microclimate would occur but to the extent that they are of negligible scale.
Protected Area/ Forest Reserve				P: No impact is expected.
				C/O: There is no forest/ protected area adversely affected in the Project site, or near its vicinity.
Soil Erosion		✓	✓	P: There is no activity causing such impact during the pre-construction stage.
				C: Soil erosion is not expected in major quantities, however, during construction and the monsoon period leaving excavated areas open may lead to some soil wash outs
				O: The Project is expected to improve the conditions and thus reduce the risk of soil erosion as measures of slope protection and stabilization should prevent soil erosion.
Groundwater		✓		P: There is no activity causing such impact during pre-construction stage.
				C: The Project does not envisage the extraction or use of groundwater. However, due to the construction of the underpass, ground water flow may be altered during construction periods
				O: No impact is expected during the operation and maintenance stages.
Ecosystem, Flora, Fauna and Biodiversity		✓		P,C,O: No areas with high conservation values, protected areas, or habitats for rare and endangered species exist along the alignment of the project.
Landscape		✓		P: There is no activity causing such impact during pre-construction stage.
				C: Changes in landscape during the construction work would be limited to the Project boundary only and would be temporary to the construction period.
				O: No impact is expected on landscape caused by the traffic and maintenance of the road.
Natural Disaster		✓		P: No activity during the pre-construction stage is expected to have an impact on natural disasters.
				C: Sediment flow, soil erosion may occur along the route, and sufficient caution is required during construction.
				O: No impact is expected on natural disaster caused by the traffic and maintenance of the road.
Social Environment				
Involuntary Resettlement	✓	✓	✓	P: The Project works is in urban areas with structures along the alignment, so involuntary resettlement is required. The

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	Construction Stage	Operation	Rationales of the Assessment
				proposed alternative to minimize widening and restrict to ROW will minimize resettlement. C/O: There is a possibility of resettlement, and it is assumed that there will be little impact after resettlement due to compensation and rehabilitation support.
Land use/ landless communities	✓	✓	✓	P: Land acquisition and involuntary resettlement are likely to cause changes in existing land use. C: While changes in land use associated with construction work are relatively minor at the expanded section of the existing road, land usage, shifting businesses might be significantly affected at the new improvement section. O: Land use will be permanently changed, especially in the new improvement section.
Local economy such as employment and livelihood	✓	✓	✓	P/C: Loss of income source and livelihood due to involuntary resettlement are expected to negatively affect the landowners who depend on income from renting out land or buildings at the area where land needs to be acquired for the Project O: Over the long term, the Project is expected to have positive impact on the local economy as improved road network facilities. The Project may trigger unintended side effects on the local community, e.g., influx of non-local people and more competition in business and unnatural hike in land prices.
Local resource use, Communal/ Common resource use rights/ Land use		✓		P: No activity during the pre-construction stage is expected to have such impact. C: Use of large quantities of construction materials, such as sand, aggregates etc., may escalate prices for local people in the area. O: No impact on such resource use is caused by the traffic and maintenance of the road.
General, Regional /City Plans			✓	P: No activity during the pre-construction and construction stage is expected to have an impact. O: Better infrastructure network may trigger influx of outsiders and economic development in the region.
Water Usage, Water Rights and Communal Rights	✓	✓		P: Water usage and water rights of the affected households may be curtailed due to resettlement. C: Disturbance to water usage, water rights and communal rights during construction work is expected to be minor and short-term in nature. However, communal rights and distribution should be carefully examined to avoid negative impacts. O: No impact on water usage is caused by the traffic and maintenance of the road.
Social Institutions and Local Decision-making Institutions.	✓	✓	✓	P: Land acquisition and involuntary resettlement are likely to affect social institutions such as social capital and local decision-making institutions. C: Social capital and local decision-making institutions will be affected by the influx of resettling population and construction workers. O: Social capital and local decision-making institutions will be affected by the influx of resettling population.

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	Construction Stage	Operation	Rationales of the Assessment
Traffic/Public Facilities, infrastructures, social services,	✓	✓	✓	P: Common property resources such as community house/hall Temple, etc., may be affected, which negatively affects social infrastructure and services.
				C: Access to social infrastructure and services may be temporarily affected due to preparation of construction yard and accommodation for workers as well as traffic jams due to the operation of construction vehicles, and traffic restrictions on on-going construction areas. Especially in Tinkune Jintersection, as an alignment option TK-2R is taken, since the alignment of the underpass section is close to the existing road, it is necessary to occupy two lanes of the current road as a construction yard cum road during the construction period, which will continue for about 3 to 4 years. During that time, traffic congestion is expected to become even more severe due to the reduction in the number of lanes. Temporary by-pass for traffic will be needed.
				O: The resettlement can result in prolonged disturbance in social infrastructure and services. In the long term, however, the Project is expected to improve access to social infrastructure and services by providing a better road network.
Unequal Distribution of Benefit and Damage	✓	✓	✓	P: Land acquisition and involuntary resettlement will lead to unequal distribution of benefits and damages between groups, who are directly affected by the Project and who are not.
				C: While resettling households and ones whose livelihood depends on affected lands will bear much of the damage, others may even enjoy benefits from new business opportunities created by construction work, resulting in unequal distribution of benefits and damages.
				O: People residing along the Project Road may accrue greater benefits compared with others. Location and types of traffic-dependent businesses along the stretch of existing highway will be affected.
Local Conflicts of Interests	✓	✓	✓	P/C/O: Unequal distribution of benefits and damages may trigger and/or intensify local conflicts of interests in the community.
Historical and Cultural Resources	✓	✓		P: One of the impacts of the Project Road construction is interrupted access to the cultural properties on either side of ROW. There are chances that users of the cultural property may face difficulty in accessing the property during the period of pre- construction.
				C: Access to one cultural property is likely to be lost during the construction period, due to movement of construction machinery, construction and workers' camps or setting up of borrow areas, setting up of service stations, etc.
				O: No heritages nearby the Project Road may be indirectly affected.
Religious Facilities	✓	✓		P, C: One religious facility, which is not a major facility, but established by a group of families, will need to be relocated and suitably compensated.

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	Construction Stage	Operation	Rationales of the Assessment
				O: No impact is expected on the religious facility after construction of the road.
Sensitive Facilities (e.g., Hospital, school, precision machine factory)	✓	✓		P, C: No sensitive facilities exist, except for the land owned by the Airport Authority. At the underpass construction area, the airport's aircraft beaconing lights may be affected temporarily, which will require to be avoided. The airport authority will be duly coordinated by the Project to conduct construction works following the airport's requirements.
				O: No impact is expected on the land owned by the Airport Authority after construction of the road.
Poverty		✓	✓	O: No impact is expected on poverty status during the pre-construction stage.
				C: The poor may bear a disproportionally higher burden due to their limited coping capacity, although they can benefit from employment opportunities during construction work.
				P: Economic development achieved by the road improvement in the region is expected to benefit the poor.
Ethnic Minorities/ Indigenous People				P/C/O: No indigenous communities are found in or around the planned alignment of the Project.
Gender	✓	✓	✓	P: The Project might affect gender-related work division such as cultivation, harvest and processing of crops.
				C: The general social and cultural norms need to be carefully studied to avoid gender-related conflicts. The Project can affect gender roles in cultivation, harvesting and processing.
				O: The Project might affect gender-related work division such as cultivation, harvesting, and processing of crops.
Children's Rights		✓		P: No impact is expected.
				C: Only adults are eligible for potential employment opportunities created by the project as per rule of GON
				O: No impact is expected.
Sanitation, Public Health Condition, Infectious diseases such as HIV/AIDS		✓	✓	P: There is no activity causing such impacts during the pre-construction stage.
				C: Influx of construction workers may increase in health risks, particularly that of STD/STI, HIV/AIDS, corona virus, etc.
				O: An increase in traffic volume and road users may have negative impact on public health.
Industrial safety and health, working environment (OHS)		✓	✓	P: There is no activity causing such impact during pre-construction stage.
				C: Occupational health and safety of construction work should be properly managed through adequate Environment Management Plan.
				O: Maintenance and repair works should take into account the occupational health and safety of the workers.
Others				
		✓	✓	P: There is no activity causing such impact during pre-construction stage.

Item	Scoping Analysis of the Anticipated Environmental Impacts			
	Pre-construction	Construction Stage	Operation	Rationales of the Assessment
Accidents Traffic accidents/ Jams				C: An increase in the risk of accidents caused by the operation of construction machinery and the running of construction vehicles are expected.
				O: Increased traffic volume and increased risk of accidents due to speeding are expected. On the other hand, it is considered that the accident risk can be reduced by rehabilitating the route and implementing accident prevention measures (such as installing a reflector on the curve).
Climate Change		✓	✓	P: There is no activity causing such impact during pre-construction stage.
				C: Although the impact is temporary and small, greenhouse gases (GHGs) are emitted by the operation of construction machinery and the running of construction vehicles.
				O: GHGs emission is expected to increase due to the increase in traffic volume. In addition, adaptation measures will be implemented by considering the effects of climate change (increase in precipitation, etc.) when considering measures for landslides and soil erosion.

Note: P: Pre-Construction; C: Construction; and O: Operation Period
Source: JICA Survey Team

(2) Terms of Reference (TOR) for Environmental and Social Impact Assessment

Table 19.1.9 shows the TOR for Environmental and Social Assessment survey, which was approved by MOPIT.

Table 19.1.9 Survey TOR

Impact item	Prediction and evaluation method
Air Pollution	-Measure 24 Hr. roadside NO_2, SO_2, SPM, PM 2.5 and PM 10. At 3 locations. -The survey method conforms to the environmental standards of Nepal.
Water Pollution	-Measure the water quality (pH, BOD, COD, SS) of the Manohara and Bagmati rivers that are in the vicinity of the Project. -Study on literature and similar cases reviews to predict the impacts.
Soil contamination	Predict the impact based on the results of the field survey, literature and similar cases reviews, and road design (scale of cuts and fills)
Noise and vibration	-Predict roadside equivalent noise level with instrument Digital Sound Level Meter using international standards. -Study on literature and similar cases reviews to predict the impacts.
Waste / hazardous material	-Estimate volume and types of wastes generated at a particular location. -Investigate the collection/disposal status of waste along the Project Road and the status of illegal dumping (location, amount and type of waste, etc.) -Study on literature and similar cases reviews to predict the impacts.
Offensive Odor	-Calculate its level from the prospected waste categories/generation estimate and the activities of the construction workers and users. –Estimate malodorous gaseous emissions using relevant environmental standards
Topography	Evaluate changes in topographic conditions due to the planned cutting and filling work.
Hydrology	Predict the impact based on the results of the field surveys and the results of hydraulic and hydrological surveys and plan the appropriate placement of culverts for drainage.
Soil erosion	Predict the impact based on the results of the field survey, literature and similar cases reviews, and road design (scale of cuts and fills)
Ecosystem, flora, fauna and biodiversity	-Confirm the condition of the natural environment in the vicinity of the Project alignment through site surveys and interviews with related organizations and residents around the project alignment. -Study on literature and similar cases reviews to predict the impacts.
Landscape	-Consider the potential of the entire Project route and tourism potentials through site surveys and interviews with related organizations and residents around the project alignment. -Check the connectivity of the original landscapes as well.
Natural disasters	Areas with a high risk of disaster will be selected through field surveys and interviews with relevant organizations and residents around the project alignment. Study on literature and similar cases reviews to predict the impacts.
Involuntary resettlement	-Predict the number of involuntary resettlements due to widening work. -Conduct surveys on affected residents and compensation details.
Land use	Predict impacts based on field survey results and literature reviews and similar cases
Utilization of local resources	Predict impacts based on field survey results and literature reviews and similar cases
General, Regional/City Plans	Predict impacts based on field survey results and literature reviews and similar cases

Impact item	Prediction and evaluation method
Social institutions and local decision-making institutions	-Predict impacts based on field survey results and literature reviews and similar cases
Social infrastructure and services	-Study on literature and similar cases reviews to predict the impacts. -Confirm the buried objects such as telephone lines, water pipes, optical cables, etc., in the Project Road site by conducting field surveys and collecting information by related organizations.
Local economy and livelihood	Predict impacts based on field survey results and literature reviews and similar cases
Unequal distribution of benefit and damage	Predict impacts based on field survey results and literature and similar cases reviews
Local conflict of interest	Predict impacts based on field survey results and literature and similar cases reviews
Water usage, water rights and communal rights	Predict impacts based on field survey results and literature and similar cases reviews
Cultural and historical heritage	-Confirm the location, scale and importance of cultural heritage along the road. -Study on literature and similar cases reviews to predict the impacts.
Religious facilities	-Check the location and scale of religious facilities such as graveyards and churches along the Project Road. -Study on literature and similar cases reviews to predict the impacts.
Sensitive Facilities (e.g., hospital, school, precision machine factory)	-Check the requirements from Airport Authority and clearance needed prior to construction -Check the locations of roadside hospitals, schools, nurseries, recreational facilities, and religious facilities that require special consideration. -Predict impacts based on field survey results and literature reviews and similar cases
Gender	Study on literature and similar cases reviews to predict the impacts.
Children's rights	Study on literature and similar cases reviews to predict the impacts.
Public Health (sanitation and infectious diseases)	Study on literature and similar cases reviews to predict the impacts.
Occupational safety and health (OHS)	Study on literature and similar cases reviews to predict the impacts.
Accidents	Study on literature and similar cases reviews to predict the impacts.
Climate change	Literature and similar cases reviews and consider adaptation measures that should be included in road design.

Source: JICA Survey Team

19.1.6 Results of Environmental and Social Considerations

(1) Air Quality Status on Existing Road (Jadibuti- Koteshwor-Tinkune)

The air quality parameters that were measured during the monitoring were: Total Suspended Particles, Repairable Particulate Matter (PM_{10}), and Repairable Fine Particles ($PM_{2.5}$) for ambient air quality and Nitrogen Dioxide (NO_2) for gaseous pollutants. Mainly air quality monitoring was carried out at three locations, Jadibuti, Koteshwor and Tinkune Intersections of the existing road. In order to get the baseline information of the air quality status along the alignment of the Project Road. The measuring points are set based on current traffic situations and high traffic conintersection intersection. The primary air pollution sources were contributed by the vehicles on the highway emitting smoke and dust.

The major sources of air pollution are vehicular emissions from combustion of biomass and fossil fuels. Vehicular emission in urban areas is aggravated by the use of leaded, substandard and adulterated fuel, poor traffic management, use of old vehicles and the poor maintenance of those vehicles.

IEE study team has conducted the air quality monitoring at three stations along the existing road. The air quality parameters were measured three times during 24 hours.

Table 19.1.10 Air Quality Sample Location

Sample Area	Jadibuti IS	Koteshwor IS	Tinkune IS
Monitoring Date	12/06/2023-13/06/2023	13/06/2023-14/06/2023	14/06/2023-15/06/2023
Distance from Road	15m	25m	10m
Elevation	1311 m	1311 m	1311 m
Latitude	27°40´31.5´´N	27°40´41´´N	27°40´31.5´´N
Longitude	85°21´8.01´´E	85°20´57´´E	85°21´8.01.5´´E
Weather	Sunny	Sunny	Sunny

Source: JICA Survey Team

Results:

Table 19.1.11 shows the result of the sampling survey together with the national standards (NAAQS) of Nepal and also the WHO standard.

The observed TSPM and PM10 values complied with the national standard on all three monitored locations. The measured results of PM2.5 at all three monitored stations show that the values exceed the prescribed NAAQS standard. The dust due to pavement sweeping, and high traffic were responsible for release of particulate matter in the sampling point. The measured results at three locations show that the SO_2 and NO_2 values at all three stations did not exceed the prescribed NAAQS standard.

Table 19.1.11 Air Quality at Different Locations within Project Area

S. N.	Location	TSP * $\mu g/m^3$	Total PM_{10} * $\mu g/m^3$	$PM_{2.5}$ * $\mu g/m^3$	SO_2 $\mu g/m^3$	NO_2 $\mu g/m^3$
1	Jadibuti	177.10	90.37	49.36	1.23	4.52
2	Koteshwor	183.72	91.07	52.07	1.86	6.60
3	Tinkune	159.48	84.37	42.14	0.88	3.39
National Ambient Air Quality Standard for Nepal (2012)		230	120	40	80	70
WHO Standard (2004)		150	50	25	500 (Max)	150 (Max)

* 24 – hour Average

Source: JICA Survey Team

(2) Noise Status on Existing Road of Project area

The noise level in the existing road section of the Project area was measured at three locations shown in Table 19.1.12, which are exactly at the same locations where air quality was measured. The noise descriptors were calculated during both the day and night.

Table 19.1.12 Noise Sample Location Along Existing Road

Sample Area	Jadibuti IS	Koteshwor IS	Tinkune IS
Monitoring Date	12-06-2023	13-06-2023	14-06-2023
Distance from Road	15m	25m	10m
Elevation	1311 m	1311 m	1311 m
Latitude	27°40′31″N	27°40′41.1″N	27°40′59″N
Longitude	85°21′8.0″E	85°20′57″E	85°20′58″E

Source: JICA Survey Team

The National Noise Standard 2012 that came into effect as per the rule 15 of Nepal Government Environmental Protection Regulation 1997 requires effective monitoring and collection of daytime and night-time noise level permitted limits as in Table 19.1.13. The standard in residential area is almost same as European WHO's Guidelines 2009.

Table 19.1.13 National Noise Level Standards for Nepal

Area	Permitted Noise Level (Leq dBA)	
	Daytime	Nighttime
Industrial Area	75	70
Commercial Area	65	55
Rural Residential Area	45	40
Urban Residential Area	55	50
Mix Residential Area	63	55
Protected Area	50	40
Maximum Noise level permission by Residential Equipment		
S. N	Equipment	Max. Noise Level (Leq dBA)
1	Water Pump	65
2	Diesel Generator	90
3	Entertainment Equipment	70

Source: JICA Survey Team

Results:

Although during the day, the noise level doesn't comply with the standard value of Nepal, during nighttime, the noise level almost complies with the permissible level at all three monitored stations. Structures are relatively gathered and close to the exiting road in these areas, therefore, the measured values of noise might be high because of stopping cars, reflection from the structure, and other people's activities.

Table 19.1.14 Sound Pressure Level of Existing Road

S. N	Noise Descriptors	Jadibuti IS	Koteshwor IS	Tinkune IS
1	L_d (Average daytime)	81.9	79.6	77.5
2	L_n (Average nighttime)	57.6	55.9	57.3
3	L_{dn} (Average day & nighttime)	69.8	67.8	67.4

Source: JICA Survey Team

(3) River and Ground Water Quality along Existing Road

The rivers within the Project area are highly polluted and are not appropriate for human use. The Manohara River and the Bagmati River have some discharges even during the dry season but the river water quality is not better. The practice of discharging raw sewerage and industrial effluents have also almost killed all the aquatic life of the rivers.

The ground water is extracted and used by local people of the area through wells and deep tube well. The water quality of the surrounding area is not drinkable due to high concentration of iron, sulphur and ammonia, but the people use it for daily life usage other than for drinking.

During the IEE study, the water quality parameters were measured at the two rivers namely the Manohara River at the Jadibuti side and the Baghmati River at the Tinkune side, with two wells and supply water from Jadibuti and Koteshwor side. Mainly four parameters were measured namely pH, Total Suspended Solids (TSS), (mg/l), Biological Oxygen demand (BOD), (mg/l) and Coliform, (MPN Index/ 100ml). All the parameters in the three sites are within their permissible level and do not exceed the standard values of the parameter.

Table 19.1.15 Sample Location

Sample Area	SW1: River Manohara	SW2: River Bagmati	GW1: Well, Jadibuti	GW2: Well, Tinkune	GW3: Boring Koteshwor	Municipal Water Supply, Jadibuti	Municipal Water Supply, Koteshwor
Sampling Date	16-06-2023	16-06-2323	16-06-2023	16-06-2023	16-06-2023	16-06-2023	16-06-2023
Test Performance date	16-06-2023-2023/06/28	16-06-2023-2023/06/28	16-06-2023-2023/06/28	16-06-2023-2023/06/28	16-06-2023-2023/06/28	16-06-2023-2023/06/28	16-06-2023-2023/06/28
Location	Jadibuti	Tinkune	Jadibuti	Tinkune	Koteshwor	Jadibuti	Tinkune

Source: JICA Survey Team

Results:

The detailed results of all the tested water sample from different seven areas are illustrated in Table 19.1.16. All samples meet the industrial effluent standards of Nepal for all parameters. However, most of the turbidity and ammonia values in the samples from the two rivers and the three groundwater sources (wells) are beyond drinking water standard values. In addition, all samples, including the two from water supply, have BOD values above 5 mg/L, which is the

BOD level of river water that the Japanese Ministry of Environment considers unsuitable for drinking and fish farming.

Table 19.1.16 Surface and Ground Water Quality Results of Existing Road

S.N	Parameters	Observed Value						
		SW1: River Manohara	SW2: River Bagmati	GW1: Well, Jadibuti	GW2: Well, Tinkune	GW3: Boring Koteshwor	Municipal Water Supply, Jadibuti	Municipal Water Supply, Koteshwor
1	pH @ 17^0C	7.7	7.5	7.3	7.3	7.2	7.4	7.1
2	TSS (mg/L)	148	152	14	60.67	10	10	14
3	TDS (mg/L)	196	210	354	12	208	174	44
4	Turbidity, NTU	534.67	695.33	12.42	60.67	124	2.21	0.4
5	BOD (mg/L)	5.7	5.9	6.4	6.6	6.2	6.9	6.7
6	Ammonia, (mg/L)	2.62	2.48	2.68	2.65	1.47	<0.02	<0.02

Source: JICA Survey Team

Table 19.1.17 National Standards for Industrial Effluent and Drinking Water in Nepal

		Tolerance Limits for Industrial Effluents to be Discharged into Inland Surface Waters *1	Tolerance Limits for Industrial Effluents to be Discharged into Public Sewers *1	Tolerance Limits for Wastewater to be Discharged into Inland Surface Waters from Combined Wastewater Treatment Plant *1	Drinking water *2
1	pH @ 17^0C	5.5-9.0	5.5-9.0	5.5-9.0	6.5-5.8
2	TSS, (mg/L)	30-200	600 max	50 max	-
3	TDS (mg/L)	-	-	-	1,000
4	Turbidity, NTU	-	-	-	5(15)
5	BOD (mg/L)	30-100	400 max	50 max	-
6	Ammonia (mg/L)	64.29 max *3	64.29 max *3	64.29 max *3	1.5 max

Source: *1 *Nepal Gazette 2058/1/17*, *2 *National Drinking Water Quality Standards and Directives, 2005.*
*3 A value converted from that of Ammoniacal Nitrogen (50 mg/L max).
( ) Values in parenthesis refers the acceptable values only when alternative is not available.

(4) Overall Physical Condition of the Road, Traffic Volume and Acoustic Environment

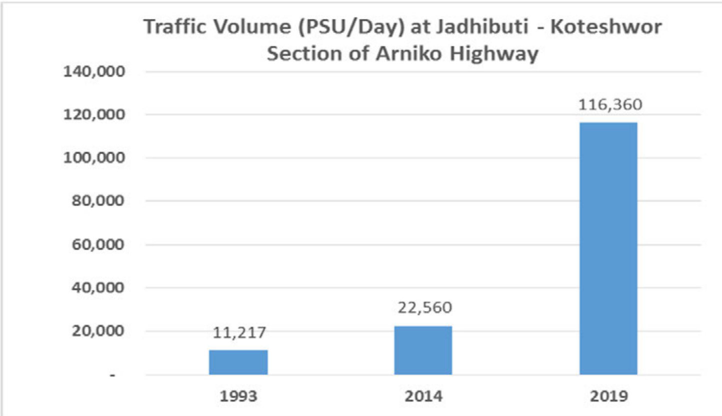
1) Road Condition

Completed in 1972, the Araniko Highway is a main link between Kathmandu and Bhaktapur. The Kathmandu to Suryabinayak Road section was upgraded and widened to four-lane standard by the JICA in 2011.

The general condition of the road is satisfactory but the due to the increasing volume of traffic, the intersections at Jadhibuti, Koteshwor and Tinkune are over congested. The ROW as determined by the DOR was initially determined as 25 yards and later changed to 25 meters on both sides from the road centerline. In general, the ROW is maintained throughout the road corridor, but at places, only the 25 yards ROW has been maintained.

2) **Current Traffic Condition on Roads**

Urban transportation problems in the Kathmandu Valley are strongly related to land use problems such as urban sprawl in the suburb and overconcentration of functions in the city center. Currently the major road traffic problem in this section of the road is the traffic congestion at Koteshwor and Jadibuti intersections.



Source: Pre-Survey Report (2019)

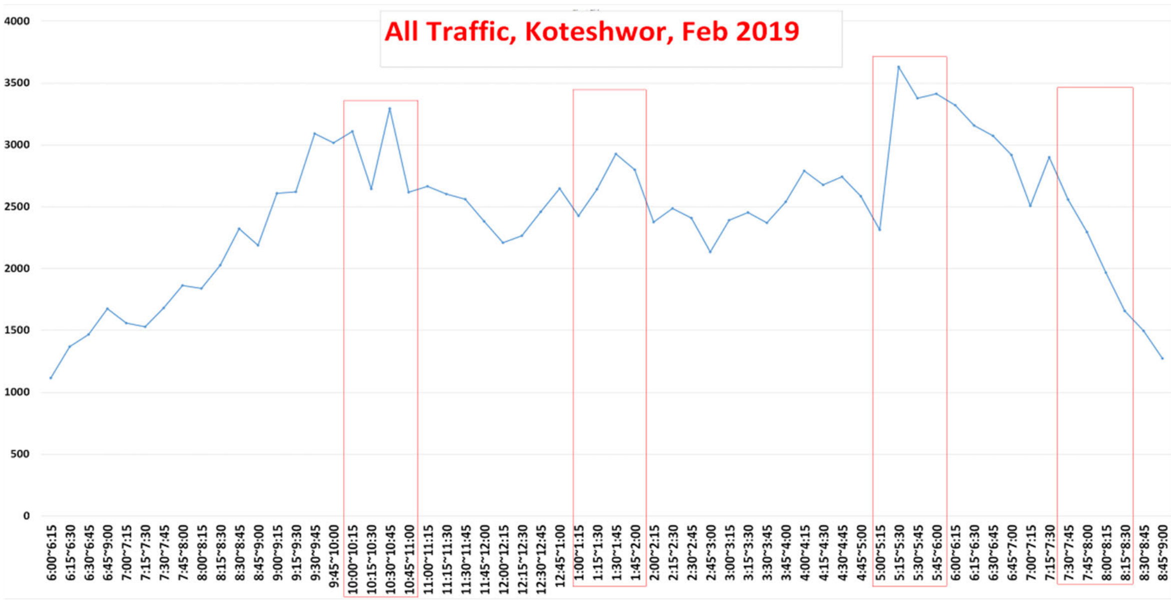
Figure 19.1.5 Traffic Volume at Jadibuti-Koteshwor Section

The traffic volume on these road sections is already beyond its capacity. The capacity upgrading (i.e., road widening or new construction) of these roads is quite difficult due to land constraint. The traffic congestion problem is attributed greatly from the conditions of road infrastructure that cannot cope with the rapid increase of population and traffic demand.

Saturation degree of the existing traffic is from 0.5 to 3.4. Maximum traffic volume is 186,000 pcu per day at Jadibuti intersection(Total of inflow traffic volume), and 92,800 pcu per day at at the segment between Jadibuti intersection and Koteshwor intersection (Total of both direction), as per 2020 data.

3) **Daily Traffic Variation**

As per the traffic data collected in February 2019, four predominantly peak hours were seen, namely at Morning: 10~11 am; Day: 1~2 pm; Evening: 5~6 pm and Night:7:30~8:30 pm – (the nighttime is mainly when the heavy trucks are allowed to enter Kathmandu, causing excessive vibrations along the road.)



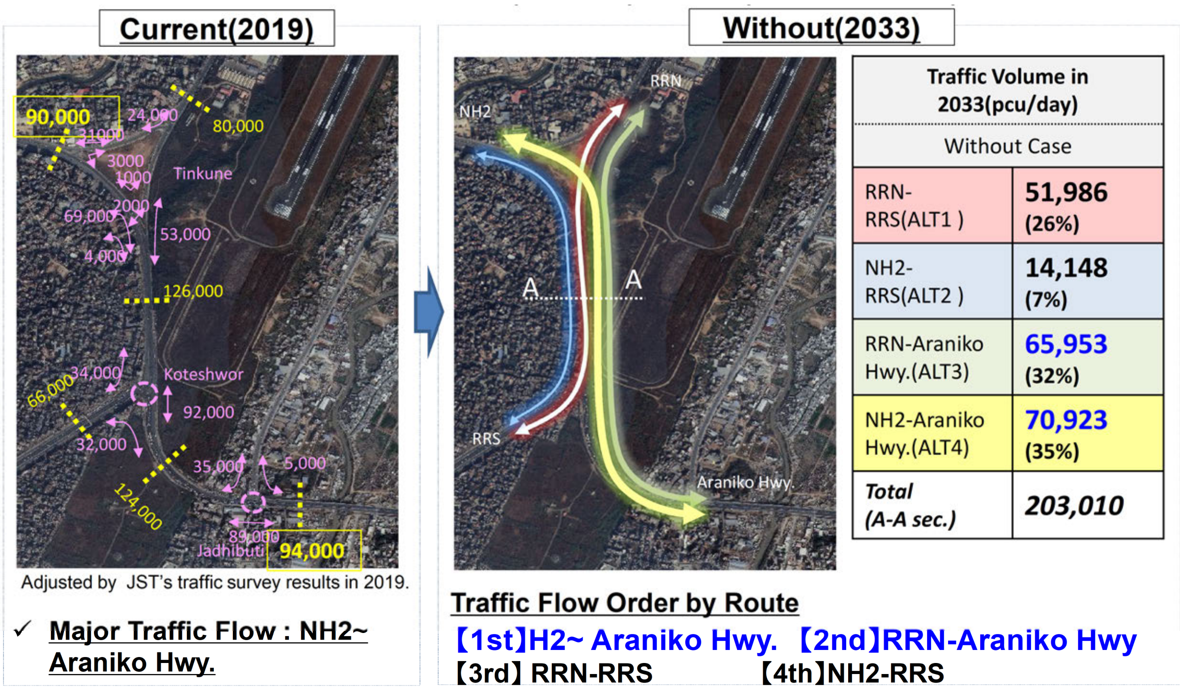
Source: Pre-Survey Report (2019)

Figure 19.1.6 Daily Traffic Flow Variation- 21Hour Data for Koteshwor, 2019 February

4) **Traffic Demand Forecast for Year 2033**

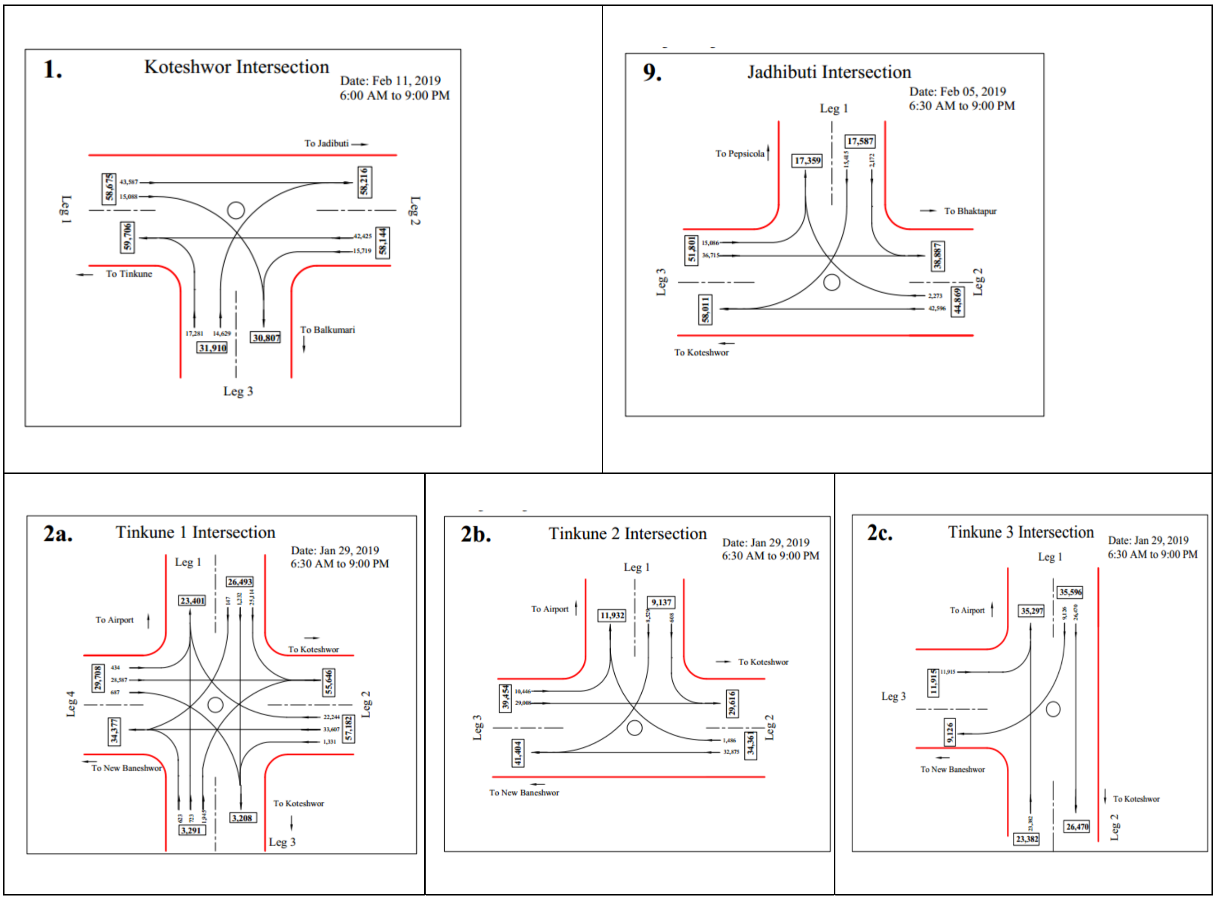
As described in section 7.1.6, all intersection and major segment is beyond the its capacity. According to JST study, this traffic congestion will get worse as the traffic grow. As shown in Figure 19.1.7, traffic volume at A-A section in 2033 is 203.010 pcu/day which is almost 1.6 times compared with the one in 2019.

The forecast clearly indicates insufficient traffic flow capacity and Grade Separated Civil Structure for Koteshwor intersection is necessary.



Source: JICA Survey Team

Figure 19.1.7 Traffic Volume Situation for 2019 and 2033 Forecast



Source: JICA Survey Team

Figure 19.1.8 Traffic Volume at Intersections, Survey 2019 Data

Source: JICA Survey Team

Figure 19.1.9 Present Traffic Condition at Koteshwor Intersection

(5) Vicinity of Tribhuvan International Airport

Aviation Conditions: Since the target intersections are located near the Tribhuvan International Airport, aviation conditions issued by ICAO (International Civil Aviation Organization) will be considered during the construction works. The base elevation of the runway is EL+1314masl. The aviation condition required for the operation of the aircrafts is shown below, as per the Airport Authority.

Point	Obstacle Limit	Ground EL	Clearance [m]
Point A	+1,326 (+1,323)	+1,310	16 (13)
Point B	+1,329 (+1,326)	+1,309	20 (17)
Point C	+1,330 (+1,327)	+1,305	25 (22)

Note: Number in bracket is calculated by 1.6% gradient.

Source: JICA Survey Team

Figure 19.1.10 Airport Clearance Requirements

(6) Biological Environment

1) Protected Forest Areas or other forests

There are no protected forest areas or any other preserved areas or forests within the proximity of this Project Road.

2) Roadside Trees

There are no roadside trees along the project alignment. Few shrubs and bush vegetation exist at Koteshwor's footpath areas, which will not be affected by the activities of this Project.

There are some bushes and shrubs on the north side of the existing road in the Tinkune area around Muni Bhairab Temple belonging to the airport land. Only these vegetation bushes with some shrubs are required to be cleared along Tinkune area for project construction activities. The chance of noise created during the execution of construction works may create discomfort to the fauna existing in those areas.

3) Wildlife

Since the Project area lies in the center of the urban city area, no fauna or wildlife exists in the Project area.

(7) Socio-economic and Cultural Environment

1) Demographic Features

The Project area is along the existing road starting from Manohara river bridge through Koteshwor intersection to Tinkune (Araniko Highway side) of approximately 1.86 km in length. Along this road section, from Manohara river bridge.

2) Settlement Pattern

Most of the settlements along the road alignment are developed as ribbon settlement along the existing main and frontage roads. Settlement development have been very fast. Because of commercial value along the roads almost all ground floor of the houses have been used as shops or retail outlets and upper floors have been used as residential purpose. This type of commercial cum residential buildings are seen form at the Koteshwor area to Jadibuti intersection. There is no agricultural land or any open areas in the vicinity of the Project areas.

3) Economic Activities

In the road along the alignment of Kathmandu's Tinkune to Bhaktapur's Manohara, a mixed type of economic activity can be seen. The people residing along the main and frontage roads are predominately in business which are mostly retail markets for food, daily commodities and some construction hardware materials, etc. These businesses are run by the house owners themselves or tenants. Others are engaged in agricultural activities, administrative jobs, technical jobs. The majority of bus commuters from Bhaktapur/Kavre Districts disembark at Koteshwor to transit, so that Koteshwor intersection is very busy with pedestrians all throughout the daytime, especially during morning and evening peak hours.

On south side there are private buildings and sheds with commercial activity form the Manohara river bank to Kamakha Petrol Pump located around the boundary of TIA.

There is a traffic police building on the south side of the Koteshor intersection. Commercial and residential buildings are located on the west side of the road between the Koteshor and Tinkune intersections, and the TIA boundary is enclosed by a barbed wire fence up to Sinamangar. Near the Tinkune intersection is the Muni Bhairab Temple, the only religious/cultural structure affected by the project.

Source: JICA Survey Team

Figure 19.1.11 Aerial View of Koteshwor Intersection

Source: JICA Survey Team

Figure 19.1.12 Aerial View of Jadibuti Intersection

4) Land Transaction

The area from Tinkune, Koteshwor to Jadibuti and beyond has experienced a tremendous increase in the sale of land for residential purposes. The land adjacent to the main road has reached to high market prices and very few plots are vacant. The transaction of land has been a major characteristic of this entire area and a significant urban development is seen in this area.

5) Land use pattern along Road Alignment

Land use pattern of the project area is classified as a built-up urban area with mainly commercial settings. The description by each section is shown in the following table.

Table 19.1.18 Present Land-Use Pattern along Highway Corridor

Chainage	Length (Km)	Location	Land use pattern	
			Adjacent to Highway	Beyond Highway corridor
0+000~0+800	0.8	Tinkune Area	Open vacant land With One Temple	Land of TIA
0+800~1+500	0.7	Koteshwor Area	Open land of TIA	Vacant lands of TIA and Airport approach
1+500~1+750	0.25	Jadibuti	Built-up area, Roadside houses	Scattered settlements
1+750~1+900	0.25	Jadibuti – Manohara River	Office premises	Scattered settlements

Source: Field Study, Dec. 2017

6) Religious and Cultural Site

The only religious sited to be affected by the Project is the Muni Bhairab Temple that lies at Tinkune intersection. Within the temple's premises, there exists a 3-storied building used as community space. A temple and a community building, Saraswoti Youth Club lie in that premises. The total area of that is $350m^2$ (11 Anna). The ownership of land where the temple is located is CAAN.

The detail of the temple is given below.

Temple and Community Building at Tinkune

Temple Name : **Muni Bhairab Temple**
Community Name : Saraswoti Youth Club
Land Area = 11 Anna (350 m2)
Land Ownership = CAAN
CAAN relocated the Temple from its original place near the Runway, to present location at Tinkune
CAAN gave its land to construct the Temple and Community Building to

Community Building :
Construction Started : 2003, Completed 2006
Constructed by Collection of Donations from various people, organization (Names of donors are inscribed in stone inscriptions)
Plinth Area of Community Building : 85 m2
Nos. of Floors : 3
Total Area : 255 m2
Nos. of Rooms : 6
Building Line : 12m from edge of Foot Path, 16m from Centerline of Road
Usage : Religious purpose, (Bhajan, Worships, Puja, Saptaha) under Hindu Religious beliefs
Special Use : Religious rituals after death - as venue for mourning period by family of deceased (Kriya-putri home)

Muni Bhairab Temple
Area : 40 m2
Pagoda Style, Bronze Metal Sheet Roofing, Ground Floor Temple

Responsible Person : Mr. Achut Parajuli, Tinkune

Source: JICA Survey Team

Figure 19.1.13 Outline and Photos of the Temple to be Affected in Tinkune

7) Other Public Structures

The other public structure to be affected is the water collection and distribution pump station, located at Jadibudi. KUKL manage this structure. The details of the pump station are given hereunder. It is within the airport's boundary.

The detail of the pump station is given below.

Local Drinking Water Collection & Distribution Pump Station

Name : Kathmandu Valley Drinking Water Management Board, Bhaisepati
Managed By : KUKL, Baneshwor
Jadhibuti Pump Station

Capacity : 700 lit per minute
Water Collection : Deep Tube Well Boring
Collection Tank : RCC 35m x 10m
Filteration System : 1m dia. Cylinder , 3m height
Water Storage Tank : 7m Diameter Circular RCC Covered Tank

Others : Pump House, Staff Quarter Building

Land Area : 950 m2
Land Ownership : CAAN

Water Distribution : to Approx. 500 Households in Jadibuti, Koteshwor, Narephat and Nikhileshwor area.

Source: JICA Survey Team

Figure 19.1.14 Outline and Photos of the Water Collection and Distribution Pump in Jadibuti

19.1.7 Impact Assessment

A result of the impact assessment is as shown in Table 19.1.19

Table 19.1.19 Result of Impact Assessment

Issue No.	Project Activities	Impacts	Impact Prediction			Total Score	Significance of Impacts	Responsibility
			Magnitude	Extent	Duration			
Physical Environment (Construction Phase)								
P1	**Temporary and Permanent change in land use**							
P1-i	Acquisition of private land due to construction and road width formation	Cumulative impact on socio-economic situation of residents who lost land and houses	H	SS	ST	75	Significant	Contractor/ DOR
			60	10	05			
P2	**Impacts on air, noise and water quality degradation due to construction activities**							
P2-i	Road formation clearance Transportation of construction material	Social impact on residents along road and road users with air pollution due to the operation of drilling machines, excavators, vehicle movements on unpaved roads	M	L	ST	45	Insignificant	Contractor
			20	20	05			
P2-ii	Operation of concrete batching plant and bitumen mixing plant	Social impact to local people due to excessive dust production and noise pollution due to operation of concrete batching plant and bitumen mixing plant	M	L	MT	50	Insignificant	Contractor
			20	20	10			
P2-iii	Road formation clearance and track opening Construction of flyovers at Tinkune and Jadibuti Camp site wastewater from kitchen, bath/toilet and bitumen mixing plant operation at riverbanks along the Existing Road	Impact due to degradation of water qualities of existing Manohara and Bagmati River. Siltation and deposition at lower, downstream sections on riverbanks altering the level of pH and Suspended Solid. Surface water contamination from unsanitary disposal of waste on nearby water bodies altering the BOD level.	L	SS	ST	25	Insignificant	Contractor
			10	10	05			
P2-iv	Road formation clearance Transportation of construction material	Social impact on resident along road and road users with noise pollution due to operation of drilling machines, excavators, vehicle movements on unpaved roads	M	L	ST	45	Insignificant	Contractor
			20	20	05			
P2-v	Hill side rock cutting for road width formation.	Physical impact on roadside residents due to vibration and noise pollution during excavation activities	M	SS	ST	35	Insignificant	Contractor/ DOR
			20	10	05			
P3	**Impacts / issues due to originating from solid wastes, soil waste & Liquid waste generation**							
P3-i	Construction and use of the stock yard, concrete mixing plant,	Physical impact to local resident due to produced solid wastes	M	SS	ST	35	Insignificant	Contractor/ DOR
			20	10	05			

Issue No.	Project Activities	Impacts	Impact Prediction			Total Score	Significance of Impacts	Responsibility
			Magnitude	Extent	Duration			
	storage, etc.,							
P3-ii	Construction and use of the Workers' Camp.		M	SS	ST	40	Insignificant	
			20	10	05			
P3-iii	Construction and use of the septic tanks at campsite	Physical impact due to produced solid wastes and liquid waste to surrounding environment	M	SS	MT	40	Insignificant	
			20	10	10			
P3-iv	Construction of the underpass and flyover with earth excavation work	Social and physical Impact to residents around underpass and flyover area due to production of spoil/ soil waste	M	SS	MT	40	Insignificant	Contractor/ DOR
			20	10	10			
P3-v	Generation of Spoil/Soil and construction of Spoil Disposal Site		M	SS	MT	40	Insignificant	
			20	10	10			
P3-vi	Establishment of bitumen yard and fuel, lubricants storage area	Physical impact to locales due to production of liquid waste	M	SS	LT	50	Significant	Contractor/ DOR
P4	**Impacts / issues on Topsoil and Soil Contamination**							
P4-i	Activities of construction equipment and tools	Physical Impact to Soil Contamination due to construction activities	L	SS	MT	30	Insignificant	Contractor/ DOR
			10	10	10			
P4-ii	Construction and use of the stock yard, concrete mixing plant, storage, etc.		L	SS	MT	30	Insignificant	
			10	10	10			
P4-iii	Earth Excavation for Underpass and Flyover road alignment.	Physical impact to topsoil due to construction activities	L	SS	ST	25	Insignificant	Contractor/ DOR
			10	10	05			
P4-iv	Construction of the underpass	Ground water flow may be altered during construction periods	L	SS	ST	25	Insignificant (As the underpass is located in high altitude, limited impact is expected)	Contractor/ DOR
			10	10	5			
P5	**Impact of chemical, toxic and non-toxic materials upon Environment**							
P5-i	Mechanical parts/ vehicle maintenance and cleaning and mixing of its discharge into water bodies	Impact with chemical contamination on of water bodies due to mechanical parts/ workshop/ vehicle maintenance and cleaning and mixing into water bodies	M	SS	ST	35	Insignificant	Contractor
			20	10	05			
P5-ii	From Construction materials for road site	Physical impact with use of chemical such as epoxy, gypsum, additives, admixtures, cements, bitumen etc. residues mixing in land and water	M	SS	ST	35	Insignificant	Contractor
			20	10	05			
P6	**Impacts due to Labor Camp, Contractor's Camp operation**							
P6-i	Labor Camp and Contractor's camp operation	Socio-economic impact on residents due to temporary loss of land	M	SS	ST	35	Insignificant	Contractor
			20	10	05			
P6-ii	Labor Camp and Contractor's camp operation activities	Social Impact to residents due to Solid waste disposal issues	M	SS	ST	35	Insignificant	Contractor
			20	10	05			

Issue No.	Project Activities	Impacts	Impact Prediction			Total Score	Significance of Impacts	Responsibility
			Magnitude	Extent	Duration			
P6- iii	Labor Camp and Contractor's camp operation activities	Physical impact to surface due to contamination from unsanitary disposal of toilet waste	M 20	SS 10	ST 05	35	Insignificant	Contractor
P7	**Physical Impacts due to slope instability, landslide, erosion of hill slopes along road alignment**							
P7-i	Slope cutting for Underpass and flyover piers formation. Excess spoil disposal Construction and earth excavation activities	Physical impact on slope instability due to landslides and erosion of fresh cut hill-side slopes and valley sides slopes	H 60 20	L 20 10	MT 10 10	90	Very Significant	Contractor
P8	**Physical Impacts due to incorrect disposal of excess excavated earth material**							
P8-i	Road foundation clearance, earth excavation for Underpass Direct disposal of spoil into nearby river, roadside and lower land	Social and physical impact due to direct disposal and deposition of materials at the valley side of the road affecting river and vegetation cover and existing road	H 60	L 20	MT 10	90	Very Significant	Contractor
P8-ii	Excavation of the hills for underpass and earth for flyover road alignment Direct dispose of excavated materials to rivers and drainages.	Physical impact due to disruption / blockages of rivers and drainage with excavation materials (small drainages and large drainage systems).	H 60	L 20	MT 10	90	Very Significant	Contractor
P8-iii	Road formation clearance and track opening	Physical and social impact within road ROW due to future washout during heavy rains damaging road width	H 60	L 20	MT 10	90	Very Significant	Contractor
P9	**Impacts on River flow regime and river environment**							
P9-i	Disposal of construction wastes to rivers and water bodies	Biological and physical impacts on water due to operation of concrete batching plants and storing of material	L 10	SS 10	ST 05	25	Insignificant	Contractor
P9-ii	Haphazard disposal of excavated materials during construction of highway at upstream areas such as at river corridor	Impact due to siltation and deposition on river banks	L 10	SS 10	ST 05	25	Insignificant	Contractor
P10	**Impact upon existing public utilities and Physical Structures and Infrastructures**							
P10-i	Flyover Road and Underpass formation clearance	Physical damage to existing highway surface, damage to culverts etc., causing difficulty in local movements.	H 60	SS 10	MT 10	80	Very Significant	Contractor/ DOR
P10-ii		Physical impact to electric poles, pylons situated along roadside	H 60	SS 10	LT 20	90	Very Significant	Contractor/ DOR
P10-iii		Social Impact to users due to damage on existing water	H 60	SS 10	MT 10	80	Very Significant	Contractor/ DOR

Issue No.	Project Activities	Impacts	Impact Prediction			Total Score	Significance of Impacts	Responsibility
			Magnitude	Extent	Duration			
		pipelines, local trails, etc.						
P11	**Impact/Issues of OHS due Construction Activities**							
P11– i	Flyover road and Underpass formation clearance, construction of structures and flyover bridge	Physical impact to laborers due to Occupational Health and Safety issues during construction	H 60	L 20	MT 10	90	Very Significant	Contractor/DOR
P11 – ii	Underpass formation clearance and construction of structures	Physical impact to laborers on safety issues due to handling of explosives, during transporting, storing and use	M 20	L 20	ST 05	45	Insignificant	Contractor/DOR
P11 – iii	Construction vehicles will run on existing roads disturbing other local transportation and movement of the locals	Social impact to road users due to road safety issues during construction works	H 60	L 20	ST 05	85	Very Significant	Contractor/DOR
P12	**Impact/Issues due to operation of Asphalt concrete plant/hot mix plant**							
P12 i	Road Surfacing activities	Physical impact to locals due to increases air pollution from plants	H 60	SS 10	ST 05	75	Significant	Contractor/ DOR
Operation Phase								
P14	**Obstruction to local movement between adjacent lands and settlement of highway alignment**							
P14-i	Operation of alignment without direct accessibility to people between adjacent lands	Social impact to residents due to inaccessibility between adjacent settlement & market areas	M 20 20	L 20 20	MT 10 10	50	Significant	Contractor/ DOR
P16	**Impact Air pollution due to Traffic exhaust gas on the Road**							
P16-i	Traffic of vehicles	Physical impact upon air due to traffic of vehicles	L 10	R 60	LT 20	90	Very Significant	DOR
P17	**Impact of noise Pollution from the traffic on the Road to nearby local residents**							
P17-i	Operation of the road	Social impact to residents along road due to noise pollution; as large number of vehicles will run through this section of highway.	M 20	R 60	LT 20	90	Very Significant	Contractor DOR
P 18	**Issues related to Highway and Road Safety**							
P18-i	Operation of underpass and plying of large number of vehicles	Social impact to road users due to road safety and safe driving issue	H 60	SS 10	LT 20	90	Very Significant	Contractor/ DOR
P18-ii	Installation of traffic signals and indicators including separate traffic lanes	Physical impact to road users due to traffic management	M 20	SS 10	LT 20	50	Significant	Contractor/ DOR
Biological Environment (Construction Phase)								
B1	**Impact due to disturbance in the Ecology of the area**							
B1-i	Road formation clearance	Impact on species and their habitat	M 10	L 10	LT 05	25	Insignificant	Contractor/ DOR
B2	**Impact upon Flora, Fauna and Aquatic Life due to construction work**							
B2-i	Road formation clearance	Biological impact on local species due to earth excavation of	L 10	SS 10	ST 05	25	Insignificant	Contractor/ DOR

Issue No.	Project Activities	Impacts	Impact Prediction			Total Score	Significance of Impacts	Responsibility
			Magnitude	Extent	Duration			
		underpass area						
B2-ii	Road formation clearance	Limited impact on natural habitat	L	SS	ST	25	Insignificant	Contractor/ Proponent
			10	10	05			
Socio-Economic & Cultural Environment (Construction Phase)								
S1	**Impact due to Private/Public Property Acquisition for Construction**							
S1 –i	Road formation clearance	Socio-economic impact to the residents of roadside due to land acquisition; 0.244ha private land will be acquired permanently.	H	L	LT	100	Very Significant	Contractor/ DOR
			60	20	20			
S1 –ii	Road formation clearance	Socio-economic impact to resident of roadside due to acquisition of residential houses	H	L	LT	100	Very Significant	Contractor/ DOR
			60	20	20			
S1 –iii	Road formation clearance Contractor's camp operation activities	Socio-economic impact to small landholders due to acquisition of their land	H	L	LT	100	Very Significant	DOR/ Local Stakeholders
			60	20	20			
S1 –iv	Road construction activities	Socio-economic impact to residents along the roadside due to due to loss of their shops and economic activities	H	L	LT	100	Very Significant	DOR/ Stakeholders
			60	20	20			
S2	**Impact due to Outside Workers**							
S2 –i	Contractor's camp operation activities	Socio-cultural impact on social, cultural and religious practices due to immigration	L	SS	ST	25	Insignificant	DOR/ Local Stakeholders
			10	10	05			
S2 –ii	Contractor's camp operation activities	Social impact to locals due to degradation of sanitation and hygiene condition of the area	M	SS	ST	35	Insignificant	Contractor/DOR
			20	10	05			
S2-iii	Immigration of outside workers, establishment of labor camp, economic activity of laborers with locals at market and settlement areas	Physical impact to local residents due to pressure upon existing natural resources such as water, existing food availability, existing educational facilities with the increase in the number of outside workers and the utilization of resources.	M	SS	ST	35	Insignificant	Contractor/DOR
			20	10	05			
S2-iv	Road construction and acquisition of private land and property	Social impact on the area due to conflict between workers and local people during the time of construction as there could be a struggle for same commodity and natural resources.	M	SS	ST	35	Insignificant	Contractor/DOR
			20	10	05			
S3	**Depriving locals from continuation of their economic and business activities during the construction of road**							
S3 –i	Road construction activities	Socio-economic impact to small business holders due to	M	SS	ST	45	Insignificant	Contractor/ DOR
			20	20	05			

Issue No.	Project Activities	Impacts	Impact Prediction			Total Score	Significance of Impacts	Responsibility
			Magnitude	Extent	Duration			
		deprivation from their economic activities during road construction						
S3 –ii	Road construction activities	Impact on people's cultural behavior and local economy due to economic activities	M	SS	ST	45	Insignificant	DOR/ Local Stakeholders
			20	20	45			
Operation Phase								
S5	**Social and cultural impacts due to Road Operation**							
S5 –i	Increase in vehicular movement entire the road length	Social & physical impact to road users due to an increase in traffic accidents because of the speed and heavy flow of vehicles	M	R	LT	100	Very Significant	DOR/ Local Stakeholders
			20	60	20			
S5 –ii	Prevention of direct accessibility into the highway	Social impact to resident due to inaccessible / separation due to fragmentation of land	M	SS	LT	50	Significant	DOR/ Local Stakeholders
			20	10	20			

Note: Magnitude (H-High, M-Medium, L-Low), Extent (R-Regional, L-Local, SS-Site Specific), Duration (LT-Long Term, MT-Mid Term, ST-Short Term).
Note: Nature of Impact: D= Direct; IN= Indirect; R= Reversible; IR= Irreversible at site-specific level

Magnitude	High/Major = 60	Medium = 20	Low = 10
Extent	Regional = 60	Local = 20	Site Specific = 10
Duration	Long-Term = 20	Medium-Term = 10	Short-Term = 5

These points / scores for Magnitude, Extent and Duration are taken from the National EIA Guidelines, 1993.

Significance of Impact:

Total Score:	More than 75	:	Very Significant
	50 to 75	:	Significant
	Less than 50	:	Insignificant

This section identifies the potential environmental impacts associated with the Project's activities. All the environmental impacts that have been predicted during the scoping stage and identified during the study stage has been categorically analyzed and assessed based on characteristics of the existing condition and sensitivity of environmental components (physical, biological, socio-economic & cultural and chemical). The beneficial impacts due to the Project implementation are discussed for the Project Construction phase and Project Operation phase. Then after, likely adverse impacts are analyzed and elaborated in detail, with their potential impact level and evaluation of significance of the impact on the surrounding environment – for all identified impacts.

(1) Impacts on Physical Environment

1) Change in Land Use, Loss of Productive Agriculture Land

Changes of land use due to the construction of the flyover with underpass road of this section of road alignment are mainly conversion of private and government land of CANN may result in numerous social consequences. The proposed area for intersection improvement and new flyover road alignment will have a ROW and 1.88km long from Tinkune to Jadibuti.

Land acquisition will have to be made for total ROW. The road alignment will pass through private land areas. The areas of land use change and expected loss of land illustrated in Table 19.1.20.

Table 19.1.20 Summary of Additional Land to be Acquired

Location	Land Area (in m2)	Land Area (in Ropanis)	Remarks
A. Land Required for Flyover			
1. Eastern Section	5,537	10.88	GON Land
2. Eastern Section	2444	4.80	Private land
3. Western Section	18,690	36.74	ROW of Road
Sub Total of A	**26,670**	**52.42**	
B. Land Required for Underpass	12,810	25.18	GON Land of CAAN
Sub Total of B	**12,810**	**25.18**	
Total including Underpass and Flyover	**39,481**	**77.6**	

Source: JICA Survey Team

The Impact of land use change will be direct in nature, high in magnitude with site specific in extent and long term in duration.

2) Impacts on Air and Noise Quality Degradation Due to Construction Activities

- Air and noise pollution due to operation of drilling machines, excavators, vehicles on existing roads
- Excessive dust production and noise pollution due to operation of concrete batching plant and bitumen mixing plant, etc.
- Vibration and noise pollution due to earth excavation and construction activities on entire road alignment corridor

The impact will be direct in nature with medium in magnitude, local in extent and short-term in duration.

3) Impacts on Water Quality Degradation Due to Construction Activities

Various construction activities cause increase in the turbidity of streams, and due to improper sanitation of workers and disposal of wastewater from labor camps, pollutes existing surface water sources. The water pollution effects health hazards, increased sedimentation in the downstream, which may become unfit for bathing, drinking, animal consumption, irrigation, etc. Among various parameters to study the water quality, only two parameters, namely BOD and TSS, are analyzed, so that these parameters can be regularly monitored during construction activities. The following project activities can alter the water quality of the area.

- Wastewater from kitchen, bath and toilet shall be generated at the camp.

- The ground water discharged from the work area of the underpass shall be mixed with sands and clay on the site.
- Further degradation of the water quality of existing rivers due to construction activities and spillover effect of work.
- Spoil tipping, soil erosion and mixing in water bodies causing water quality degradation.
- When the septic tanks are not installed and managed properly, overflow of raw sewage may occur, and BOD of Manohara and Bagmati rivers will further increase significantly.
- Turbidity of the effluent from the surface runoff during earth excavation of underpass and flyover foundation works during rainy season.

4) Vibration and Noise Pollution Due to Construction Activities

Mechanical equipment such as generators, excavators, bulldozers, piling rigs, stabilizers, drills, graders, vibratory rollers, concrete-mixing plants, and screening plants can generate significant noise and vibration during construction. The cumulative effects from several machines together may cause significant nuisances. Local residences, schools etc., will be the major impact receivers during the time of construction.

Vibration will further aggravate the disturbance to the local people in the entire project area is likely. It is anticipated that impact from vibration and noise pollution at road sections near settlement and market areas and at underpass tunnel locations of Koteshwor and Tinkune and its adjoining areas are likely to be affected. The impact will be direct in nature, medium in magnitude, site specific in extent and short-term in duration.

The impact will be direct in nature, medium in magnitude, site specific in extent and short-term in duration.

5) Impacts / Issues due to Originating from Solid Wastes, Soil Waste & Liquid Waste Generation.

a) Solid waste disposal issues

Operation of labor camps can cause impact upon ambient environment if camp operation will not be planned in advance. The main issues of concern are unmanaged disposal of solid and liquid wastes into watercourses, natural drains.

- Construction of road and earth excavation for underpass and flyover foundation works.
- Construction and use of the construction yard, concrete mixing plant, storage, etc.,
- Construction and use of the Workers' Accommodation, including septic tanks,

- Construction and operation of the water treatment facilities for the turbid water from construction sites.

The impact of solid waste disposal will be direct in nature, medium in magnitude, site specific in extent and short-term in duration.

b) Spoil/Soil waste issue from earth Excavation works.

The extraction of materials from inappropriate places or in excessive amount can seriously damage the local environment. For example, quarrying from a slopy area and fragile terrain can result slope instability; extraction of sand and gravel in excessive amount from river can cause riverbank cutting, erosion, and changes of river regime. This will eventually affect the local environment in terms of erosion, flooding of cultivated land, damage to community infrastructures, affect road and road embankment itself and eventually affect the entire livelihood of local people.

Side-tipping of excavated spoils from underpass areas and road excavation are often likely, which invites most hazardous environmental and social impacts. Such construction practices overload unstable materials triggering slides, cause valuable soil erosion, destroy vegetation, cause hazard to settlement at lower side, disrupt rivers and drainages and pollute water sources, etc. Similarly, soil runoff from the construction site and if not properly disposed, the construction debris may lead to off-site contamination (particularly during rainy season).

Impact of land use change will be direct in nature, high in magnitude with site specific in extent and long term in duration.

c) Surface water contamination and from unsanitary disposal of Liquid waste

Other major issues of concern with the establishment of a labor camp are likely to be uncontrolled open defecation by construction workers, unmanaged disposal of toilet wastes into watercourses and natural drains. Surface water contamination is likely if toilet waste and other sanitary waste dispose haphazardly in the entire project area.

The impact will be direct in nature, medium in magnitude, site specific in extent and short-term in duration.

d) Chemical, combustible and Toxic Materials such as epoxy, gypsum, additives, admixtures, cements, bitumen etc., residues mixing in land and water bodies

The use of chemicals such as epoxy, gypsum, additives, admixtures, cements, bitumen etc.. is inevitable during the time of construction. All these chemicals are hazardous materials used for road construction and maintenance activities. The storage of such chemicals might be an environmental problem that can only be met by special precautionary measures. Containers of such chemicals such as bitumen drums often get damaged during transit, leading to a leakage in storage places which often are not adequately cleaned up afterwards. It is likely that the bitumen could remain at the boiling area and decanter sites for many years after the completion of road construction if it is not properly rehabilitated.

Release of bitumen into the environment through runoff into surface water is likely during the construction phase if no caution measures will be taken seriously; such hazardous chemicals can also cause pollution due to their spillage in large quantity. The typical primary and secondary effects of water pollution include health hazards to the downstream water users and impact on local fisheries are likely.

The impact will be direct in nature, medium in magnitude, site specific in extent and short-term in duration.

e) Hazards caused by combustible and Toxic Materials

Combustible and Toxic Materials which will cause damage to nearby property causing human injury, disturbance to wildlife, air pollution, water pollution etc., are likely during construction. Locals near all proposed project areas are likely to be affected by noise, air and water pollution if handling of explosives will not be carried out safely. Further, water bodies and inhabitants downstream will also be affected with the haphazard disposal of such combustible and toxic materials causing nuisance and health hazards.

The impact will be direct in nature, medium in magnitude, site specific in extent and short-term in duration.

f) Accidental Leakage or Spillage of Stored Fuel /Chemicals

During the construction phase, there will be the requirement of storage of fuel/chemicals. During the process of storage and handling, there is the possibility of accidental leakage or spillage of stored fuel/chemicals. If not removed quickly, the spilled chemicals/fuel may be absorbed by the floor. This may lead towards the contamination of soil & water. This will affect the community living around this area.

The impacts are direct in nature, local in extent, low in magnitude and short-term in duration.

6) Impacts due to Labor Camp, Contractor's Camp operation and Temporary settlement

a) Temporary loss of land

Additional land apart from the project site will be acquired to establish the labor camp and contractor's camp at the vicinity of the project area.

Tentative open spaces for the establishment of labor camps have been identified along the proposed highway. Other project sites such as project engineer camp station, construction material and chemicals storage and vehicle parking areas, workshops etc., could also be established at the identified open spaces. Three labor camp sites are identified which will be established according to the construction work. The identified labor camp areas along the proposed highway are presented in the following table.

The impact of temporary loss of land will be direct in nature, medium in magnitude, site specific in extent and short-term in duration.

Table 19.1.21 Possible Location of Labor Camp Sites of Existing Road

S. N	Location	Side from existing Road	Present Status of Land
1	Jadibuti	Left	Barren land side of Manahara River
2	Tinkune	Left	Barren Land Inside Tinkune Park
3	Koteshwor	Left (Underpass Portal)	Barren Land side of Airport Premises
4	Thapagaon, Pespsicola	Left of Jadibuti Pespsicola road	DOR Yard

Source: JICA Survey Team

b) Solid waste disposal issues

Operation of labor camps can cause significant impact upon ambient environment if camp operation will not be planned in advance. The main issues of concern are unmanaged disposal of solid and liquid wastes into watercourses, natural drains.

The impact of solid waste disposal will be direct in nature, medium in magnitude, site specific in extent and short-term in duration.

c) Surface water contamination from unsanitary disposal of toilet waste

Other major issues of concern with the establishment of labor camp are likely to be uncontrolled open defecation by construction workers, unmanaged disposal of toilet wastes into watercourses, natural drains. Surface water contamination is likely if toilet waste and other sanitary waste dispose haphazardly in the entire project area.

The impact will be direct in nature, medium in magnitude, site specific in extent and short-term in duration.

7) Impacts/Issues due to Slope Instability, Landslides and Erosion of Hill Slopes after Cut and Fill Activities

Slope stability can be upset by the creation of road cutting, filling or embankments activities. Excessive steepness of cut slopes, deficiency of proper drainage, altered and concentrated water flows and excessive slope loading from spoil disposal can result in landslides and soil erosion. Disturbance during construction with vibration, spoil disposal and slope cutting/filling activities can upset the delicate balance between stabilizing factors.

- Construction of the soil disposal site, and disposal,
- Excavation and construction of the underpass

- Excavation and construction of the flyover

a) Impact due to Earthwork and Excavation for Underpass and Flyover

A series of controlled earthwork excavation needs to be carried out for the underpass at the airport alignment depending of the rock and geological formation of the area. Excavation activities are likely to produce seismic vibration including landslide and soil erosion at the portal areas during the time of work.

Impact of air, noise and vibration are likely during construction and excavation of underpass. However, no settlements and houses exist at the proposed underpass area.

Impact due to earthwork and excavation will be direct in nature with high in magnitude, local in extent and mid-term in duration.

b) Soil Erosion, Gully Formation at New Open Cut Sections

Consequences of soil erosion and gully formation not only affect the safety and serviceability condition of roads but also have chain effects on the loss of crops or farmland, degradation due to silt/debris deposition, degradation of water quality, loss of vegetation and on other existing infrastructures. This sort of impact is likely in the entire proposed alignment, especially during earth excavation work at the slope for underpasses and areas for pier foundation excavation for flyover roads.

Impact of soil erosion, gully formation at new open cut sections will be direct in nature, medium in magnitude, site specific in extent and mid-term in duration.

8) Impacts/Issues due to Incorrect Disposal of Excess Excavated Earth Material

Construction materials are usually stockpiled for relatively short periods without covering. This situation may lead to environmental degradation in air pollution, land pollution, pollution of surface water, and permanent changes of land use if not rehabilitated after work complete. Standing crop or future cultivation on such land is disrupted. So, while stockpiling construction material, the following areas should be taken into consideration.

- Place where considerable vegetation is available.
- Low land inundation forest area where folding and water logging is prone.
- Agricultural field where folding and water logging is prone.
- Settlement area where access roads will be blocked with materials.

Impact of incorrect disposal of spoil and excavated materials will be direct in nature, moderate in magnitude, local in extent and mid-term in duration.

9) Impact due to Generation and Disposal of Spoil from Underpass at Koteshwor

The spoil volume from underpass excavation for airport pass at Koteshwor is estimated to be 161,040m3 that will cause several impacts if not treat properly in the surrounding environment. Side-tipping of spoils of the slope towards the existing road is likely, which invites the most hazardous environmental and social impacts. Such construction practices overload unstable slope areas triggering slides, cause valuable soil erosion, destroy vegetation, cause hazard to settlement and roadside at downside, disrupt rivers and drainages and pollute water sources etc. Although a substantial amount of the excavated material will be reused for filling and construction material, a huge amount of spoil will be required to be disposed safely into the proper refuse sites.

Impact due to generation and disposal of huge amount of spoil from proposed tunnels will be direct in nature, high in magnitude, local in extent and mid-term in duration.

10) Impacts on River Flow Regime and River Environment.

The impact upon river/stream flow and its regime is anticipated to be higher during the construction phase. The construction civil works includes storage of materials excavated for bridge foundation, Concrete Batching Plants, etc. Such construction activity will produce anticipated adverse impacts such as siltation and deposition at lower downstream sections and on agriculture land situated at riverbanks.

- Water intake for the concrete plant, other construction facilities and the Workers' Camp,
- Construction of the soil disposal site, and disposal,
- Construction of the new road alignment
- Construction, widening and upgrading of the existing road.

Impact on river flow regime and river environment will be direct in nature, low in magnitude, local in extent and short-term in duration.

11) Impact upon Existing Public Utilities, Existing Physical structures and Infrastructures

The construction of flyover and underpass roads might split the existing community permanently. During the Construction Phase, temporary closure of existing roads may cause difficulties in movement among the nearby population. The activities and the potential impacts are:

- Construction of the grade separation structure split thelocal commmunity
- Construction of flyover Road will split the existing community, for example, the water supply system and roadside pole, permanently.

- Temporary closure of existing roads during the construction will cause difficulties in movement.

Table 19.1.22 List of Electric Poles that are Likely to be Affected

Side	Metal Poles	Concrete Poles	Wooden Poles
Jadibuti side			
North	3	6	0
Total A	**3**	**6**	**0**
Tinkune side			
North	10	6	0
Total B	**10**	**6**	**0**
Sub-Total (A+B)	**13**	**12**	**0**
Total Poles	**25**		

Source: Field Survey, May. 2023, JICA Survey Team

12) Impact/Issues due to Operation of Asphalt Concrete Plant/Hot Mix Plant

Operation of asphalt concrete plant/hot mix pants and use of Bitumen during it is one of the most hazardous materials during road construction and maintenance activities. Bitumen storage, transfer and burning causes the frequent environmental problems that have to be handle with special precautionary measures. Bitumen drums during transportation often get damaged and leads to leakage in stored and hot mix pant area which cannot be adequately cleaned up afterwards. Application and mixing of bitumen often have health and occupational hazard leading to workers injures and burn hence required protective equipment. Burning of local forest timber as firewood for heating bitumen causes environmental air pollution as well as the release of it into the surrendering area can runoff into surface water causing pollution.

The impact will be direct in nature, high in magnitude, local in extent and long-term in duration.

13) Impact/Issues due to Operation of Batching Plant

Establishment and operation of a Batching plant cause massive air pollution and noise pollution to the nearby area. Siltation and pollution of surface water resulting from uncontrolled runoff from storage piles, also cause damage to the local crops and surface water in the nearby surrounding area. It emits excessive noise and dust from the plant while in operation will cause an adverse impact in nearby settlements, schools, health post, etc.

Concrete batching plant sites are high risk areas for accidents and injuries. Also, there will be continuous flow of heavy vehicles for carrying the materials to construction sites. If their path is along school and busy market areas, there will always be the potential risk of serious accidents. River flow regimes are likely to be changed if extraction of sand and gravel in excessive amount from riverbed and riverbanks causing riverbank cutting and erosion.

The impact will be direct in nature, medium in magnitude, site specific in extent and mid-term in duration.

(2) Impacts on Biological Environment

1) Impacts on Roadside Vegetation

The field study shows that the proposed project does not affect any forest or protected area. Hence there is no requirement of forest land for project construction, there will be no impact on biological environment in regard to the forest land acquisition.

The impact is direct in nature, local in extent, low in magnitude and short-term in duration.

2) Impacts on Aquatic Life

As the tentative locations of three proposed worker's camp sites are nearby the rivers and natural drainage which is itself is in a degraded stage, it is possible that the workers may use the proposed outfalls for their daily activities like waste disposal, sanitation activities etc. This may pollute the river quality that could be detrimental to aquatic life.

The impact is indirect in nature, local in extent, low in magnitude and short-term in duration.

(3) Impacts on Socio-economic Environment

1) Impact due to Private Property Acquisition for Construction

a) Loss of private land and properties

An additional 39,481 sq.m. of total land area of different types will be required for permanent purpose that will come under direct influence of the road construction Project. From the total additional land requirement, 2,444 sq.m. belonging to private, 15,330 sq.m of land below to CAAN authority and remaining 21.707 sq.m. of land belonging to government of Nepal is required by this project for construction of flyover and underpass road.The following table illustrates the land used and land requirement by each type for this road improvement work.

Table 19.1.23 Present Land and Land Requirement for different Features of Road

Chainage	Location	Required for	Length	Area (Sq.m)	Owners of Land	Total Land (Sq.m)
0+00~0+120	Tinkune-32	Retaining Wall	120m	2,520	GON	16,170
0+120~0+770	Tinkune-32	Flyover	650m	13,650	GON	
0+770~0+890	Tinkune-32	Retaining Wall	120m	2,520	CAAN	15,330
0+890~1+500	Koteshwor-32	Underpass	600m	12,810	CAAN	
1+500~1+620	Jadibuti-32	Flyover	116.35m	2,444	Private	2,444
1+620~1+750	Jadibuti-32	Flyover	133.65m	2,807	GON	5,537
1+750~1+880	Jadibuti-32	Retaining Wall	130m	2,730	GON	
Total			1880m			39,481

Source: Field Study, April 2023, JICA Survey Team

The following table illustrates the land requirement by different type of structures of the proposed improvement road project.

Table 19.1.24 Present Land Type Required as per the Construction Line

VDC/Municipality		Private Land Area (sq.m.)			Total Area (m^2)
Location	Ward No.	For Flyover	Underpass Tunnel	Retaining Wall	
Tinkune	Kathmandu-32	13,650 (650m)		5,040 (240m)	18,690
Koteshwor	Kathmandu-32		12,810 (610m)		12,810
Jadibuti	Kathmandu-32	5,251 (250m)		2,730 (130m)	7,981
Sub Total		18,901 (1.8901ha.)	12,810 (1.281 ha.)	7, 770 (0.777 ha)	39,481 (3.948ha.)

Source: Field Study, April 2023, JICA Survey Team

Table 19.1.25 Loss of Structure with Number of HH and Population

Type of Loss	No. of HHs			No. of Person		
	Legal	Informal	Total	Legal	Informal	Total
Required for displacement						
1 Structure owner on Gov. Land	-	-	-	-	-	-
2 Structure on Private Land	18	0	18	79	0	79
3 Tenants	0	6	6	0	26	26
4 CBEs (Structure owner on Gov. Land)	-	-	-	-	-	-
5 CBEs (Structure Private Land)	24	0	24	103	0	103
6 CBEs (Tenants Land)	15	0	15	65	0	65
7 Community Owned Structure including physical cultural resource	-	-	-	-	-	-
Not Required for Displacement						
8 Landowners	-	-	-	-	-	-
9 Wage Earners	-	-	-	-	-	-
Grand Total (1-9)	**57**	**6**	**63**	**250**	**26**	**276**

Source: JICA Survey Team

Fifteen houses fall within the alignment that should be displaced. Among the total land required by the project, 2,444 sq.m. (0.244 ha) of private land will be affected and needs to be acquired. Table 19.1.26 illustrated the total area of affected land and houses.

Table 19.1.26 District Wise Total Area of Land and Houses Affected

Section	Land For	Required Land(sq.m.)	Private land (sq.m.)	Affected Houses
Flyover works	ROW maintenance for Flyover at Jadibuti Area	5,537	2,444	12
	ROW maintenance for Flyover at Tinkune Area	18,690	-	0
Underpass Tunnel works	ROW maintenance for Underpass at Koteshwor Area	12,810	-	0
Sub- Total		37,037 (3.703ha)	2,444 (0.2444ha.)	12
Total		39481 (3.948ha.)		

Source: JICA Survey Team

About 3.948 hectares of cultivated land is likely to be acquired permanently along the entire road length.

About 12 houses are likely to be removed within the entire road alignment length where the alignment affects private houses of different types.

The impact of land acquisition will be direct in nature, high in magnitude, local in extent and long term in duration.

b) Impact on small landholders due to land and properties acquisition

The economic earning and status of small landholding farmers will decline due to land acquisition. Causing fragmentation of private land and declining the economic benefit due to loss of their available limited land and structures on it. As a result, marginal land holding populations are likely to be affected due to a decrease in economic income from their commercial land. Those households will be severely affected with the acquisition of their land and property. Deficit in the storage of marginal land holding individuals will further be severely affected with the permanent acquisition of their land. However, there are not only negative effects upon the dwelling communities. The construction and widening of the road along the proposed area will diversify their current economic benefits in the long run. The compensated people may expect to manage the losses of properties by utilizing the received compensated money.

The impact will be direct in nature, high in magnitude, local in extent and long term in duration.

c) Issues due to difficulty in movement due to construction works across existing roads, tracks etc.

Fragmentation of road and other land increases due to the construction of the existing road project hence, their mobility and productivity on their work will decline sometimes during construction. Locals adjacent to the road alignment and Project Affected People (PAPs) will have inaccessibility in moving between their private lands situated adjacent to the road during construction activities going on. Construction of the road project will prevent direct movement and accessibility into their lands due to various activities. This sort of difficult will be faced by the locals inhabited at the entire length of the road alignment. Similarly, people inhabited adjacent to the road alignment and adjacent areas are likely to be deprived from their existing economic activities during the time of road construction. This type of impact is especially envisaged due to road excavation works, dust and noise pollution due to machine operation, likely accidents, vibration, probable landslides during road width formation, haphazard felling of trees along proposed alignment and side tipping upon private cultivated lands.

The impact will be indirect in nature, medium in magnitude, site specific in extent and short term in duration.

2) Occupational Health, and Safety of Workers

a) Occupation health and safety condition of laborers and locals on site during construction

Labor forces required to undertake works especially in rock cutting, hazardous materials handling, heavy equipment operations, earth excavation work, transporting and translocation of heavy construction materials etc. they are prone to various risks and health hazards in absence of works undertaken without adequate safety measures. Other potential impacts to health are respiratory, eye disease due to exposure to dust, and gas emissions during pavement works especially in bitumen works.

Occupational Health and Safety of laborers during the construction of the proposed road alignment will be a significant issue. Similarly, the health and safety of the local people will be another significant issue during the construction stage of the project. During construction, existing local tracks and vehicle tracks will be affected and may need to be either closed temporarily or synchronized with the construction vehicles. Construction activities on the project site are likely to cause hindrance to pedestrians and existing traffic flow if not managed properly. Although, this is not likely to be a major problem, it could affect the passage of the existing traffic.

Road safety issues during construction works will be significant to construction workers, passenger vehicles etc. Safe handling of construction vehicles and equipment during the construction phase will be an important issue for the contractor. Collection and transportation of construction materials, disposal of spoil from excavation will be executed smoothly during construction. The existing Araniko highway will not be disturbed during the time of construction and widening/upgrading of the exiting road alignment. Road safety of the highway will be ensured by managing existing traffic properly.

The impact will be direct in nature, high in magnitude, local in extent and mid-term in duration.

b) Road safety issues during construction works

Excavation of the road having rocky portions required substantial amount of heavy equipment. Accidental explosive hazards are likely during transportation, storing and its use during the time of construction phase. Mismanagement of equipment will likely to claim human life and property accidentally.

The impact will be direct in nature, high in magnitude, local in extent and short-term in duration.

c) Safety issues due to handling, transporting, storing and use of toxic and combustible materials

Handling, transportation, storage and use of toxic and combustible materials will be major issues of concern especially during various construction related activities. Loss of life and property is likely if due care has not been taken while handling of such toxic and combustible materials.

The impact will be direct in nature, medium in magnitude, local in extent and short term in duration.

d) Gender involvement and Child labor during construction

During construction, women workers will be involved in various kinds of construction activities. They could be discriminated against or sexually harassed by male workers, such as a different wage scale. Child labor have been and discontinued as well,

The impact will be indirect, low, local, short term and hence insignificant.

3) Impact due to Outside Workers

a) Possible social conflict and social pollution; impact on social, cultural and religious practices due to immigration of people

Conflict between workers and local people is likely during the time of construction. Conflict is likely as there could be a struggle between local people and labor workers for the same commodities and natural resources. Such impacts are likely through the entire road length during the time of construction, especially at market places.

The impact will be indirect in nature, medium in magnitude, site specific in extent and short term in duration.

4) Impact due to Pressure on Social Service Facilities Such as Drinking Water, School, Health Post etc., by Influx of Construction Workers

Influx of people is anticipated during the time of construction. Pressure upon existing natural resources such as water, existing food availability, existing educational facilities are likely to be affected with the increase in the number of outside workers and the utilization of such resources and increase the number of students in the existing educational facilities. Such impacts are likely at the existing market and settlement areas such as at Jadibuti, Koteshwor and Tinkune Settlement area are likely to be affected.

The impact will be direct in nature, medium in magnitude, site specific in extent and short term in duration.

5) Degradation of Sanitation and Hygiene Condition

Locations where labor camps are established there are likely possibilities of degradation of sanitation and hygiene condition due to influx of workers and migrant populations.

The impact will be indirect in nature, medium in magnitude, site specific in extent and short term in duration.

6) **General Safety Issues Like Vehicular Emission Management and Smoke Management during Accidents inside The Extended Road and Underpass**

Air emissions due to vehicular movement are one of the prime sources of air pollution in the study area. The project area is currently having 4-lanes. The construction of 4-lane flyover with underpass road will result into ease of traffic movement and reduction of traffic congestion, particularly in the urban intersection of Jadibuti, Koteshwor and Tinkune areas of this road section, which are currently having significant daily traffic density.

In order to assess the impact of current traffic volume on the surrounding areas as well as for prediction of impact on air quality due to future projected growth of traffic volume with road improvement this air quality dispersion modelling study has been performed. Quantitative assessment for predicted level of pollutants concentration has been done using Model, a recommended model by JICA for prediction of air quality from point, area and line sources.

7) **Air Pollution due to Traffic Exhaust Gas on The Road**

The operation of this section of Araniko Highway can be expected to increase air pollution from heavy vehicle emissions. The major source of air pollution will be vehicular emission assuming if no other air pollution sources such as industries will be established within the project area. Oxides of nitrogen and carbon and dust might be the main air pollutants during operation. The traffic flow is likely to increase over the years but there will also be ample opportunity to others for such emissions into the atmosphere, therefore no significant adverse air quality impact is predicted from the operation of the project.

The Impact will be direct in nature, low in magnitude, regional in extent and long term in duration.

8) **Noise Pollution from the Traffic on The Road to Nearby Local Residents along the Road**

Vehicle movement could cause chronic noise exposure as a large number of vehicles will run through Araniko Highway on this section resulting in communication problems and leading to elevated stress levels, as well as associated behavioural and health effects of the local people. This sort of pollution could cause auditory fatigue, temporary and permanent lessening of hearing ability, sleep disorders, and can contribute to learning problems in children.

The impact will be direct in nature, medium in magnitude, regional in extent and long term in duration.

9) **Alteration in ground water level due to the construction of underpass tunnel and the volume of spring water may decrease.**

Ground water is one of important parameters in the designs of underpass structures because urban areas are characterized by soil ground which is relatively permeable than rock ground and a high level of ground water due to low elevation. Therefore, it is important to properly predict variations of the ground water when they can affect underpass structures. In turn the stability of an underground structure is assessed using the predicted ground water level.

The impact will be direct in nature, medium in magnitude, regional in extent and long term in duration.

10) **Issues Related Community Health and Safety Problems due to High-Speed Highway**

Road safety and safe driving could be one of the major issues for highway safety due to high speed. Road accidents are likely due to faulty road geometry, irregular road surfaces, over speeding, etc. Accidental loss of life and property is likely if ventilation and lighting systems and their sufficient backups are not maintained properly during the time of operation of this underpass Lack of required traffic signals including other enhancement measures will likely to lead in the number of accidents within the road.

The impact will be direct in nature, high in magnitude, regional in extent and long term in duration.

11) **Impacts / Issues due to Road Accidents and Road Safety**

It is anticipated that the road traffic accidents are likely due to the high-speed vehicles. Although the highway will have separate lane for to and for movement; high speed vehicles accidents are likely.

The impact will be direct in nature, have medium magnitude, regional extent and long term in duration.

12) **Impacts due to Increase Population Pressure, Change in Social Behavior**

Various socio-economic and cultural changes are likely in the project areas and adjacent areas due to the widening/upgrading and construction of this section of Araniko Highway project. Together with the change in land use pattern economic activities of the locals will be altered. The overall inter-regional connections will also be expected to bring changes in the lifestyle of locals. Trafficking, prostitution, consumption and import of alcoholic products are expected to increase especially at existing settlement areas and likely at the service and facility sites that will be introduced by this smooth highway after widening.

The impact will be direct in nature, have medium magnitude, regional extent and long term in duration.

19.1.8 Mitigation Measures, Environmental Management Plan and Costs of Environmental Management

(1) Environmental Management Plan

Proposed mitigation measures for adverse impacts identified are presented in the following Matrix. Most of the proposed mitigation measures are considered to be the civil Engineering. Their costs are included in the Project cost Environmental Management Plan will be managed by DOR. Most of activities are implemented by contractor and supervised by the consultant which contract with the project owner.

Table 19.1.27 Environmental Management Plan

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
Physical Environment (Construction Phase)						
P1	**Temporary and Permanent change in land use**					
P1- i	Road width formation clearance, construction of underpass and flyover, cross drainages, retaining structures, etc.	Loss of land and houses.	Engineering structures will be provided to prevent landslides and river cuttings maintaining rivers and drainage pattern of the terrain within the project area. Land acquired for temporary purposes will be reclaimed and rehabilitated.	Project Alignment	During Construction	DOR
P2	**Impacts on air, noise and water quality degradation due to construction activities**					
P2- i	Road formation clearance, earth excavation for foundation work and underpass	Air pollution due to operation of drilling machines, excavators, vehicle movements on unpaved roads	- Contractor will prepare and implement dust control measures, such as periodical water spray, covering on construction material, etc. - Contractor will actively use electrically-powered equipment. - Contractor will maintain their construction equipment in adequate working conditions. - Contractor will keep clean road surfaces. - The supervision consultant will monitor dust, exhaust gas and complaint from the local people. If the local residents and pedestrians complain about the dust and gas, the supervision consultant and contractors should reconsider the construction technique and method. - Vehicles washing station will be established in appropriate locations.	Along the alignment, workshops, material storage sites, disposal sites	During Construction phase	Contractor
P2-ii	Operation of concrete batching plant and bitumen mixing plant	Excessive dust production and noise pollution due to operation of concrete batching plant and bitumen mixing plant etc.	Contractor will operate the plant in accordance with manufacturer's specifications.	Plant sites	During construction phase	Contractor

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
P2-iv	Road formation clearance, earth excavation for foundation work and underpass	Noise pollution due to operation of drilling machines, excavators, vehicle movements on unpaved roads	Preventing noise pollution due to operation of drilling machines, excavators, vehicle movements on unpaved roads by using appropriate machine and time management.	Entire alignment	During construction phase	Contractor
P2-v	Road formation clearance and track opening and concrete batching plant and bitumen mixing plant operation near riverbanks	Degradation of water volume and/or qualities of existing rivers.	Use water treatment facilities for discharged water from construction related sites. Contaminated water must not be discharged at the site and moved to water purified plants.	Along the alignment where the existing river is situated close to the proposed route	During construction	Contractor
P3						
P3-i,ii	Construction and use of the stock yard, concrete mixing plant, storage, etc., Construction and use of the Workers' Camp.	Impact due to produced Solid Wastes	Undertake necessary institutional coordination and allocate a budget plan for hiring collection and disposal service provider. Workers and camps in charge will be trained for source segregation and handing of generated solid waste at site. The concerned body that has the contract from the contractor will perform the solid waste management work being within the clause of Solid Waste Management Act 2011. Establish solid waste collection and management through incineration, proper landfill and decomposing for degradable wastes in pit at labor camps. Develop and implement waste management "Code of Conduct" and enforce strict penalty to violator of "Code of Conduct". Educate about non-use of bio non-degradable materials such as plastic, metal, glass etc. and separation of such waste material and	Labor Camps, stock yard, water treatment plant and entire constructio n site.	During construction phase	Contractor, Supervision Engineer

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
			incineration safely			
P3-iv, v,	Construction of the underpass and flyover with Earth excavation for Road Construction Generation of Spoil/Muck/Soil and construction of Spoil Disposal Site	Impact due to production of Spoil/ Soil Waste	Design the Disposal Site so that the impact on the downstream water use is minimized. Only dispose soil waste at designated place. Avoid Soil disposal on: - Natural water course posing a threat of or causing choking in its flow and course change. - Over the edge of the excavations and fresh embankments. - Immediately above potential arable land and forest areas. The concerns the body that has the contract from the contractor will perform the solid waste management work being within the clause of Solid Waste Management Act 2011.	Along the entire road.	During construction phase	Contractor, Supervision Engineer
P3-iii, vi	Construction and use of the Workers Camp's septic tanks Construction and operation of the workers camp and discharge of the turbid water from construction sites and camps Establishment of Bitumen yard and fuel, lubricants storage area	Impact due to production of Liquid Waste	- Storing and handling of fuel, lubricants bitumen etc., should be done in a safe manner. - Storing compounds will have fire extinguisher facilities. - Used lubricants will not be discarded in a haphazard manner or disposed in streams and water sources. - Direct cleaning of vehicles or equipment should prohibit in streams, rivers or canals. - Liquid waste must not be discharged at the site and moved to water purified plants. DOR and Contractor will find and contract with authorized treatment plant/facilities which is effective for the wastewater from the sites. - Avoid contamination if liquid waste with water sources in case of spillage. - Protective clothing, gloves, boots etc., should be provided to the laborers dealing with liquid waste.	Labor and Contractors camps	During construction phase	Contractor, Supervision Engineer
P4	**Impacts / issues on Topsoil and Soil Contamination**					
P4-i,	Activities of earth	Impact due to Soil	Education of the workers about the negative	Equipment'	During	Contractor,

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
ii, iii	excavation Activities of construction equipment and tools, Construction and use of the stock yard, concrete mixing plant, storage, etc.	Contamination	impacts of soil contamination. Training of good handling of the oils and chemicals to avoid soil contamination. Preparation of clear guidelines of handling, recycling and discarding the empty containers or bags of the chemicals. Designation of site managers who monitors condition of stock yards.	s Service Yard, Labor Camps, Stock yard/Storage area Mixing plants area, and entire road area	construction phase	Supervision Engineer
P-iv	Construction of the underpass	Groundwater flow may be altered during construction periods	Monitoring (visual observation) of any groundwater discharge during the construction of underpass.	Underpass	During construction phase	Contractor, Supervision Engineer
P5	**Impact of Chemical upon Environment**					
P5- i	Mechanical parts/ vehicle maintenance and cleaning and mixing of its discharge into water bodies	Chemical contamination of water bodies due to mechanical parts/ workshop/ vehicle maintenance and cleaning and mixing of its discharge into water bodies	Workshops and chemical storage sites will not be established nearer to the water bodies and river side. Bitumen drums will be stored at designated locations and not scattered along the road. If contaminated, the contaminated runoff from storage areas will be captures in ditches or ponds with an oil trap at the outlet.	Workshops and batch mixing plant sites	During construction phase	Contractor
P5-ii	From construction materials for road site	Chemical such as epoxy, gypsum, additives, admixtures, cements, bitumen etc. residues mixing in land and water bodies	During site clearance, all cut and grubbed materials will be kept at a secured location so to maintain environmental safety.	Workshops and batch mixing plant sites	During construction phase	Contractor
P6	**Labor camps**					
P6- i	Labor camp and	Temporary loss of	Recovering and rehabilitating temporary loss of	Labor	Right after	Contractor

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
	Contractor's camp operation	land	lands	Camp and Contractor's camp sites	the completion of construction	
P6-ii	Labor camp and Contractor's camp operation camp activities	Solid waste disposal issues	Avoiding direct disposal of Solid waste	Labor Camp and Contractor's camp sites	During operation of camps	Contractor
P6-iii	Labor camp and Contractor's camp operation camp activities	Surface contamination from unsanitary disposal of toilet waste	Managing safe disposal of toilet waste to prevent surface contamination	Labor Camp and Contractor's camp sites	During operation of camps	Contractor
P7	**Physical Impacts due to slope instability, landslide, erosion of hill slopes along road alignment**					
P7- i a	Slope cutting for road width formation and underpass, Excess spoil disposal Construction and excavation activities Disposal of spoils	Slope instability, landslides and erosion of fresh cut hill-side slopes and valley sides slopes	Angle of slope cutting will be maintained for fresh cutting slopes in order to avoid instability, landslide and erosion.	Stretch along the alignment where vertical slope cutting and box cutting is required	During Construction	Contractor
P7-I b	Earth excavation for underpass and flyover foundation, slope cutting for road width formation and clearance of vegetation	Soil erosion, gully formation at new open cut sections	Cut spots and embankments will avoid the creation of angle greater than the natural angle of repose for the local soil type. Re-vegetation of cut slopes will be carried out as soon as possible. Destruction of vegetation in the right of way will be minimal as far as applicable.	Along the fresh cutting slopes vulnerable to landslide after destruction	During Construction	Contractor
P8	**Physical Impacts due to incorrect disposal of excess excavated earth material**					
P8- i	Earth excavation	Direct disposal and	Avoiding direct disposal and stockpiling of	Valley side	During	Contractor

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
	for underpass and flyover foundation formation clearance, slope cutting Direct disposal of spoil into surrounding river and at its banks	deposition of excavated materials at the valley side of the road affecting river and vegetation cover and its loss	excavated materials at the valley side of road	of the proposed road alignment	Construction	
P8-ii	Excavation of the hills for underpass and road track opening for flyover. Direct dispose of excavated materials to natural drainages.	Disruption / blockages to river and drainage. (Small drainages and large drainage systems).	Avoiding impact upon rivers and drainage from disposal	2 rivers identified along the alignment	During Construction and operation	Contractor/Proponent
P8-iii	Road formation clearance and track opening	Dangers of future washout during heavy rains, damage to road width	Fresh cutting outer slopes throughout the alignment will be maintained with the angle of cutting slopes.	Stretch along the alignment where vertical slope cutting and box cutting is required as per detail design	During Construction	Contractor
P9	**Impacts on River flow regime and river environment**					
P9- i	Disposal of construction wastes to rivers and water bodies	Concrete Batching Plants and storing of material on riverbanks.	Such sites will be established and operated at the selected and identified sites only. Proper traffic signals and markings will be provided at the vicinity of such plants in order to avoid	Concrete Batching Plants and material	During Construction	Contractor

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
			accidents and injuries.	storage sites		
P9-ii	Haphazard disposal of excavated materials during construction of highway at upstream areas	Siltation and deposition at lower, downstream sections, on riverbanks	Contractor will select the stockpiling sites that are located away from cultivable lands and settlements, drinking water intakes, public places, school and health centers.	Along the alignment	During Construction	Contractor
P10	**Impact upon existing Physical Structures and Infrastructures**					
P10-i	Road formation clearance	Likely damage to existing highway road surface, damage to culverts etc., causing difficulty in local movements.	Minimizing damage to existing highway road surface, damage to culverts etc., avoiding difficulty in local movements	Along the alignment	Construction Phase	Contractor/DOR
P10-ii	Road formation clearance	Electric poles, pylons are likely to be affected at few locations	Relocation of Electric Poles and Pylons	Along the entire route	Pre-construction phase	Contractor/DOR
P10-iii a	Road formation clearance	Damage to existing local water supply system, water pipelines, local trails, etc.	Relocation of existing water supply facilities, irrigation canal and water supply pipelines	Along the entire route	Pre-construction phase	Contractor/DOR
P10-iii b	Excavation of road and new section	Impact upon houses and residences due to excavation works	Avoiding impact upon houses and residences due to excavation.	Along the entire route	Pre-construction and construction phase	Contractor/DOR
P11	**Impact/Issues of OHS due Construction Activities**					
P11-i a	Track opening, opening of underpass tunnel portals,	Occupational Health and Safety of laborers during construction	Working safety measures will be executed by the contractor to workers providing ample numbers but not limited to helmets, boots, rubber gloves, and masks as required. Life of	Along the alignment and labor camp sites	During construction	Contractor/DOR

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
	construction of structures and flyover bridge		worker will be ensured by maintaining Life insurance of each worker of the project. First aid facilities for the workers will be provided at working sites as well as at labor camp sites.			
P11- i b	Track opening and earth excavation works with vibration, high decibel of noise, dust and air pollution might deteriorate human health of local people.	Health and Safety of the local people	Earth excavation and construction work will not be executed during night hours. Time schedule of such work will be fixed and will be informed to locals as well as dissemination related information through voice media and newspaper. Awareness will be provided to locals about health and safety regarding such activities.	Along the entire alignment	During excavation and construction works	Contractor/DOR
P11-ii	Road formation clearance and opening of tunnel portal	Safety issues due to handling of explosives, during transporting, storing and use	Handling of explosives, its transportation, storing and use will be other issues of safety during construction. Handling of combustible and explosive will be carried out as per prevalent acts and regulations.	Along the entire alignment	During construction	Contractor/DOR
P11-iii	Construction vehicles will run on existing roads disturbing other local transportation and movement of the local population	Road safety issues during construction works	Construction Traffic Management Plan will be developed in the detailed design stage that will comply by contractor to maintain flow of construction vehicles without hampering good flow of passenger vehicles.	Along the entire alignment	During construction	Contractor/DOR
P12	**Impact/Issues due to operation of Asphalt concrete plant/hot mix plant**					
P12 i	Operation of asphalt concrete plant/hot mix plant	Air pollution	Asphalt plant activities should be controlled. (E.g., asphalt hot-mix plants should be downwind of close sensitive receptors such as schools, religious places, etc.) Sites should be selected for these plants at least 500 m away from the sensitive receptors. Temperature of the hot-mix plant should be controlled at appropriate level in order to	Sites for asphalt concrete plant and hot mix plant	During construction	Contractor/DOR

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
			control exhaust gasses to comply relevant emission standards			
Operation Phase						
P14	**Obstruction to local movement between adjacent lands and settlement of highway alignment**					
P14-i	Operation of alignment without direct accessibility to people between adjacent lands	Inaccessibility between adjacent settlement and market areas	Significant settlement and market area will not be disturbed with the proposed alignment.	Entire the alignment	Operation phase	Contractor/DOR
P15	**Impact due to land fragmentation**					
P15-i	Implementation project	Possible fragmentation of land with the implementation of project and difficulty caused by it to access the land	Optimum design of alignment has been proposed to maintain existing land use pattern as far as possible. The final alignment has been proposed and maintained to construct in-between two types of land use pattern	Along the alignment of cultivated land	During construction and operation	Contractor/DOR
P16	**Impact on air, water and noise during project operation**					
P16-i a	Operation of the project	Impact due to noise pollution; as large number of vehicles will run through this section of Araniko Highway.	Proper management of the road to avoid unnecessary noise pollution > 80dBA. Restrict to use pressure horns by vehicles users. Conduct awareness to vehicles users regarding noise pollution and its impacts. Traffic signals will be installed properly where exist sensitive receivers such as forest areas, hospital and school areas to avoid excessive blow of horns.	Along the alignment	After the completion of construction and before the operation	Contractor/DOR
P16-i b	Traffic of vehicles	Impact upon air and water due to traffic of vehicles	Prohibition of the old vehicles that do not meet the emission criteria will decrease the amount of emission in the tunnel and road section. Control and minimize the quality and the amount of exhaust gas on the Road with roadside tree plantation. Avoiding air and water pollution through regular	Along the alignment	Operation phase	Contractor/DOR

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
			monitoring.			
P17	**Impact of noise Pollution from the traffic on the Road to nearby local residents**					
P17-i	Movement of new road and traffic	Increase in Noise pollution of the road	Proper management of the road to avoid unnecessary noise pollution > 80dBA. Restrict the use of pressure horns by vehicle users. Conduct awareness to vehicles users regarding noise pollution and its impacts. Proper management of the road to avoid unnecessary noise pollution.	Along the alignment	Operation phase	Contractor/DOR
P 18	**Issues related to High-Speed Highway**					
P18-i	Operation of smooth road and plying of large number of vehicles	Issue of road safety and safe driving	Addressing road safety and safe driving conditions on the road	Along the alignment	Operation phase	Contractor/traffic police
P18-ii	Installation of traffic signals and indicators including separate traffic lanes	Issues related to traffic management	Managing local traffic	Along the entire alignment	Operation phase	Contractor/DOR
Biological Environment (Construction Phase)						
B1	**Impact due to disturbance in the Ecology of the area**					
B1-i	Road formation clearance	Impact upon shrub land and loss of vegetation	Plantation will be carried out at each and every possible site along the highway alignment including at reclaimed sites and spoil disposed sites after its closure. It is anticipated that shrubs and bushes will grow naturally within those plantation sites.	Along the bush and shrub vegetation area of the alignment	Pre-construction phase and construction phase	Contractor/ Traffic police
Socio-Economic & Cultural Environment (Construction Phase)						
S1	**Impact due to Private/Public Property Acquisition for Construction**					
S1-i	Road formation clearance	Impact due to Land Acquisition; additional 0.252ha. of Private land will be acquired	Adequate provisions and compensation arrangements and rehabilitation will be maintained following the Resettlement Action Plan.	Along the entire alignment	Pre-construction and construction phase	Contractor/DOR

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
		permanently.				
S1-ii	Road formation clearance	Impact due to acquisition of residential houses	The project will compensate all loss of private land and property. Similarly, the resettlement principles will be adopted providing compensation and resettlement assistance to all affected persons based upon the GON norms and prevalent practices. Acquisition of private land, house and buildings will be executed regarding the prevalent Acts and Regulations.	Along the entire alignment	Pre-construction phase	Contractor/DOR
S1-iii	Road formation clearance Contractor's camp operation activities	Impact on small landholders due to acquisition of their land	At least one family member of each project affected family will be provided with income generating training and opportunity will be provided for at least one family member in the construction of project.	Along the entire alignment	Pre-construction and construction phase	DOR/ Local Stakeholders
S1-iv	Road construction and acquisition of private land and property	Likely obstruction by marginal land holding and low-income level population upon construction	Locally operating and experienced NGOs and local interested stakeholders will be engaged to assist the marginal land holding and low-income level population. The project will provide income generation training and livelihood training to marginal land holdings and low-income level population.	Along the entire alignment	Pre-construction and construction phase	DOR/ Local Stakeholders
S2	**Impact due to Outside Workers**					
S2-i	Contractor's camp operation activities	Possible impact on social, cultural and religious practices due to immigration of people	Security systems will be established to avoid various sorts of conflicts between the local population and immigrants during the time of construction.	Along the alignment and labor camps	Construction phase	DOR/ Local Stakeholders
S2-ii	Contractor's camp operation activities	Degradation of sanitation and hygiene condition	Contractor and labor workers will be responsible to maintain healthy sanitary and hygiene condition of labor camps and its vicinity.	Along the alignment	Construction phase	Contractor/DOR
S2-iii	Immigration of outside workers, establishment of labor camp, economic activity of labors with	Impacts due to influx of people are anticipated. Pressure upon existing natural resources such as water, existing food	Contractor will manage all the labor workers maintaining their daily schedule of labor camp and working hours of workers.	Along the alignment and labor camp sites	Construction phase	Contractor/DOR

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
	locals at market and settlement areas	availability, existing educational facilities are likely to be affected with the increase in the number of outside workers and the utilization of such resources and increase in the number of students in the existing educational facilities.				
S2-iv	Road construction and acquisition of private land and property	Conflict between workers and local people is likely during the time of construction. Conflict is likely as there could be a struggle between local people and labor workers for the same commodities and natural resources.	Security system will be established to avoid conflict between workers and local people. However, contractors will be responsible to control their own labors those are imported from outside the project area.	Along the alignment and labor camp sites	Construction phase	Contractor/DOR
S3	**Depriving locals from continuation of their economic and business activities during the construction of road**					
S3-i	Road construction activities	Possible impact on social, cultural and religious practices due to immigration of people	Security systems will be established to avoid various sorts of conflicts between the local and immigrants during the time of construction.	Along the road alignment	Road excavation at pre-construction phase	Contractor/DOR
S3-ii	Road construction activities	Degradation of sanitation and hygiene condition	Contractor and labor workers will be responsible to maintain healthy sanitary and hygiene condition of labor camps and its vicinity.	Along the alignment	Construction phase	DOR/ Local Stakeholders
Socio-Economic & Cultural Environment (Operation Phase)						

Issue No.	Project Activities	Impacts	Mitigation Measures	Location	Time	Responsible Implementing Agency
S5	**Social and cultural impacts due to Road Operation**					
S5-i	Increase in vehicular movement entire the road length	Likely increase in road traffic accidents because of the speed and heavy flow of vehicles	To avoid the accident road traffic signals and road marking and other safety measures will be applied to reduce driving risks and providing enhancements to driving conditions near the intersections of road.	Along the entire alignment	During construction and operation	DOR/Local Stakeholders
S5-ii	Prevention of direct accessibility into the highway	Inaccessible / separation due to fragmentation of public and private land	Locals adjacent to the proposed highway will be provided with passing zones at several locations as appropriate.	At proposed passing zone areas	During construction and operation	DOR/Local Stakeholders

Source: JICA Survey Team

(2) Mitigation Measures

Mitigation Measures required during the Project's Pre-construction, Construction and Operation phase is discussed in this section. The measures to prevent or to minimize the impacts due to the implementation of the Project within the proposed Project area have been discussed in this section. Mitigation measures for the affected existing physical structures situated within the proposed ROW width will also be required to minimize its severity and impact in the environment and to the people.

All the adverse environment impacts upon Physical, Biological, Socio-economic and Cultural Environment are discussed below and the required mitigation measures of corrective, compensatory and preventive types are proposed in order to avoid, reduce or minimize such impacts as well as augmentation measures for achieving beneficial environmental impacts with the implementation of the Project. Different guidelines, reference manuals, criteria and general practices exercised and published by GON and DOR will be followed to safeguard the environment.

The major activities during pre-construction and construction phase are site clearance, earthworks, road excavation, excavation for the construction of roadside structures, disposal of spoil and other civil works and those works will require measures that could mitigate the adverse impact upon existing environment. Civil works and other activities will be further likely to create dust, noise and vibration rendering likely impact of slope instability and landslides; these activities will further require corrective and preventive mitigation measures. Haphazard disposal of spoil in the nearby private lands, roadside and water bodies of the Manohara River and Bagmati River will likely affect the physical environment of the Project area requiring preventive mitigation measures.

Compensatory and preventative mitigation measures will be required to mitigate biological issues relate to removal of existing roadside vegetation during the implementation of the Project. Similarly, compensator mitigation measures will be followed for social issues such as acquisition of private property and land and its compensation and resettlement. Moreover, corrective and compensatory measures will be followed in order to mitigate the impacts upon affected existing infrastructures such as water supply pipelines, electric poles and irrigation facilities existed within the proposed highway alignment.

(3) Pre-construction and Preparation Phase

(4) Physical Environment

1) Selection of Route

Alignment route with all alternatives has been analyzed and presented in Chapter 7 for the finalization of the appropriate route for the highway that can serve in constructing the highway in an environmental friendly manner avoiding or minimizing environmental degradation by avoiding slope instability and soil erosion, avoiding disruption of water bodies, minimum loss of private land, avoiding impacts of social and cultural in nature and in terms of avoiding loss of flora and fauna, etc. Alternative analysis has been carried out as a preventive mitigation measure in terms of different aspects and criteria such as Total Length, Road Geometry, Geology, Hydrology Environmental Impact, Social Impact, Land Use pattern, Difficulty in Construction, Operation and Maintenance, Sustainability and Construction Cost. Among different alternatives studied, this one is selected as feasible alignment that will be easier for construction maintaining smooth gradient, having technical viability and with less environmental implications.

2) **Review of the Alignment**

A final alignment has been established with ROW avoiding a majority of the sensitive receivers. However, some significant construction impacts that could affect stability, as well as other social and cultural environment will be revised. Therefore, the alignment will be further fine-tuned at detailed design stage to avoid such impacts and unnecessary burdens in terms of technical, financial, environmental and social nature. Consultation with local stakeholder and severely affected people will further be anticipated to solve those sort of problems before commencement of construction works.

3) **Detail Survey and Design**

Detail survey and Design will be carried out and will assess the potential impacts and losses of properties and land. The survey will be carried out avoiding or minimizing the loss of private land as far as applicable. The survey and study will be culminated with all possible preventive measures to avoid or minimize slope instability, disruption of water systems, minimize disturbance to settlements and avoiding loss of cultural assets and social norms.

Furthermore, dust, noise and air pollution during site clearance and preparation will be minimized through appropriate measures. Existing infrastructures such as electric poles and pylons, irrigation canals and water supply pipelines set up within the project area have been identified and budget has been allocated for the relocation of such infrastructure. Furthermore, passing zones areas required at appropriate locations as mitigation measures for affected existing local tracks of various types to access the lands adjacent to the proposed highway has been identified. Further, details of these information will be incorporated in detail survey and design report.

4) **Review of Mitigation Measures**

All the mitigation measures presented in the IEE report will be reviewed by detail design team to ensure the incorporation of measures into Bill of Quantity (BQ) and tender documents. Contractor will be responsible to implement all of the measures during and after the commencement of construction work as per proposed. Further, the project will finalize the required mitigation measures that will be implemented rigorously to avoid significant adverse environmental impacts.

5) **Inclusion of EMP and Mitigation Measures in BQ**

All the measures and provision mentioned in the EMP will be reflected in the BQ to ensure effective implementation avoiding and preventing environmental degradation during the time of construction and operation of the project. All the provisions regarding the safe disposal of spoil into identified tipping sites and its rehabilitation will be mentioned in the BQ. Similarly, provisions for the operation and reclamation and site clearance of labor camps, batch mixing plant sites, contractor’s camp sites etc., will be explicitly mentioned in BQ while issuing the Tender Document for the contract. The contractors must clearly quote those activities in BQ rate and provide any comments beforehand in case of opposing these clauses.

6) **Inform contractors to address Mitigation Measures**

Contractors will be informed about project nature and its likely environmental impacts and required mitigation measures at the different stages of the project before its implementation. A series of meetings with interested contractors will be carried out to solicit further information from them as well as to disseminate project information. Power Point Project presentations of the project including environmental issues will be carried out before the construction phase. Contractors will be responsible to address all the environmental related issues as per the tender documents. Furthermore, the contractor will address environmental mitigation measures in the construction survey report prepared after the commencement of the construction survey. The report will be further reviewed by EMU of the project for monitoring as well as ensuring effective implementation of proposed mitigation measures.

7) **Biological Environment Mitigation Measures**

Clearing of trees and other desirable vegetation will be discouraged to contractor’s cure members during the time of site clearance. Only those trees and vegetation in areas which are absolutely necessary to operate the sites will be cleared. As loss of roadside tress will be the only biological impact due to this project activities and compensatory mitigation measures of re-plantation and greenery maintenance work will be awarded to local communities, local clubs and maintaining the trees for at least a five-year period. The affected and vulnerable slopes will be stabilized applying appropriate engineering designs together with bioengineering. Only those trees which are absolutely necessary to operate the sites will be marked and fell for track opening. Any felled trees will be handed over to district forest office and respected groups as per existing rules and practice.

8) **Socio-economic and Cultural Environment**

Acquisition process of both public and private land will be required to be completed before the starting of site clearance and construction works. Amount of land to be acquired has been documented and analyzed. Similarly, compensation and resettlement issues have also been studied and will be completed before the starting of construction works.

Compensation Determination Committee (CDC) will be established with the consultation of local stakeholders and local government body. Cash compensation amount will be determined as per Act4 and rates established by CDC. List of affected houses and affected private lands has been recorded and analyzed. Loss of land and property of the affected people will be addressed either through cash compensation or through cash and equity share compensation. Project Affected Families (PAF) and Seriously Project Affected Family (SPAF) has been identified and categorized as per guideline5.

SPAF is defined as a family who loses over 25% of its total land holdings or whose land is reduced to an uneconomic holding or who is being displaced. A Resettlement and Rehabilitation Plan has been prepared to clarify the entitlements for resettlement and for compulsory purchase of land and other matters for compensation. Sufficient compensation to enable families to build and move to new houses as preferred such that the AFs will have better living standard or are no worse off than if they were not affected. Similarly, there are some of the cultural sites, temples and mane of local importance existed within the ROW of the proposed alignment that will be relocated for the implementation of the highway project.

Similarly, some of the cultural sites, temples and major local importance within the ROW of the proposed alignment will be relocated at the appropriate places as requested by locals during the time of compensation distribution in the Construction Phase if any adverse impact occurs.

a) Addressing Temporary and Permanent change in land use

- Likely change in land use pattern of 3.948ha of land into Highway alignment and its ROW is inevitable with the construction of 1.851km flyover and underpass road Project. Land use cover will be changed permanently into the carriage width of Project. 0.244 Ha. of private land at Jadhibuti Chowk north need to be acquired for the project.
- Land use pattern of adjacent land will be taken into account during construction in order to avoid erosion and other detrimental effects. Appropriate mitigation measures will be carried out in order to avoid severe impacts upon adjacent land use pattern. Appropriate engineering structures will be provided to prevent landslides and river cuttings maintaining natural drainage pattern of the terrain within the project area.

4 *Land Acquisition Act*
5 *Land Acquisition Guidelines 1989*

- As heavy equipment and road excavation will be carried out for excavation of road sections; labor intensive construction method will be adopted within the appropriate sections for the road width opening.

- Land acquired for temporary purposes will be reclaimed and rehabilitated. Cultivated land and other private land will not be used for the establishment of labor camps, worker camp sites, for the disposal of spoil etc. Lands such as barren land and other government land will be acquired for temporary purpose which will be reclaimed after the completion of construction works.

9) **Reducing Air, Noise and Water Quality Degradation due to Construction Activities**

a) Reducing air pollution due to operation of drilling machines, excavators, vehicle movements on unpaved roads

Contractor will carry out dust protection measures during road construction phase such as plastic sheets will be used to prevent the residences that are close enough to receive such impacts. Drill machines, excavators, load and unload heavy vehicles etc., will be avoided while wind velocity is high enough to disperse and erode excavated materials. Vehicles transporting soil, sand and other construction materials will be covered with tarpaulin sheets to avoid impact from dust. Water will be sprinkled to excavated material to avoid sheet erosion and emissions to nearby human settlements or forest areas. Similarly, water will be sprinkled on the road and exposed surfaces in order to minimize the spreading of dust to close receivers. Contractor will carry out excavation and drilling activities only from 5 am to 6 pm. Excavation during evening and night hours will be avoided. As far as possible, labor intensive construction methods will be applied at the alignment existed nearer to settlement, school, health post, etc.

- Use of Construction/ Transportation Vehicles complying with NVMES, 2069.

- Regular inspection & maintenance of construction/transportation vehicles and construction equipment/machinery.

- Selection of Asphalt Mixing Plant and Materials Storage location considering less sensitive areas.

- Regular Maintenance of Dust Collectors at Asphalt Mixing Plant.

- Pre notification in regard to the prohibition of use of firewood for cooking and Ensuring availability of clean cooking fuel to workers to avoid the use of firewood.

b) Preventing noise pollution due to operation of drilling machines, excavators, vehicle movements on unpaved roads by using appropriate machines and time management.

All heavy equipment and machinery of the contractor will be fitted with noise pollution control devices that are operating correctly. Contractor will provide ear mufflers to construction crew working at high noise exposure areas. Noise barriers will be used in order to break the line of sight between the noise source and the possible receptors. Contractor will use various materials and barrier, façade patterns can be used to obtain maximum reflection, absorption or dispersion of noise without being aesthetically ugly. Noise barriers commonly employed consist of earth mounds or walls of wood, metal, or concrete which form a solid obstacle between the road and roadside communities. Project will provide awareness trainings to local drivers avoiding noise pollution in operating construction machines.

Prohibit the use of pressure horn by transportation vehicles.

- Conduct noise level test at the same time of Air Quality Test as discussed in the above section during peak construction stage twice a month at locations near school, hospital and settlement areas.
- Avoid noise generating activities like excavation works, dismantling for excavation works, operation of asphalt mixing plant, loading & unloading of construction materials, noise of material transportation vehicles etc., during school time and at hospital areas if any.
- Execute construction works at night in the core area.
- Regular inspection & maintenance of construction/transportation vehicles to ensure the use of Vehicles complying with NVMES.
- Regular inspection & maintenance to ensure the use of Equipment/Machinery, Asphalt Mixing Plant and Diesel Generators.

c) Mitigating excessive dust production and noise pollution due to operation concrete batching plant and bitumen mixing plant etc.

Contractor will establish concrete batching plant and bitumen mixing plant only at the selected and identified sites. Plant should be operated only during daytime. If necessary and if requested by locals based on rational reasons, timing of operation should be planned in consultation with local communities so as not to disturb local schools, health posts, markets, settlement areas etc. Contractor will compensate to the affected landowners if land and crops are damaged due to operation of plant. Contractor should clean and brought to original condition after closure and dismantling of the plant site in order to avoid siltation and deposition at downstream. Contractor will adopt the technical preventive and safety measures to control dust and avoid noise pollution. Further, the contractor must exert all efforts to supervise this work site, especially to prevent children from approaching the plant.

d) Avoiding degradation to water qualities of existing rivers

Construction activities will be carried out in an environmentally friendly way so as to avoid further adverse impact upon water quality of River adjacent to proposed alignment and other water bodies. Disposal of construction waste and spoil into the river will be avoided. Adequate sanitation facilities will be provided at the labor camps with the adequate supply of water for washing, cleaning and drinking purposes. Labor camps will be established only at the pre-identified sites establishing appropriate drainage and installing pit latrines and toilets. Open defecation will be avoided strictly at the vicinity of labor camps. Similarly, labor workers will be provided with awareness training and further, the contractor will be responsible for mitigation if any sort of improper sanitation condition has been carried out by work force. Disposal of wastewater from labor camps and organic wastes from kitchen will be disposed safely in pits avoiding direct disposal in water bodies. Liquid wastes form vehicle washing, and workshop waste will not be disposed directly into river system and nearby water bodies.

e) Minimizing/ Managing Emission of CO_2

- Ensure proper maintenance status of vehicles with respect to emissions.
- All the heavy equipment and machinery will be fitted with air pollution control devices that are operating correctly.
- Conduct awareness program on energy efficiency for transport issues.
- Enforce the requirements for vehicles testing and warrant of fitness.
- Develop vehicles standards to maximize energy efficiency.

10) **Minimizing/ Managing Impacts due to Waste Generation**

a) Minimizing/ Managing Impacts due to Solid Waste

To minimize the impact due to solid waste following measures will be applied:

- Institutional coordination and budget plan for hiring collection and disposal service providers will be undertaken.
- Workers and managers will be trained for appropriate source segregation.
- Direct disposal of solid waste by the construction workers in the water bodies will be strictly prohibited.
- Knowledge and awareness about the biodegradable and non-biodegradable waste to the workers will be provided.

- Work camp will be established far from the water bodies.
- Separate bins for the collection of biodegradable and non-biodegradable waste will be established at the worker camps.
- Strict code of conduct will be followed in the camp and the penalty for the violation of rules will be regulated.

b) Minimizing/ Managing Impacts due to Soil Waste

To mitigate the impact due to soil waste during Pre-construction careful and thorough communication will be undertaken in the Pre-construction Phase so that the site(s) are planned in the accepted area with sufficient safety measures and design. In order to minimize the impacts due to soil waste following methods are proposed:

- Natural water source below the disposal site shouldn't pose significant threat.
- The natural drainage system shouldn't be damaged due to the deposition of soil.
- The private land below shouldn't be damaged due to disposal activity.
- Careful and thorough communication will be undertaken in the Planning Phase so that the Disposal Site to be accepted.
- Design the Disposal Site so that the impacts on the water use downstream is minimized.
- Natural water source below the disposal site shouldn't pose significant threat.
- The land below downstream shouldn't be damaged due to disposal activity.

Reduce:

- ➢ Purchasing high quality & durable goods so that it can be used for longer periods.
- ➢ Avoid over ordering of construction materials to the extent possible by doing exact measurements to have the exact quantity of the require material. This may be challenging as it requires strong coordination with the concerned contractors and it cannot be made mandatory. However, it is not impossible to coordinate with the contractors in this regard.

Reuse:

- ➢ Identify the materials that can be reused that includes Bricks, Timber, Brick Bats, Broken Concrete Pieces/Broken Plasters etc., and store them in good condition after the use so that it can be used in another site or project.
- ➢ Reuse of Larger unusable pieces (at construction site) for filling up low lying areas
- ➢ Reuse of fine materials like Sand, Dust etc., as cover material over sanitary landfill, as required.

Recycle:

Identify the materials that can be recycled like Scrap Metals, Plastics, Papers, Gravel, Glass, Roofing Materials etc. and Sale of these recycled materials to the scrap dealers

c) Minimizing/ Managing Impacts due to Liquid Waste

To minimize the impact due to liquid waste following measures will be applied:

- Required capacity of site-specific septic tanks will be installed at the facilities.
- The septic tanks will be managed in appropriate manner.
- The bitumen will be stored at proper place and not scattered along the road. Contamination of it with the water body source will be avoided as possible.
- The fuel/lubricants for the construction vehicles will be stored in a proper place and the contamination with the water bodies will be avoided.
- Cleaning of construction vehicles in the water bodies will strictly be prohibited.
- Direct disposal of chemical wastes upon land/soil, water bodies will be strictly prohibited.
- Workshops and chemical storage sites will not be established nearer to the water bodies and natural drainage system.

d) Minimizing/ Managing Impact due to Soil Contamination and Top Soil

To minimize the impact due to soil contamination following measures will be applied:

- Educate and aware workers about the negative impacts of soil contamination.
- Conduct training on good handling of the oils and chemicals to avoid soil contamination.
- Prepare guidelines of handling, recycling and discarding the empty containers or bags of the chemicals.
- Designation of site managers to monitor condition of stock yards.
- Storage and handling of bitumen will be done properly as per the manual and guideline and contamination with the existing water source should be avoided.
- Strict code of conduct should be regulated in the construction area and avoid spilling and leakage the chemicals in the work area.
- Pouring of oils/lubricants will be avoided so that it does not degrade the land located nearby of the construction area.

Carefully Stripping and safely storing nutrient Topsoil for later use

- Use it as valuable resource in back filling and during Bio-engineering works

- Use in slope filling and embankment fill before the plantation and bio-engineering work.

11) **Avoiding Chemical Impact upon Environment**

a) Avoiding chemical contamination in water bodies due to mechanical activities/ workshop/ vehicle maintenance, cleaning and mixing

Workshops and chemical storage sites will not be established near water bodies and the river side. Bitumen drums will be stored at designated locations and not scattered along the road. If contaminated; the contaminated runoff from storage areas will be captures in ditches or ponds with an oil trap at the outlet. Contaminated and worn plastic sheet will be packed into drums and disposed into safe disposal site. Direct disposal of chemical wastes from workshop upon water bodies will be strictly prohibited.

b) Site clearance and removal of residues of chemical such as epoxy, gypsum, additives, admixtures, cements, bitumen etc. avoiding impact upon land and water bodies.

During site clearance, all cut and grubbed materials will be kept at a secured location so to maintain environmental safety. Contractor will be responsible to restore all the construction related sites including workshop into their original state. Contractor will obey the Toxic and Hazardous Chemical Handling and Management Plan for handling and use of all sort of toxic materials and will comply till the completion of construction and site clearance. The boundaries of the water body particularly existing nearby rivers will be left undisturbed and tidy with the completion of construction. If unavoidable, drainage channels of adequate capacity will be provided for the water body being impacted by storm waters.

In case of bituminous wastes, dumping will be carried out over a 60 mm thick layer of rammed clay so as to eliminate any chances of leaching. In case of filling of low-lying areas with wastes, contractor will ensure the ground level matches with the surrounding areas. In this case of storing of rainwater care will be taken that low lying areas are not used for storage. In case oil and grease are trapped for reuse in a lined pit, care will be taken to ensure that the pit will be located at the lowest end of the site. The Contractor will regularly educate his workforce location of disposal site as well as the specific requirement for the management of these sites. The waste management practices adopted by the Contractor, including the management of wastes at construction camps etc. Will be controlled on a regular schedule by the Project EMU during the progress of construction.

c) Avoiding hazards caused by explosive, combustible and toxic materials

The Contractor must educate the workers to undertake safety precaution while working at the plant / site as well as in the around heavy equipment. Contractor will ensure the occupational health & safety measures of labor work force. Contractor will obey the Occupational Health and Safety Management Plan prepared for the project. The Contractor will further ensure all vehicles must possess a Pollution under Control (PUC) Certificate, from designated authority by the DOR, which and will be renewed regularly. The Contractor must also ensure that all machinery, equipment, and vehicles will comply with the existing noise and emission norms of GON.

No bituminous materials will be discharged into side drains. Nearby tree, vegetation and private property will be protected during bitumen spraying work. Skilled labor will be used while hand placing the pre-mixed bitumen material. Contractor will be responsible to provide safety equipment i.e., rubber boots and gloves to the workers while handling bitumen. While applying Tack Coat, spraying of bitumen will be done in the wind direction. The labor will wear jacket while spraying the bitumen. Transportation, storage and use of explosives will be carried out as per Act[6].

12) **Safe operation of Labor Camp, Contractor's Camp etc.**

a) Camp site, Stockyard and Equipment yard

- Site-1: Temporary use of Tinkune Park site during construction
- Site-2: Land owned by DOR in Thapagaon

As the land proposed for the Camp site, Stockyard and Equipment yards is belong to government land, hence there is no issues of land acquisition and resettlement with this work issues for this project. There is no possible mitigation measure for these issues except of proposed spoil disposal.

[6] Explosives Act , GON, 1961

Source: JICA Survey Team

Figure 19.1.15 Expected Camp Site and Storage Yard

b) Recovering and rehabilitating temporary loss of lands

All construction camp sites and facilities will be dismantled and removed from the site right after the completion of construction work. The site will be restored to an original condition prior to commencement of the works. Contractors will be recommended for photographic documentation to verify and settle possible disputes before and after the establishment of such sites. Further, oil and fuel contaminated soil will be removed and transported and buried in waste disposal areas. Construction campsite will be planted grasses after site clearance to recover into natural condition; and Soak pits and septic tanks will be covered and effectively sealed off.

c) Avoiding direct disposal of Solid waste

Labor camps and contractor’s camps will be established at the pre-identified appropriate place within the project area. Consultation with the local people is an important step prior to the establishment of such camps. The contractors will further ensure that labor workers will not dispose of chemicals, raw sewage, and wastewater effluent.

Solid Wastes & Effluent from Worker’s Camp:

- Segregation of Solid Waste based on being biodegradable or non-biodegradable. It is because decomposers cannot break down non-biodegradable wastes and their disposal poses a big problem.
- Implementation of 3R (Reduce, Reuse & Recycle) concept for non-biodegradable waste.

Reduce:

- Use of reusable utensils like paper/plastic plates, cups and utensils.
- Purchasing goods with less packaging.

Reuse:

- Use of empty containers if any, to store leftover.
- Use of reusable shopping bags.

Recycle:

- Identify the segregated materials that can be recycled like Scrap Metals, Plastics, Papers, Glass etc., and Sale of these recycled materials to the scrap dealers.
- Cooking appropriate quantity of food as per the number of workers to avoid left over food.
- Management of biodegradable wastes that includes food waste, paper waste, biodegradable plastic, etc. if any, by any suitable processes that can be Composting. If this does not seem possible then, the wastes shall be managed either by handing over these wastes to the municipality waste collectors who will dispose those wastes to the designated landfill sites of the project town.
- Strict Prohibition on open incineration of solid wastes.
- Avoid the use of plastic materials as far as possible.
- Construction of temporary latrines with temporary soak pits & septic tanks within the campsite for proper disposal of sanitary sewage.
- Provision of temporary pit at the premises of worker’s camp into which the wastewater drained out from the camp can be disposed. The wastewater generated from cooking can be directly used in gardening purposes.
- Employ local people from nearby areas to maximum extent possible. It will minimize the number of workers residing at worker’s camp. Lesser the number of people, the less solid waste & effluent will be generated. However, it cannot be made mandatory because availability of local people with required skills will not be ensured at the time of construction.

Non-Recyclable & Non Saleable Wastes:

Handing over the wastes generated at construction site or worker’s camp, that can neither be recycled nor can be sold to the municipality. Afterwards, the municipality will manage and dispose them to the existing landfill site.

Chemical Wastes:

- Collection of Chemical Wastes in separate leak proof container
- Sale of the recyclable chemical wastes to the concerned available vendors
- Handing over the non-recyclable chemical waste to the municipality for final disposal

13) **Managing Safe Disposal of Toilet Waste to Prevent Surface Water Contamination**

Contractor will ensure the operation of labor camps without production of nuisances and adverse environment impact to the locals. Sanitary wastes and excreta will be safely disposed into septic tanks. The contractors will further adopt good management practices ensuring sustainable supply of water to rest rooms as well as for washing and bathing purposes, energy for cooking and other necessary purposes, and ample drinking water for labor workers and other project staffs. The contractors will further ensure that labor workers will not dispose chemicals, raw sewage, and wastewater effluent.

Prior to the close out of construction the worker camps will be removed and restored to the original condition as far as is reasonably practicable. Construction camps will be established in areas with adequate natural drainage channels in order to facilitate flow of the treated effluents. Contractor will ensure that no sort of negative impacts upon environment and local community and no any sort of contamination into the rivers and drainages and water resources from the operation of camps within the project area. It is further anticipated that contractor will work under close coordination with Environmental Monitoring Unit (EMU) of project.

14) **Slope Instability, Landslide and Erosion**

a) Maintaining fresh cut slopes to prevent slope instability, landslides and erosion

Angle of slope cutting will be maintained for fresh cutting slopes in order to avoid instability, landslide and erosion. However, sections with highly weathered rock exposure area will be considered duly providing civil engineering structures.

The exposed slope should be protected using conventional civil engineering structures in conintersection with bio-engineering techniques. It is also advised to do minimum damage to vegetation during construction. Exposed slopes should be planted with suitable vegetation as soon as possible using previously stockpiled topsoil.

All areas susceptible to erosion, such as cutting and filling areas will be protected by either temporary or permanent drainage works. Measures will be taken to prevent pounding of surface water and scouring of slopes. Newly eroded channels will be backfilled and restored to natural contours. Where crossing unstable terrain is unavoidable, minimize the road width for the section affected to reduce disruption to the slope. Special attention will be given to drainage and will leave a temporary road surface until a stable condition is achieved.

b) Avoiding soil erosion and landslides due to excavation activities

Labor and machines will be used in order to maintain cut slope angle which will prevent subsequent landslide of fresh cutting hill area. Further landslides will be prevented with the stockpiling of material at the inward side of formation width. Side tipping and stockpiling of materials at the outward facing slopes and at the existing roadside will be avoided strictly in order to prevent air pollution, land pollution, pollution of surface water and permanent changes of land use pattern of the adjacent lands. If stockpiling will be required; appropriate drainage facility will be provided preventing possible washout of materials from rainwater into water bodies and other properties situated at the downhill.

During construction, precautionary measures will be taken, proper backfilling trenches will be done, and the excavated soil will be protected against erosion. The key elements to proper backfilling include:

- Protecting the foundation from damage during backfilling
- Using the right backfill materials
- Compacting the backfill
- Final finishing the subgrade to ensure that water drains away from the foundation
- Implementation of Drainage Plan prepared in final design

15) **Managing Impact from Underpass Excavation**

Authority of CAAN and Locals will be aware about the possibilities of such hazards and will be strictly prohibited from traveling towards underpass portals and periphery areas during earth excavation. Earth excavation of underpass portals, if required, will be done in a controlled manner that will not be carried out during evening and night hours. Contractor will comply to the Construction Management Plan including other necessary guidelines[7] published by GON for slope protection works as well as the condition and working procedural set by the CAAN with DOR. The vibration from excavation work might be exceeding the maximum permissible level, information from the excavation will be used to modify the techniques for prevention of its effects. In the event excavation works will be carried out in the prescribed manner and after prior notice to all local residents and the local town authorities. Impact due to generation and disposal of huge amount spoil from underpass section will also be managed properly.

[7] Guide to Slope Protection Works, DOR, GON, 2007

a) Avoiding landslides due to earth excavation activities

Earth excavation materials will be managed and will be avoided from direct tipping at the existing road. Labor and machines will be used in order to maintain cut slope angle which will prevent subsequent landslide of fresh cutting hill area. Further landslide will be prevented with the stockpiling of excavated material at the inward side of formation width. Side tipping and stockpiling of excavated materials at the outward facing slopes and at the roadside will be avoided strictly in order to prevent air pollution, land pollution, pollution of surface water and permanent changes of land use pattern of the adjacent lands. If stockpiling will be required; appropriate drainage facility will be provided preventing possible washout of materials from rain water into water bodies and other properties situated at the downhill.

b) Preventing soil erosion and gully formation at new open cut sections

In order to avoid soil erosion and gully formation, cut spots and embankments will avoid the creation of angle greater than the natural angle of repose for the local soil type. Re-vegetation of cut slopes will be carried out as soon as possible. Destruction of vegetation in the right of way will be minimal as far as applicable. Disturbed areas will be replanted immediately after disturbance has stopped maintaining the slope angle and will not wait for the completion of construction works. Drainage improvement works will be carried in order to control volume and speed of water flows in water courses in the vicinity of exposed soils and slopes. Further, contractor will comply with EMAP and guidelines[8] published by GON for sustainable management of environment.

Spoils should be safely disposed by adopting the following mitigation measures:

- Follow Spoil Management Plan
- Spoil should be stored and managed with toe protection wall to control erosion and slide
- Use of excess Spoil or Soil for filling depressed areas or borrow pits wherever possible.
- Appropriate disposal of Spoil at the designated places
- Spoils should not be disposed on rivers or drainages, canals and other infrastructures.

c) Avoiding haphazard disposal of spoil

d) Avoiding direct disposal and stockpiling of excavated materials

The generated large amounts of spoil will be disposed properly into the identified spoil disposal sites. Although it could be difficult in keeping a balance between cut and fill, and expensive because of the haulage distance to the disposal site, side tipping of excavated materials will be strictly avoided during the time of construction. Awareness will be provided to contractor's

[8] Environmental Management Guidelines, DOR, GEU, 1999

crew members to avoid environmental and social impacts along the proposed highway with the haphazard disposal of spoil. Excavated materials will be loaded into trucks and will be taken to identify spoil disposal sites for safe disposal. Stockpiling of excavated materials at the valley side will be restricted to avoid land slide, soil erosion, destruction of vegetation, hazard to settlement at downhill side, disrupt upon rivers and drainages and pollute water sources.

Cut and fill material during construction will be balanced as far as applicable. However, the excavation for underpass and foundation work of this section of new road project will require massive amount of cutting with some filling works to maintain the highway alignment and its periphery. Whereas not all the cut materials will be suitable for filling and therefore, the surplus rock and soil-based materials will be disposed at identified spoil disposal site safely. A massive amount of spoil and haphazard disposal must be controlled to avoid potential impacts. Sites for stockpiling of material should be located away from cultivable lands and settlements, drinking water intakes, public places, near school and health centers. Sites for stockpiling of material should be located away from forest area, sensitive ecosystem, fragile and landslide prone slope or terraces etc.

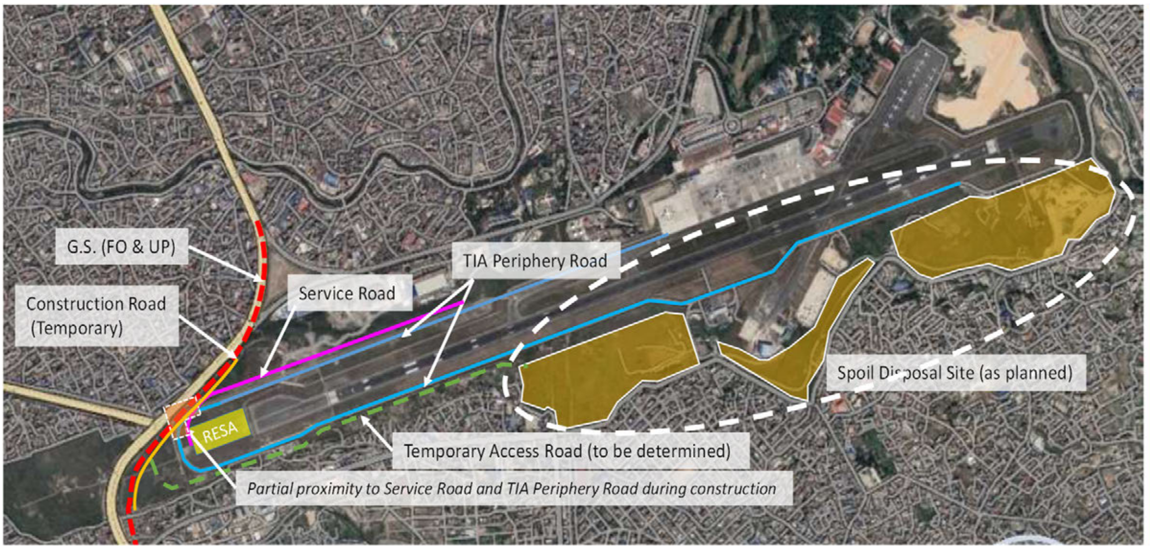
e) Managing stockpiling

Stockpiling of earth fill will in most cases not be permitted during the rainy season unless covered by a suitable material. Stripped material should not be stored where river or drainage will be disrupted. Stockpiled material should be protected from erosion prior to rainy season, including construction of drainage, trenches and ponds around the heap. As necessary, seal the area so surface water pollution does not occur. Storage of material on private property will be allowed only if written permission is obtained from the owner of authorized lessee. Furthermore, compensation for land damaged due to stockpiling of materials should be given by the Contractor to the affected landowners and the site should be cleaned and brought to original condition after closure and removal of the stockpile.

f) Managing spoil from underpass and flyover foundation excavation

Excess spoil originating from underpass and flyover foundation excavation work will be disposed at identified tipping sites by the project. Appropriate civil engineering structures will be provided to channelize the adjacent rivers avoiding erosion and mass wasting into water bodies. Toe protection wall will also be provided to stabilize disposed spoil. A level of compaction will be done during disposal. The details of appropriate civil engineering structures required for each disposal sites including drain management will be decided by Construction Management Team prior to construction of that stage as per requirements. All the spoil disposal sites will be closed after its proper rehabilitation maintaining proper drainage system and planted with vegetation after well managed landscaping. Some of the disposal sites will be developed into playgrounds and parks whereas some will be developed into facility sites, resting and recreational areas etc.

The proposed and identified spoil disposal sites are also shown in the following figure.



Source: JICA Survey Team

Figure 19.1.16 Expected Spoil Disposal and Storage Area

g) Avoiding impact upon river and drainage from disposal

The proposed highway alignment crosses river and natural drainage systems at different locations. However, the road works proposed are designed to improve the drainage discouraging soil erosion in the operational phase. Impact upon the river and drainage during the construction stages will be avoided as far as applicable. Haphazard disposal and storage of spoil and other construction materials into the river and drainage will be avoided in order to prevent the natural flow of the drainage triggering landslide and mass wasting. Proper water management and natural flow of existing drainages will not be disturbed.

h) Avoiding direct disposal and deposition on valley side affecting private land, other lands

Direct disposal of excavated materials and soil affecting the topsoil of private lands will be avoided. The deposition of excavated material on roadside will be avoided in order to prevent erosion. The construction works and disposal works will not produce significant impact upon other public land adjacent to the proposed highway alignment. Similarly, impact upon infrastructures and water resources available at the nearby settlement areas and agricultural lands will be avoided. During the commencement of construction, the contractor will have been primed by informing the detailed EMAP and incorporating environmental assessments in the bidding and contract documentation. The contractor will be required to follow method statements and plans in advance of commencement of construction as required in the EMAP for Construction related management plans including other plans incorporated in BQ.

Following are the plans for the contractor to follow during the commencement of construction civil works but not limited to:

- Muck / Spoil Site Management Plan
- Topsoil Saving Management Plan
- Occupational Health and Safety Management Plan

Muck/Spoil Site Management Plan will include the following necessary required steps and guidelines that will be abide by the contractor but not limited to:

- Spoil will be disposed properly at identified spoil disposal site.
- Spoil disposal sites will be rehabilitated by providing proper water drainage systems and applying bioengineering techniques and plantation.
- Direct and haphazard disposal of spoil upon valley side River, water bodies, cultivated and private lands will be strictly avoided.
- Disposal of spoil upon natural forest will also be strictly avoided.
- Excess muck and earth will not be disposed of on fragile hill slopes instead will be used for back filling of gabion walls and other toe and retaining walls.
- Locals feed backs and consent including guidelines[9] lined by the government agency will be followed to safeguard environment.
- Wherever possible, surplus spoil will be used to fill eroded gullies and depressed areas.
- If feasible, spoil material will be disposed in abandoned quarries and borrow pits as means to help restore original contours.
- Contractors will be advised to use the excavated materials for reclaiming the degraded land in near vicinity in consultation with local communities on their preferences.
- Spoil on fragile slopes, flood ways, wetland, farmland; forest areas, natural drainage path; religious and culturally sensitive sites, canals and other infrastructures will never be disposed.
- Acidic and saline spoil will not be spread onto agriculture land.
- Spoils will never be disposed on areas that will create inconvenience to the local community or it will deprive the livelihood of people.
- Spoil material may be discharged to a landfill or tipping site that is constructed using a series of small spoil benches to prevent slope overloading.

[9] *Guide to Slope Protection Works, DOR, GON 2007*

- The spoil will be placed in layers of 30 cm with compaction on each layer,
- After the disposal, the site will be landscaped, provided with proper drainage, plant with vegetation, and will provide adequate protection against erosion and scouring.
- Spoil will not be disposed in rivers, lakes and water bodies.
- Exposed areas will be planted with suitable vegetation following the GESU/DOR Manual on 'Vegetation Structures for Stabilizing Highway Slopes- a Manual for Nepal'.
- Contractor will be responsible to provide adequate compensation to land and property; if damaged by spoil storage and disposal.
- Spoil disposal sites will be developed into community facilities like park by reclaiming.
- Spoil will be used in local road net and embankment construction works.

i) Avoiding dangers of future washout during heavy rains, damage to road width

Valley side tipping will be strictly avoided that could washout affecting downhill settlements, roadside and private lands. Fresh cutting outer slopes throughout the alignment will be maintained with the angle of cutting slopes.

16) **Addressing likely River Flow Regime and Change in River Environment**

a) Preventing change of river flow regime

The construction works will be carried out without aiming to change the river flow regime. Direct disposal of excavated material upon rivers and natural drainages will be strictly avoided. Concrete batching plants etc., will be operated only at the selected sites to avoid adverse impact upon environment. Contractor will obey the physical and construction related management plans. Further, probable siltation at lower downstream sections upon agricultural land will be monitored during the construction period.

b) Addressing impacts due to operation of concrete batching Plants and storing of material near river banks

Concrete batching plants will be established and operated at the selected and identified sites only. Proper traffic signals and markings will be provided at the vicinity of such plants in order to avoid accidents and injuries. Extraction of sand and gravel form riverbeds will be avoided. Substantial number of stones and boulders are expected to be acquired from the excavation and opening of road width. For the storage of construction materials, contractor will provide bricks and sands for flooring in order to prevent soil and water contamination due to oil spillage.

Similarly, contractor will provide damp–proof flooring for the storage of cements will be carried out as per standard codes. Further, contractor will store blasting materials as per the specific provisions provided in the Act10.

c) Avoiding siltation and deposition at lower, downstream sections, on land on riverbanks

Contractor will select the stockpiling sites that are located away from private lands, settlements, drinking water intakes, public places, school and health centers. Sites for stockpiling of material will be located away from forest area, fragile and landslide prone slope or terraces etc. Plant will be operated establishing proper drainage systems avoiding direct flow and deposition of crushed materials into river systems to avoid deposition at the downstream.

17) **Avoiding Impact upon Existing Physical Structures and Infrastructure**

Affected major infrastructures such as roads, tracks, water supply pipelines, community water supply facility, water storage tanks, and electric poles/pylons will be either relocated or will be compensated as far as applicable. Hence, the mitigation measures for this impact include:

- Follow up of Layout Plan to avoid damage to existing utilities
- Monitoring construction workers to adopt carefulness during sewer excavation works

Similarly, during excavation works, damage to the existing paved as well as unpaved roads can be mitigated Rehabilitation & Restoration Work. The proposed project has provision for this reinstatement works and the cost estimate has been included in the detailed cost estimate of this proposed project.

a) Minimizing damage to existing highway road surface, damage to culverts etc., avoiding difficulty in local movements

During construction, affected tracks and highway need to be either closed temporarily or will be repaired continuously without halting it from operation. Traffic of existing highway will be managed properly together with the construction vehicle of highway during the time of construction. Road surface together with other roadside structures will be repaired properly if it is damaged due to the operation of heavy construction vehicle of this road project.

b) Addressing impact upon existing roads and tracks

Implementation of project is likely to affect accessibility of local people through two existing road tracks situated at the Jadibuti area during construction. Alternative accessibility has been

[10] *Explosives Act , GON, 1961*

proposed in the design to maintain smooth running of existing accessibility within the project area.

c) Relocation of electric poles and pylons

Relocation of affected electric poles will be required as a mitigation measure to the suitable places near the alignment of proposed highway. Similarly, affected electric pylons will be relocated at suitable location after coordinating with related government agencies. The cost of relocation has been incorporated in the detail design under the heading of Provisional Sum. Relocation of locally distributed iron electric poles will also be carried out after acquiring the consensus of the local authority and government line agencies as well as coordinating with locals during the time of relocation.

d) Relocation of existing water supply facilities

All the affected water supply pipelines and water collection reservoirs will be relocated after the close coordination with locals and related managing body. Although the households which exist within the proposed alignment need relocation; locals adjacent to the ROW will not be deprived from the utilization of resources. Project will make sure that the water supply will not be cut completely during the construction and relocation period by providing with alternative and temporary means. The overall cost of relocation has been incorporated in the detail design under the heading of Provisional Sum.

e) Addressing impact upon Existing community water supply facility

The majority of affected facility of community water supply situated at the Jadhibuti area is underground boring, distribution network, Generator house and ground storage reservoir. The implementation of this proposed road project work will deprive local residents who are dependent on that water supply system. All the probable affected water supply facilities of that system will be relocated and rebuilt by the project in the same area located on northern side before the implementation of this proposed rode project and before commencement of construction work for the continues supply of water to locales.

The supply will not be cut completely during the construction and relocation period. Rigorous monitoring will also be carried out during the time of construction to ensure the supply is not hampered. The overall cost of relocation and maintenance has been incorporated in the detail design under the heading of Provisional Sum in BQ.

f) Avoiding impact of OHS due construction activities

Working safety measures will be executed by the contractor to workers providing ample numbers but not limited to helmets, boots, rubber gloves, and masks as required. Life of worker will be ensured by maintaining life insurance of each worker of the project. First aid facilities for the workers will be provided at working sites as well as at labor camp sites. If possible, one qualified nurse or first aider will be present at all times. Routine checkups of laborers will be performed; this will be at least once per week for each labor workers.

Awareness programs to local people will be provided regarding environment health and safety. Furthermore, handling, transportation, storing and use of different machines, equipment and petroleum product will be other issues of safety during construction. It is recommended that contractor will further comply with the Safety Plan developed in the detailed design stage. Similarly, a Construction Traffic Management Plan will be developed in the detailed design stage that will comply by contractor to maintain flow of construction vehicles without hampering good flow of passenger vehicles.

Summary of the construction traffic management plan is as follows.

a. Traffic Diversion at Manohara

b. Traffic Diversion at Tinkune

- Road diversion installed within the intersection
- Installed the residential road on west side of intersection
- Deployment of traffic officer on roads

c. Pedestrian Traffic Safety Management

- Deployment of traffic officer on roads

d. Total Road Closure during Superstructure Erection

- Traffic control by reducing the number of lanes on the current road during road improvement, box culvert construction and nighttime girder erection
- Deployment of traffic officer on roads

e. Safety measures

- Traffic Safety at elevated bridges section (flyover) crash barriers and sound barriers walls etc., will be placed during construction and operation time
- Concrete barrier will be installed at edge of bridge to avoid car falling.

During construction, traffic safety will be secured by providing a detour depending on the progress of construction, and temporary traffic safety facilities to control traffic movement. After the construction, permanent road facilities such as railings along footpath, traffic signals, traffic signs will be provided.

Since the tunnel section will be newly constructed in TIA land along the Araniko Highway, this construction will partially affect the existing road. In this construction period, provision of detour and temporary traffic control facilities will be made.

After the construction, streetlights and other emergency facilities will be provided inside tunnel. Note that pedestrians are not allowed to pass through the tunnel.

18) **Community Health & Safety Hazards**

The mitigation measures for this impact include:

- Contractor's implementation of EMP
- Adequate lighting and Provision of temporary fencing, reflecting barriers and signage at active work sites
- Contractor's preparedness in Emergency Response
- Adequate dissemination of GRM and Contractor's observance/implementation of GRM
- The mitigation measures to deal with COVID issues as mentioned above includes: i) Establishing coordination with the nearby community; ii) Communication through posters, pamphlets, radio, test message, electronic meetings; iii) Maintaining physical distance with construction workers if any of the workers are staying on rent within the community; iv) Use of Face Masks (N95 Masks) and Face Shields during interaction with the workers using local facilities; v) Placing signage at various public places to remind community of maintaining hygiene (Frequent Hand Wash, Use of Sanitizers, Social Distancing, Use of Face Masks (N95 Masks) etc.); vi) Prohibition on unnecessary entry into the construction sites and labor camps for the community

19) **Worker's Health & Safety Hazards**

The mitigation measures for this impact include:

- Comply Labor Act,2074 B.S. (2017 A.D.) of GON
- Submission of Simple OHS plan for employer's approval that involves appropriate health & safety arrangement that includes minimum requirements for various activities like excavation works, works within the confined spaces, use of warning signs, boards & signage, Use of PPE, Accident & Emergency Response and Monitoring & Reporting.
- Preparation of COVID Response Plan and Immediate Action in its implementation. Here, the COVID Response Plan includes;
    - Facilitate Coordination & Cooperation with workers;

- Information Delivery to workers in regard to COVID issues prior to the construction through communication and trainings;
- Prohibiting physical contact with other persons, even with co-workers and social gatherings as far as possible;
- Enforcing strict control over external access;
- Implementing queue management through marking on the floor;
- Implementing physical barriers and decreasing work density;
- Installing plastic sheeting barriers when workers need to occupy specific areas of an indoor work sites where they have to be in close contact with co-workers
- Placing signage at construction sites & worker's camp to remind workers of proper hand hygiene and instituting a system to monitor compliance;
- Provision of hand washing stations or alcohol-based sanitizer at entrance of construction sites, bathrooms and worker's camp;
- Cleaning & Disinfecting construction sites, worker's camp and equipment's/machineries;
- Provision of suitable & sufficient PPE and Providing trainings and monitoring safe use among its workers;
- Provision of Face Masks (N95 Masks) and Face Shields to each worker and enforcing a strict rule to use them during working hours;
- Retraining workers on proper use of protective equipment on a monthly basis;
- Routine screening of at-risk workers (Easy Access to laboratory testing, Availability of Rapid Antigen Test in accordance with WHO guidelines, Enforcing workers with developed symptoms consistent with COVID-19 to stay home, Provision of Quarantine for 14 days to the workers who had maintained close contact with known cases) ;
- Provision of COVID Vaccination (if any of the workers are not found to be vaccinated)
- Setting Up staggered work shifts by splitting workers into teams across a day and night shift after reopening of construction sites
- Provision of proper food, medical & lodging facilities

- Train all the site personnel regarding environmental health and safety issues.

- Provide Personal Protective Equipment (PPEs) to workers that includes protective clothing, helmets, goggles, boots and other equipment designed to protect the wearer's body from injury or infection and ensure their effective usage
- Require workers to wear high visibility clothes
- Maintain hygiene within the labor camp as well as construction sites.
- Ensure no water stagnation either in construction site or in labor camp to get rid of the breeding grounds for the mosquitoes to prevent dengue outbreak.
- Provision of mosquito netting to the workers during sleep hours.
- Make the workers to dress with the full body covered clothing.
- Prohibit the workers to prepare or eat raw or undercooked poultry products.
- Recommend workers to avoid contact with the chiggers while working within the forest areas to reduce the risk of getting scrub typhus.
- Ensure availability of health care facilities for diagnosis and testing if any symptoms of Dengue/Scrub Typhus or Influenza H5N1 or H1N1 are seen.
- Ensure immediate availability of treatment facilities if those suspected cases of Dengue/Scrub Typhus or Influenza H5N1 or H1N1 comes out to be positive.
- Maintain accident reports and records.
- Make first aid kits readily available
- Maintain hygienic accommodation in work camps
- Assure clean eating and food preparation areas
- Make sure sanitation facilities are readily available
- Provide adequate space and light to the camp site
- Adequate supply of potable water to the camps and good sanitation within camps
- Provide medical insurance coverage for workers
- Ensure moving equipment is outfitted with audible backup alarms;
- Hearing protection equipment enforced in noisy environment
- Chemical and Material storage areas need to be marked clearly
- Implementation of Emergency Preparedness Response Plan to be prepared for the earthquake risks that includes i) Reporting of Incidents; ii) Investigation of

incidents and iii) Preparedness for availability of Stretchers, Life buoys, first aiders, first aid kits etc.

20) **Traffic Hindrance and Public Protests**

This impact cannot be avoided because the structure of the bazaar area is very congested. However, this impact can be mitigated as follows;

- Backfilling trenches as soon as possible
- Provision of signage at appropriate locations indicating available alternate access routes to minimize traffic disruptions.
- Provision of simple wooden walkways to ensure access to shops and residences.
- Provision of alternative way for vehicular movement and pedestrians if possible
- The contractor shall follow the Traffic Management Plan prepared especially at tinkune section during construction work
- Developing and Implementing Effective Traffic Control and Lane Closure Strategies
- Public Consultation should be carried out at various stages & locations as per requirement.
- Implementation of Grievance Redress Mechanism
- Pre-notification to the public regarding the construction works that may hinder their daily activities and Coordinate with them properly
- Establishing coordination with the community in regard to COVID outbreak issues and advising them to follow suitable measures to mitigate COVID issues

a) Avoiding impact due to Operation of Asphalt concrete plant/hot mix plant

Speeds limits will be established for vehicles within the works sites of the project area. Bitumen plant will be controlled maintaining appropriate distance from the sensitive receiver etc., but located at convenient sites nearby project area and more than 100 m from sensitive receptors such as schools and residence in order to avoid air and noise pollution.

b) Avoiding impact due to operation of batching plant

Batching plant activities will be controlled maintaining appropriate distance from the sensitive receiver etc. but located at convenient sites nearby project area and more than 100 m from sensitive receptors such as schools and residence in order to avoid air and noise pollution.

Contractor will fit Batching plant equipment with approved dust control devices and operated in accordance with manufacturer's specifications. Contractor will establish plant only at the selected and identified sites. Plant should be operated only during daytime. If necessary and if requested by locals based on rational reasons, timing of operation should be planned in consultation with local communities so as not to disturb local schools, health posts, markets, settlement areas etc. Contractor will compensate to the affected landowners if land and crops are damaged due to operation of crushing plant. Contractor should clean and brought to original condition after closure and dismantling of the plants in order to avoid siltation and deposition at downstream. Contractor will compulsorily adopt the technical preventive and safety measures to control dust and avoid noise pollution.

21) **Biological Environment**

a) Avoiding impact due to Clearing of existing roadside Vegetation and Bushes

- Prevent and protect the topsoil for further use, the topsoil will be kept separately and replaced in its original position after construction of underpass.
- Tree cutting will be avoided and fetching of fuel-wood by workers will be prohibited.
- Re-vegetating disturbed slopes and grounds, as applicable;
- Awareness programs regarding policy related to the conservation of existing flora & fauna, to the workers prior to the construction and the community during various meetings and discussion programs
- Strict Monitoring on the daily activities of workers and prohibition on disposal of wastes to the nearby water bodies during construction works at source area.
- Provision of temporary toilets at working site
- Adopt measures mentioned above for the solid waste management at site

22) **Socio-Economic & Cultural Environment**

a) Mitigation of the private land acquisition and resettlement

As stated in Section 19.2.

23) Health and safety issues during Construction

a) Maintaining Occupational Health and Safety of labors during construction

Occupational Health and Safety of laborers during construction of the proposed highway alignment will be significant issue. Working safety measures will be executed by the contractor to workers providing ample numbers but not limited to helmets, boots, rubber gloves, and masks as required. Life of worker will be ensured by maintaining life insurance of each worker of the project. First aid facilities for the workers will be provided at working sites as well as at labor camp sites. If possible, one qualified nurse or first aider will be present at all times. Routine checkups of laborers will be performed; this will be at least once per week for each labor workers. Similarly, the health and safety of the local people will be another significant issue during the construction stage of the project. Awareness programs to local people will be provided regarding environment health and safety. Furthermore, handling, transportation, storing and use of different machines, equipment and petroleum product will be other issues of safety during construction.

During construction, existing local tracks and vehicle tracks will be affected and may need to be either closed temporarily or synchronize with the construction vehicles. Construction activities on the project site are likely to cause hindrance to pedestrian and existing traffic flow if not managed properly. Although, this is not likely to be a major problem; it could affect the passage of the existing traffic.

b) Addressing Health and Safety of the local people

Construction work and excavation of road alignment will not be executed during night hours. Time schedule of road excavation and road closure will be fixed and will be informed to locals as well as dissemination related information through voice media and newspaper. Awareness will be provided to locals about health and safety regarding construction work. It is recommended that contractor will further comply with the Safety Plan developed in the detailed design stage.

c) Proper handling of explosives during transporting, storing and use

Handling of explosives, its transportation, storing and use will be other issues of safety during construction. Handling of explosive will be carried out as per prevalent Act[11] and regulations. It is recommended that contractor will further comply with the Explosive Handling and Safety Plan developed in the detailed design stage.

d) Managing accidental hazards and road safety during construction

A Construction Traffic Management Plan will be developed in the detailed design stage that will comply by contractor to maintain flow of construction vehicles without hampering good flow of passenger vehicles. Road safety issues during construction works will be significant to construction workers, passenger vehicles etc. Safe handling of construction vehicles and equipment during construction phase will be an important issue for contractor. Collection and transportation of construction materials, disposal of spoil from excavation will be executed smoothly during construction. The Araniko Highway connecting Kathmandu to China’s border and Eastern Part of the country and the lower Terai region through B.P highway not be disturbed

[11] *Explosive Material Act, 1962*

during the time of construction work and upgrading of this section of Araniko Highway alignment. Road safety of the highway will be ensured by managing existing traffic properly.

e) Managing Gender involvement and Child labor during construction

To minimize the impacts on gender following measures will be applied:

- Avoid total closure of the important access to the market, water source or river as much as possible.
- If obstruction is not avoidable, information dissemination to the community regarding the timing of start and finish of the obstruction will be carefully and thoroughly conducted in the manner that as many local women as possible has access to the information.
- Preference will be given to the residents in the Affected Area who wish to work as unskilled labor in the Project without discrimination by sex.
- The advertisement of the recruitment will be designed in the manner that as many local women as possible has access to the information.
- When found necessary and appropriate, training and consultation for job/skill improvement will be operated.
- Contractor should follow the Child Labor Prohibition and Regularization Act, 2000 which enacted in favour of the welfare of the Children's right.
- Prohibits the involvement of children less than 16 years of age to employ in the works.
- The Child Labor Prohibition Act and Regularization will be followed in all the works carried out under the Project.
- Awareness programs will be organized to educate parents, local people on the child labor act.

24) Addressing Impacts due to Sanitation, Public Health Condition Infectious Diseases such as HIV/AIDS

- Contractor and labor workers will be responsible to maintain healthy sanitary and hygiene condition of labor camps and its vicinity. Provide HIV related education and test to the willing workers.
- Awareness programs will be organized to educate the workers about the Sexually Transmitted Diseases (STD) to the workers.
- Providing first aid facility to the workers on site and also on the camp.
- Workers should be checked every month in the project site

- The contractor will strictly obey the construction related management plans that will be prepared during the time of Site specific EMAP.
- Provide training on awareness about sanitation, hygiene, safe-sex and family planning for the workers.
- Provide sufficient care-taking staff to conduct cleaning and monitoring activities on camp site

25) Preventing impact from outside workers

a) Addressing possible impact on-migration of people on social, cultsocialural and religious practices

Security systems will be established to avoid various sorts of conflicts between the local and immigrants during the time of construction. As majority of the rural areas along the proposed highway is; conflict upon existing natural resources between inhabitants and immigration people will be avoided establishing polish post at several locations as appropriate. The project will further encourage local people to participate in the construction and upgrading of this section of highway generating their livelihood.

b) Managing influx of people

Contractor will be responsible to manage all the labor workers maintaining their daily schedule of labor camp and working hours of workers. Local NGOs and stakeholders will introduce programs against alcohol abuse, violence, sexual abuse etc. Local educational institutions existed nearer to the project alignment will upgrade themselves in order to recruit likely increased number of students.

c) Avoiding conflict between workers and local people

Security system will be established to avoid conflict between workers and local people. Some of the workers have the habit of drinking alcohol, and this may cause sanitation problems which creates problems with local people. However, contractors will be responsible to control their own laborers, in particular those who are imported from outside the project area. Whereas the Contractor will be responsible to encourage locals for labor work including women providing both genders with equal wages not less than district rate.

d) Maintaining sanitation and hygiene condition

Contractor and labor workers will be responsible to maintain the healthy sanitary and hygiene condition of labor camps and its vicinity. Furthermore, the Contractor will strictly obey the construction related management plans that will be prepared during the time of detail design phase of the project.

(5) Operation Phase

Physical Environment

1) Addressing the Impacts of Obstruction to Local's Accessibility between Adjacent Lands and Settlement of Highway Alignment (Avoiding inaccessibility between adjacent settlement and market areas)

Significant settlement and market area will not be disturbed with the proposed alignment but one of the existing road access points at the north part of Jadibuti intersection will face obstruction due to fill embankment of the road. Alternative route access has been proposed and presented for above section in order to provide accessibility for local movement at different locations with huge settlements and intersection area. However, the size and location of such access road will be finalized during the detail design stage with the series of consultation with local affected people. Locals will use proposed access for their accessibility between the adjacent lands and highway. Further, traffic signals and other enhancement facilities to access zones will be provided to avoid accidents from direct crossings of highway alignment.

2) Minimizing Fragmentation of Private Land

Optimum design of alignment has been proposed in destructing existing land use pattern as far as possible. Similarly, passing zones will be introduced at different chainages in order to mitigate the barring from the direct movement of locals between adjacent lands. Such passing will support movement to locals including transportation of local materials, cattle movement, etc.

3) Surface Runoff and Lead Off Drains

Direct impact due to surface runoff upon public and private lands, water resources, river and natural drainage will be avoided by providing lead off drains at the appropriate sections of highway alignment. The direct disposal of roadside surface lead off drains upon private cultivated lands and properties will be avoided. Surface runoff and roadside lead off drains will be managed properly in order to prevent significant adverse impacts upon public and property. Locations of runoff and lead off drains will be further taken into account in the detail design stage that will not trigger further landslide and soil erosion at the basement area of the highway alignment as well as inundation and siltation of private and cultivated lands.

4) Avoiding Noise Pollution

Traffic signals will be installed properly where sensitive receivers, such as forest areas, hospital and school areas exist to avoid excessive noise from vehicle horns. As no highway project could be implemented and operated avoiding substantial noise pollution level, it is inevitable that sound from the vehicle movement could not be mitigated and reduced into negligible level. However, plantation of bush and hedge, bamboo plantation etc., will be applied as noise barriers in the vicinity of sensitive receivers. The project will provide appropriate education to local drivers as awareness training to minimize sound pollution. Sound barriers will be installed in the highly sensitive receptor areas near this road like schools, colleges, and hospitals if deemed necessary by the project during operation stage.

5) **Avoiding air and water pollution**

Control of air quality and amount of exhaust gas on the road by the vehicular emissions will be difficult within the scope of road. However, the prohibition of the old vehicles that do not meet the emission level shall be applied which will decrease the amount of vehicular emissions on the highway. Period air quality will be monitored during operation phase to ensure no significant adverse impact upon air quality due to operation of the project.

River water quality will be also affected during the operation of the project. The provisions of water quality monitoring (using parameters tested during baseline) will be carried out in order to maintain rivers and river systems under condition prior to construction phase. If there have been significant adverse impacts on water resources due to the operation of project; necessary steps of action will be executed to maintain water quality prior to construction.

6) **Addressing road safety and safe driving**

Road safety measures will not be compromised during the operation of highway. Environmental enhancement including safe driving will be provided installing all measures established in Asian Standard Highways. Road accident will be avoided as far as possible maintaining road geometry, regular road surface, controlled speed of vehicle etc. A number of traffic signals, including other enhancement measures, will be provided considering driving safety along the highway.

7) **Managing Local Traffic**

Local traffic will be managed establishing a merging/ diverging section at the starting point Jadibuti and the end point at Tinkune area in order to allow the passage of local vehicles. These merging/ diverging sections are the major points from where local tracks will be interconnected with proposed highway. Road markings, signals including traffic lightings will be established for the smooth ply of local and highway traffics. Further, pamphlets and brochures will be distributed for the dissemination of information regarding the traffic rules including dos and don’ts while travelling along the highway, rules of entry and exit from highway, information of highway lane, use of this section, directions etc. In addition, information and help desk will be established at each entry point of the highway.

8) **Maintenance**

To avoid any impact to surrounding environment, maintenance of structures, such as tunnels, roads, and facilities for ventilation and drainage will be implemented appropriately based on operation and maintenance schemes.

9) **Emergency Cases**

Establish operational organization especially for tunnel section to fulfil emergency counter measures for traffic accident, vehicle trouble, and fire.

Biological Environment

10) Avoiding Forest Resource Encroachment and Minimize Forest Resource Clearance

Construction work will not destroy vegetation cover beyond extreme cut and fill area during excavation. Contractor will ensure in avoiding massive excavation of forest area and vegetation of project sites without disturbing wildlife habitats. The project management will closely coordinate with Forest Office and forest user groups to control illegal felling of trees, illegal poaching and trappings by other outside wildlife poachers, wildlife traders and timber smugglers.

Socio-economic & Cultural Environment

11) **Avoiding Road Traffic Accidents and Road Safety during Operation**

To avoid accidents, road traffic signals and road marking and other safety measures will be applied to reduce driving risks and providing enhancements to driving conditions near the intersections. In order to avoid illegal crossing and accidental crossings by the local people, fencing will be carried out along the the highway. Awareness campaigns at the local level will be conducted to avoid such accident during operation. It is further anticipated that a large amount of traffic will be diverted from the currently overburdened single track linking Kathmandu with Terai. Overall, road facilities will be enhanced and driving conditions will be improved by providing substantial traffic signals and other facilities. Passengers as well as freight will be motivated to use the highway alignment by providing service and facility sites within the project area.

12) **Minimizing Impact on Livelihood based on Business of Various Type and Products**

The project is expected to improve transportation facilities including substantial economic benefit to the country. Similarly, the major benefits of the project recognized by the different stakeholders are potential employment opportunities & increase in income, generation of revenue, reduction in travel time & vehicle operating costs, tourism development, and decrease in market value of commodities in densely populated capital city Kathmandu, enhancement of local potential areas through area development projects etc. The livelihood condition of the severely affected people will be changed permanently to service oriented and business motive forms after at this busy intersection of Araniko highway. The project will attempt to generate employment opportunity within the project during operation. As many of the affected people will have opportunities in the project construction in appropriate designations.

13) **Avoiding Trafficking and Prostitution, Minimizing Population Pressure, Change in Social Behaviour**

The highway will serve freight transportation enhancing economic benefits to the intra and international entrepreneurs. Although import and export of alcoholic products benefitted to such business; consumption of alcoholic products at local level especially by the poor, laborers and those depending upon subsistence livelihood will be avoided by providing awareness training. During operation, awareness training will be provided to poor peoples' communities who will be more vulnerable to such impacts. Besides, such impacts will be minimized by increasing the local manpower and stakeholders as workforces to the extent possible. However, for the proposed project local labor force may not be adequate to accomplish the construction work, the necessary administrative and security measures will be adopted in coordination with the District Administration Office. Also, programs to communicate and interact with local communities through appropriate public interaction programs will keep good relationship between the local communities and project staff.

(6) Costs of Enhancement Measures and Environmental and Social Supports

Cost of enhancement measures and social support are presented in the table below:

Table 19.1.28 Cost of Enhancement Measures Environmental and Social Support Costs

	Particulars	Nos. / Units	Amount (NRs.)
1	Training to enhance the skills of local workers	75 nos.	(Secret)
2	Livelihood Enhancement Skills and Training to PAF	5 nos.	
3	Orientation to School Children on Road Safety	25 nos.	
4	RAP implementation		
5	Improvement/Enhancement of community infrastructures, Temples etc.	LS	
6	Re-establishment of Water Supply System at Jadhibuti	1 nos.	
7	Orientation of EMP to Authority, Concerned agencies, Consultation & Contractors groups	LS	
8	Erection of Signs and Signals at road crossings	LS	
9	Information and Educational Material (printed) distribution	LS	
10	EMAPs Implementation	LS	
11	Plantation along the Roadside, Greenery Management on slopes	LS	
12	Training on Road Operation and Risk	LS	
13	Awareness Programme on OHS and Road Safety	LS	
	Total		

Source: JICA Survey Team

The necessary on the training in table above will be judged on experience/skill of worker. The training program will be conducted by sexpert or service provider institution.

Cost of other mitigation measures are presented in the table below:

Table 19.1.29 Cost of Other Environmental Mitigation Measures

SN	Particulars	Nos. / Units	Amount (NRs.)
1	Air, Water and Noise Quality Monitoring	LS	(Secret)
2	Cross drainage	5 nos.	
3	Cost for installation of Safety barriers	LS	
4	Sprinkling of water to Reduce Air pollution	LS	
5	Implementation of OHS and Safety Materials	LS	
6	Waste Management	LS	
7	Improvement of Public Services	LS	
	Total		

Source: JICA Survey Team

Table below presents the summary of the tentative estimated cost environmental mitigation measures.

Table 19.1.30 Summary of Cost Estimation of Mitigation Measures

SN	Items	Amount (NRs.)	Percentage
1	Private Property Compensation Costs	(Secret)	
2	Environmental and Social Enhancement Costs		
3	Other Environmental Mitigation Costs		
	Total Environmental Mitigation Costs		

Source: JICA Survey Team

19.1.9 Environmental Monitoring Plan

Based on the survey results, an environmental monitoring plan is prepared as follows. In addition, grievance records shall be analyzed periodically, and monitoring frequency and items shall be reviewed as necessary.

Table 19.1.31 Environmental Monitoring Plan

S.N.	Parameters	Indicators	Methods	Locations	Frequency / Time schedule	Responsible Monitoring Agency
A. Pre-construction Phase						
Physical Environment						
1	Muck / Spoil Site Management Plan prepared and Materialized	Muck / Spoil Site Management Plan prepared by Contractor	Review of IEE Document, Enquiry with proponent and IEE Team	Proponent office	Weekly/During pre-construction Stage	Project/ EMU/ Consultant
2	Construction Camp Management Plan prepared and materialized	Construction Camp Management Plan prepared by Contractor	Review of IEE Document, Enquiry with proponent and IEE preparing consultant	Proponent office, IEE preparing consultant office	Weekly/During pre-construction	Project/ EMU/Consultant
3	Site selection of workers and contractor camps	Open space and barren land along the alignment	Visual observation of sites with the identified location presented in IEE	Project sites	Once/Pre-Construction and Preparation Phase	DOR/Project/EMU/ Consultant
4	Site selection for asphalt mix plant and Stock yard	Open space and barren land along the alignment	Visual observation of sites with the identified location presented in IEE	Project sites	Monthly/Pre-Construction and Preparation Phase	DOR/Project/EMU/ Consultant
5	Occupational Health and Safety Management Plan prepared and materialized	Occupational Health and Safety Management Plan prepared by Contractor	Review of IEE Document, Enquiry with proponent, consultant and IEE Team	Proponent office	Daily/During pre-construction	Project/ EMU/Consultant
6	Landslides and vulnerable areas	Identified and mentioned in design and project report	Review of documents and field verification	Proponent office	Weekly/During pre-construction	Project/ EMU/Consultant / Proponent
7	Existing infrastructures	Number and type of affected infrastructures identified	Review of document and field verification (visual observation)	Project area, Proponent & consultant office	Weekly/During pre-construction	Project/ EMU/Consultant / Proponent
8	Identified spoil disposal sites	Sites identified during Design stage	Review of document and field verification (visual observation)	Project area, Proponent & consultant office	Dry and wet Season/During pre-construction	Project/ EMU/Consultant / Proponent

S.N.	Parameters	Indicators	Methods	Locations	Frequency / Time schedule	Responsible Monitoring Agency
9	Identified labor camp sites.	Sites identified during feasibility	Review of document and field verification (visual observation)	Project area, Proponent & consultant office	Once/During pre-construction	Project/ EMU/Consultant / Proponent
10	Land use	Type of land acquired for the project	Visual observation	Along the road alignment	Dry and wet Season/Prior to construction and during construction	Project/ EMU/Consultant / Proponent
11	Watershed	Erosion slope stability in the catchment and streams	Visual observation Measuring water depth/volume	Along the road alignment	Dry and wet Season/Prior to construction and during construction	Project/ EMU/Consultant / Proponent
12	Air and water quality parameters	Air: NO_2, SO_2, PM10 Water: pH, TSS, BOD, Coliform	Measurement	Along the road alignment	Dry and wet Season/Prior to construction and during construction	Project/ EMU/Consultant / Proponent
Biological Environment						
1	Existing ecosystem condition	Ecosystem (Fauna and Flora) along the alignment	Review and field Observation and measurement	Along the alignment	Monthly/During pre-construction	Project/ EMU/Consultant / Proponent
Socio-Economic and cultural Environment						
1	Procedures of land acquisition and compensation	Land acquisition procedures; Field & HH survey, Inventory of affected infrastructures	Review of Document, ARAP Report, Interaction with Locals and proponent	Proponent office, consultant office	Weekly/Before construction/ Project preparation phase	Project/EMU/ Proponent / Consultant / DOR
2	Potential loss of land, properties and business	Land use pattern as per IEE & ARAP, affected households	Review of ARAP and field verification	Along the alignment	Weekly/During pre-construction	Project/EMU/ Proponent / Consultant / DOR
3	Likely Resettlement	PAFs and SPAFs identified in ARAP and IEE	Review of IEE and ARAP	Along the alignment	Weekly/ During pre-construction	Project/EMU/ Proponent / Consultant / DOR
4	Number of affected households	Houses existed along the alignment	Review of ARAP and field verification	Along the alignment	Weekly/During pre-construction	Project/EMU/ Proponent / Consultant / DOR
5	Relocation and resettlement area	Resettlement area identified	Review of detail design and resettlement plan	Proponent office,	Bi-Weekly/During pre-construction, during detail design phase	Project/EMU/ Proponent / Consultant / DOR

S.N.	Parameters	Indicators	Methods	Locations	Frequency / Time schedule	Responsible Monitoring Agency
				consultant office		
6	Relocation and rehabilitation of affected infrastructures	Status and benefit from the affected infrastructures, such as well, spout, and other water sources	Site observation and discussion with locals, if relocated Measuring water depth/volume	Along the highway alignment	Weekly/During Pre-construction and immediately during construction	Project/EMU/ Proponent / Consultant / DOR
B. Construction Phase (Compliance)						
Physical Environment						
1	Restriction on haphazard disposal of spoil along hill slopes, vegetated areas, water bodies and sensitive areas	Haphazard disposal of spoil	Field visit along alignment corridor	Along highway corridor	Weekly / during site clearance and project construction	Project/EMU/ Proponent / Consultant/Contractor
2	Enforce the use and regular monitoring of spoil loading, transportation and dumping at recommended disposal site	Status of disposal land, vegetation cover, drainage system, initiated erosion, affected aesthetic value	Observation, Interview, Photographs,	Designated Sites of spoil disposal	Weekly / during site clearance and project construction	Project/EMU/ Proponent / Consultant /Contractor
3	Regular monitoring on materials handling at earthworks	Stockpiling of excavated and construction materials	Observation, Interview, Photographs	Designated Sites of spoil disposal	Weekly / during site clearance, construction	Project/EMU/ Proponent / Consultant /Contractor
4	Procedures for safe storage and use of explosives and toxic materials	Adoption of explosive & Toxic management/handling plan by contractor, safe transport, storage and use	Site observation and discussion with local residents, workers. Public alert. Contingency planning.	Project alignment	Monthly/ during construction	Project/EMU/ Proponent / Consultant /Contractor
5	Regular water spraying to arrest dust, and vehicle maintenance to minimize gaseous emission	Water sprinkling during construction and availability of water sprinkling vehicles	Site observation and discussion with locals	Project construction sites especially near settlement areas	Twice a day during construction and excavation period	Project/EMU/ Proponent / Consultant /Contractor

S.N.	Parameters	Indicators	Methods	Locations	Frequency / Time schedule	Responsible Monitoring Agency
6	Timely construction of other slope protection measures, such as, retaining walls	Bio-engineering, adoption of slope protection measures	Site observation and discussion with locals	Location where mass cutting is required as per design estimate	Twice a week during construction and excavation period	Project/EMU/ Proponent / Consultant /Contractor
7	Rehabilitation and restoration of work camps and labor camp(s) etc.	Slope stability & drainage, close pits latrines, sanitation and vegetation condition	Site inspection, discussion with workers and local people. Vegetative restoration plan	Proposed camp site locations and along the highway alignment	Daily/After the completion of construction work	Project/EMU/ Proponent / Consultant /Contractor
8	Proper reclamation of disposal sites with vegetation and drainage	Status of such sites, erosion, landslide, drainage, disposal into water bodies, vegetation cover, impact adjacent lands	Site observation, discussion with local people, observe spoil disposal practice of contractor.	Along the highway alignment	Weekly / During site clearance, Construction and excavation	Project/EMU/ Proponent / Consultant /Contractor
9	Integration of local people's environmental concerns	Opinions and suggestion during public consultation	Review design reports, discussion with local stakeholders.	Proponent office/ IEE preparing consultant	Bi- Weekly/During the study and design process and prior to approval.	Project/EMU/ Proponent / Consultant /Contractor
10	Road safety and accident	Number accidents along highway	Observation of accident records, interview with locals	Project area	Monthly / construction and operation stage	Project/EMU/ Proponent / Consultant /Contractor
Biological Environment						
1	Care for vegetation in the ROW and immediate vicinity	Vegetation remaining along the ROW during earthwork and excavation	Site observation,	Along ROW of this road section	Monthly/ during construction and operation phase	Project/EMU/ Proponent / Consultant /Contractor
Socio-Economic and Cultural Environment						
1	Compensation of land, property	Allocation of budget in contract and documents, distribution of compensation	Review of design and project specification, observation and interview with affected	Proponent and consultant office/ project area/ field	Weekly/Preparation and pre-construction phase and following the completion of detailed design	Project/EMU/ Proponent / Consultant /Contractor

S.N.	Parameters	Indicators	Methods	Locations	Frequency / Time schedule	Responsible Monitoring Agency
2	Temporary acquisition of private land	Allocation of budget and distribution of compensation	Review of design and project specification, observation and interview with Affected	Proponent and consultant office/ project area/ field		
3	Compensation paid to SPAFs for house, land and their status	Distribution of compensation	Site observation	Resettlement area, project vicinity		
4	Extent of local laborers employed and skill training	Employment of local laborers during construction	Site observation, discussion and interview with laborers	Along the Highway	Weekly / During construction	Project/EMU/ Proponent / Consultant /Contractor
5	Health and sanitation facilities at workers camp and site etc.	Health condition with record of health check Sanitary condition of labor camps	Site observation, discussion and interview with laborers	At camp sites and work camp sites	Weekly / During construction	Project/EMU/ Proponent / Consultant /Contractor
6	Ensure Life Insurance of the laborers	Insurance paper of the laborers	Review of contractor's document and insurance paper	Project sites, contractor's office	Monthly/Before commencement of construction work	Project/EMU/ Proponent / Consultant /Contractor
7	Wage paid to laborers not less than wage fixed by concerned district to both male and female.	Monthly wage paid to laborers	Review of contractor's documents, interview with laborers	At construction site, labor camps	Monthly / During Construction	Project/EMU/ Proponent / Consultant /Contractor
8	Provision for occupational health and safety measures	Use of safety measures by laborers	Observation, interview with laborers	At construction site, labor camps	Monthly / During Construction	Project/EMU/ Proponent / Consultant /Contractor
9	Occurrence of communicable diseases	Health of construction laborers	Observation, interview with laborers	At construction site, labor camps	Monthly / During Construction	Project/EMU/ Proponent / Consultant /Contractor
10	Compensation for land acquisition	Grievances of land acquisition and compensation	Interview affected people, observe deed transformation	Along the project alignment	Before commencement of construction work	Project/EMU/ Proponent / Consultant /Contractor
11	Resettlement of SPAFs	Resettled with proper compensation and shelter	Site observation, discussion and interaction with locals	Resettlement areas and along the project sites	Before commencement of construction work	Project/EMU/ Proponent / Consultant /Contractor

S.N.	Parameters	Indicators	Methods	Locations	Frequency / Time schedule	Responsible Monitoring Agency
12	Living standard and Economic status of the PAFs and locals	Use of household facilities, employment, education and monthly earnings of PAFs	site observation, discussion with locals and interview with PAFs	Resettlement areas and along the project sites	Monthly / During construction and operation stage	Project/EMU/ Proponent / Consultant /Contractor
13	Launching of skill training, and public awareness activities	Minutes of trainings, list of participants of training	Review of training documents, interview with local people	Project area		
14	Avoid damage and disturbance historical, cultural sites	Resettlement of affected cultural sites	site observation, discussion with locals	Project area		
C. Construction and Operation Phase (Impacts)						
Physical Environment						
1	Workers and contractor camps	Sanitation and drainage condition	Observation & interview with locals & camp workers	Camp sites along the alignment	Monthly / construction and operation stage	Project/EMU/ Proponent / Consultant / DOR
2	Asphalt mix plant, Road excavation, Spoil disposal site.	Disposal process, emissions, air, water, land & noise pollution	Observation and air, water, land and noise level measurement	Along the road alignment, Batch mixing & Spoil disposal sites	Monthly, Construction / Bi-monthly, Operation	Project/EMU/ Proponent / Consultant / DOR
3	Construction of roadside drainage and location of dispose	Impact upon private land due to dispose of side drain	Observation and interview with locals	Along the alignment	Monthly / during operation	Project/EMU/ Proponent / Consultant / DOR
4	Flow condition of Existing Drainage and watershed	Blockage of river and drainage and erosion of adjacent land	Observation and interview with locals	Along the alignment	Monthly / during operation	Project/EMU/ Proponent / Consultant / DOR
5	Disposal of excavated materials and other construction wastes	Use of identified tipping sites with protection walls	Observation	Along the alignment	Weekly/ construction and excavation	Project/EMU/ Proponent / Consultant / DOR
6	Side tipping of excavated soils and wastes	Impact upon adjacent private lands and infrastructures	Observation	Along the alignment	Weekly / construction and excavation	Project/EMU/ Proponent / Consultant / DOR
7	Landslides, erosion, and unstable slopes	Vulnerable landslide and erosion area, new cut slopes	Observation	Along the alignment	Weekly / construction and excavation	Project/EMU/ Proponent / Consultant / DOR

S.N.	Parameters	Indicators	Methods	Locations	Frequency / Time schedule	Responsible Monitoring Agency
8	Safeguarding of Community Infrastructures	Status of affected community infrastructures	Observation	Along the alignment	Weekly/construction and excavation	Project/EMU/ Proponent / Consultant / DOR
9	Vibration on Structures	Cracks of structures, health impact during excavation	Observation, discussion with locals and interview	Along the alignment	Weekly/construction and excavation	Project/EMU/ Proponent / Consultant / DOR
10	Proper sitting of Camp sanitation facilities	Sanitation along the camp sites	Observation	Along the camp sites	Weekly/construction and excavation	Project/EMU/ Proponent / Consultant / DOR
11	Quality of surface water, and water level changes	River quality and water level	Observation, water quality and water level measurement	Along major river crossings & settlement areas and service sites including the locations of baseline data	Monthly/ Construction and operation	Project/EMU/ Proponent / Consultant / DOR
12	Air pollution, vehicular emission, noise, traffic volume	Measure Air quality parameter like NOx, Sox, TSP, PM_{10}, traffic volume count	Measurement	Along the major settlement	Monthly, Construction /Bi-monthly, Operation	Project/EMU/ Proponent / Consultant / DOR
13	Maintenance of road and road structures.	Status of road and its associated structures	Observation	Along the alignment	Bi-monthly / during operation	Project/EMU/ Proponent / Consultant / DOR
14	Surface flow interruption and its consequences along river.	Direct disposal of spoil into major river	Observation	Along the highway alignment	Weekly / construction and excavation	Project/EMU/ Proponent / Consultant / DOR
Socio-Economic and Cultural Environment						
1	Impacts on agricultural land due to spoil disposal/soil erosion/ due to construction.	Direct disposal of spoil upon private lands, steep slopes, side tipping	Observation	Along the alignment	Monthly / During construction	Project/EMU/ Proponent / Consultant / DOR
2	Care for local utilities	Relocation of affected local infrastructures and its use	Observation and interview with locals	Project area	Monthly / During operation phase	Project/EMU/ Proponent / Consultant / DOR

S.N.	Parameters	Indicators	Methods	Locations	Frequency / Time schedule	Responsible Monitoring Agency
3	Encroachment into common property.	Establishment of houses and physical structures and use	Observation and interview with locals	Project area	Monthly / During operation phase	Project/EMU/ Proponent / Consultant / DOR
4	Damage to private properties.	Disposal of spoil, destruction of physical structures during road width formation	Observation and interview with locals	Project area	Monthly / construction and operation phase	Project/EMU/ Proponent / Consultant / DOR
5	Protection of culturally sensitive spots.	Relocation and rehabilitation of culturally sensitive areas	Observation and interview	Project area, relocation sites	Monthly/ Construction and Operation Stage	Project/EMU/ Proponent / Consultant / DOR
6	Landscape aesthetics value	Value of land near to project alignment, number of tourists, restaurant	Interview with locals and land transaction	Project area	Bi-monthly during operation	Project/EMU/ Proponent / Consultant / DOR
7	Highway safety and accident	Number and type of accident and deceases	Observation, official records and interview	Entire road alignment	Bi-monthly during operation	Project/EMU/ Proponent / Consultant / DOR
8	Impact due to operation of service and facility sites	Involvement of locals in types of livelihoods available at service sites.	Observation and interview	Entire road alignment	Bi-monthly during operation	Project/EMU/ Proponent / Consultant / DOR
9	Impact due to relocation of affected infrastructures	Status and benefit of relocated infrastructures	Observation and interview	At entire project alignment	Bi-monthly during operation	Project/EMU/ Proponent / Consultant / DOR
10	Impact due to deprive of locals from using natural resources	Type and availability of natural resources, source of energy used by locals	Observation and interview	At entire project alignment	Bi-monthly during operation	Project/EMU/ Proponent / Consultant / DOR
11	Livelihood and income generation of locals	Available opportunities & Economic activity of the local people	Observation and interview	At entire project alignment	Bi-monthly during operation	Project/EMU/ Proponent / Consultant / DOR
12	Impact upon Socio-economic its change	Change in local economy (changes in living)	Survey and Interview	Entire Project Area	Bi-monthly during operation	Project/EMU/ Proponent / Consultant / DOR

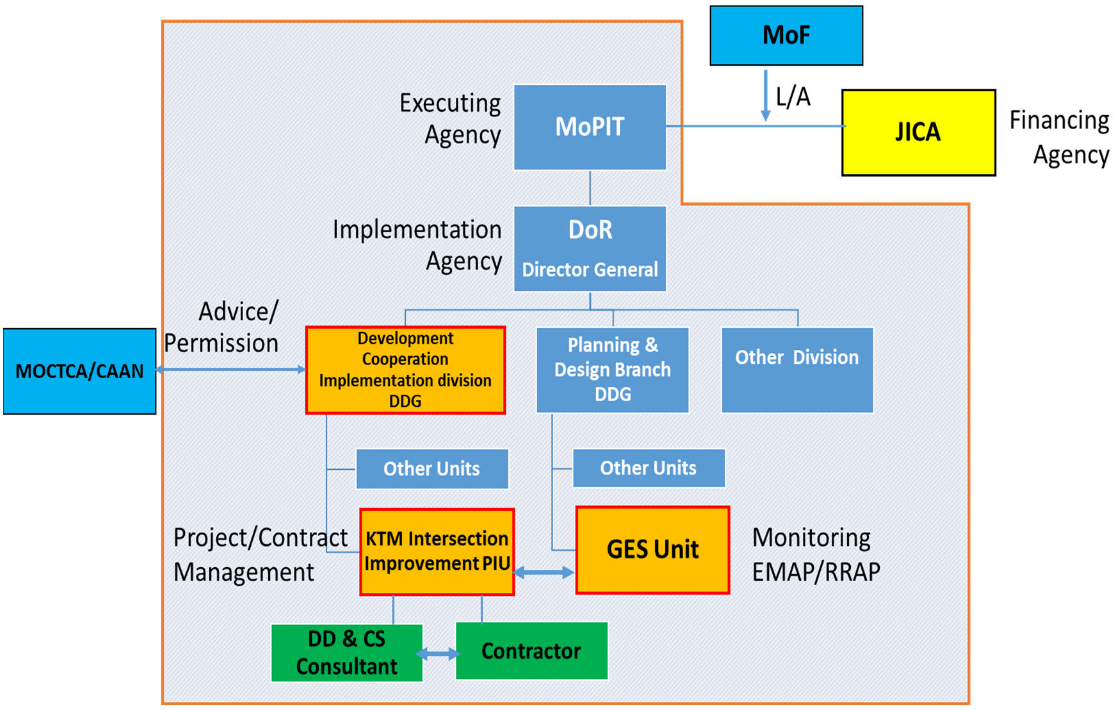
Source: JICA Survey Team

19.1.10 Institutional Frameworks for Environmental and Social Consideration

As mentioned above, DOR will recruit an international consultant team for conducting a detailed design, tender assistance and construction supervision for the Project under International Competitive Bidding (ICB), which has been a common practice in Nepal under Japanese Yen Loan projects. Furthermore, DOR will procure an international contractor or joint venture to construct the Project facilities supported by the selected Consultant and the Bid committee.

Through the detailed design and construction stages, GESU will provide advices on environmental and social issues to both DOR and the Consultant while monitoring the construction activities.

During the detailed design and construction stage, DOR will consult with CAAN under MOCTCA to get permission of the works and the working conditions within TIA territory in order to secure the safety of airport operation.



Note: PIU organization was planned based on on-going Nagdhunga Tunnel Project
Source: JICA Survey Team

Figure 19.1.17 Proposed Organization Structure of PIU

(1) Ministry of Physical Infrastructure and Transport (MOPIT)

The overall responsibility of the MOPIT comprises the coordination with the Nepal Planning Commission (NPC) and Ministry of Finance (MOF) for the final selection of strategic road network project sections and the finalization concerning budget allocation. This ministry is the umbrella agency in Nepal undertaking the planning and construction of the Strategic Road Network, to be implemented through its Department of Roads.

(2) Project Proponent(DOR)

The Proponent(DOR) shall review the IEE report to ensure that it meets the IEE requirements and procedures as per EPA, 2019 and EPR 2020, and other environment related acts, rules and guidelines administered by concerned agencies. The Proponent shall submit the final EIA report to the concerned line Ministry for review through the MOPIT and shall get approval from the Ministry before its implementation.

(3) Affected Municipality and Municipal Ward Offices

Municipality shall provide recommendations to the proponent with comments and suggestions and assist the proponent in the project implementation. Assist in public consultation awareness building organized by the proponent and provide suggestions to the proponent in the matters related to community mobilization. Review of monitoring reports of project construction and operation and give comments for corrective actions Ensure that transparency in the project activities are maintained by all the concerned stakeholders as per IEE/ EIA report and commitment

(4) Local Stakeholders, NGO and CBOs

Local stakeholders shall support the proponent in settling all sorts of social disputes that arise during the process of acquisition of affected land and houses. Stakeholders shall assist affected locals.

19.1.11 Stakeholder Consultation

At the stage of field study from Sep. 2022 to June 2023, the meetings, consultations, interviews and workshops were organized to collect information from stakeholders fort the IEE and preparation of ARAP.

Stakeholder consultations after disclosure of the draft scoping and the draft report of the study were carried out following the JICA Guidelines on 24th September, 2022 and 30th June, 2023 respectively. Details of the consultation is reported in the following Section 19.2.10, as the main issues discussed in the consultations ware land acquisition and involuntary resettlement.

19.1.12 Grievance Redressal Mechanism

(1) Purpose

A project-specific grievance redress mechanism (GRM) will be established to receive, evaluate and facilitate resolution of affected persons' concerns, complaints, and grievances related to social, environmental and other concerns on the project. The GRM will aim to provide a time-bound and transparent mechanism to resolve such concerns. The mechanism, developed in consultation with key stakeholders, will ensure that: (i) the basic rights and interests of every person adversely affected by the social and environmental performance of a Project are protected; and (ii) their concerns are effectively and timely addressed.

A common GRM will be in place for social, environmental or any other grievances related to the project. The GRM will provide an accessible forum for receiving and facilitating resolution of affected persons' grievances related to the project. Project will publish the sample grievance registration form on its website, and publish it in local language, at the hoarding board of each of the project effected wards office/municipality office. Every grievance shall be registered with careful documentation of process adopted for each of the grievance handled, as explained below. The environmental and social safeguards officer (ESO/SSO) at the project Implementation Units (PIU) will have the overall responsibility for timely grievance redress on environmental and social safeguards issues. The Social Safeguards Officer at the PIU will be the focal person for facilitating the grievance redress at the local level.

A ward/municipal-level public awareness campaign will be conducted on a regular basis to ensure awareness on the project and its GRM to public. The social and environmental safeguards experts of the supervision consultant will support the Ward/municipality office in conducting ward wide awareness campaigns, which will ensure that all stakeholders including poor and vulnerable are aware of the GRM and project's entitlements.

(2) Proposed Set-Up

The project shall establish two tiers of Grievance Redress Committee (i) field level and (ii) and (iii) Project level (PD/DOR level). After the formation of the committee, orientation will be conducted to the committees about the grievance management and roles and responsibilities of the committees. All the committees are active in registering the grievances related to the project and initiating the solution as soon as possible. The Project staff is to continuously exchange information with the committee. All grievances and decisions related to the project are to be well documented with full information of the person and issue. The social resettlement team of the project checks the grievances received both in written and verbal and facilitate for resolving the grievances in time.

(3) Field Level GRC:

The Safeguard and Monitoring & Evaluation Unit under the Project Management and Construction Supervision Consultant (CSC) will establish the field level GRM from the start of the project and before construction work begins. Local households and stakeholders will be informed about the setting up of the grievance mechanism by the CSC before the start of any construction as part of the community mobilization process. Besides, the information board will be in place at the construction site with specific information related to the construction works and will provide in the local language the description of the project and grievance mechanism, where and to whom stakeholders can deliver their complaints.

The Safeguard and M&E Unit will handle received grievances related to works on the road construction in collaboration with the GESU-DOR and the construction contractor. In each case, the Safeguard and M&E Unit will be supported by the CSC in cooperation with the proponent DCID, DOR. The construction contractor will clarify if the construction works cause the complaint. The CSC will inform and update the complainant about the progress of grievance mitigation within 24 hours for urgent issues and 7 days for non-urgent issues. Once verified problem/complaint is well-founded and due to the construction works, the decision will be implemented together with the Safeguard Unit, CSC and Contractor. The contractor will take the necessary corrective actions and try to resolve the grievance informally directly with the complainant.

The functions of the field GRC are as follows: (i) provide support to affected persons on problems arising from environmental or social disruption; asset acquisition (if necessary); and eligibility for entitlements, compensation and assistance; (ii) record grievances of PAPs, categorize and prioritize them and provide solutions within 15 days of receipt of complaint by the local bodies; and (iii) ensure feedback to the aggrieved parties about developments regarding their grievances and decisions of the GRC.

(4) Project Level GRC:

A Grievance Redress Committee (GRC) will be formed at the DOR, comprising the DOR as Chairperson of GRC, and PMO as Secretary. The GRC members will comprise of (1) representative of Ward No.32 Council; (2) PMO Engineer; (3) PMO social /environmental (as relevant) officer, (4) representative of project affected persons, (5) a representative of reputable and relevant community organization working in the project area, and (6) contractor's representative. The secretary of the GRC will be responsible for convening timely meetings and maintaining minutes of meetings. All GRCs shall have at least two women committee members. Along with representatives of the project affected persons, civil society and eminent citizens can be invited as observers in GRC meetings.

If any sort of field level grievance is not possible to redress or at the choice of the complainant, a formal redress can be forwarded to the project level GRC. Any unresolved or major issues at local level will be referred to the Project level (PIU level) for final solution. The PIU's Project Director (PD) will have special meeting to find solutions. A decision has to be made within 15 days of receipt of complaint.

19.2 Land Acquisition and Involuntary Resettlement (Abbreviated Resettlement Action Plan)

19.2.1 Requirement of Land Acquisition and Resettlement

This Project Activity that will lead to land being expropriated or to people being resettled by the construction of the flyover road at Jadibuti intersection road and underpass tunnel on airport land and soil disposal/storage site.

(1) Project Main Components Causing Resettlement and Impact Area

1) Road Alignment and Flyover and Underpass Plan

The flyover road and underpass alignment from Jadibuti intersection to Tinkune intersection is as shown in Figure 19.1.2. The new road alignment is on the northern side of the existing Araniko Highway / Ring Road, and the underpass is proposed under the southern land of Tribhuvan International Airport premises. The total length of this road alignment with Flyover and Underpass is 1,851 meters Bagnati River at Tinkune till Manohara Bridge of Jadibuti.

2) Flyover Plan

The Project's flyover section of the alignment is located to cross the existing road intersections at Jadibuti and Tinkune. The Width of flyover is 17 m with 4 lane. 5 m of extra ROW on one side is secured. At the Jadibuti intersection side, the length of the flyover is 238 m, and at the Tinkune side, the length will be 664.5 m. The clearance at intersections is 5.5 m.

3) **Underpass Plan**

The Project's underpass section of the alignment starts after the end of flyover section. The underpass is proposed under the premises of Tribhuvan International Airport. The alignment is adjacent to the existing Araniko / Ring Road. The total length of the covered underpass is 600 m and after it exists, the 100 m section will be an open passage (inverted "U" shaped), until it gets connected to the flyover section. The underpass will be conducted by 'open cut or earth retaining wall method'. The construction within the Airport section will follow the requirements and guidelines issued by the TIA office.

(2) Review of Alternative Alignments

In the basic design phase, the following values shall be considered in the design of road alignment, to reach the most feasible and rational alignment.

- Secure the traffic and pedestrian safety on the Project Road and vicinity.
- Minimize the volume of soil disposal.
- Minimize the number of persons required involuntary resettlement.
- Avoid or minimize negative impacts on reso

- urce use, such as farmland, water and forest.
- Avoid negative impacts on local cultural and religious places and activities.

(3) Methodology for Minimizing the Resettlement for the Project

The project road is a national highway and quality standard in any aspect cannot be compromised. The technology, including the selection of the construction equipment and the operational facilities, however, may have alternatives considering following issues.

- Requirement to achieve the highest standard results.
- Availability in Nepal
- Suitability and duplicability in Nepali condition

Source of the raw materials for construction shall be examined in the IEE study whether to purchase from the local suppliers, to import from Japan or the third country, or to plan the project specific sites such as queries.

Construction time schedule shall be further studied during the basic design phase. Following Nepali-specific conditions shall be taken into consideration formulate the most feasible and realistic schedule.

- Nepali calendar and holidays.
- Agriculture season and off-season in the surrounding area of the ROW
- Dry season and monsoon season.
- Acceptability of night shift working

Electricity supply for the underpass tunnel has not been settled between the NEA and MOPIT. During the basic design phase, various discussions, coordination, and agreement are expected.

Since the flyover with underpass tunnel road is a new project in Nepal, the regular institutional structure for the following monitoring activities shall be reviewed considering the operation and management structure of the underpass to formulate the most suitable distribution of responsibilities and funding.

- Environmental monitoring
- Resettlement monitoring

(4) ROW Planned in the Project

1) New Alignment

This Project includes new roads both with flyover and underpass tunnel section, which will be a part of Araniko Highway. Therefore, the ROW of the new road is need to be acquired by the project according to the Land Acquisition Act, 1977 and the Land Acquisition Guidelines 1989 in Nepal.

The ROW for the surface road with flyover and underpass tunnel alignment is defined as “directly affected area”. In other words, directly affected area is defined as Corridor of Impact (CoI). Within 500 m from the boundary of the ROW is defined as “indirectly affected area”.

In terms of the important facilities near the ROW within the 500 m (Corridor of Impact) from the boundary of the ROW of the proposed road, there are one local temples, other water supply facilities.

The scope of Resettlement Action Plan is basically applicable to persons who are directly affected by the loss of privately owned structure or community property within the CoI.

2) Existing Alignment

Nepal’s roads are broadly classified as National Highways, Feeder Roads, District Roads and Urban Roads. The overall management of National Highways and Feeder Roads, collectively called Strategic Roads Network (SRN) roads, comes within the responsibility of the Department of Roads (DOR) under the Ministry of Physical Infrastructure and Transport (MOPIT). Urban roads are managed by the respective municipalities. Within Kathmandu Valley, the urban roads are managed by the Kathmandu Valley Development Authority (KVDA), which carried out a large number of roads’ width widening initiatives during 2011 to 2019, as per the Kathmandu Valley Development Authority Act 2045.

The minimum Right-of-Way (ROW) according to road class determined as per the Nepal Road Standards-2027 (1970), aas shown in Table 19.2.1.

Table 19.2.1 Minimum Right-of-Way According to Road Class

	Minimum Right-of-Way	Between Building Lines
Trunk Roads (Highways)	**50 m** (25m on either side of the road center line)	62 m
Feeder Roads	**30 m** (15m on either side of the road center line)	42 m
District Roads	**20 m** (10m on either side of the road center line)	32 m

Source: Nepal Road Standards-2027 (1970)

Ring Road Right-of-Way: In Kathmandu, the Ring Road was constructed in 1970, whose length is 27 km. After its construction, the ROW was declared as 50 m with a building line setback of 6 m, so the total width from one building line to other was 62 m. The construction of building within 62 m was strictly prohibited around the Ring Road and the Cadastral Map of the area indicates the 62 m Ring Road corridor. Due to this enforcement of ROW, the recent Ring Road widening from Koteshwor to Kalanki (10 km) stretch, was commissioned without hindrance due to land issues. However, the 62 m width of ROW for all sections of Ring Road is not available. The section from Chabahil to Gaushala is narrower than the 62 m ROW, where the building lines are up to at 15 m or 7.5 m from the road center line.

Change of ROW provisions within Urban Roads in Kathmandu Valley

Within Kathmandu Valley, there are instances where the ROW is not fully maintained, due to reasons such as people being unaware of ROW provisions, government's non-payment of compensation, government's inability to maintain its ROW boundaries, or people's non-abiding of the regulations, etc. In the past, there has also been some people's protests regarding the ROW, especially at dense residential areas, where abiding the ROW regulations would result in heavy loss of private property. There have been instances of court cases against the government's decision. There are some instances where the Government has altered the ROW width of certain sections of the road, as per public demand. One such instance at Koteshwor is as follows:

1. For Koteshwor – Tinkune Section of Araniko Highway: Even though the Koteshwor – Tinkune Section is under Araniko Highway (and also overlaps with the Ring Road), this section has been treated as the Commercial Sub-Zone and for this section, the criteria of the ROW has been determined as 15 m from road's centerline, on the west side of the road (opposite of the Airport boundary), for a length of 303 m from the center of the Koteshwor intersection.
2. This provision is stipulated in: Construction Bylaw for Municipalities within Kathmandu Valley and Urbanizing VDCs – 2064, Enforced from 2007/5/15, Kathmandu Valley Town Development Committee [now KVDA], page 24 and 40.

Source: JICA Survey Team

Figure 19.2.1 Present ROW Situation at Koteshwor Intersection

19.2.2 Legal Framework for Land Acquisition and Resettlement

(1) Outline of the Legal System for Land Acquisition and Resettlement in Nepal

Essential legal frameworks for the proposed projects are summarised in Table 19.2.2.

Table 19.2.2 Overview of Land Acquisition and Resettlement Legal Frameworks in Nepal

Category	Topic	Laws and Regulations	Authority
Social considerations	Land acquisition and compensation	Land Acquisition Act, 2076 (2019) Land Acquisition Act, 2034 (1977) Land Acquisition Guidelines, 2046 (1989)	DOR/GESU
		Land Acquisition, Resettlement and Rehabilitation Policy, 2072 (2015)	
		Immovable Property Acquisition Act, 2013 (1956)	
	Community forest	Forest Act, 2049 (1993) Forest Rules, 2053 (1995)	MOFE, District forest user groups (FUGs)
	Drinking water	Nepal Water Supply Corporation Act, 2046 (1989) Drinking Water Regulation, 2055 (1998) Essential Commodity Protection Act, 2012 (1955)	Department of Water Supply and Sewerage Management (DWSS)
	Indigenous groups	National Foundation for Upliftment of Aadibasi /Janjati Act, 2058 (2002)	DOR/GESU
	Dalit groups	Caste-based Discrimination and Untouchability (Offence and Punishment) Act, 2068 (2011)	DOR/GESU
	Additional assistances	Environmental and Social Management Framework, 2064 (2007)	DOR/GESU
	Underground property rights	None	N/A

Source: JICA Survey Team

(2) Land Acquisition Act, 2034 (1977)

The Land Acquisition Act, 2034 (1977) and its subsequent amendment in 1993 specify procedures of land acquisition and compensation. The Act empowers the Government to acquire any land, on the payment of compensation, for public purposes or for the operation of any development project initiated by government institutions. There is a provision of Compensation Fixation Committee (CFC), which is also called as “Compensation Determination Committee (CDC)” chaired by Chief District Officer and other members are representative of District Development Committee (DDC), Chief of District Land Revenue Office, and Chief of the Project to determine compensation rates for affected properties. Steps of Land Acquisition plan as per Land Acquisition Act 1977 are presented in the figure below.

The Dept. of Road will forward a proposal for land acquisition to the Ministry of Physical Infrastructure and Transport

Ministry approves and orders the initiate acquisition process

Compensation Determination Committee (CDC) to be formed under chairmanship of respective Chief District Officer (CDO)

Publication of notice for the land acquisition in national level newspaper

Owners may file complaints within 15 days notification of Government of Nepal through CDO

Resolution by Home Ministry, Government of Nepal within 15 days of filing complaint

Start land acquisition and compensation payment

Source: JICA Survey Team

Figure 19.2.2 Land Acquisition Process (Based on Land Acquisition Act)

(3) Land Use Act, 2076 (2019)

The Land Use Act, 2019 has come into force in Nepal. As per the act, land has been classified into 10 categories: agricultural; residential; commercial; industrial; mining and mineral; forest; river, stream, pond and wetland; public use; cultural and archaeological; and others. The land classification is based on the composition and use of the land. The classification has not clearly pinpointed guthi land, which is religious land in the name of temples or shrines, from the revenue of which the religious ceremonies or festivals associated with the temples or shrines are celebrated and the repairs and maintenance of the temples or shrines are carried out.

(4) JICA's Policy on Involuntary Resettlement

JICA's fundamental policy on involuntary resettlement is shown in the table below.

Table 19.2.3 JICA's Policy on Involuntary Resettlement

7. Involuntary Resettlement 1. Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. When, after such an examination, avoidance is proved unfeasible, effective measures to minimize impact and to compensate for losses must be agreed upon with the people who will be affected. 2. People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported by project proponents etc. in a timely manner. Prior compensation, at full replacement cost, must be provided as much as possible. Host countries must make efforts to enable people affected by projects and to improve their standard of living, income opportunities, and production levels, or at least to restore these to pre-project levels. Measures to achieve this may include: providing land and monetary compensation for losses (to cover land and property losses), supporting means for an alternative sustainable livelihood, and providing the expenses necessary for the relocation and re-establishment of communities at resettlement sites. 3. Appropriate participation by affected people and their communities must be promoted in the planning, implementation, and monitoring of resettlement action plans and measures to prevent the loss of their means of livelihood. In addition, appropriate and accessible grievance mechanisms must be established for the affected people and their communities. 4. For projects that will result in large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A

Source: JICA Guidelines for Environmental and Social Considerations (2022): Appendix 1.

(5) Gaps between the JICA Guidelines and the Legal System in Nepal

As stated in Section 19.1.3. There might be gaps on determination of compensation rate between Nepali side and the JICA Environment Guidelines. In the past cases, deduction and/or using government fixed rate lower than market price are common. There is no direct regulation of recommendation regarding the cut-off date for compensation in Nepali laws and regulations. Cash for land is the common way of compensation for both formal and informal land users in Nepal, and PAPs also prefer to cash compensation generally. Support for the transition period is not clearly mentioned in Nepali laws and regulations.

(6) Policy for this Project

Land acquisition and resettlement will be implemented following the legal system in Nepal and the JICA Guideline, and where there is a gap between them, the countermeasure for filling the gap stated in the above section is applied. Compensation to the affected households for their private property will be provided. Furthermore, displacement allowance will be given to the residential house owners. During the time of replacement, the factory owners may lose their income due to disturbance in their business; therefore, project has managed to allow them some amount of displacement allowance. In the case of permanent and temporary loss of land and other structure, compensation will determine with equal to replacement cost and with mutual negotiation between two parties.

19.2.3 Scale and Range of Land Acquisition and Resettlement

(1) Census of the Project Affected Households and Persons

1) Demography

According to the Population Census 2021, total population of the project affected Ward No. 32 is 483,390, where the male and female population is 43,362 and 40,028 respectively. The population of the project-affected ward is presented the table below.

Table 19.2.4 Household and Population of Affected VDCs

Location	No. of HH	Male	Female	Total	Ave. HH Size
Ward 32	24,338	43,362	40,028	83,390	3.43
Total	24,338	43,362	40,028	83,390	3.43

Source: Census 2021, Central Bureau of Statistics (CBS)

As revealed by the Census data, an estimated number of 79 Persons of 18 households are likely to be affected due to resettlement affect their land and structures. The population composition of project affected surveyed households is presented in table below:

Table 19.2.5 Population Distribution of Project Affected Household by Area

Location	No. of HH	Male	Female	Total	Ave. HH Size
Ward 32	18	41	38	79	4.4
Total	18	41	38	79	4.4

Source: Census/Socio-economic Survey of this JICA preparatory Survey, May 2023

2) Age Category of Project Affected Population

The total population of project wards no 32 with total households is 27.228, where 52.07% are male and 47.93 % female. This has been calculated for broad age groups, which indicate the population proportion for each category of age group. The survey shows that the population between 20-34 years of age is high and considered as economically active group. The broad age group from 20-49 years naturally accounts for higher share (55.70%) in the total population along the project area.

Table 19.2.6 Population Size by Sex and Age Group

Age Group	Gender	Ward No. 32	Total	%
< 5 Year	Male	2396	4420	5.3
	Female	2024		
5 to 19 Year	Male	10927	19634	23.54
	Female	8707		
20 to 34 year	Male	15106	29373	35.22
	Female	14267		
35 to 49 Year	Male	8335	17081	20.48
	Female	8746		
50 to 64 Year	Male	4875	9202	11.03
	Female	4327		
65 to 79 Year	Male	1443	2992	3.59
	Female	1549		
More than 80 Year	Male	280	688	0.83
	Female	408		
Total		83390		100.0

Source: Census/Socio-economic Survey of this JICA preparatory Survey, May 2023

3) **Ethnic Composition**

Ethnic composition and characteristics have a prominent place in Nepalese society and they reflect directly in the social status, economy, and livelihood pattern of the people in most cases. Ethnicity, culture, and religions are also important factors needing attention when new programs are conceived, designed, and implemented in any area. The responses of these social attributes to outside interventions are sensitive and greatly influence the performance.

Among the total affected household, about 55.6 percent households are Newar ethnic groups whereas remaining 44.4 percent are Brahmin. It is found that are no Janajati among the affected households. The ethnic group is also one of the criteria to identify vulnerable people in the development project however, the category couldn’t be applied here so far. Ward-wise ethnic composition of the project affected households is presented in the table below.

Table 19.2.7 Ethnic Composition of Affected Household

Location	Newar		Brahmin		Chhetri		Janajati		Total HH
	No.	%	No.	%	No.	%	No.	%	
Ward-32	10	55.6	8	44.40	0	0	0	0	18
Total	10	55.6	8	44.40	0	0	0	0	18

Source: Census/Socio-economic Survey of this JICA preparatory Survey, May-June 2023

4) **Occupational Status**

The Census shows that about 44.4% of the population depend on Business/Rent and 16.7 % population depend on service. A remarkable percentage (about 11.1%) of affected people are involved in household works. Though the road alignment passes through urban commercial area having higher percentage involved in business and real state. Occupational status of the surveyed household is given in Table 19.2.8.

Table 19.2.8 Occupational Status of Surveyed Household (not included student and <6 years children)

Main Occupation	Gender	Jadibuti	Total	%	
Agriculture,	Male	0	0	0	0
	Female	0		0	
Trade/ industry	Male	2	2	11.1	11.1
	Female	0		0	
Service	Male	2	3	11	16.7
	Female	1		5.6	
Household work	Male	0	2	0	11.1
	Female	2		11.1	
Business/Rent	Male	7	8	38.9	44.4
	Female	1		5.6	
Agriculture labor	Male	0	0	0	0
	Female	0		0	
Pension	Male	1	2	5.6	11.1
	Female	1		5.6	
Other labor	Male	1	1	5.6	5.6
	Female	0		0	
Total			18		

Source: Census/Socio-economic Survey of this JICA preparatory Survey, May-June 2023

5) Educational Status

The overall educational status of project affected population is good. The Census survey shows that about 88.9 % of the population are literate. Of the total population, 38.9% are SLC pass, 22.2% are within 10 class, 16.7 % are high school pass where as 11% have a higher degree (Bachelor Level). 55.5 % male and 33.3% female household members are found to be literate with different levels of education. The Table 19.2.9 presents the educational status of the project affected people.

Table 19.2.9 Educational Status of the project Affected Population

Education Level	Gender	Jadibuti	Total	%
Less than 5 Years	Male	0	1	5.6
	Female	1		
Illiterate	Male	0	1	5.6
	Female	1		
Literate but no schooling	Male	0	0	0
	Female	0		
Grade 1-10	Male	2	4	22.2
	Female	2		
SLC Pass	Male	5	7	38.9
	Female	2		
Certificate level Pass	Male	2	3	16.7
	Female	1		
Bachelor level or above	Male	1	2	11.0
	Female	1		
Total			18	100.0

Source: Census/Socio-economic Survey of this JICA preparatory Survey, May-June 2023

6) Annual Household Income, Income range of affected households

The Census revealed that majority (44.4 %) of the project affected people's annual household' income range in between NRs 200,000 to 500,000. Average annual income of the project affected HHs is shown in the table below.

Table 19.2.10 Average Annual Income range of the Surveyed Households

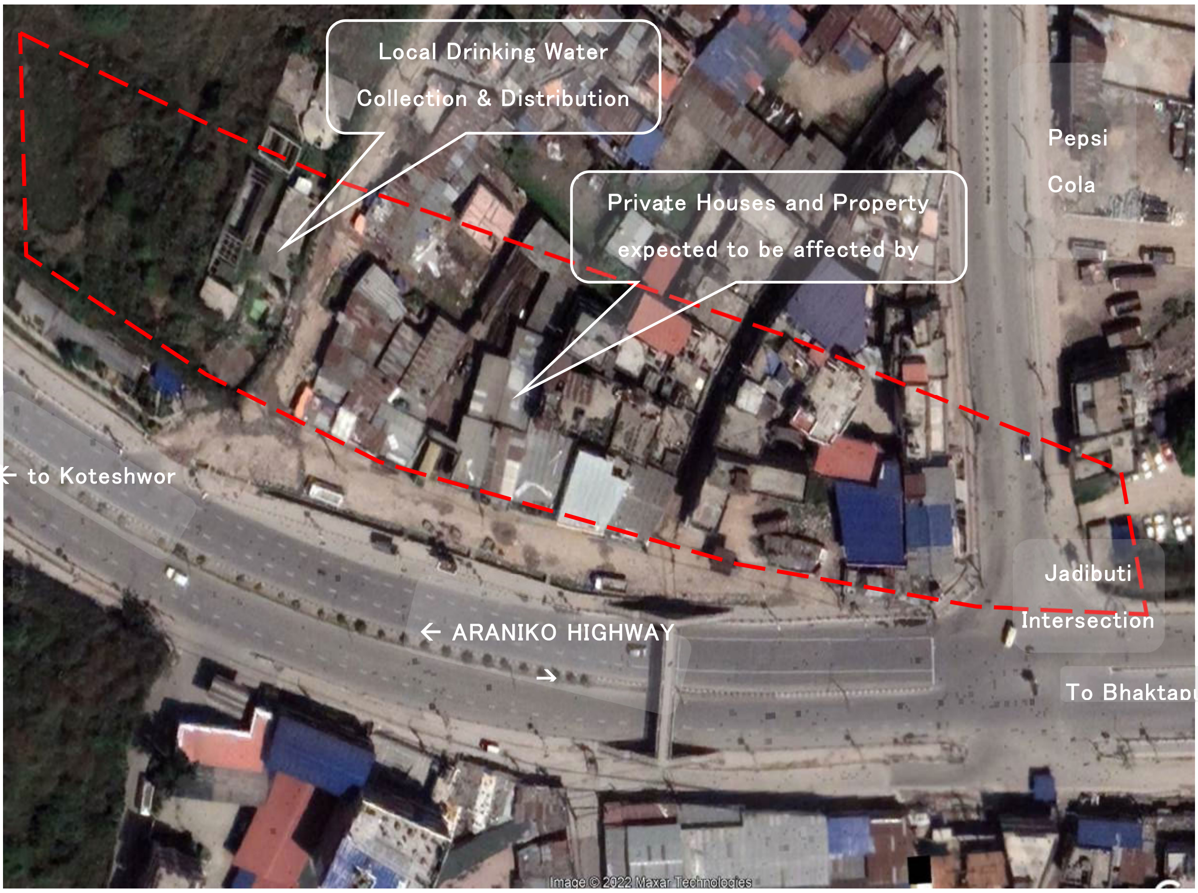
Income Range	Jadibuti	Total	%
less than 50,000	-	-	0.0
50,000 to 100,000	-	-	0.0
100,000 to 200,000	5	5	27.8
200,000 to 500,000	8	8	44.4
more then 500,000	5	5	27.8
Total		18	100.0

Source: Census/Socio-economic Survey of this JICA preparatory Survey, May-June 2014

(2) Property and Land to be Affected

1) Private Land and Structures to be Affected

The Project is planning to construct a flyover bridge structure, starting from Manohara River Bridge. Construction of the flyover bridge from Manohara River Bridge, between the crossing the Jadibuti intersection and the entrance of the underpass, which lies within the premises of CAAN's Airport premises, north to the existing Araniko Highway, an approximate length of 100 m and with of 50 m private land is expected to be directly affected by the Project, and this private land and related buildings will need to be acquired by the government. The map of affected private area at Jadibuti is shown hereunder.



Source: JICA Survey Team

Figure 19.2.3 Private Land and Structures to be Affected at Jadibuti

Some public land and structures are identified for possible acquisition for the Project components. About 2,444 square meters of additional private land is required at Jadibuti locations for construction of Project structures such as flyover. The total numbers of 17 land plots of 18 Households owners with 79 people, along with the structures therein are as follows.

Table 19.2.11 Land Required for the Project

		Land Details			Buildings Details			
S.N	Plot No.	Present Land Owner's Name	Total Land Area (m2)	Land Area Required (m2)	Type	Floors	Constructed Year	Area (m2)
1	43	(Secret)	380	145	RCC Framed	3 F	1995	420
2	42		175	175	Truss with CGI Sheet Roofing	2F	2015	203
3	135		3.96	3.96				None
4	136		546.79	442	RCC	3 F		510
5	38		135	135	CGI Sheet Roofing (Corner 2 sides open)	1F	2006	135
6	140		75.62	75.62	Load Bearing	3F		324
	138		78.93	78.93				
7	172		15.89	15.89	CGI Sheet Roofing	1F		147
	141		68.48	68.48				
	139		85.7	85.7				
8	122		302	302	Load Bearing	2F		152
9	186		280.14	165	CGI Sheet Roofing	1F		481
	187		222.53	222.53		1F		
	210		95.4	90		1F		
10	209		103.29	99	CGI Sheet Roofing	1F		240
	128		206.7	206.7				
11	129		133	133	CGI Sheet Roofing	1F		
			2908.43	2443.81				

Source: Census/Socio-economic Survey of this JICA Preparatory Survey, May-June 2023

The cadastral survey shows that approximately total 2443.81 sq.m. (0.244 ha) of land at Jadibuti Intersection is belonging to private land and approximately total 3.7 ha. belongs to governmental land in the affected area. These lands will be required for the proposed Project.

The location land requirement of the private land for the Project is presented in the table below.

Table 19.2.12 Location Wise Land Requirement

S.N.	Location	Land Requirement (Sq. M.)		Remarks
		Private land	Government Land	
1	Jadibuti (North side)	2,444 (0.244 Ha.)		Private land need to be acquired
2	Manohara Bridge-Jadibuti		5,537	(Being GON Owned Land)
3	Koteshwor (For Underpass)		12,810	(Being CAAN, GON land)
4	Tinkune (For Flyover)		18,690	(ROW of DOR)
Total		2,444	37,037	
		39,403 (3.948 ha.)		

Source: JICA Survey Team

2) Loss of Private Trees and Crops

Based on the results of the Census Survey, none of the private trees were confirmed with the affected landowners within the ROW. There are no private trees or cultivated crops within the affected households because the area being commercial and in a highly urban center.

3) Temporary Loss of Land

Temporary loss of private land will be undertaken within the framework of the Public Road Act 1974. This project might also take land temporarily to the construction activities if required. The compensation for the temporary occupation of land will be provided to the affected owners. Contractor will be responsible to negotiate a contract agreement on the rental rate with the owner for temporary acquisition of land. The practice is that if the government land is available, the project will use such type of land with the coordination of concerned government agency.

(3) Livelihood of the Project Affected Households

Refer to Section 19.2.3(1).

19.2.4 Land Acquisition and Resettlement to be Noted Although not the Project Impacts

(1) Dispute over land acquisition and compensation for land plots in the Tinkune junction

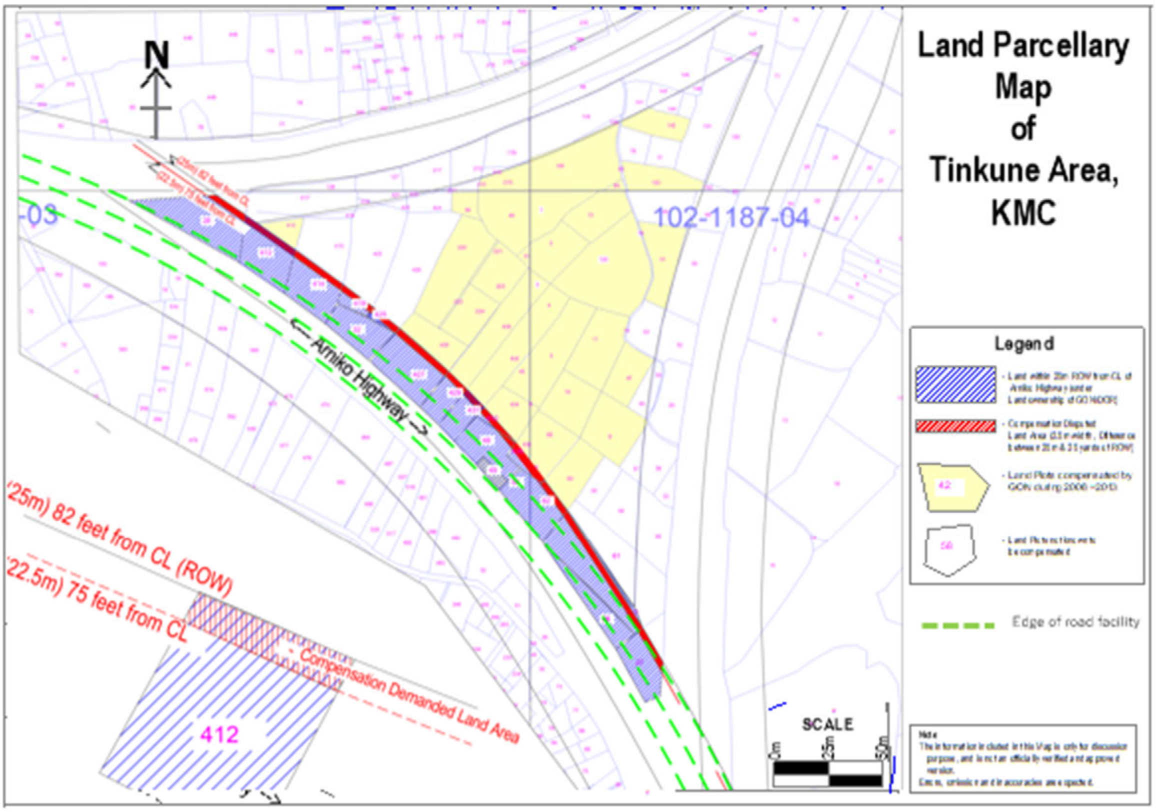
In the triangular area surrounded by existing roads at the Tinkune junction, there has been a dispute between the former landowners and the government over the land acquisition of the past private land. In 1995, ownership of all land plots were transferred to the Government of Nepal or DOR. However, the former landowners sued the landowners, claiming that they had not been paid due compensation for the land acquisition, and in 2000 the Supreme Court gave verdict to return of land ownership from the government to former landowners and if land is required, then acquire only after paying compensation. Also in 2010, the Supreme Court made a direction to re-evaluate present land costs, and make compensation payments, as per 2000 verdict. In accordance with the verdict, from 2007 to 2013, Kathmandu Municipality Office paid compensation, and some former landowners received compensation and the dispute was resolved with them, but the other former landowners were not satisfied with the compensation rate and conditions and did not receive compensation, and the dispute continues with them. The history of the dispute is shown in the table below.

Table 19.2.13 History of the Land Dispute in the Tinkune Area

Year	Event
1974	Government Publish Notice for Land Acquisition of Tinkune Lands.
1983	Government declares NRs. 80 Thousand per Ropani (508m^2), but landowners demanded NRs. 200 Thousand per Ropani. Landowners did not accept nor take the compensation amount.
1995	Land Ownership Transferred to Government and Department of Roads, without paying compensation and without notifying landowners.
2000	Landowners appeal at Supreme Court. Supreme Court gives a verdict to return of land ownership from the government to original landowners and if land is required, then acquire only after paying compensation At Arniko Highway side, only 75 feet from centre can be acquired and not 82 feet.
2001	Government declares Compensation Rate of NRs. 1,600,000 per Ropani and NRs. 800,000 per Ropani.
2002	Government declares Compensation Rate of Rs. 5,220,000 per Ropani.
2007	Government Treasury Transfers NRs. 150,000,000 in Kathmandu Municipality's Account for Compensation Distribution
2007-2013	Kathmandu Municipality Office distributed Total NRs. 108,000,000 as compensation. Sine landowners took compensation . The others did not take it.
2010	Supreme Court makes directions to Re-evaluate present land costs, and make compensation payments, as per 2000 verdict.
2013	Kathmandu Municipality returns the remaining NRs. 41,900,000 to Government Treasury.
2019	Government's Cabinet Ministers decide to solve the dispute on Land and its Compensation and to collect landownership and compensation details.
2020	Actual Landownership details were made by Survey Department and Land Administration Office, and submitted to the Kathmandu Municipality Office.

Source: JICA Survey Team based on information the Ward No.32 Council

The figure below shows the locations of the land plots and the status of their dispute. The land indicated by the blue diagonal lines in the diagram is owned by the DOR as a ROW, of which the strip of land highlighted in red between 22.5 m (75 ft) and 25 m (82 ft) from the center line has not been compensated and is still in dispute. In addition, within the triangular area, the land plots highlighted in yellow are the plots for which compensation was paid between 2007 and 2013, and the dispute appears to have been closed. On the other hand, in the triangular area, land plots that are not highlighted in yellow outside the ROW do not appear to be pending because compensation has not been paid for them.



Source: JICA Survey Team

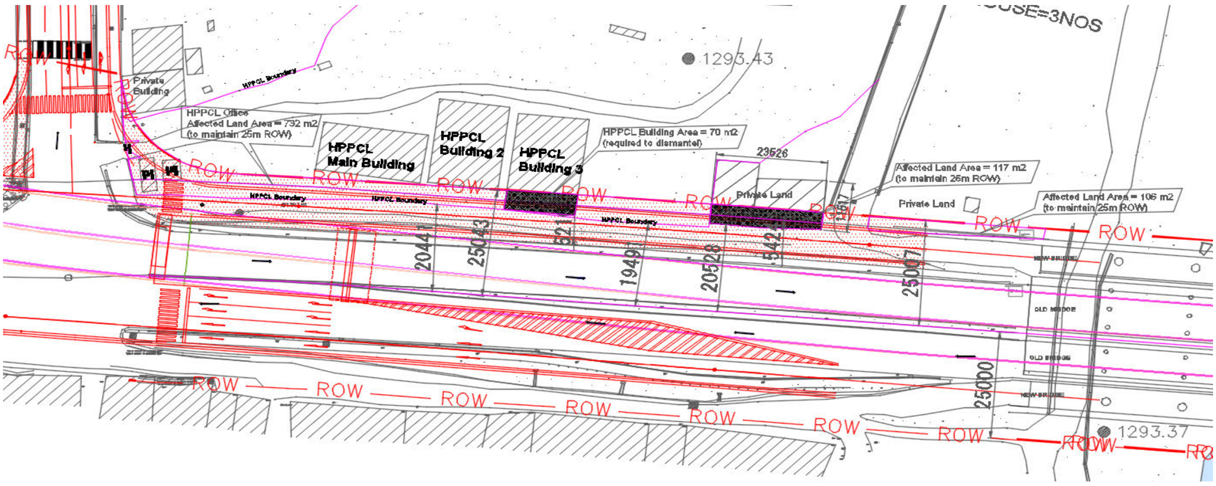
Figure 19.2.4 Location of the Disputed Land Plots in the Triangular Area in the Tinkune Junction

As described in Chapter 8, TK-2R is developed within undisputed ROW (22.5 m from the road centerline) without overlapping with these identified disputed lands. As shown in Figure 19.2.4, the edge of grade separation structure represented by green line is located within the ROW represent by red shade.

(2) Land Acquisition and Resettlement Caused by the Ongoing Road-Widening Project by DOR (outside of the Project funded by JICA)

Along the project alignment, from the Jadibuti intersection to the Manohara River, road improvements are planned within the ROW boundary, 25 m away from the road's centerline, as shown in the figure below. However, road widening up to 25 m from the centerline is planned to be implemented solely by DOR, prior to the start of the project. Therefore, although the road-widening will result in some land acquisition and involuntary resettlement, these impacts do not require examination and assessment under the project.

However, for reference, the scale of land acquisition and resettlement caused by the road-widening is stated here.



Source: JICA Survey Team

Figure 19.2.5 The Plan of Improvement of the Road between Jadibuti Intersection and Manohara River under the Project

Herb Production and Processing Co. Ltd.,

The company's current boundary is located 19.5 m away from the centerline of the Arniko Highway. To widen the ROW of the Arniko Highway to 25 m from the centerline and to construct two additional lanes on this side as part of the project, approximately 732 m^2 of land will need to be acquired. Additionally, a two-story building owned by Herb Production and Processin will need to be dismantled; its plinth area is approximately 70 m^2.

Two Land plots at Manahara Bridge site:

The land adjacent to Herb Production and Processin is owned by a private individual and is home to 13 households living in temporary sheds. The boundary of the temporary sheds is located 20.5 m away from the centerline of the Arniko Highway. Therefore, to maintain a Right-of-Way (ROW) of 25m, an area of 117 m^2 will need to be acquired, and 6 families with 23 people in the sheds will need to be resettled.

Another privately-owned land plot near the Manohara Bridge is also affected. A total of 106 m^2 of the plot will need to be acquired; however, this area is unoccupied, and no resettlement is required.

19.2.5 Compensation and Livelihood Recovery Support

(1) Compensation

The first proposal for compensation is monetary compensation to its owners, as per Land Acquisition Act and Guidelines. In this practice, a Compensation Determination Committee (CDC) consisting of the following members (Table 19.2.14) determine the amount of compensation. In general practice, representatives of people affected by the project is invited.

Table 19.2.14 Members of the Compensation Determination Committee

	Member	Position
i	Chief District Officer	Chairperson
ii	Representative of the District Development Committee (DDC)	Member
iii	Mayor of Municipality / Chairperson of Village Development Committee (VDC)[12]	Member
iv	Chief of the Land Revenue Office	Member
v	Chief of the Concerned Project	Member Secretary
vi	Specially Invited Members (members of the legislature parliament of the concerned constituencies, representatives of people affected by the project, representatives from the office of land measurement, and experts of resettlement and rehabilitation programs)	Invitees

Source: JICA Survey Team

The Entitlement Matrix below specifies compensation and/or rehabilitation measures for each different targets such as i) House and other Structure, ii) Land, iii) Other privately Owned Resources, iv) Community Structures and Resources, v) Rehabilitation Assistance, and vi) Governmental Property, of entitlement individuals including affected individuals and their households, and groups.

In addition to compensation for asset losses, some households who are losing houses will qualify for the displacement allowances. Households, which require to be relocated, will receive a housing displacement allowance equal 90 days minimum wage rate as established at the national or local level. The provision of displacement allowance is that the house owners are free to demolish the affected house and can carry away to reuse the materials for new housing. The displacement allowance is a provisional compensation for facing trouble for the transitional period. It is recommended by the public consultation in different place that three-month (90 days) period is sufficient for replacement of households since they have another house in nearby areas and villages, so they can shift in new residence within three months. Owners of factories, who are required to be relocated, will receive land improvement/ factory

[12] VDC does not exist anymore, but this is the term used in older official documents.

establishment cost, business closure allowance and labor allowance. The cost of this item is calculated based on existing market price discussion with factory owner and other relevant stakeholders.

According to Land Acquisition Act 1977, the date of public notification for land acquisition is the cut-off date. In this project, the cut-off date is 15^{th} May, 2023,published notification on the major newspapers in Nepal

It is also recommended that the DOR could consider any countermeasures such as setting signboards of the notification of the alignment in the site, to avoid the encroachment.

(2) Rehabilitation of Livelihood

The resettlement households are scattered individually along the road alignment. The Interaction Meetings during the Preparatory Survey with the affected households show that there is no need of group resettlement (relocation site) due to scatter households in different places. All the affected households expressed their opinions that they preferred to get cash compensation. Therefore, it is not necessary to consider the relocation site by this Project.

Employment priority will be given to the displaced households during road construction. Cash compensation and support allowance will be provided to the affected households or families for lost assets. It will be a main income restitution measure envisaged for this project. As far as possible, the project will provide job opportunities through contractor for the affected people during the project implementation, in order to enable families to earn sufficient to restore their income, if needed.

In the ARAP there is provisioned for Livelihood Enhancement Skill Training (LEST). One person of each affected households belonging to low income group will be provided LEST according to their choices. The trainings will be conducted based on result of training need assessment report. Apart from the above mention provision, the PAPs will be getting additional support through preferential access to employment as per their willingness and capabilities to work in road construction. The PAPs will be employed in a construction project with a high priority. It does not mean that all PAPs are economically weak and willing to work in the construction project. All rehabilitation activities will be monitored by Social Development and Resettlement Expert.

(3) Entitlement Matrix

Table 19.2.15 Entitlement Matrix

Type of Loss	Entitlement Unit	Description of Entitlements	Implementation Measures
1. House and Other Structure			
1.1 Loss of own house and residential plot	• Titleholder	• Cash compensation for full or partial loss of house at replacement cost, according to house type. • Where displaced, cash compensation (at replacement value) for residential plot, or provision of suitable replacement residential plot in the vicinity, if available.	• Compensation rates of land and structures negotiated by Compensation Determination Committee (CDC) taking reference to succeeding bullet 2 and 3 (which is legal authority), • Land valuation undertaken by District Land Survey and Revenue Office (mostly negotiated) on the reference of local market price and government rate fixed for land registration; • Building valuation undertaken by project authorities (on the basis of standard norms of Department of Urban Development and Building Construction and existing local market price); Material may be salvaged with no deduction from compensation. • Displaced households will receive a housing displacement allowance. • Notice to vacate will be served at least 35 days prior to acquisition. • An appropriate compensation advance and housing displacement allowance to be paid at time of notice to vacate; balance payable prior to possession of property. • Compensation for partial losses payable prior to acquisition. • To ensure fair compensation, determination of rates will be done not more than one year prior to property acquisition.
1.2 Loss of commercial establishment	• Titleholder • Non-titleholder	• Cash compensation for full or partial loss at replacement cost, according to building type.	• Compensation determination, notice to vacate, and compensation payment as for 1.1. • Owners of displaced commercial establishments will receive a business displacement allowance.
1.3 Loss of other private structures	• Titleholder	• Cash compensation for full or partial loss at replacement cost, according to structure type.	• Other structures include: sheds, water reserve tank, etc. • Loss of structures other than houses and commercial establishments does not entail payment of a displacement allowance. • Compensation determination, notice to vacate.

Type of Loss	Entitlement Unit	Description of Entitlements	Implementation Measures
2. Land			
2.1 Loss of private land	• Titleholder	• Provide compensation at full replacement cost, or • Provide full title to land of equal area and productivity acceptable to owner in the vicinity. • Provide cash compensation at full replacement cost based on current market rate or Government rate whichever is higher. • Resettlement assistance in lieu of compensation for land occupied (land, other assets, employment) at least restore their livelihoods and standards of living to pre-displacement levels. • In the case of farmland, the PAP will be entitled the cultivation disruption allowance equal to one-year production.	• A list of affected and entitled persons and the area of land loss is required. • Notice to vacate will be served at least 35 days prior to acquisition date. • Case-wise compensation will be either by cash or cheque, depending on the owner's preferences. • To ensure fair compensation, determination of rates will be established not more than one year prior to property acquisition.
2.2 Temporary loss of private land	• Titleholder	• Compensation for crop, land productivity and other property losses for the duration of temporary occupation. • Compensation for other disturbances and damages caused to property. • Contractor to negotiate a contract agreement on the rental rate with the owner for temporary acquisition of land. • Land should be returned to the owner at the end of temporary acquisition period, restored to its original condition, or improved as agreed with owner.	• A temporary occupation contract will be signed with the affected landowner, specifying; • Period of occupancy; • Formula for the calculation of production losses (the market value of crops normally produced on the land) and annual inflation adjustments; • Frequency of compensation payment; and • Land protection and rehabilitation measures. • • The land will be returned to the owner at the end of temporary acquisition, restored to its original condition.

Type of Loss	Entitlement Unit	Description of Entitlements	Implementation Measures
3. Other Privately Owned Resources			
3.1 Potential regulation of land-use activities (land use right) above the underpass tunnel	• Titleholder; • other evidence of ownership • Non-titleholder • Tenant	• Restoration of the land use right, which will be followed by a newly preparation of the land use guideline above the underpass alignment.	• If any house or physical assets are damaged during underpass tunnel construction, it will be addressed by CDC • Development activities (Land use change) above the underpass tunnel alignment will be regulated and secured by the newly preparation of the land use guideline
4. Structures and Resources			
4.1 Community buildings and Structures	• Local Community	• Restoration of affected community structures to at least previous condition, or replacement in areas identified in consultation with affected communities.	• Affected community buildings/ structures include: schools, temples, health posts, water points, irrigation canals, trails etc will be rehabilitated by project.
4.2 Land and trees	• Local community or user groups	• Assistance with improvement of remaining grazing areas. • Restoration of access to community resources.	• The Departments of Agriculture and Forestry will be requested to assist communities so that benefits from grazing areas are adequately mitigated.
5. Rehabilitation Assistance			
5.1 Displacement of household	• Titleholder • Non-titleholder	• Housing displacement allowance for loss of own residential accommodation. • Rental stipend for loss of rented accommodation.	• The housing displacement allowance will be based on two months per capita poverty level income (PLI), as established by the Nepal Living Standards Survey, for a household of 5.5 members. The value of the allowance will be adjusted annually for price escalation. • The rental stipend will be based on 0.5 months PLI as defined above. • Allowances will be paid at the time of serving the notice to vacate. • Displacement allowances (housing, business and cultivation) will be paid severally.
5.2 Displacement of commercial enterprise	• Titleholder • Non-titleholder	• Business displacement allowance for loss of commercial establishment.	• Calculation as for housing displacement allowance.

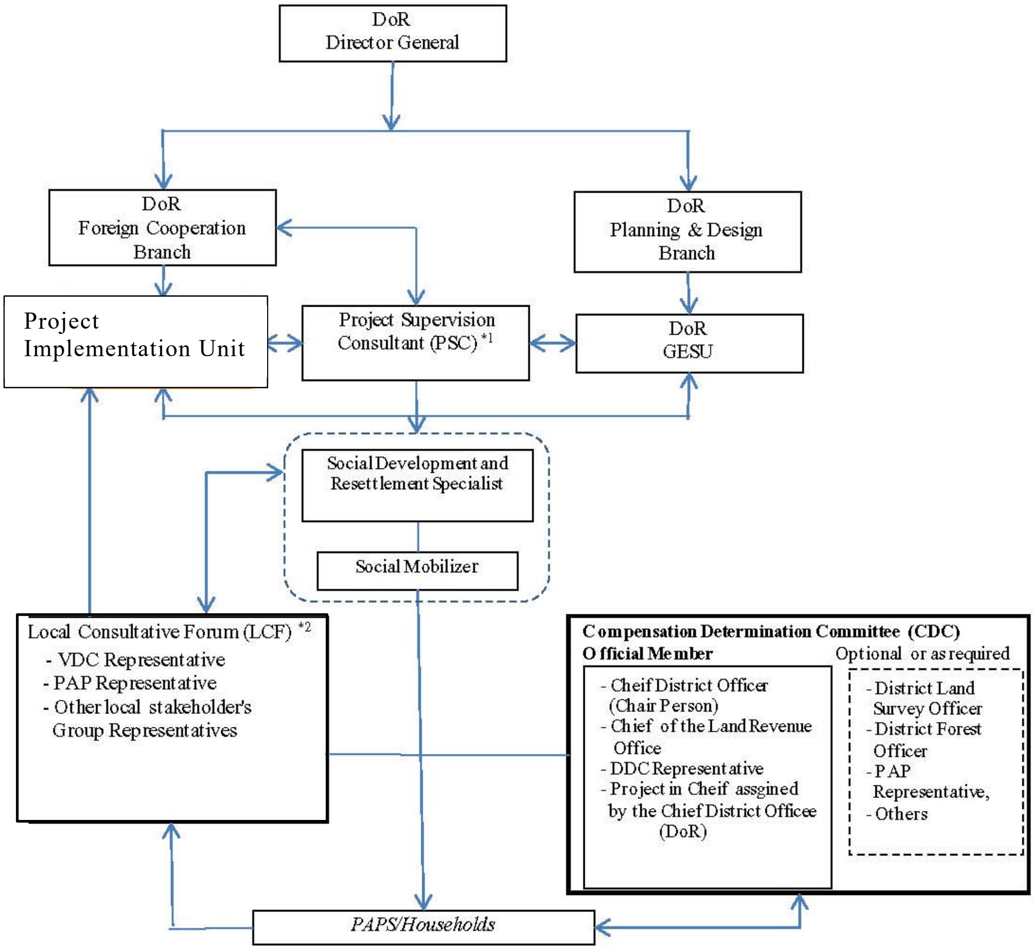
Type of Loss	Entitlement Unit	Description of Entitlements	Implementation Measures
5.3 Vulnerable social categories	• Adults 18 years and older in the vicinity of the Directly Affected Area and severe impact Indirectly caused by the project.	• If any Vulnerable social categories identified during detail design/ implementation period by the study or consultation. • (The census survey did not find any Vulnerable people in this stage.)	• Assistance in reestablishment and improvement of livelihood. • Preferential employment on road construction and maintenance to the extent possible.
6. Government Property			
6.1 Loss of Infrastructure	• Relevant agency	• Facilities will be repaired or replaced.	• To be undertaken in consultation with the relevant department or ministry.
6.2 Loss of other Government Land	• Relevant agency	• No provision of compensation.	• Consultation with relevant government agencies.
7. General Counselling			
7.1 All project impacts	• Persons within and adjacent to the road corridor	• General counselling on project impacts; construction schedules and acquisition dates; valuation, compensation, and grievance resolution mechanisms; construction employment procedures; and local development initiatives.	• This will be achieved through the periodic distribution of information sheets and consultation with local officials. • Cooperation with GON ministries and departments such as Departments of Agriculture, Forest, and Local Development to support effective resource utilization and community development.
8. Additional Assistance			
8.1 Preference in employment in wage labor in project activities	• All APs	• Vulnerable HH due to loss of physical assets.	• Construction contracts include provision that APs will have priority in wage labor on project construction during implementation. • APs shall be given priority after construction for work as maintenance worker, mandated in local body agreement
8.2 Skill training and income generation support	• One member of each PAF belonging to vulnerable group/below poverty line.	• Vulnerable HH due to loss of physical asset.	• Skill training and income generation support financed by project • ARAP to include a need assessment and skill training program for APs.

Type of Loss	Entitlement Unit	Description of Entitlements	Implementation Measures
8.3 Priority in poverty reduction /social development programs	• All APs	• Vulnerable HH due to loss of physical asset.	• Participation of APs with priority in saving credit scheme facilitated by the Project. • Participation of APs with priority in life skills, income generation, and other entrepreneurship.
9. Damage caused During Construction			
9.1 Public and private building and structures, infrastructure, land crops and trees	• All categories of entitled persons as defined in clause 1,2 and 3 above in this table.	• Appropriate countermeasures should be taken by contractors to avoid damaging public and private property unnecessarily	• Where damages do occur to public or private property as a result of construction works, the affected families, groups, communities, or government agency shall be compensated for damages to crops and trees; damage land, structure, and infrastructure shall be restored to their former conditions.

Source: JICA Survey Team

19.2.6 Institutional Frameworks for Resettlement Plan Implementation

An organizational setup for ARAP implementation is necessary for effective coordination to ensure compliance with policies and procedures, land acquisition and resettlement activities and implementation of mitigation measures. To ensure the achievement of these activities, organization for ARAP implementation and management will occur at both central and project level. The below figure shows proposed organization framework for ARAP Implementation.



Note 1): PSC is the actual implementation body for Social Impact Monitoring. 2): LCF is also the locally established as a "Grievance Redress" committee, communication link between the PAPs, and the Project as well as the PSC.

Source: JICA Survey Team

Figure 19.2.6 Proposed Organization Framework for ARAP Implementation

(1) Central Level Arrangement

The central level arrangement of resettlement starts from the financial management for land acquisition and compensation from the Ministry of Physical Planning and Works. The required money for compensation will send to the Project Implementation Unit (PIU) through DOR. The DOR program coordination unit is responsible to draft policy documents and project implementation strategies. The project coordinator with his team from the project coordination unit will be responsible for overall project coordination and management of ARAP implementation. The Geo-Environment and Social Unit (GESU) will lead the overall management of social issues, review, and approval of ARAP and monitoring of timely and successful implementation of ARAP.

(2) Project Level Arrangement

While central level arrangements are necessary for coordination of ARAP activities, project level arrangements are required for effective ARAP implementation. There will be a Project Implementation Unit. The PIU is responsible to form Compensation Determination (fixation) Committee in association with Chief District Officer (CDO) of concern districts. CDC is chaired by CDO. CDC determines the rate of compensation in consultation with PAPs and local stakeholders, categorizing land, and structures. The PIU will have a road section support team. Other relevant district officials will be deputed during the land and assets acquisition process when required. As the project authority, PIU will resume overall responsibility for ARAP implementation. This will require:

- Implementation of procedures to minimize adverse social impacts throughout the planning, design and implementation phases.
- Implementation of procedures for the recording of all projects affected persons by means of census and asset verification and quantification exercises;
- Establishment of procedures for the coordination of resettlement and compensation activities.
- Implementation of information dissemination campaigns
- Capacity building initiatives to create a supportive environment for the implementation of ARAP activities.
- Coordination with other government line agencies, local stakeholders, NGOs to ensure effective delivery of mitigation and rehabilitation support measures.

19.2.7 Resettlement Plan Implementation Schedule

The project authority will ensure that funds are delivered on time to CDC and the implementing consultants for timely preparation and implementation of ARAP, as applicable. Generally, civil works contracts will not be awarded unless required compensation payment has been completed. In the context of this project compensation process as well as income rehabilitation measures may continue and be completed even after civil works has begun. Tentative implementation schedule for ARAP is given in the table below.

Table 19.2.16 Implementation Schedule of ARAP

(Secret)

19.2.8 Cost and Sources of Finance

(1) Cost Estimation for Private Land

The Land Revenue Office of Kathmandu district has fixed the minimum land cost which is basically used for land transaction purpose. During the Census and Socio-economic survey, the Project Affected Persons (PAPs) expressed that they will not accept the government rate which is very low than current market rate. The estimated cost of affected land is calculated based on current government price and current market price.

It is assumed that the current market price denotes the replacement cost by which the PAPs can purchase similar types of land nearby project area with the compensation amount. It covers the land registration fee and the other necessary fee such as leveling fee, if needed, within this cost. The current market prices are estimated based on a Replacement Cost Survey of this JICA Preparatory. Each estimate market price is derived from relevant information from the local peoples such as real estate planner, indirect affected persons, and direct affected persons in the area.

All of the affected lands by the Project are located within the urban areas. Therefore, each estimation cost is basically calculated based on the distances from the main roads with actual land conditions such as undulation, but without considerations of the types (farm land, housing land, or commercial land) of the land.

The estimated compensation for private land is shown in the table below.

Table 19.2.17 Estimated Compensation for Private Land

(Secret)

Note : For reference only. Still need to be confirmed by Ward Office Official
Source: JICA Survey Team

(2) Cost Estimation for Private Structures

The Census and Socio-economic survey at the basis of cadastral map shows that 3 various types of residential structure need to be demolished due to project. The cost estimation is based on the discussion with project affected people and other stakeholders. The estimated costs for the houses/ structures are presented below.

Table 19.2.18 Estimated Compensation for Private Structure

(Secret)

Note : For reference only. Still need to be confirmed by Ward Office Official
Source: JICA Survey Team

(3) Cost Estimation for Relocation and Rehabilitation of Water Supply Facility

There is a water deep boring and distribution site, at Jadibuti has to be relocated by the project before the project work is commenced by allocation of required budget of relocation and rehabilitation with required area of lost land through negotiation with CAAN. The relocation cost covers land availability, impacted facility establishment cost, structure cost, relocation cost, and labor cost. Estimated compensation for relocation and rehabilitation of impacted Water Supply Facility is presented in Table 19.2.19.

Table 19.2.19 Estimated Compensation for Water Supply Facility

(Secret)

(4) Housing Displacement Allowances

The displacement/rehabilitation allowance basically covers the housing displacement allowance for residential houses. Displacement/rehabilitation allowances are based on 90 days minimum wage as established at the national or local level. The national minimum wage rate is NRs 500.00/day.

Estimated cost for the displacement/ rehabilitation allowances is given below.

Table 19.2.20 Displacement and Rehabilitation Allowances

(Secret)

(5) Business Disruption Allowance

The Business Disruption allowance basically covers the business hamper of the shop keepers or any type of business being done at disrupted premises. Business Disruption allowances are based on 90 days minimum wage as established at the national or local level. The national minimum wage rate is NRs 500.00/day.

Estimated cost for the business disruption allowance allowances is given below.

Table 19.2.21 Business Disruption Allowances

(Secret)

(6) Livelihood Enhancement Skills Training (LEST) Program

Sixteen people from the project affected families (25 % of total affected households) selected through training need assessment of all affected households will be provided Livelihood Enhancement Skills Training (LEST) program. The training cost for each participant is estimated (Secret) (including lodging, food, transportation, trainer cost etc., so total (Secret).

(7) Resettlement Plan implementation cost

There are several ARAP implementation activities need to be carried out during the project implementation period such as public consultation and information dissemination, CDC meeting, RP updating etc. Estimated cost for ARAP implementation is presented in table below.

Table 19.2.22 Estimated Cost for RP Implementation

(Secret)

(8) Total Cost Estimate

The total estimated cost of the affected private land, structure, factory relocation, displacement, life skill training, and ARAP implementation cost is presented in table below:

Table 19.2.23 Summary of Compensation Cost

(Secret)

Note: The contingencies amount will be used for community infrastructure, compensation payment for trees and crops if required during project implementation period and other unidentified item during project design phase.
Source: JICA Survey Team

19.2.9 Monitoring System by the Implementing Agency, Monitoring Form

The project has the objective to ensure that the economic condition of affected households shall not be worse than that of their previous situation due to project intervention.

Regular monitoring is essential and is only an instrument to understand the socio-economic condition of the affected household. Two types of monitoring, internal, and external will be administered in three levels: (i) process level (ii) output level and (iii) impact level of: (a) record and assess project inputs and the number of persons affected and compensated and (b) confirm that former subsistence levels and living standards are being re-established.

(1) Internal Monitoring

The internal monitoring is the job of GESU, PCU and PMU on a regular basis with the help of Social Officer in GESU and Resettlement Specialist from monitoring and supervision consultant. A quarterly report of internal monitoring will be prepared by Social Officer of GESU in consultation with Social Development and Resettlement Supervision Consultant. The program implementation unit will maintain a record of all transaction in their resettlement database, followed by entitlement records signed by the affected persons and survey-based monitoring of resettlement and land acquisition progress. The Local Consultative Forums will play an important role in monitoring providing feedback on community concerns, grievances, and requests. Internal monitoring focuses and ensures the following points:

- Verification that there are not outstanding or unresolved land acquisition issues with respect to the project and that property valuation and economic rehabilitation in accordance with the provision of the plan
- Information campaign, discrimination and consultation with affected persons
- Status of land acquisition and timely payments on land compensation
- Value of entitlement received equal to that of actual land and structure acquired
- Use of entitlement and check its misuse
- Compensation for affected structures and other assets
- Payments for loss of income
- Relocation of affected persons and supports provided
- Implementation of economic rehabilitation and income restoration measures
- Effective operation of the Grievance Redress Committees
- Funds for implementing land acquisition and economic rehabilitation activities in a timely manner and sufficient for the purposes and spent in accordance with the plan

The Social Development and Resettlement Expert through its resettlement team will submit reports to GESU on a quarterly basis. The Social Mobilizers precede the monthly progress report to the Social Development and Resettlement Expert. Project field offices will be responsible for monitoring the day-to-day resettlement activities. The social mobilizers will play an important role to assist the project field office in course of regular monitoring. Socio-economic census and assets acquisition data provides the necessary benchmark for field level monitoring. Field level monitoring will be carried out through:

- Review of census information for project affected persons
- Consultation and informal interview with project affected persons
- Informal sample survey of project affected persons
- Key informant interviews

- Public consultation meeting

A performance data sheet will be developed to monitor the project at the field level. Social Development/Resettlement Specialist will monitor the ARAP implementation and proceeds quarterly reports to DOR and the JICA, received from the Social Mobilizers from the field offices. Framework for internal monitoring is presented in Table 19.2.24.

Table 19.2.24 Proposed Monitoring Form for the Internal Monitoring

Indicators	Issue	Procedure	Timing	Responsibility	Results
Process level monitoring					
ARAP implementation in project works	Employment of local labor including women and children	Site observation, attendance record, interaction with laborers and contractors	Monthly	Project/ social mobilizer / SDRS	
	Campsite management including lodging arrangement and	Site observation, interaction with laborers, contractors	Monthly	Project/ social mobilizer/ SDRS	
	Use of health and safety measures	Site observation, interaction with laborers, contractors	Quarterly	Project/ SDRS	
	Temporary leasing of private land and house	Site observation, contractors, check contract agreement	Monthly	Project/ social mobilizer/	
	Discrimination of wage rate between male and female workers	Interaction with laborers, labor survey, record of wage payment	Monthly	Project/ social mobilizer/ SDRS	
Output level					
Land Acquisition	Encroachment into public land like grazing land, temples, etc.	Visit the identified public land interact with local people, take photographs	Biannually	Project/ social mobilizer / SDRS	
	Development of new settlements/slum along the roadside	Observation, recording of sites, photograph	Quarterly	Project/ social mobilizers/ SDRS	
	Migration to the roadside/displacement of local people	Review of land holding records, discussion with local people	Quarterly	Project/ social mobilizer/ SDRS	
	Incidence of road accidents	Discuss with local people, health institutions' records	Biannually	Project/ SDRS	
	Incidence of communicable diseases like respiratory, STD, HIV/AIDS etc.	Discuss with local people, health workers/ health post/ center such as National Referral Centre of Nepal, records	Annually	Project/ social mobilizer/ SDRS	

Indicators	Issue	Procedure	Timing	Responsibility	Results
Input level					
Change in household level income and economic activities	Changes in the land price, land use and agricultural practices, productivity and crop export	Discuss with farmers and extension workers, agricultural statistics of District Agriculture Office	Annually	Project/ social mobilizer/ SDRS	
Social safety	State of social harmony and social security like alcoholism, narcotism, etc.	Police records, discussion with local residents	Annually	Project/ SDRS	
	Changes in the living standard of people	Interview with families, VDC records, discussion with local leaders, CBOs	Annually	Project/ SDRS	
Cultural impact	Condition of cultural and historical areas and aesthetic	Visit the area, discuss with people, observation and photographs	Annually	Project/ SDRS	

Social mobilizer: Field Level staff hired by the Project Supervision Consultant.
SDRS: Social Development and Resettlement Specialist hired by the Project Supervision Consultant.
Source: JICA Survey Team

(2) External Monitoring

External monitoring will be carried out by the DOR. The external monitor will be carried out annually by an independent consultant. The external monitor will review the internal resettlement implementation activities. The external monitoring involves on:

- Review of internal monitoring reports
- Review of compensation status
- Monitor Rehabilitation support program
- Information disclosure system
- Process and mechanism of compliance redress
- Employment status of the PAPs
- Effectiveness of Livelihood restoration program
- Effectiveness of Awareness in HIV/AIDS and human trafficking

Based on the above-mentioned activities the external monitor will focus on:

- Evaluation of social and economic impact of land acquisition and economic rehabilitation of the project affected persons.
- Verify the objectives of enhancement of economic condition PAPs, or at least restoration of income levels and standard of living of the affected persons.

- Furnishing creative suggestions and modifications in land acquisition and economic rehabilitation, if necessary.
- Making to ensure all resettlement and land acquisition activities are properly conducted. External monitoring agency will require the following activities to be performed:
- Verification of internal monitoring to ensure the appropriateness of activities carried out by program implementation unit in the field.
- Conduct household survey of PAPs to monitor progress comparing with pre project, pre-resettlement standard.
- Evaluation of delivery system to the PAPs and assess impacts of entitlements to determine the approved resettlement action plan.
- Evaluation of consultation and grievance redress procedures to identify the levels of public awareness of grievance-redressed procedures, accessed by project affected persons and households for information and rapid conflict resolution.
- Evaluation of actual operations of a grievance committee to assist project affected persons as required and to act as observers.
- Declaration of successful implementation for summing up of activities related to entitlements, distribution, and resettlement.
- Recommend follow up action relating to outstanding actions required to complete achievement of objectives of the ARAP and resettlement policies, additional mitigation measures for project affected persons.

Table 19.2.25 Proposed Monitoring Form for the External Monitoring

Indicators	Procedure	Timing	Results
Resettlement is implemented as scheduled	Review of internal monitoring Reports	Annually	
Employment of local labor including women and children	Site observation, attendance record, interaction with laborers and contractors	Annually	
Campsite management including lodging arrangement and campsite facilities	Site observation, interaction with laborers, contractors	Annually	
Use of health and safety measures	Site observation, interaction with laborers, contractors	Annually	
Temporary leasing of private land and house	Site observation, contractors, check contract agreement	Annually	
Discrimination of wage rate between male and female workers	Interaction with laborers, labor survey, record of wage payment	Annually	
Encroachment into public land like grazing land, temples etc.	Visit the identified public land interact with local people, take photographs	Annually	
Development of new settlements/slum along the roadside	Observation, recording of sites, photograph	Annually	
Migration to the roadside/displacement of local	Review of land holding records, discussion with local people	Annually	

Source: JICA Survey Team

19.2.10 Stakeholder Consultation

(1) Stakeholders Consultation at Scoping

The first stakeholder consultation after disclosure of the draft scoping of the project was carried out following the JICA Guidelines on 24th September, 2022 at the meeting hall of Ward No. 32. to disseminate the plan of the project and its likely environmental impacts found in the scoping of the project. 45 project affected people (including 1 female) participated in the consultation. They include local residents, Ward Chairperson, local representatives of the ward office and other stakeholders from the affected areas of Jadibuti. Koteshwor and Tinkune areas. They presented their valuable suggestions, opinions and recommendations regarding the proposed project.

Maps, figures and information leaflets were presented during the meetings displaying proposed road alignment with its alternatives in the topographical map. The relevant experts had also presented a good understanding of all aspects of the proposal, proposed actions and their potential negative and positive impacts.

The participants involved in the stakeholder meetings had shown tremendous interest and curiosity towards the project. The people have shown their keen interest and are willing to support the project. Following comments and suggestions were given in the consultation and from the participants:

1. The land dispute in Tinkune has been lingering for a long time, so the dispute should be settled before the initiation of this project with assurance of appropriate compensation to the landowners.
2. If there is a risk of impact on Muni Bhairab Temple by this proposed project, its relocation with the coordination with CANN to an appropriate location nearby should be discussed.
3. In Tinkune, the ROW used to be set to 25 yards from the centerline and the residents had houses following it, but now the government says the ROW is 25 meters. Thus, it impacts on our property. The difference in the land should be compensated with assuring what will be done on this issue.
4. The Kamakha petrol pump, a private property is right next to the proposed highway. This pump needs to be removed during this road improvement project then they should get appropriate compensation for that.
5. Improvement of the existing intersection with the construction of the flyover would have minimal public land and property impact. However, as per the design if the project impact on land and houses on both sides should be acquired by the project with appropriate compensation.
6. Entire participants of this meeting are in favor of this proposed project, but they seek appropriate resolution on the raised issues so that they agree with the design of the proposed project.

(2) Stakeholders Consultation at Draft Report

The second stakeholder consultation meeting was conducted at the meeting hall of Ward No. 32 on 30th June 2023 to disseminate project information and likely environmental impacts for the Improvement of Koteshwor - Tinkune Intersection Improvement Project as the stage of draft plan of the project activities. The second stakeholder meeting was held at the stage of preparation of the draft report of this study following the JICA Guidelines, and it was also held as a “public hearing” stipulated in EPR 2020 to share the project information of IEE report.

Mr. Manandhar expressed that the proposed bypass road starts from the Manohara Bridge with a flyover (440 m) and passes through an underpass tunnel under the Tribhuvan International Airport (640 m), then join another flyover bridge at Tinkune side (400 m). The part of flyover bridge at Tinkune will be constructed within the available right-of-way (ROW) of the existing road, and with some acquisition of private lands will be required at Jadibuti area. Based on this preliminary design, the Project will affect a total of 2441 m^2 (4 Ropani-12 Aana-3 Paisa-2 Dam in Nepalese unit) at Jadibuti area. No land will be needed to be acquired at Koteshwor because the plan is to construct an underpass, under the premises of the TIA. A portion of land currently used by Munibhairab temple will also be required. Other impacts likely to be caused by the construction of the Project was also discussed during the meeting. The major issues raised by the participants during the meeting were:

Table 19.2.26 Outline of the Second Stakeholders Consultation

SN	Type	Male	Female	Total
1	Ward Officials	4	2	6
2	Organizer (DOR/DCID)	5	2	7
3	Consultants (FBC/ JST)	6	-	6
4	Meeting Participants	25	3	28
4a	From: Jadibuti	11	1	12
4b	From: Koteshwor	2	2	4
4c	From: Tinkune	11	-	11
4d	Others	1	-	1
	Total	40	7	47

Source: JICA Survey Team

Following comments and suggestions were given in the consultation and from the participants:

1. We are fully aware about the traffic jam problem at Koteshwor intersection and we are ready to support the Government by contributing our lands after getting appropriate compensation. In this stance, the Project Design Team or DOR should provide exact information about the exact quantity of land that the Project wishes to acquire.

2. We understand that this is one of the Pride Projects for us and our contribution will be historical for the coming generations.

3. Having said that, some of the Project's affected people, owns only small patch of land. Within this small land, if the Project acquires only a part of the land and a smaller strip of land remains, this smaller piece of land becomes unusable to the landowner.

4. Our request to the Government is to acquire whole parcel of such lands, if the remaining land plot is not adequate for further use.

5. We are also in mental stress after this Project has informed us about the land acquisition. The land price decreases, and the bank will not accept collateral of this land.

6. If this Project wants to start, it must not be delayed or left hanging. If it gets delayed, our mental stress increases.

7. We, the landowners of the project affected area (Jadibuti) are ready to provide our land to the Government with negotiable compensation.

8. Since, the proposed construction site is located at the highly commercial area of the city, some of the business entrepreneurs are operating their business on lease also. In this stance, how the Project addresses about their loss?

9. After acquisition of our land, some of us have to displace away from this area. We need to buy land at new locations for our living; for this, can we be able to get the new land alike of this location? How can we maintain our business or our living standard as we are practicing here since long duration?

10. Hence, our request to the Government to resettle us in an appropriate location ensuring the similar facilities for business and other amenities.

11. Project officials are requested to share mainly the current law/act related provision of resettlement issues; otherwise, the affected persons could expect more things that might be problematic during the project design period.

12. Some of us are leasing out the proposed project affected land for business purposes, and some are repairing their residential houses, and others are planning to extend current structures. In this instance, until when may the possible affected person can use their land/property? What will be the exact schedule of land acquisition and project work commencement period?

13. Based on today's presentation, the DOR seems to have undermined the pending issue of Tinkune land dispute. Our common voice is - without solving the entire issue of the Tinkune's land, no Government's Project planned will be accepted by the landowners of Tinkune.

14. We the landowners of Tinkune area have been victimized for many decades from the Government and even from the CAAN. The Government have forcefully captured our land without paying compensation. This time too, if the Government is trying to commence this Project without solving our issues, then we will be compelled to protest against the Government and even against the donor agencies – JICA. We do not accept the Project, at the cost of our land after losing everything that we own.

15. Being a locally elected representative, our special request to the Ward Chairman is to take initiative arranging meeting with high level authorities, where we want to have direct interaction with concerned government ministers, even with the Prime Minister on the chronic issues of our valuable land of Tinkune. But this is not happening.

16. We will not allow the Project to use the even the existing ROW for construction, because those parts also used to belong to us as our private property; although the Government claims the ownership of ROW is already transferred to the government, but they have not yet compensated.

17. The issue of land difference between 25 meters and 25 yards of Araniko Highway is still unsolved, as per the two Supreme Court verdicts.

18. Using land that affects the Muni Bhairav Temple will not be acceptable to us, because the temple is belonging us with religious and cultural values; if the Project wants to use this land the temple should be relocated in an appropriate open space under the premise of CAAN

(3) Focus Group Discussions

Focus group discussions were carried out at Jadibuti, Koteshwor and Tinkune area to as a part of the study of the existing socio-economic and cultural situation and identify issues and concerns of the local people regarding the project. During discussion, information about existing roads within the ward, public utilities and their rehabilitation, health facilities, educational situation, energy consumption pattern, agricultural practice and related infrastructures, market status, existing market value of land and houses has been discussed.

Similarly, focus group discussions were carried out during identification of candidate site for soil disposal areas, camp site, and stockyard area to find out the surrounding public view and concerned regarding the establishment of spoil disposal site around the area and their concerned suggestion.

Table 19.2.27 Outline of the Focus Group Discussions

Date	Interaction Location	Number of Participants		
		Male	Female	Total
13 September 2022	Ward-32 Office	6	2	8
15 September 2022	Tinkune area	4	1	5
2 May 2023	Jadibuti area	11	4	15
28 May 2023	Ministry	15	2	17
30 May 2023	DCID office	6	1	7

Source: JICA Survey Team

(4) Issues Raised in Stakeholders Consultations

The major queries were raised by the participants and response during the first and second public consultations at Jadibuti, as well as interaction meetings are summarized in the below table.

Adjacent to the planned construction site in the Tinkune area, there is an ongoing dispute between the government and the former landowners over land ownership. The second stakeholder meeting revealed opposition to the project due to its proximity to the disputed land. These opposing opinions are indicated in the shaded cells in Table 19.2.29Table 19.2.29 below.

It has been confirmed that the road to be constructed under this project will not encroach upon the disputed land, and that the former landowners who have objections are not currently residing on this land. Furthermore, the opposition primarily seeks to resolve the existing land dispute, with no specific objections identified regarding the project's impacts. The implementing agency has been confirmed to continue taking appropriate measures to address the issue on the disputed land.

Table 19.2.28 Participant's Questions and Project Implementer's Responses at the First Public Consultation on 24th Sep. 2022

Participant's Name	Opinion Expressed	Response
(Secret)	• Should give first priority to settle the issues of land of Tinkune as its very valuable land • We all have the religious value with the Muni Bhairab Temple so if it is disturbed by the project than it should be relocated • CNN have acquired our large area of land with¥out good compensation so this project should provide us good current value of land with at least 15 million per Ropani	• If the further land is required beyond 75 feet its compensation will be given • If the project impacted the Muni Bhirab Temple the compensation of building and relocation of temple will be done • Project will give compensation of land beyond ROW following the land acquisition act
	• This type of project is the first in the county with both Flyover and Underpass • What will be the alternation and access provision for the Narefat area with this proposed road	• Yes beside the underpass of Kalanki this project is the first kind with both Underpass and Flyover structure in Nepal initiated by JICA team. This road will connect from Maahara Bride toward Tinkune side living the existing road with access to sub road of the area.
	• What Will be the ROW of this proposed road: is it 25 Meter? • Muni Bhairab should be relocated to the open area then now	• The estimated ROW of the proposed road will be at least 15 m that will be finalized after the final design. • If the project impacted the Muni Bhairab Temple the compensation of building and relocation of temple will be done
	• All the land occupied by the Araniko Highway as well by CNN is the land of our ancestor • Please coordinate with CAN and just acquired the additional land from airport side rather than west said of Koteshwor • There was lot of Public land acquired by CNN earlier so it should also be compensated now	• The compensation of additional land and properties that is required by the project will be given
	• Please coordinate with CAN and just acquired the additional land from airport side rather than west said of Koteshwor • Please only build this new road and intersection improvement by utilizing land area on the East side i.e. Airport side avoiding the west side of Koteshwor road.	• The proposed road alignment is design on the east side of the highway toward Airport side only.

Participant's Name	Opinion Expressed	Response
(Secret)	• The land of Kamakha Petrol Pump is our valuable land and the pump was built as per the Road policy of 2054, hence if this project impacts it, we should get appropriate compensation. There is vacant land behind our pump area, project should get and provide us that land.	• At the moment this design is still underway, once it's finalized and if the Project requires that area, appropriate compensation will be given by the project.
	• Before the ROW was set to be 25 Gauge and we have houses as per it and now they said ROW is 25 meters so it will impact our property so it should be compensated	• If the Project required the land beyond 25 Gauge the compensation will be given and the matter will be solved
	• There is not service track build till now from Tinkune to Manohara River which need to be build	• This issue is being looking after divisional road office
	• 303 meters from Koteshwor the ROW is 15 meters toward west side of work that should be maintained	• The proposed road alignment is design on the east side of the highway toward Airport side only.
	• What will be the road access toward the Pepsi cola side after the underpass??	• The access toward the Pepsi cola side from the existing road will be maintained with the Flyover of this proposed road

Source: JICA Survey Team

Table 19.2.29 Participant's Questions and Project Implementer's Responses at the Second Public Consultation on 30th Jun. 2023

Participant's Name	Opinion Expressed	Response
(Secret)	• We are fully aware about the traffic jam problem at Koteshwor intersection, and we are ready to support the Government by contributing our lands after getting appropriate compensation. In this stance, the Project Design Team or DOR should provide exact information about the exact quantity of land that the Project wishes to acquire.	• The IEE Consultant have identified the affected land to be acquired as 2441 m2 (4 Ropani-12 Aana-3 Paisa-2 Dam in Nepalese unit). However, this is an estimation only, and slight change can be expected after final design is complete, and the design map is overlapped in the Cadastral Map. • The Project Proponent (DOR/DCID) will inform the actual affected people, after the actual affected land is known to the Project.

Participant's Name	Opinion Expressed	Response
(Secret)	• We understand that this is one of the Pride Projects for us and our contribution will be historical for the coming generations. • Having said that, some of the Project's affected people, owns only small patch of land. Within this small land, if the Project acquires only a part of the land and a smaller strip of land remains, this smaller piece of land becomes unusable to the land owner. • Our request to the Government is to acquire whole parcel of such lands, if the remaining land plot is not adequate for further use. • We are also in mental stress after this Project has informed us about the land acquisition. The land prices decreases, and bank will not accept collateral of this land. • If this Project wants start, it must not be delayed or in hanging. If it gets delayed, our mental stress increases.	• The Ward office will recommend the Government to acquire whole plot area of such small lands, if the remaining land is smaller than the minimum plot size determined by the government. (Response by Ward Chairperson) • The Project can accumulate such small parcels of land and used as open space and beautification purpose. (Response by DDG/DOR)
	• We, the landowners of the project affected area (Jadibuti) are ready to provide our land to the Government with negotiable compensation. • Since, the proposed construction site is located at the highly commercial area of the city, some of the business entrepreneurs are operating their business on lease also. In this stance, how the Project addresses about their loss?	• As per the provision of the prevalent law/act (Land Acquisition Act, 1977), it is the landowner's obligation to settle the tenancy and other types of land use issues. In the case of such issue, the Government will develop special provision for this project; the DOR will be more attentive providing optimal benefits to the affected people. (Response by Social Expert /DOR)

Participant's Name	Opinion Expressed	Response
(Secret)	• After acquisition of our land, some of us have to displace away from this area. We need to buy land at new locations for our living; for this, can we be able to get the new land alike of this location? How can we maintain our business or our living standard as we are practicing here since long duration? • Hence, our request to the Government to resettle us in an appropriate location ensuring the similar facilities for business and other amenities.	• The Government will provide compensation land to be acquired for the project as determined by the Compensation Determination Committee (CDC); • Value of properties (house, shades and other structures) will also be provided as per the government's norms; • Getting exactly similar location (like Koteshwor) may not be possible within the city area. The current Act/law has no provision to acquire new land for the project affected people. If the Government feels necessary, the current Act will be amended. DOR will take initiation to do so. • (-Response by DDG/DOR)
	• Project officials are requested to share mainly the current law/act related provision of resettlement issues; otherwise, the affected persons could expect more things that might be problematic during the project design period.	• As far as the resettlement issue will be resolved under the current acts; • Since the project is considered as highly prioritized project, the Government will be provided more flexibility providing optimum facilities to the project affected persons. • (-Response by DDG/DOR)
	• Some of us have leasing out the proposed project affected land for business purpose and some are repairing their residential houses, some other are planning to extend current structures. In this stance, up to when the possible affected person can use their land/property? What will be the exact schedule of land acquisition and project work commencement period?	• The expected time for finalizing design and completing the land acquisition process is about 2 years; the affected people can use their land/properties up to the mobilization of contractor for construction that take one more year from the finalization of design. It means, you can continuously use your property for 3 years from now. • (-Response by DDG/DOR)

(Secret)	• Based on today's presentation, the DOR seems to have undermined the pending issue of Tinkune land dispute. Our common voice is - without solving the entire issue of the Tinkune's land, no Government's Project planned will be accepted by the land owners of Tinkune. • We the landowners of Tinkune area have been victimized since many decades from the Government and even from the CAAN. The Government have forcefully captured our land without paying compensation. In this time too, if the Government is trying to commence this Project without solving our issues, then we will be compelled to protest against the Government and even against the donor agencies – JICA. We do not accept the Project, at the cost of our land after losing everything that we own. • Being a locally elected representative, our special request to the Ward Chairman is to take initiative arranging meeting with high level authorities, where we want to have direct interaction with concerned government ministers, even with the Prime Minister on this chronic issues of our valuable land of Tinkune. But this is not happening. • We will not allow the Project to use the even the existing ROW for construction, because those parts also used to belong to us as our private property; although the Government claims the ownership of ROW is already transferred to the government, but they have not yet compensated. • The issue of land difference between 25 meter and 25 yards of Araniko Highway is still unsolved, as per the two Supreme Court verdicts. • Using land that affects the Muni Bhairab Temple will not be acceptable to us, because the temple is belonging us with religious and cultural values; if the	• Responding on the issues of Tinkune areas' land, the DDG (Dr. Jaisi), presented the first draft feasibility report of 3 options (TK-1, TK-2R and TK-3) in the layout maps, then explained to the participants: • DOR prioritizes the TK-3 option to implement (this option passes through Tinkune), because construction time and costs are minimum, and is a better alignment. To make it possible, the DOR, including the line Minister is working to resolve the Tinkune land issue as a win-win situation for the government as well as the affected landowners. The DOR is fully aware of this issue, and will do its best to satisfactorily resolve the issue so that TK-3 option is possible. • The reason of choosing TK-2R option –for this presentation is that the Consultant needs to conclude their given assignment. However, the DOR wants to proceed with TK-3 option, after reaching to an amicable resolution of this issue. We will make the local landowners aware of the developments about the Government's steps. • Further clarified by Ward Chairman: • I assure you all that, as a representative of the local people of this ward, I will always stand for the benefit of the local people of this area but I am fim that this Project is very much required for the easing of the traffic situation in this area. • We have done a consultative meeting with higher officials of concerned departments / ministries, a month ago, about this issue of Tinkune land. I have also presented the possible methods to resolve this issue. • I want to also disclose for resolution of this issue, I have discussed with the Mayor of Kathmandu Metropolitan, and the Board Meeting, and have decided that KMC is willing to contribute one-third of the expenses for land compensation costs, on the condition that the central government contribute the

Participant's Name	Opinion Expressed	Response
(Secret)	Project wants to use this land the temple should be relocated in an appropriate open space under the premise of CAAN.	remaining two-thirds of the amount. This could be a breakthough if the Government is positive about this proposal.

Source: JICA Survey Team

(5) Consultation with PAPs of the Road-Widening Project (who are not include in PAPs of the JICA funded Project)

A consultation meeting was held with residents in the sheds between Jadhibuti and Manohara, who are likely to be affected by the road-widening by DOR, which is planned in advance of the Project start. This consultation meeting was conducted to share information from the IEE report. It took place on September 1, 2023, and was attended by the consultants from JICA Survey Team, the landowner of the sheds, and residents of the sheds.

Matters discussed during the meeting included:

1. The affected landowner is positive about the project and the government's road extension plans, stating that he will support these efforts for their potential benefits.
2. The project should allocate sufficient time for the relocation and dismantling of affected structures.
3. Construction should commence only after all other required tasks are finalized, in order to avoid delays and leaving the area in disarray once work begins.
4. Water-logging issues that may arise due to road construction should be carefully addressed to prevent drainage problems in the area during the monsoon season.
5. A proper footpath, equipped with sufficient street lighting, should be maintained along the road.

Table 19.2.30 Participants in the Meeting on 1 Sep

SN	Name	Gender	Status
1	(Secret)	M	Rented Resident
2		M	Rented Resident
3		F	Rented Resident
4		F	Rented Resident
5		M	Rented Resident
6		M	Rented Resident
7		M	Rented Resident
8		M	Rented Resident
9		F	Rented Resident
10		F	Landowner & Resident's representative
11		M	Land Owner
12		M	Consultant
13		M	Consultant

Source: JICA Survey Team

19.3 Status of the Gender Issues and Considerations of Persons with Disabilities

19.3.1 Consideration of Gender Issues

During Project identification

- Include gender and inclusion specialist/sociologist in project identification team
- Consult women, poor and excluded groups to identify needs

During Initial environmental and social assessment

- Disaggregate road groups and project affected people by income/ sex/ caste/ ethnicity/ regional identity to assess what additional socio-economic barriers they may experience.
- Identify social risks e.g., of HIV and AIDS, human trafficking due to project activities
- Conduct labor availability survey (with disaggregation) and identify required gender-specific support and support for extreme poor labor.
- Identify project affected people from women, poor and the excluded group and make appropriate provisions for them.
- Identify women, poor and the excluded group through poverty mapping and include appropriate indicators for the same.
- Cost wages of labor must be equal for both women and men in the project
- Identify children who are vulnerable and explore support for them to prevent/control child labor
- Plan for funds to cover Gender Equality And Social Inclusion (GESI) issues; include provision for a GESI expert.
- Gender specific facilities like toilets, child care etc. should be included in cost estimates of the project;
- GESI related activities like social mobilization, skill development of women for skilled jobs etc. to be included in cost estimates.
- Stakeholders to include women, poor and excluded women of the project area, women property owners, wives of property owners should also be consulted; effort must be made to identify people of excluded groups and the poor affected or those who could be potentially impacted by the project.
- Include human and capital resources required to address GESI issues (e.g., resources needed for consultations with women, poor, the excluded and for skill training, etc.) and include them as milestones.

- DPR should integrate all the GESI analysis, design standards and data

19.3.2 Considerations of Persons with Disabilities

As there is no gender and disabilities issues among the project affected households but these matters will be address by the project considering the other users of this road service and other residents around the project site. In the absence of access to transportation, persons with disabilities are more likely to be excluded from essential services and social interaction. Therefore, it is essential that our societies are sensitive to the needs of persons with disabilities and our cities are designed to ensure that their right to transportation and access to public spaces and services are not hindered in any way. In other words, cities need to be designed for universal accessibility. This clearly demonstrates the need for disabled-friendly transport facilities and services in Kathmandu.

The current scenario regarding access to transport services for person with disability (PWD) in Kathmandu Valley describes the problems faced by people with disability in access to transportation and highlights the gaps between available policies and their implementation. Nepal has introduced several laws, policies and guidelines, including the recently promulgated People with Disability's Rights Act, 2017, which establishes the rights forepersons with disabilities, include the right to mobility and the right to access all public facilities.

Nepal has also signed international conventions related to persons with disabilities which require the state to provide adequate facilities for universal access. However, in spite of a few initiatives, including the recently introduced disable-friendly buses by Sajha Yatayat which have space and ramps for wheelchairs, Nepal still has a long way to go make universal access a reality and ensure that persons with disabilities can enjoy their constitutional rights. According to the 2021 Census, 2.23 percent of the total population of Nepal has some kind of disability. According to the 2021 census, the number of people with disability in Nepal was found to be highest in Kathmandu district with 17,122 people, although in terms of percentage of the total population it was the lowest at 0.98 percent.

There are no standards or guidelines which can or should be used in designing urban and local roads. However, the Nepal does have a few provisions for urban streets. For example, in the case of footpaths in cities, it says, "Width of the footpath depends on the volume of anticipated pedestrian traffic. But a minimum width of 1.5 m is required." However, it should be noted that the pavement width of 1.5 m is not sufficient for two wheelchairs to pass one another. For this, a minimum of 1.8 m would be required.

19.4 Mitigation of Climate Change (Reduction CO_2 Emission)

Using JICA Climate-FIT (Mitigation), a tool for quantitative evaluation of greenhouse gas emission reduction (removal), a quantitative evaluation of the project's reduction of CO_2

emission was conducted. For the evaluation of this project, the evaluation method called "4. Measures on road congestion" in the "Transport" sector[13] was selected.

JICA STRADA's traffic demand simulation provided some values needed for evaluation of CO_2 emission for each "with project" and "without project (baseline)" scenario, such as the road length (km) of the all roads in Kathmandu and each of the road links improved and constructed by the project. JICA STRADA also provides values of traffic volume (unit/year) of each type of vehicle on a particular road link/links. The values of the CO_2 emission factor (t-CO_2/km) of a particular vehicle type at a particular average vehicle speed are taken from *TECHNICAL NOTE of National Institute for Land and Infrastructure Management No. 671* (February 2012, p.8-31)[14]. The emission factor values for a conventional vehicle manufactured in 2010 have been used. The emission factor value for motorcycle is not found in the reference, then the value of a passenger car multiplied by 85.5/167[15] was applied. For the trucks and buses, the emission factor values for "medium weight freight vehicle" were applied.

The evaluation was carried out at two different scales, the change of CO_2 emission on the whole road network in Kathmandu, and the change on the 12 road links improved and newly constructed by the project. The evaluation results are presented in the two tables below.

The first table shows the evaluation result of the project's CO_2 emission reduction compared to the baseline, on the whole road network in Kathmandu. It shows that the project will reduce 5,827 tCO_2/year compared to the baseline (no project).

The second table shows the evaluation result of the CO_2 emission reduction on the 12 road links (10 improve links and 2 newly constructed links). The evaluation result is -1,139 tCO_2/year, which means that the project will increase CO_2 emission on these links by 1,139 tCO_2/year.

The results can be discussed as follows. The project will improve the 10 existing road links and construct two new links (flyovers and an underpass tunnel under the airport). This is due to the increase in the number of passing vehicles resulting from the project's increase in of road capacity. The traffic volume on the 12 target links (including the two new links) in the "with project" case is 129,672,987 km*unit/year, while the traffic volume on the 10 existing target links in the baseline is 108,079,014 km*unit/year.

However, the CO_2 emissions per vehicle per kilometre will be drastically reduced due to the increased speed by the project. The emission per unit per kilometre, reduces by the project,

[13] https://www.jica.go.jp/Resource/english/our_work/thematic_issues/climate/fh2q4d000000phkh-att/estimation_04.pdf retrieved on 11 Jul. 2023.

[14] https://www.nilim.go.jp/lab/bcg/siryou/tnn/tnn0671pdf/ks0671.pdf

[15] Based on the ratio between petrol consumptions of a motorcycle and a passenger car, studied in JABODETABEK Urban Transportation Policy Integration Project Phase 2 (JUTPI2) in Indonesia funded by JICA.

from 10.53858615 g-CO_2/km/unit (baseline) to 8.783633557 g-CO_2/km/unit. Furthermore, when considering the entire road network in Kathmandu, the project reduces the total CO_2 emissions.

Table 19.4.1 the evaluation result of the project's CO_2 emission reduction on the whole road network in Kathmandu

4. Transport / Measures on road congestion

Project Name

The Project for Intersection Improvement in Kathmandu in Federal Democratic Republic of Nepal

Country

Nepal

Emission Reduction (On the whole road network in Kathumandu)

		Value	Unit
ER_y	Emission reduction	5,827	tCO_2/year
BE_y	Baseline emission	933,884	tCO_2/year
PE_y	Project emission	928,057	tCO_2/year

Inputs

*Input only orange cell

		Baseline case									Project case								
Parameter			Vehicle type 1(Motorcycle)		Vehicle type 2 (Car)		Vehicle type 3 (Truck)		Vehicle type 4 (Bus)			Vehicle type 1(Motorcycle)		Vehicle type 2 (Car)		Vehicle type 3 (Truck)		Vehicle type 4 (Bus)	
		$D_{BL,j}$	$TV_{BL,i,j}$	EF_{i,v_BL}	$TV_{BL,i,j}$	EF_{i,v_BL}	$TV_{BL,i,j}$	EF_{i,v_BL}	$TV_{BL,i,j}$	EF_{i,v_BL}	$D_{PJ,j}$	$TV_{PJ,i,j}$	EF_{i,v_PJ}	$TV_{PJ,i,j}$	EF_{i,v_PJ}	$TV_{PJ,i,j}$	EF_{i,v_PJ}	$TV_{PJ,i,j}$	EF_{i,v_PJ}
Description		Road length of the road link j in the baseline scenario	Traffic volume of vehicle type 1 in the road link j in the baseline scenario	CO2 emission factor of vehicle type 1 on average vehicle speed v_BL	Traffic volume of vehicle type 2 in the road link j in the baseline scenario	CO2 emission factor of vehicle type 2 on average vehicle speed v_BL	Traffic volume of vehicle type 3 in the road link j in the baseline scenario	CO2 emission factor of vehicle type 3 on average vehicle speed v_BL	Traffic volume of vehicle type 4 in the road link j in the baseline scenario	CO2 emission factor of vehicle type 4 on average vehicle speed v_BL	Road length of the road link j in the project	Traffic volume of vehicle type 1 in the road link j in the project	CO2 emission factor of vehicle type 1 on average vehicle speed v_PJ	Traffic volume of vehicle type 2 in the road link j in the project	CO2 emission factor of vehicle type 2 on average vehicle speed v_PJ	Traffic volume of vehicle type 3 in the road link j in the project	CO2 emission factor of vehicle type 3 on average vehicle speed v_PJ	Traffic volume of vehicle type 4 in the road link j in the project	CO2 emission factor of vehicle type 4 on average vehicle speed v_PJ
Unit		Unit	unit*km/year	t-CO_2/km	unit*km/year	t-CO_2/km	unit*km/year	t-CO_2/km	unit*km/year	t-CO_2/km	Unit	unit*km/year	t-CO_2/km	unit*km/year	t-CO_2/km	unit*km/year	t-CO_2/km	unit*km/year	t-CO_2/km
Road link No.j	1	1	2502050100	8.1538E-05	2347205400	0.0001597	825598800	0.0001493	1552319100	0.0001493	1	2481138900	8.1538E-05	2333757300	0.0001597	822018600	0.0001493	1542677700	0.0001493
	2																		
	3																		
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*In case of calculating road link more than 20 and vehicle categories more than 4, add rows and columns.

*Please provide the source of data

Table 19.4.2 the evaluation result of the project's CO_2 emission reduction on the 12 road links targeted by the project

4. Transport / Measures on road congestion

Project Name

The Project for Intersection Improvement in Kathmandu in Federal Democratic Republic of Nepal

Country

Nepal

Emission Reduction (on the 12 road links improved and newly constructed by the project)

		Value	Unit
ER_y	Emission reduction	-1,139	tCO_2/year
BE_y	Baseline emission	12,403	tCO_2/year
PE_y	Project emission	13,542	tCO_2/year

Inputs

*Input only orange cell

Parameter	Baseline case									Project case								
		Vehicle type 1(Motorcycle)		Vehicle type 2 (Car)		Vehicle type 3 (Truck)		Vehicle type 4 (Bus)			Vehicle type 1(Motorcycle)		Vehicle type 2 (Car)		Vehicle type 3 (Truck)		Vehicle type 4 (Bus)	
	$D_{BL,j}$	$TV_{BL,i,j}$	EF_{i,v_BL}	$TV_{BL,i,j}$	EF_{i,v_BL}	$TV_{BL,i,j}$	EF_{i,v_BL}	$TV_{BL,i,j}$	EF_{i,v_BL}	$D_{PJ,j}$	$TV_{PJ,i,j}$	EF_{i,v_PJ}	$TV_{PJ,i,j}$	EF_{i,v_PJ}	$TV_{PJ,i,j}$	EF_{i,v_PJ}	$TV_{PJ,i,j}$	EF_{i,v_PJ}
Description	Road length of the road link j in the baseline scenario	Traffic volume of vehicle type 1 in the road link j in the baseline scenario	CO2 emission factor of vehicle type 1 on average vehicle speed v_BL	Traffic volume of vehicle type 2 in the road link j in the baseline scenario	CO2 emission factor of vehicle type 2 on average vehicle speed v_BL	Traffic volume of vehicle type 3 in the road link j in the baseline scenario	CO2 emission factor of vehicle type 3 on average vehicle speed v_BL	Traffic volume of vehicle type 4 in the road link j in the baseline scenario	CO2 emission factor of vehicle type 4 on average vehicle speed v_BL	Road length of the road link j in the project	Traffic volume of vehicle type 1 in the road link j in the project	CO2 emission factor of vehicle type 1 on average vehicle speed v_PJ	Traffic volume of vehicle type 2 in the road link j in the project	CO2 emission factor of vehicle type 2 on average vehicle speed v_PJ	Traffic volume of vehicle type 3 in the road link j in the project	CO2 emission factor of vehicle type 3 on average vehicle speed v_PJ	Traffic volume of vehicle type 4 in the road link j in the project	CO2 emission factor of vehicle type 4 on average vehicle speed v_PJ
Unit	km	unit/year	t-CO_2/km	unit/year	t-CO_2/km	unit/year	t-CO_2/km	unit/year	t-CO_2/km	km	unit/year	t-CO_2/km	unit/year	t-CO_2/km	unit/year	t-CO_2/km	unit/year	t-CO_2/km
Road link No.j H2-01	0.32	2304000	5.67243E-05	3440700	0.0001111	1953900	0.0001142	2419800	0.0001142	0.32	2374500	5.67243E-05	3463200	0.0001111	1989900	0.0001142	2483400	0.0001142
H2-02	0.32	13858500	8.1538E-05	9606600	0.0001597	3097500	0.0001493	7419900	0.0001493	0.32	7004400	6.51487E-05	6246300	0.0001276	2017200	0.0001269	4488300	0.0001269
H2-03	0.06	16162500	6.51487E-05	13047300	0.0001276	5051400	0.0001269	9839700	0.0001269	0.06	9378900	5.67243E-05	9690000	0.0001111	4007100	0.0001197	6971700	0.0001197
IR003	0.37	13579800	7.18372E-05	12100200	0.0001407	4104900	0.0001364	8711100	0.0001364	0.37	13659600	7.18372E-05	12370800	0.0001407	4368300	0.0001493	9046800	0.0001493
IR004	0.14	28114500	8.1538E-05	22286400	0.0001597	7407600	0.0001493	16503600	0.0001493	0.14	21180900	7.18372E-05	19022100	0.0001407	6432600	0.0001493	13732200	0.0001493
IR005	0.2	28114500	8.1538E-05	22286400	0.0001597	7407600	0.0001493	16503600	0.0001493	0.2	21180900	7.18372E-05	19022100	0.0001407	6432600	0.0001493	13732200	0.0001493
IR006	0.18	28114500	8.1538E-05	22286400	0.0001597	7407600	0.0001493	16503600	0.0001493	0.18	21180900	7.18372E-05	19022100	0.0001407	6432600	0.0001493	13732200	0.0001493
AR001	0.22	28910400	6.51487E-05	18145500	0.0001276	5074200	0.0001364	11928000	0.0001364	0.22	23560500	6.02983E-05	15857700	0.0001181	4300200	0.0001269	9326400	0.0001269
AR002	0.19	28910400	6.51487E-05	18145500	0.0001276	5074200	0.0001364	11928000	0.0001364	0.19	23560500	6.02983E-05	15857700	0.0001181	4300200	0.0001269	9326400	0.0001269
AR003	0.19	28910400	6.51487E-05	18145500	0.0001276	5074200	0.0001364	11928000	0.0001364	0.19	23560500	6.02983E-05	15857700	0.0001181	4300200	0.0001269	9326400	0.0001269
F-AL5-2										0.38	11719500	6.02983E-05	7467000	0.0001181	2049300	0.0001269	5721300	0.0001269
F-AL5-1										1.12	11719500	6.02983E-05	7467000	0.0001181	2049300	0.0001269	5721300	0.0001269
12																		
13																		
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*In case of calculating road link more than 20 and vehicle categories more than 4, add rows and columns.

*Please provide the source of data

19.5 Others

19.5.1 Environmental Monitoring Forms

DOR, as the Project owner, will conduct periodical monitoring at each Project phase, using the following monitoring formats. General monitoring period for some items after operational phase will be considered, for example five years. However, if it is observed exceeding impacts much more than expected degrees and is not able to be covered by planned mitigation measures, the monitoring periods will be extended with appropriate additional measures.

(1) Planning and Construction Phase

Air (Ambient air quality) Monitoring Format

<table>
<tr><th>Item
(Unit)</th><th>Measurement
(24 hr.)</th><th>Nepal Environmental Standard
(24 hr.)</th><th>Pre-Project Measurement
(24 hr.)</th><th>Survey Method</th></tr>
<tr><td>NO_2
(micro gram/m3)</td><td></td><td>150 (WHO)
Maximum 80</td><td></td><td rowspan="3">Location :1 (Jadibuti Chowk), 2 (Tinkune), 3 (Koteshwor Chowk)
Interval: 1 measurement in every month (work day), or upon urgent request/complaint from local residents.
Survey method: Continuous measurement for 1 hour to obtain the average concentration of the hour. Then take average of the 24 measurements.</td></tr>
<tr><td>SO_2
(micro gram/m3)</td><td></td><td>150 (WHO)
Maximum 70</td><td></td></tr>
<tr><td>PM_{10}
(micro gram/m3)</td><td></td><td>70 (WHO)
Maximum 120</td><td></td></tr>
<tr><td>Other (Complaints, Observations)</td><td colspan="4">Date :
Location :
Problem :
Solution measures taken :
Follow-up condition observation :</td></tr>
</table>

Water (Public surface water quality) Monitoring Format

Item (Unit)	Measurement	Nepal Environmental Standard	Pre-Project Measurement	Survey Method
pH				**Location :1** (Manohara Khola, downstream), **2** (Bagmati Khola, downstream of the HW), **2**(Deep well at Koteshwor and Tinkune), **2** (Supply water at Jadibuti and Koteshwor) **Interval:** 1 measurement in every month (work day), or upon urgent request/complaint from local residents.
TSS (mg/l)		30-200 mg/L		
BOD (mg/l)		100 mg/L		
Coliform		MPN/100ml		**Survey method:** 1 to 3 sampling per measurement. Take average as the survey result.
Other (Complaints, Observations)	Date : Location : Problem : Solution measures taken : Follow-up condition observation :			

For Waste Water monitoring, see Liquid Waste.

Noise (Ambient noise) Monitoring Format

Item (Unit)	Measurement (dB)	International Environmental Standard (dB)	Pre-Project Measurement (dB)	Survey Method
Noise		WHO Uncomfortable : 120 - Very high : 90 - Medium : 70 - Peace : 50 -	On the existing HWY (expected level): At the Eastern Portal (peace condition):	**Location :** (Jadibiti Cowk), **2** (Tinkune), **3** (Koteshwor Chowk) **Interval:** 1 measurement in every month (work day), or upon urgent request/complaint from local residents. **Survey method:** 10 minutes continuous measurement in one hour for at least 4 times in day time for all 4 Locations, and another 4 times in night time for Tunnel Locations.
Other (Complaints, Observations)	Date : Location : Problem : Solution measures taken : Follow-up condition observation :			

Waste Management Monitoring Format

Items	Sub-items/Location	**Monitoring** (once in every month)
1) Soil	Excavation area Disposal to construct the base for the Road	Planned volume : Excavated volume (m3, %): Remaining volume (m3, %): Disposal and/or storage condition : Problems/Concerns : Solution measures taken : Follow-up condition observation :
	Temporal Storage Area Reuse for road embankment Disposal or reuse for public/private purposes	Planned volume : Excavated volume (m3, %): Remaining volume (m3, %): Disposal and/or storage condition : Problems/Concerns : Solution measures taken : Follow-up condition observation :
2) Solid Waste	Construction work areas Labor/contractor camps Road/Bridge	Main types of the waste generated : Total volume for disposal : Date of disposal : Contractor name for disposal : Location of disposal : Cost of disposal : Reused/Recycled waste types :
	Stock yards (West) (East)	Main types of the waste generated : Total volume for disposal : Date of disposal : Contractor name for disposal : Location of disposal : Cost of disposal : Reused/Recycled waste types :
	Water Treatment Plant (Discharge from the Camps)	Main types of the waste generated : Sludge Total volume for disposal : Date of disposal : Contractor name for disposal : Location of disposal : Cost of disposal : Reused/Recycled waste types :
3) Liquid Waste	Water Treatment Plant (Discharge from the labor and contractor camps) Mechanical workshop and fuel storage area	**Location :1** (West Plant discharge point), **2** (East Plant discharge point) **Interval:** 1 measurement in every month (work day), or upon any irregularity or request/complaint from local residents. **Survey method:** 1 to 3 sampling per measurement. Take average as the survey result.

Water regime, water use Monitoring Format

Items	**Monitoring (**1 measurement in every month, or upon any irregularity or request/complaint from local residents.**)**
1) Surface water sources	Location : Any change compared to Pre-Project condition : YES / NO If YES, describe : PHOTO : Related water users : Solution measures taken : Follow-up condition observation :
2) Groundwater sources	Location : Any change compared to Pre-Project condition : YES / NO If YES, describe : PHOTO : Related water user : Solution measures taken : Follow-up condition observation :
3) Spring water sources	Location : Any change compared to Pre-Project condition : YES / NO If YES, describe : PHOTO : Related water user : Solution measures taken : Follow-up condition observation :

Slope Stability Monitoring Format

Items	Monitoring (Every day in morning and evening)
Slope stability	Location : Any abnormality from planned condition : YES / NO If YES, describe : PHOTO : Potential cause : Solution measures taken : Follow-up condition observation :

Land use, Local resource use Common resource use rights Monitoring Format

Items	Monitoring (as occurrence of issues)
Land use/Local resource /Common resource	Date : Communication originated by : Responded by : Issue : Field observation conducted by (Date) : PHOTO : Potential cause : Solution measures taken : Follow-up condition observation : Communication with Ranger Post / DFO :

Work Related Issues Monitoring Format

Items	Monitoring (as occurrence of issues)
Negative impacts on sanitation and public health condition involving the workers hired by the Project Infectious diseases such as HIV/AIDS involving the workers hired by the Project	Date : Issue : Field observation conducted by (Date) : PHOTO : Potential cause : Solution measures taken : Follow-up condition observation : Report / Communication with respective public offices :
Industrial safety and health, Working environment among the workers hired by the Project	Date : Issue : Field observation conducted by (Date) : PHOTO : Potential cause : Solution measures taken : Follow-up condition observation : Report / Communication with respective public offices :
Traffic accidents involving the vehicles hired by the Project	Date : Issue : Field observation conducted by (Date) : PHOTO : Potential cause : Solution measures taken : Follow-up condition observation : Report / Communication with respective public offices :
Child Labor Issues	Date : Issue : Field observation conducted by (Date) : PHOTO : Potential cause : Solution measures taken : Follow-up condition observation : Report / Communication with respective public offices :
Crime involving the workers hired by the Project	Date : Issue : Field observation conducted by (Date) : PHOTO : Potential cause : Solution measures taken : Follow-up condition observation : Report / Communication with respective public offices :

(2) Operation Phase

Water regime, water use Monitoring Format

Items	**Monitoring (**1 measurement in every month, or upon any irregularity.**)**
1) Surface water sources	Location : Any change compared to Pre-Project condition : YES / NO If YES, describe : PHOTO : Related water users : Solution measures taken : Follow-up condition observation :
2) Groundwater sources	Location : Any change compared to Pre-Project condition : YES / NO If YES, describe : PHOTO : Related water users : Solution measures taken : Follow-up condition observation :
3) Spring water sources	Location : Any change compared to Pre-Project condition : YES / NO If YES, describe : PHOTO : Related water users : Solution measures taken : Follow-up condition observation :

Slope Stability Monitoring Format

Items	Monitoring (once in every month)
Slope stability	Location : Any abnormality from planned condition : YES / NO If YES, describe : PHOTO : Potential cause : Solution measures taken : Follow-up condition observation :

19.5.2 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
1 Permits and Explanation	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a)N/A (b)N/A (c)N/A (d)N/A	(a) According to the laws and regulations in Nepal, EIA is not required for the project. IEE is. TOR of IEE has been approved by the authority and IEE report was prepared in the JICA Preparatory Survey. (b) The IEE report is being revised in response to comments from GESU at DOR (as of 8/24). After confirmation by GESU, it will be submitted to the Ministry of Infrastructure and Transport (MOPIT) for approval. It is expected to take at least about one month to receive approval. (c) The IEE report has not been approved yet. (d) No other environmental permit is required (while land acquisition is required).
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a)Y (b)Y	(a) Stakeholder consultations at the scoping stage were conducted on September 24, 2022, and at the DFR stage on June 30, 2023, after the disclosure of the project content and expected impacts. Additionally, five focus group discussions were held from September 2022 to May 2023 for residents affected by the project. The participants have been confirmed to have understood the project and its impacts. (b) Their comments have been reflected to the project design and notified to the implementing agency and JICA.
	(3) Examination of Alternatives	(a) Have alternative plans of the project been examined with social and environmental considerations?	(a) Y	(a) Four alternatives including an "without project" alternative were examined with social and environmental considerations.
2 Pollution Control	(1) Air Quality	(a) Is there a possibility that air pollutants emitted from the project related sources, such as vehicles traffic will affect ambient air quality? Does ambient air quality comply with the country's air quality standards? Are any mitigating measures taken? (b) Where industrial areas already exist near the route, is there a possibility that the project will make air pollution worse?	(a) Y (b) Y	(a) At the three intersections planned for improvement, the current levels of major air pollutants are in line with national standards, except for PM2.5. While construction and increased traffic volume have the potential to worsen air pollution along the entire route, locally, at the target intersections, there is also the possibility of improvement due to alleviation of congestion. (b) According to the baseline survey results (Table 19.1.10), PM2.5 is already exceeding the local environmental standards at the intersections planned for improvement. While construction and increased traffic volume have the potential to worsen PM2.5 pollution along the entire route, there is also the possibility of improvement locally at the target intersections due to alleviation of congestion. Mitigation measures such as planting street trees and restricting the passage of vehicles that do not meet emission standards are planned.
	(2) Water Quality	(a) Is there a possibility that soil runoff from the bare lands resulting from earthmoving activities, such as cutting and filling will cause water quality degradation in downstream water areas? (b) Is there a possibility that surface runoff from roads will contaminate water sources, such as groundwater? (c) Do effluents from various facilities, such as parking areas/service areas comply with the country's effluent standards and ambient water quality standards? Is there a possibility that the effluents will cause areas not to comply with the country's ambient water quality standards?	(a) Y (b) Y (c) Y and N	(a) Degradation of river water quality is anticipated due to the large amount of excess soil from the planned tunnel construction, along with soil erosion and runoff caused by rainwater. The impact is expected to be limited to the area surrounding the construction site, and the duration will be limited to the construction period. Mitigation measures will be implemented, such as protecting cut and fill slopes to prevent erosion, minimizing the destruction of slope vegetation, and implementing vegetation restoration as soon as possible. (b) There is some possibility of runoff from roads will contaminate water sources. (c) Parking areas or service areas are not planned in the project. According to the baseline survey results of rivers and groundwater in the areas surrounding the project site, all the contamination items meet the industrial wastewater standards of Nepal. However, in two rivers and three groundwater sources (wells), values such as turbidity and ammonia exceed the standard values for drinking water. As mentioned above, the construction of parking/service areas is not planned, and the possibility of further deterioration of the pollution situation due to this project is low.
	(3) Wastes	(a) Are wastes generated from the project facilities, such as parking areas/service areas, properly treated and disposed of in accordance with the country's regulations?	(a) Y	(a) Parking areas or service areas are not planned in the project. Regarding the waste and excess soil generated by the construction, an appropriate waste and excess soil disposal site will be designed to minimize the impact on water use downstream, and the waste will be disposed of at the disposal site. The implementing agency will ensure that the contractor properly handles the waste generated during construction.
	(4) Noise and Vibration	(a) Do noise and vibrations from the vehicle and train traffic comply with the country's standards?	(a) Y	(a) Noise and vibration are in compliance with the standards of Nepal. As mitigation measures, awareness campaigns will be conducted to restrict excessive use of horns by vehicle drivers, and traffic signals will be installed in appropriate locations.
	(1) Protected Areas	(a) Is the project site located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There is no protected area in vicinity of the project site.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
3 Natural Environment	(2) Ecosystem	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Are adequate protection measures taken to prevent impacts, such as disruption of migration routes, habitat fragmentation, and traffic accident of wildlife and livestock? (e) Is there a possibility that installation of roads will cause impacts, such as destruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic (non-native invasive) species and pests? Are adequate measures for preventing such impacts considered? (f) In cases the project site is located at undeveloped areas, is there a possibility that the new development will result in extensive loss of natural environments?	(a) N (b) N (c) N/A (d) N (e) N (f) N/A	(a) It has been confirmed that the site does not include primary forests, tropical natural forests, or ecologically important habitats. There are several patches of secondary forests with low conservation value. (b) It has been confirmed that the site does not include habitats of endangered species. (c) Significant ecological impacts are not anticipated. (d) Impact on wildlife and their habitats is not expected. (e) There is no risk of disturbance to the ecosystem due to fdestruction of forest, poaching, desertification, reduction in wetland areas, and disturbance of ecosystems due to introduction of exotic species and pests associated with the development. (f) The project alignment is totally within built-up urban area.
	(3) Hydrology	(a) Is there a possibility that alteration of topographic features and installation of structures, such as tunnels will adversely affect surface water and groundwater flows?	(a) Y	(a) The construction of the underground tunnel may affect the flow of groundwater, but the impact is expected to be minor as the tunnel is close to the ground surface. Groundwater levels will be monitored during construction.
	(4) Topography and Geology	(a) Is there any soft ground on the route that may cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides, where needed? (b) Is there a possibility that civil works, such as cutting and filling will cause slope failures or landslides? Are adequate measures considered to prevent slope failures or landslides? (c) Is there a possibility that soil runoff will result from cut and fill areas, waste soil disposal sites, and borrow sites? Are adequate measures taken to prevent soil runoff?	(a) N (b) Y (c) Y and Y	(a) Soft ground with high risk of slope failures or landslides is not identified. (b) The stability of slopes may be affected by cutting, filling, or embankment. Mitigation measures such as maintaining stable slope angles, preserving existing vegetation, and promptly restoring vegetation will be taken. (c) There is a possibility of soil runoff from the embankment, cut sections, and soil disposal sites. In cut and embankment sections, angles that prevent erosion will be maintained, destruction of slope vegetation will be minimized, and vegetation restoration will be implemented as soon as possible. At soil disposal sites, appropriate civil structures including the construction of retaining walls at the lower part of the slope to stabilize the excess soil, compaction of excess soil during disposal, and drainage management will be installed, and vegetation restoration will be conducted.
4 Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement? (d) Are the compensations going to be paid prior to the resettlement? (e) Are the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(a) Y and Y (b) Y (c) Y (d) Y (e) Y (f) Y (g) Y (h) Y (i) Y (j) Y	(a) There is a possibility of involuntary resettlement of more than 79 people from 18 households. Specific compensation and support measures (compensation, livelihood rehabilitation) are planned in accordance with Nepalese land acquisition laws, domestic laws, and JICA guidelines. (b) The entitlement, compensation and livelihood rehabilitation for involuntary resettlement were explained to the project affected persons in the stakeholders consultations. (c) Surveys for resettlement have been conducted, and a resettlement action plan, including compensation at replacement cost and rehabilitation of livelihood after resettlement, has been established. Refer to sections 19.2.3 and 19.2.4 of the ARAP in the DFR. (d) Payment of compensation is planned to be made before resettlement. Refer to section 19.2.6 of the ARAP in the DFR. (e) The compensation policy has been formulated in writing. As per section 19.2.4 of the ARAP in the DFR. (f) Appropriate consideration is given to socially vulnerable people among the resettled people. Mainly described in section 19.2.4(3) of the ARAP in the DFR. (g) Agreement prior to resettlement is planned. Refer to section 19.2.6 of the ARAP in the DFR. (h) Organizational framework and budget to properly implement the involuntary resettlement are planned. Refer to sections 19.2.5 and 19.2.7 of the ARAP in the DFR. (i) Monitoring of the impacts of relocation is planned. Refer to section 19.2.8 of the ARAP in the DFR. (j) A grievance redress mechanism is planned. Refer to section 19.1.12 of the IEE report and section 19.2.5 of the ARAP in the DFR.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Living and Livelihood	(a) Where roads are newly installed, is there a possibility that the project will affect the existing means of transportation and the associated workers? Is there a possibility that the project will cause significant impacts, such as extensive alteration of existing land uses, changes in sources of livelihood, or unemployment? Are adequate measures considered for preventing these impacts? (b) Is there any possibility that the project will adversely affect the living conditions of the inhabitants other than the target population? Are adequate measures considered to reduce the impacts, if necessary? (c) Is there any possibility that diseases, including infectious diseases, such as HIV will be brought due to immigration of workers associated with the project? Are adequate considerations given to public health, if necessary? (d) Is there any possibility that the project will adversely affect road traffic in the surrounding areas (e.g., increase of traffic congestion and traffic accidents)? (e) Is there any possibility that roads will impede the movement of inhabitants? (f) Is there any possibility that structures associated with roads (such as bridges) will cause a sun shading and radio interference?	(a) N (b) Y (c) Y (d) N (e) Y (f) N	(a) The project improves traffic of the existing road network. It would not affect adversely the existing means of transportation and the associated workers (b) The target population of the project is the users of the target road. On the other hand, 79 project affected persons will be subject to involuntary resettlement. Compensation and livelihood rehabilitation are planned. Apart from the impact of resettlement, there are risks of deterioration of sanitary conditions, local competition for resources, and conflicts with local residents due to the influx of external workers during construction. Mitigation measures such as management of workers' camps and strengthening of security arrangements are planned. (c) Influx of construction workers may increase health risks, especially for STD/STI, HIV/AIDS, and coronavirus. As a mitigation measure, it is planned that DOR and contractors will maintain sound sanitary conditions in worker camps and their surroundings. (d) According to traffic demand simulation, the project will improve the overall condition of the road network in Kathmandu. However, there is a risk of an increase in traffic accidents due to increased vehicle speed and traffic volume, and as a mitigation measure, safety measures such as signage will be applied to reduce the risk of traffic accidents, and driving conditions near road intersections will be improved. (e) During construction, access to buildings and facilities along the road will deteriorate. Economic activities along the road are also expected to be hindered, and construction will be planned to minimize the impact. (f) No issues of sun shading or radio interference are anticipated.
4 Social Environment	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) Y	(a) A part of the land of the Muni Bhairab Temple near Tinkune junction will be affected by the project. Compensation for damage and livelihood restoration are planned.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) Y	(a) No landscapes that require special consideration have been identified. At the road section attached to the flyover section at Tinkune juction, if the embankment height increases, a wall
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources to be respected?	(a) N (b) N/A	(a) The project does not affect culture and lifestyle of ethnic minorities and indigenous peoples. (b) Ditto
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.? (d) Are appropriate measures being taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?	(a) N (b) Y (c) Y (d) Y	(a) Compliance with laws regarding labor safety, child labor, and other labor environments, including monitoring, is planned in the IEE reporte. This is described in section 19.1.8(4)(19) and elsewhere in the IEE report in the DFR. (b) Measures have been put in place. This is described in section 19.1.8(4) and elsewhere in the IEE report listed in the DFR. (c) It is planned to implement measures such as formulating rules on occupational health and safety, and conducting training to raise awareness regarding occupational health and safety and traffic safety. (d) Security will be established to avoid conflicts between external workers and local residents. Contractors have a responsibility to manage the workforce brought in from outside the project area.
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts?	(a) Y (b) Y (c) Y	(a) Measures such as regular water spraying and covering construction materials for dust control during road construction, use of water treatment facilities for drainage from construction sites to ensure that contaminated water is treated at wastewater treatment facilities and not discharged on-site, are planned to be agreed upon as part of the EMP. (b) The impact of construction on the natural environment (ecosystem) is limited and only involves the loss of shrub with low conservation value. Tree planting will be carried out in closed disposal sites and other locations. Within these planting sites, shrubs and thickets will naturally regenerated. (c) Involuntary resettlement and land acquisition due to the construction, social impact due to the influx of external workers, and interferance of economic activities along the road are anticipated. For the affected households, the provision of compensation and livelihood rehabilitation measures are planned to be agreed upon as an entitlement matrix.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) As shown in the environmental monitoring plan (c) Y (d) Y	(a) It is planned to be agreed as EMoP to monitor air quality, water quality, noise, and vibration during construction, and water quality during operation. (b) It is planned to be agreed as EMoP that monitoring of air quality, water quality, noise, and vibration during construction, and water quality during operation will be conducted monthly. (c) During the construction, the contractor will conduct monitoring under the supervision of the implementing agency. During the operation, the implementing agency will conduct the monitoring. (d) Described In Section 19.1.9 (Environmental Monitoring Plan), and Section 19.5.1 (Monitoring Forms), in the IEE report in the DFR.
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation). (b) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	(a) N/A (b) N/A	(a) This project does not involve activities that affect forests, such as large-scale logging. (b) This project does not involve activities that affect transmission and distribution facilities.
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) Y	(a) The amount of CO_2 emission reduction due to this project was calculated using JICA Climate-FIT (mitigation). The results indicate that, across the entire road network in Kathmandu, the project will reduce CO_2 emissions by 5,827 tonCO_2/year compared to the baseline (without the project).

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Confirmation of Environmental Considerations (Reasons, Mitigation Measures)
5 Others	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) As shown in the environmental monitoring plan (c) Y (d) Y	(a) Refer to the environmental monitoring report in the IEE report (b) Ditto (c) Refer to the IEE report (d) Refer to the environmental monitoring form in the IEE report
6 Note	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Forestry Projects checklist should also be checked (e.g., projects including large areas of deforestation). (b) Where necessary, pertinent items described in the Power Transmission and Distribution Lines checklist should also be checked (e.g., projects including installation of power transmission lines and/or electric distribution facilities).	(a) N/A (b) N/A	(a) (b)
	Note on Using Environmental Checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed, if necessary (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) Y	(a) Decrease of emission of CO_2 by the project was calculated applying JICA Climate-FIT (Mitigation).

1) Regarding the term "Country's Standards" mentioned in the above table, in the event that environmental standards in the country where the project is located diverge significantly from international standards, appropriate environmental considerations are required to be made.
In cases where local environmental regulations are yet to be established in some areas, considerations should be made based on comparisons with appropriate standards of other countries (including Japan's experience).
2) Environmental checklist provides general environmental items to be checked. It may be necessary to add or delete an item taking into account the characteristics of the project and the particular circumstances of the country and locality in which it is located.

19.5.3 Lessons Learned in Previous Nagdhunga Tunnel Project Funded by JICA

The Nagdhunga Tunnel Project has been funded by JICA, and as per their guidelines, environmental and social considerations were taken into account during the project planning phase. An Environmental Impact Assessment (EIA) was conducted for a certain design of the tunnel. However, during the course of the project, the final design was altered by a design consultant, leading to some unforeseen impacts. For instance, although the initial EIA stage did not anticipate the use of explosives, they were eventually employed at some point during the construction.

One of the notable concerns that emerged was the discrepancy in the number of affected people. Residents who owned houses in close proximity to the project site, particularly near the tunnel portal, expressed distress over the potential risks posed to their homes during the tunnel excavation work. Some of these houses were reportedly damaged, and the affected homeowners demanded appropriate compensation, which the government has not yet provided or decided upon.

Throughout the construction phase, numerous issues related to the project's execution were observed. These included challenges in managing the disposal of muck/spoil and handling the water generated from the tunnel excavation. Additionally, the project required a larger land area than initially expected during the design stage, leading to further complexities.

Safety concerns were also brought to light after a tragic accident occurred in October 2021 during the construction work. This incident underscored the importance of adhering to strict safety protocols and measures to avoid such occurrences in the future.

Another significant issue that impacted the project's timeline was the process of land acquisition and the subsequent compensation negotiations with local landowners. This aspect proved to be time-consuming and laborious, as there were discrepancies between the high demand price from the landowners and the rate allocated by the concerned authorities. The delays in resolving this matter led to further delays in certain areas of the project, jeopardizing the overall project deadline.

It is evident that land acquisition and compensation-related matters need to be addressed and resolved before commencing any construction work in the future. By addressing these issues upfront, unnecessary delays and disputes can be minimized, ensuring smoother project execution.

CHAPTER 20. DATA COLLECTION FOR DIGITAL TRANSFORMATION (DX) IN NEPAL

20.1 General

DX is an abbreviation for Digital Transformation and is a concept that aims to improve value by improving operational efficiency and labor saving by digitizing a unique product, service, operation, innovation, invention, and customer experience. There are various definitions of DX. However, according to DX Promotion Indicators and its guidance issued by the Ministry of Economy, Trade and Industry, DX is defined that "Companies, in response to drastic changes in the world, utilize data and digital technology to develop products and in addition to transforming services and business models, operations themselves, organizations, processes, corporate culture and to change the corporate culture and establish a competitive advantage.”

In the infrastructure field, we have been introducing new technologies to improve the efficiency of each process and make machines more multi-functional. However, DX will take this further, optimizing construction process through digital technologies like AI, ICT, and IoT. The introduction of Transformational Technologies (TX) is an effort to address various issues faced by the current construction industry, including labor shortages and work inefficiencies by fundamentally changing the way it works.

In Japan, the promotion of sustainable industrialization is an important goal. It requires the introduction of DX to address labor shortages resulting from declining birthrate and an aging population, as discussed in Society 5.0 defined 5th Science and Technology Basic Plan by the Cabinet Office. Furthermore, i-Construction promoted by the Ministry of Land, Infrastructure, Transport and Tourism（MLIT, aims to enhance productivity at construction sites using IT technology. The construction industry is also actively pursuing DX efforts, with the establishment of Infrastructure DX Comprehensive Promotion Office. Currently, it can be observed that DX is an area of focus, with collaboration between the public and private sectors.

DX is expected to bring about changes beyond making products and services more convenient. It will impact the essence of business, organizations, processes, and culture. Moreover, DX involves rethinking work methods through digitization, aiming for innovative problem-solving rather than automating clerical tasks by utilizing new software or computers.

Elemental technologies indispensable for DX in the infrastructure field include the following items:

- BIM/CIM: It is a technology that aims to improve the efficiency and sophistication of a series of construction production and management systems by linking and developing 3D models at each stage of construction and maintenance, facilitating information sharing among parties involved in the entire project.
- Cloud Service: It is a service that can use resources such as virtual servers on the internet. As long as there is internet access, it can be accessible anywhere. For example, the head office and the construction site can share the construction status in real-time without being conscious of the distance, and it will be possible to receive instructions and check the progress. It also reduces the cost since the cloud provider performs the system maintenance and inspections.
- 5th Generation Mobile Communication System (5G): Compared to conventional 4G, 5G has the characteristics of being able to communicate at ultra-high speed and large capacity, having high reliability and a low rate of communication slowdown, and being able to connect to many devices at the same time. For this reason, in the 4G communication environment, lack of communication capacity, communication delays, and restrictions on the number of machines that can be connected at the same time can make operations difficult and make it difficult to grasp the on-site situation in real time. Although there was an issue that it was not possible to comprehend it, it will be possible to operate more remotely and handle multiple machines, which will dramatically reduce labor and improve productivity by evolving to 5G.
- Artificial Intelligence (AI): Computers can now “learn” (machine learning), which has the advantage of quickly processing tantamount data. Machine-learning AI can process information and make decisions in the same way as humans and can provide optimal answers in less time than humans. For example, there is a system that AI analyzes images of the site and determines the progress of construction.
- Information and Communication Technology (ICT): It encompasses communication methods that utilize communication technology. In the field of infrastructure, it is also applied to technologies that enable remote equipment operation and automation, particularly in hazardous and manual tasks. It is developed a technology that can convert aerial images taken by drones into 3D survey data.
- Internet of Things (IoT): It is an internet technology that integrates communication technology into physical objects and utilizes data gathered through sensors for various purposes. This technology extends beyond mobile devices (such as mobile phones, tablets, etc.) to connect everyday items like home appliances, automobiles, factory equipment, and

construction machinery to the internet, enabling remote control and operation from distant locations.

20.2 Application Examples in the Construction Field

The following will become possible in the field of construction infrastructure by utilizing DX technology:

- Utilizing BIM/CIM centralizes information across various project stages including survey, design, construction, and maintenance, and enables more efficient information sharing, reducing labor requirements when handling changes and preventing errors.
- Remote construction involves heavy machinery operations, which include dangerous tasks like crushing, excavation, transportation, and installation. It allows for labor saving through the simultaneous operation of multiple machines, reducing the risk associated with hazardous work, improving safety, decreasing overtime hours, and enhancing the working environment by reducing worker stress.
- Enhanced construction quality automates work to the same standards as skilled engineers and expedites simple tasks by implementing full automation in construction machinery equipped by AI.
- A 360-degree camera and photo analysis result in automation and efficiency of progress management for construction work.
- Laser scanners (LiDAR) mounted on drones, smartphones, and satellites produce 3D surveys.
- Digitization of structure management status through robots and sensors (reproduction in virtual space) and image recognition of AI automatically detects structure damage (cracks, peeling of concrete, water leakage).
- Automatically identifying potential landslide hazard areas from topographic maps, a visual representation of the diagnostic logic used by experienced engineers, which was previously considered tacit knowledge.
- Traffic signals can be flexibly controlled based on AI analysis of real-time camera images installed on the roadside. It allows for the adjustment of traffic signals to ensure the rapid arrival of emergency vehicle at the scene in the event of a traffic accident.

20.3 Introduction Status of DX in Japan

MLIT considers the year 2023 as a breakthrough year to further accelerate transformation through DX and is promoting DX in the infrastructure field. MLIT has the policy to generalize ICT construction and to shift to the next stage in which ICT has been developed into overall utilization from partial optimization for each type of construction, process, and site as i-Construction.

Currently, ICT construction methods have been implemented in approximately 80% of construction sites directly procured by MLIT. The number of projects implemented in prefectural ordinance-designated cities has increased from about 300 to about 2,500 over the past five years.

BIM/CIM is expected to enhance work efficiency and productivity by facilitating data sharing at each stage of design, construction, and maintenance. Consequently, there are ongoing efforts to utilize BIM/CIM design data for construction with ICT construction machinery and utilization in road ledgers.

Furthermore, technical innovation are anticipated for the next stage, such as the development of automation and self-reliance in construction machinery, will occur, leading to an overall improvement in construction productivity through work status with ICT.

20.4 Introduction Status of DX in Nepal

Currently, no official decision related to DX has been made in Nepal. The DOR had started collecting and storing the design and as-build drawings for their construction project. However, data format is neither BIM/CIM format nor DWG format, but scanned data in PDF format. According to the DOR, there is no plan to start to use BIM/CIM in their construction project.

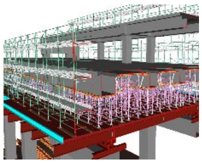
Recently, the DOR has been measuring the IRI value to their maintained road once a year. However, these measured values are not linked to digital map information and are unveiled the measured value to their HP only.

20.5 Applicable DX Technology in Nepal

The applicability of DX technology in Nepal is summarized below. In addition to BIM/CIM, the DX technologies to be studied are technologies related to the following four items:

- DX technologies that can improve the safety of pedestrians and vehicles, such as automatic speed control devices;
- DX technologies that can judge or predict the deterioration of underpass/flyover structures;
- DX technologies that can efficiently measure the traffic volume for the evaluation of the development effects of the project;
- DX technologies that are useful for environmental management (data collection and monitoring related to air quality, noise, vibration, etc.).

Table 20.5.1 Applicable Technologies to Nepal

Name of Technology	Image	Contents	Issues for application to Nepal
BIM/CIM	 Source: HP of Cadian Co., Ltd.	Technology that enables centralized management of information across various project stages, from survey and design to construction and maintenance, enhances information sharing efficiency and reduces labor when changes error occur.	●Since there is no prior experience of utilizing BIM/CIM systems in Nepal, educating engineers capable of handling BIM/CIM system is essential. ●In order to share the data from design stage to maintenance stage, the rule to establish BIM/CIM shall be decided in Nepal.
MIMM	 Source: HP of Keisokukensa Co., Ltd.	Technology enables measuring the cross-sectional shape and surface displacement and investigating water leakage points, discoloration, and cracks of 0.2 mm or more by leaser measurement and camera installed on this equipment. Since measurement can be done during car running, traffic restriction and closure are not required.	●It is necessary to outsource data analysis work to Japanese company. ●Since measurement equipment is not available for purchase, it is necessary to mobilize and demobilize the measuring equipment for each inspection.
GLOCAL-EYEZ	 Source: HP of Nichireki Co., Ltd.	Technology capable of analyzing image data captured by a smartphone mounted on a standard car to measure IRI value, crack rate and asphalt pavement rutting.	●Sending the data to a Japanese company is required for the analysis.
Geo Search	 Source: HP of GEO SEARCH Co., Ltd.	Technology enables the measurement of cavity deterioration under the pavement and the interior of the bridge deck slab using measuring equipment installed on a vehicle. Since measurements can be taken while the vehicle is in motion, there is no need for traffic restrictions or closures.	●Sending data to a Japanese company for analysis is required. ●Since measuring equipment is not available for purchase, it is necessary to mobilize and demobilize measuring equipment for each inspection work.
Real-Time Traffic Video Analytics	 Source: HP of Goodvision	Technology enables the detection of excessive speed vehicles by AI analysis of images taken by roadside cameras.	●It is possible to utilize existing camera. ●It is necessary to change regulations if excessive speed vehicles are arrested using this system.
IDEA Counter	 Source: HP of Intelligence Design inc.	Technology enables the measurement of traffic volume and pedestrian numbers using edge camera with AI.	●Installation of AI=equipped edge camera is necessary at locations requiring traffic measurement. ●It is necessary to send data to Japanese company for analyzing work.
GBiot	 Source: HP of Green Blue Co., Ltd.	Technology enables the measurement of air pollution automatically and sends the measured data via Wi-fi or 5G/4G systems to the data server.	●It is necessary to send data to a Japanese company for analysing work.

Source: JICA Survey Team

20.6 Recommended DX Technology to Nepal

The DX technologies recommended to be introduced to Nepal from the technologies listed in Table 20.5.1 are presented below.

20.6.1 Priority 1: BIM/CIM

(1) Reason for Recommendation

While there are currently no examples of BIM/CIM utilization in Nepal and no established plans for its introduction, BIM/CIM is widely utilized in various projects across many countries. The introduction of BIM/CIM is advisable to align with global trends.

(2) Necessary Action/ Support for Introduction

Education of engineers to use BIM/CIM and the establishment of rules are crucial factors for introducing BIM/CIM to Nepal. Therefore, it is recommended to provide technical assistance for the development of BIM/CIM regulations.

20.6.2 Priority 2: GLOCAL-EYEZ

(1) Reason for Recommendation

While a long-term contract with a foreign company is necessary, there is no need to deploy specialized equipment to utilize this technology, as smartphones are the only equipment required.

(2) Necessary Action/Support for Introduction

Since this technology does not require any special techniques, short term instruction (1 to 2 hours) will be necessary to use this technology.

20.6.3 Priority 3: IDEA Counter and GBiot

(1) Reason for Recommendation

While long-term contracts with foreign companies and equipment mobilization are necessary, these technologies can be utilized in Nepal, once these steps are complete.

(2) Necessary Action/Support for Introduction

Since this technology does not require any special techniques, short term instruction (1 to 2 hours) will be necessary to use this technology. However, a study of the installation location is necessary. Therefore, special support, either through technical assistance or from the company supplying these technologies, is required.

20.6.4 Priority 4: MIMM and Geo Search

(1) Reason for Recommendation

These technologies are highly beneficial for maintenance work. However, mobilization and demobilization of large-scale equipment are necessary due to the maintenance and upgrading requirements of the company.

(2) Necessary Action/Support for Introduction

Specialist from company side will visit Nepal to conduct work inspections. Therefore, no special support is needed.

20.6.5 Priority 5: Real-Time Traffic Video Analytics

(1) Reason for Recommendation

While long-term contracts with foreign companies and mobilization of equipment are necessary, once these steps are completed, these technologies can be utilized in Nepal. However, the revision of relevant laws in Nepal is essential to facilitate speeding arrests.

(2) Necessary Action/Support for Introduction

Since no specialized technique is required to use this technology, short term instruction (1 to 2 hours) will be necessary. However, conducting a study for the installation of this equipment is essential. Therefore, special support, either through technical assistance or from the company supplying these technologies, is needed.

CHAPTER 21. PROJECT EVALUATION

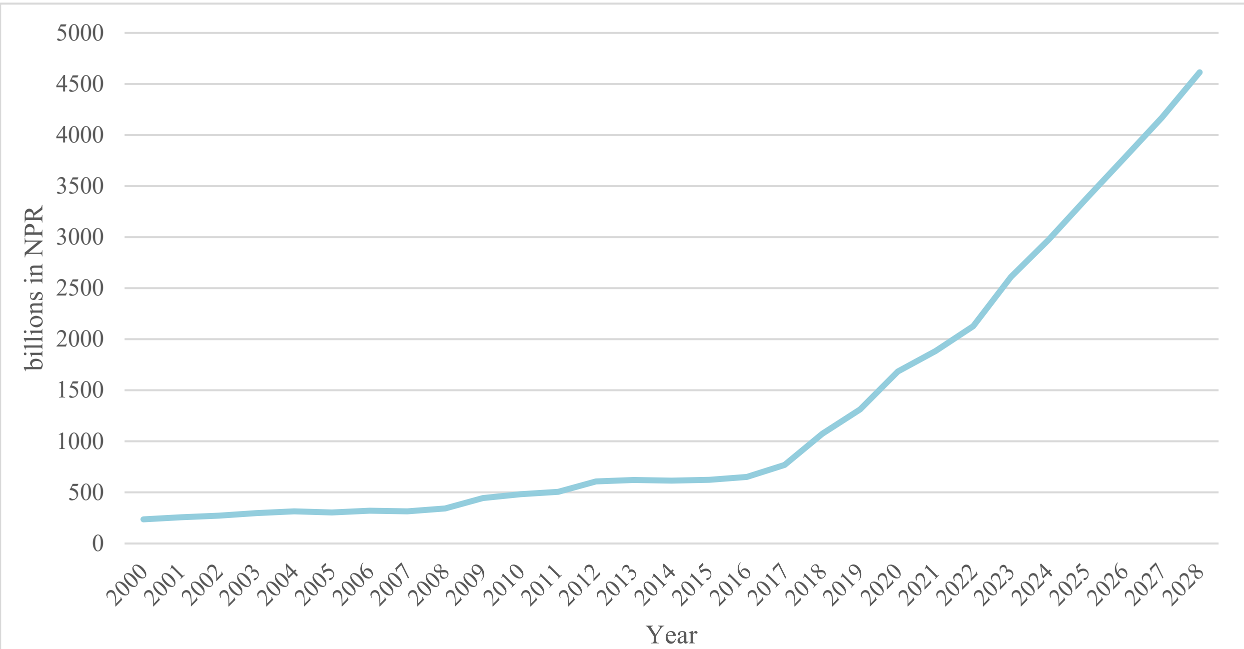
21.1 Financial Situation of Nepal

21.1.1 Debt Statistics of Nepal

In this section, the debt statistical status of Nepal is examined by referring to data from the International Monetary Fund (IMF).

(1) General Government Gross Debt in National currency

The following figure shows the general government gross debt in national currency.



Source: World Economic Outlook Database, IMF, April 2023, https://www.imf.org/en/Publications/WEO/weo-database/2023/April)

Numbers from 2000 to 2021 are actual. Numbers after 2022 are forecasted.

Figure 21.1.1 General Government Gross Debt (National Currency, 2000-2028)

The figure indicates that government debt is increasing continuously, which might continue until 2028.

(2) General Government Gross Debt as a Percentage of GDP

The following figure shows the general government gross debt as a percentage of GDP.

Source: World Economic Outlook Database, IMF, April 2023, https://www.imf.org/en/Publications/WEO/weo-database/2023/April)

Numbers from 2000 to 2021 are actual. Numbers after 2022 are forecasted.

Figure 21.1.2 General Government Gross Debt (Percent of GDP, 2000-2028)

The general government gross debt as a percentage of GDP gradually decreased until 2017 but has been increasing since. Forecasts predict it will settle at around 50% in the future. The figures infer that COVID-19 has worsened gross debt by increasing the expenditure of the Nepal government and decreasing its income after 2020.

(3) Comparing Nepal with Nearby Countries in Terms of GENERAL Government Gross Debt as a Percentage of GDP

The following table shows the government gross debt of other countries in Asia as a percentage of GDP from 2018 to 2021, examining the debt of the Nepal government in context. Furthermore, to compare the impact of COVID-19 between them, the increasing percentage rates between 2019 and 2021 of the developing countries are estimated.

Table 21.1.1 Comparison with General Gross Government Debt of Nearby Developing Countries in Asia as a Percentage of GDP in 2018-2021

Country	2018	2019	2020	2021	Increase Rate between 2019 and 2021
Bangladesh	29.55	31.95	34.51	35.61	11.46%
Bhutan	113.37	106.49	122.77	132.42	24.35%
Cambodia	28.45	28.22	34.38	35.88	27.16%
Indonesia	30.42	30.56	39.75	41.14	34.61%
Lao P.D.R.	60.59	69.13	75.97	92.36	33.60%
Malaysia	55.65	57.08	67.72	69.31	21.42%
Nepal	31.09	34.03	43.31	44.05	29.43%
Philippines	37.13	36.97	51.64	57.00	54.19%
Sri Lanka	83.59	82.59	95.70	102.24	23.79%
Thailand	41.94	41.06	49.43	58.40	42.22%
Vietnam	43.51	40.80	41.26	39.31	-3.65%
Average	50.48	50.81	59.67	64.34	27.14%

Source: World Economic Outlook Database, IMF, April 2023, https://www.imf.org/en/Publications/WEO/weo-database/2023/April)

The comparison indicates that the government debt as a percentage of the GDP of Nepal is not as high relative to other developing countries in Asia. In addition, it seems that the impact of COVID-19 on the government debt as a percentage of GDP is almost average compared to them.

These numbers infer that the debt status of Nepal is in a manageable situation.

21.1.2 Strategies of the Nepal Government for Economic Improvement

Although the statistical data indicates that the debt of the Nepal government is manageable, one of the most significant issues in Nepal is that national income is insufficient. Nepal is a lower-middle income country[1].

To improve its debt situation, Nepal must increase its governmental income. Because of its geographical location, most of its land is mountainous and lacks infrastructure. The government

[1] At present, the World Bank defines lower-middle-income countries as those with a per capita income in excess of US$1,025. However, under a reform scenario where, for example, both investment and productivity improve until 2021 and then level off, Nepal's trend rate of growth accelerates to 4.3 percent and graduation from lower-income-country (LIC) status occurs in 2027. (the World Bank, https://www.worldbank.org/en/region/sar/publication/climbing-higher-toward-a-middle-income-country)

implements inefficient regulations for fund procurement, making Nepal unattractive for foreign investments.

The Budget Speech of Fiscal Year 2022/23 (Ministry of Finance Government of Nepal[2]) mentioned the following "Objectives and priorities of the budget."

With the motive of stability, productiveness, employment growth, inclusive development, self-reliance, and economic prosperity, the objectives of the proposed budget are as follows:

a. To achieve high and sustainable economic growth by building a production-based economy,

b. To generate employment and alleviate poverty through integrated mobilization of available natural resources, human resources, capital, and technology,

c. To ensure macroeconomic stability by maintaining financial discipline and keeping inflation within the desired limit,

d. To establish federalism as a vehicle of prosperity by transferring means and resources to the provinces and local levels,

e. To build the basis of a balanced, inclusive, self-reliant, and socialism-oriented economy through economic and social transformation.

Furthermore, the speech outlined that the government has framed the budget for the upcoming fiscal year with the following policy vision: to enhance production, generate employment, promote exports, curtail imports, foster economic self-reliance, and mitigate absolute poverty by transforming Nepal's agricultural sector. The speech also detailed sector-specific programs to realize this vision:

a. To reduce the import of baseline agricultural products such as paddy, maize, wheat, vegetables, and fruits by at least 30 percent in the coming year,

b. To double exports next year, reduce imports by at least 20 percent, and maintain trading balance for the next five years,

c. To increase decent employment at a rate of 30 percent per annum,

d. To provide housing to the landless Dalits within the next three years,

e. To uplift 800,000 Nepali citizens above the absolute poverty line annually,

f. To achieve a Human Development Index score of 0.650 by improving the quality of the health and education sectors.

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[2] https://www.mof.gov.np/uploads/document/file/1656476715_Budget%20Translation%20031379%20cv.pdf

The speech tackles Public Finance Management and Budget Implementation as follows:

"In adherence to a framework of financial accountability in government expenditures, Nepal will make necessary improvements to public financial management, guided by the results obtained from the performance assessment of Nepali state financial management.

The government will enhance budget predictability through the medium-term expenditure framework to maintain fiscal discipline. Funds will be allocated by entering them into the Project Bank, ensuring their identification, prioritization, and desired outcomes.

The government will strategically mobilize public debt in high-return projects and areas of national capital formation. Additionally, it will issue bonds targeting migrant workers and non-resident Nepalis while also leveraging internal debts. It will develop and implement an annual debt plan following the Medium-Term Debt Management Strategy, 2022-27."

21.2 Economic Analysis of the Project

In this section, the economic analysis of the Project is conducted. This analysis relies on the traffic demand forecast, project schedule, and costs explained in the previous sections of this report. The methodology and the results of the economic analysis are described below.

21.2.1 Methodology for Economic Analysis

The economic analysis has been conducted estimating the advantages for both with-project and without-project scenarios. The following section details the evaluation period, costs, and benefits.

Please note that all benefits and costs are in 2023 prices, and inflation has not been taken into account within the analysis.

(1) Evaluation Period

(Secret)

(2) Costs

1) Project Costs:

- The economic analysis includes project costs, such as procurement/construction, consulting service, physical contingencies, and administration. It does not account for price escalation, taxes, or interest during construction.

- The analysis does not incorporate any residual values.
- The standard conversion factor of 0.91[3] has been assumed to convert financial costs to economic costs, applying it to the local portion (LC) of the costs.

The cost for economic analysis follows estimates in Chapter 15 and turns out as follows/

Table 21.2.1 Project Cost Estimation

(Secret)

Source: JICA Survey Team

2) Operation and Maintenance Costs:

- The total annual O&M cost of the project is (Secret) as mentioned in Chapter 18.
- The standard conversion factor of 0.91 is applied to convert financial costs to economic costs.

(3) Benefits

The economic analysis accounts for the following benefit items.

1) Travel Time Savings

- Travel time savings are estimated based on the saved time and the value of time by vehicle type; therefore, the travel time savings are calculated using the equation below:

[3] The standard conversion factor has been referred from "The Project on Urban Transport Improvement for Kathmandu Valley in the Federal Democratic Republic of Nepal, Final Report," JICA, May 2017

$$(\mathrm{TTC\ Savings}) = \mathrm{TTC_o} - \mathrm{TTC_w}$$

$$\mathrm{TTC_i} = \sum_{j} \sum_{is} (\mathrm{Q_{js}} \times \mathrm{T_{ijs}} \times \alpha_j) \times 365$$

Where,

$\mathbf{TTC_i}$	: Travel time cost in case *i* (NPR/year)
$\mathbf{Q_{js}}$	: Traffic volume of vehicle type *j* on section *s* (vehicle/day)
$\mathbf{T_{ijs}}$	: Travel time of vehicle type *j* on section *s* in case *i* (hr)
$\boldsymbol{\alpha_j}$	: Unit value of TTC of vehicle type *j* (NPR/hr-vehicle)
$\boldsymbol{i}$	: Without-Project case (*O*) and With-Project case (*W*)
$\boldsymbol{j}$	: Vehicle types
$\boldsymbol{s}$	: Section

Unit values used for estimating the value of time are in Table 21.2.2.

The estimated travel time cost for motorcycles is 110.78 NPR/hour/vehicle and 108.59 NPR/hour/vehicle for cars.

The value of time is assumed to be affected mainly by the income level, which can be measured by GDP per capita. Therefore, the future value of time was set for each year during the evaluation period, assuming this value would increase with the estimated growth rate of GDP per capita[4] growth rate. The standard conversion factor of 0.91 was applied to convert financial benefits to economic benefits.

Table 21.2.2 Unit Values of TTC by Vehicle Type, 2023 Prices

(in NPR/hour/vehicle)

	Motorcycle	Car	Truck	Bus
Unit Values of TTC	110.78	108.59	160.13	1144.16

Conversion to 2023 figures use CPI data from the *World Development Indicators*.Source: Estimated by the JICA Survey Team based on "The Project on Urban Transport Improvement for Kathmandu Valley in the Federal Democratic Republic of Nepal, Final Report," JICA, May 2017

2) Vehicle Operating Cost Savings:

- The savings of vehicle operating costs (VOC) were estimated by applying the unit values of VOC according to vehicle type in the equation below:

$$(\mathrm{VOC\ Savings}) = \mathrm{VOC_o} - \mathrm{VOC_w}$$

[4] GDP per capita of the evaluation period is assumed at 4.37%, the average growth rate for the past ten years in Nepal, until 2040. It is assumed that the increase will be settled to 0% after 2040.

$$\mathrm{VOC_i} = \sum_{\mathrm{j}} \sum_{\mathrm{is}} (\mathrm{Q_{js}} \times \mathrm{L_{is}} \times \beta_{\mathrm{ij}}) \times 365$$

Where,

$\mathbf{VOC_i}$	: Vehicle operating cost in case *i* (NPR/year)
$\mathbf{Q_{js}}$	: Traffic volume of vehicle type *j* on section *s* (vehicle/day)
$\mathbf{L_{is}}$	: Length of section *s* in case *i* (km)
$\boldsymbol{\beta_{ij}}$	: The unit value of VOC of vehicle type *j* in case *i* (NPR/vehicle-km)
$\boldsymbol{i}$	: Without-Project case (*O*) and With-Project case (*W*)
$\boldsymbol{j}$	: Vehicle types
$\boldsymbol{s}$	: Section

Unit values for estimating vehicle operating costs are in Table 21.2.3.

The average speed and peak speed were estimated for each link to identify the corresponding unit vehicle operating costs.

The ratio of average speed to peak speed utilized is 9:1.

Table 21.2.3 Unit Values of VOC by Vehicle Type, 2023 Prices

(in NPR/km/vehicle)

Km/h	Motorcycle	Car	Truck	Bus
<5	9.61	51.05	84.73	73.23
10	9.36	49.16	80.64	70.83
15	9.08	47.03	76.45	68.07
20	8.77	44.64	72.15	64.92
25	8.41	42.01	67.74	61.38
30	8.02	39.11	63.21	57.45
35	7.58	35.96	58.53	53.10
40	7.08	32.54	53.69	48.35
45	6.53	28.88	48.64	43.18
50	5.90	25.04	43.30	37.64
>55	5.17	21.25	37.45	31.88

Conversion to 2023 figures use CPI data from the *World Development Indicators*.
Source: Estimated by the JICA Study Team based on "The Project on Urban Transport Improvement for Kathmandu Valley in the Federal Democratic Republic of Nepal, Final Report," JICA, May 2017

21.2.2 Results of Economic Analysis

Based on the above assumptions, the economic costs and benefit streams are estimated. Economic Internal Rate of Return (EIRR) is estimated (Secret). The result is more than 12%, which is usually the opportunity cost of capital, inferring that the Project is feasible from an economic viewpoint.

21.2.3 Sensitivity Analysis

In this section, sensitivity analysis is conducted in order to examine how changes in the assumptions for the economic analysis affect the result of EIRR. The factors for the sensitivity analysis are project cost and benefit of the project. The following table shows the result of the sensitivity analysis.

The result indicates that if more than 10% decrease of the project benefit and more than 10% increase of the project cost occur at the same time, the EIRR becomes less than 12%.

Table 21.2.4 Result of Sensitivity Analysis of EIRR

(Secret)

CHAPTER 22. CONCLUSION AND RECOMMENDATION

22.1 Conclusion

The conclusions of the Study are as follows;

- It is concluded that the Project should be realized because it is technically, economically feasible and acceptable from the viewpoint of environmental and social consideration aspects by incorporating the mitigation measures proposed into the Project.
- The Project road of the grade separated facilities shall be implemented by the recommended route alternative with the alignment option of TK-2R, starting from the Bagmati River Bridge on Araniko Highway and ends before the Manohara River Bridge on the same highway through the TIA land without passing through the inner area of Tinkune Intersection because i) this route alternative can improve traffic congestions at three intersections, Tinkune, Koteshwor and Jadibuti ones, where the present traffic congestions are observed severe, by the grade separated facilities, ii) the least adverse impacts on traffic on the existing Project road during construction, iii) this route alternative can provide the most effectively improve the traffic congestion than other route alternatives examined in Chapter 7.
- The grade separated roads for the Project should be constructed with 4-lane carriageway, accommodating the forecasted traffic volume up to 2033 but not for further future traffic volume like 10 years after operation (e.g.2038) because of i) Uncertainty of the progress of New Eastern City Development as planned, which largely affected the future traffic volume from the eastern area to the city center of Kathmandu, ii)impacts of realization of other large scaled the development projects such the Outer-ring road project, urban mass-transit one, and new road construction connecting between the city center and the eastern area, iii) Necessity of large investment costs and land acquisitions at this stage (see Chapter 6.1.3)
- The grade separated structures of the Project road should be constructed with combination of underpasses and flyovers; whereas the former shall be applied in the territory of TIA land, combining the tunnel(box culvert) under OLS and U-shaped retaining walls out of OLS area according to the request from CAAN, the latter is applied at both sides of the TIA territory, connecting with the underpass structures, resulting in the total length of 1,851m, comprising 730m of the underpass with both box culvert and U-shaped retaining

wall, 902.5 m of the flyovers and 218.5 m of the earth section. Whereas a steel narrow box girder type is applied to the areas where longer spans are required such as crossing the intersection, a PC I-girder is applied to the remaining section with no restriction in order to seek the economical construction cost.

- The improvement of the at-grade roads for the Project shall be implemented basically within the existing ROW area except the east ramp road section of the Tinkune IS as a result of the consultation between MOTCTA and MOPIT, although its arrangement cannot maximize the improvement effect to traffic congestion on the at-grade road section of the Project roads, which would result in LOS E.
- DOR under MOPIT is an appropriate implementation agency for the Project as they have rich experience in the similar road and bridge projects financed by international donors in the past and performed as the counterpart agency through the Preparatory Study for the Project.
- Considering the Project contents with complexity and work environment, which the UP section of the Project is to be performed within the airport territory under the airplane operation, international contractor with rich experience of the similar nature of the projects must be procured for safe and smooth implementation of the Project. For this purpose, International Competitive Bidding (ICB) method with FIDIC Red Book "Conditions of Contract for Works of Civil Engineering Construction" should be applied for the contractor procurement for the Project.

(Secret)

22.2 Recommendations

Recommendations to the Project implementation are as follows;

- Although the Nepali side has decided to apply the sectional alignment option of TK-2R in the Study, through the project formulation stage for Japanese Yen Loan application, JST still strongly recommends that the Nepal side continues efforts to solve the land acquisition issues within the inter land of Tinkune IS, where is a very valuable vacant land in the urban area, and apply the sectional route option of TK-3 because i) it will result in the shorter construction period and economical construction cost, ii) there are lesser adverse impacts on traffic on the existing roads during construction, and iii) it also enables the said land to use future development projects such as introducing urban mass transit one or park development etc.

- It is recommended that Project Implementation Unit (PIU) should be established under DOR before commencement of the Project implementation in order to clarify the responsibility of the Project and deal with arrangement and coordination activities with a large number of various stakeholders because the Project runs through the city environment and within the TIA territory.

- Among the coordinating activities of DOR, a close communication with CAAN is highly required through the implementation of the Project, such as obtaining entry permission for various surveys and construction activities. Particularly, Safety Risk Assessment(SRA) for the airport operation on the Project works should be jointly conducted with CAAN by support of the Consultant at the detailed design stage in order to complete the detailed design works within the planed schedule.

- It is necessary for the Nepal side in collaboration between DOR and Kathmandu Metropolitan Municipality to complete land acquisition within the Project area and compensation to the Project affected people before commencement of the construction works. This would enable DOR to hand over the necessary lands for the Project to the awarded contractor after contract conclusion and to adhere to the designated construction schedule.

- It is vital for DOR to complete new bridge construction in parallel to the existing Bagmati River Bridge at both upstream and downstream sides before completion of the Project because those are to be utilized as the road sections for vehicles running on the at-grade roads from/to Tinkune IS. Without the new bridges, the Project roads can not function at all. In addition, the road section beyond the Bagmati River Bridge towards New Baneshwor is to be utilized as a weaving section for vehicles running from/to the GS section and the at-grade one. The detailed plan for the said transition section shall be planned and designed after attentive discussions among the Consultant, DOR and Traffic Police, while listening road users at the detailed design stage.

- The same arrangement is also required at the ending point of the Manohara River Bridge side. The road section beyond the Manohara River Bridge towards Bhaktapur is also to be utilized as a weaving section for vehicles running from/to the GS section and the at-grade road ones. Accordingly, DOR should plan to complete the frontage road sections at the both sides of main carriageway of Araniko Highway.

- As recommended in Chapter 18 “Operation and Maintenance for the Project Facilities”, it is recommendable that an O&M office for the Project facilities shall be established near the Project intersections with the necessary staff under the main O&M office for Nagudhunga Tunnel, which is planed to establish before completion of the said project because i) trained personnels for tunnel inspection and maintenance and necessary equipment and machinery procured for the Nagdhunga Tunnel project can be utilized for the Project facilities, and ii) by doing so, the O&M expenses for the Project facilities can be saved. Furthermore, it is recommended to procure the necessary equipment and machinery for the sub O&M office for the Project facilities for the underpass section, such as patrol cars, towing vehicle and trucks with air jack, proposed in the Report.

In addition to the above, there are the following remarks to be considered at the detailed design stage of the Project.

Detailed Design Stage

- Upon the request from CAAN, SRA will be conducted at the detailed design stage to ensure the safety of airport operation of TIA during construction of the Project facilities within TIA land. In order to support smooth implementation of the SRA, it is recommendable to assign an airport engineer in the Consultant team, who is familiar with SRA and its procedure. This has been requested from CAAN to JICA at the project formulation stage.
- The Project flyovers can be first ones to be constructed in urban environment in the Kathmandu Valley once the Project facility is complete, which are a 664.5m long at the Tinkune side and 238m long at the Jadibuti side. For this reason, it is recommended to include an aesthetic design aspect in the flyover design process by an aesthetic design expert, such as pier shape, superstructure one, as well as a color selection of steel superstructures etc. This experience will provide a good practice of infrastructure design in urban environment in Nepal for future.
- In addition, a manual preparation for inspection and maintenance for the FO structures shall be added to the TOR for the Consultant because i) as mentioned above, this is the first FO in Nepal comprising PC and steel box girders, ii) the Kathmandu Valley is the earthquake prone area on the relatively soft soil layers, which may cause settlement in future.
- Only four boreholes were conducted in the Study for the outline design of the Project facilities, underpass and flyover structures. At the detailed design stage, it should be increased the borehole locations at each pier position for the flyover section in order to carefully perform foundation design since there are no bearing strata observed in the Project area. In addition, sampling of undisturbed soils for consolidation test should be carefully performed in order to obtain accurate test results. For this purpose, it is preferable to incorporate an international geotechnical expert, who has rich site work experience.
- The material survey conducted in the Study could not find the material sources for basecourse from three quarry sites, which resulted in not fulfilling the requirements of basecourse (see Chapter 3) as a result of the laboratory test. Accordingly, it is recommended to find other quarry sites to meet the material requirements at the detailed design stage, in case that requires the large volume of basecourse materials.

- As mentioned above in Recommendations, the plan and design for the transition road sections at both ends beyond both Bagmati River Bridge and the Mahohara River one are required at the detailed design stage based on additional topographical survey results, which those are not included as the components of the Project so that it should be constructed by the Nepali side before completion of the Project
- At the detailed design stage, traffic operation rules for the GS section should be carefully discussed among the concerned parties, DOR, Traffic Police and TIA operator/CAAN because i) the GS section passes through the TIA territory, where the security condition is very severe, and ii) there is a high risk on the airport operation if an incident happens along the GS section. JST recommends the following countermeasures: i) prohibition of entry to the GS section by tank lorries carrying inflammable liquids, ii) installation of a protection gate not to allow to enter to the GS section by trucks with goods exceeded the regulated height of 5.0m, in order not to cause damages on the tunnel inner-upper surface.
- Furthermore, the traffic operation rules at the Koteshwor IS are also another concern of the JST, particularly, i) an access road to the intersection from Mahadevsthan, which JST proposed to detour the access to the intersection, and ii) pedestrian control measures to improve the vehicle flows within the intersection by installation of footpath brides or underpass, and iii) location of bus bay etc. Those issues should be well discussed at the detailed design stage among the concerned parties, DOR, Traffic Police, the surrounding residents and CAAN.

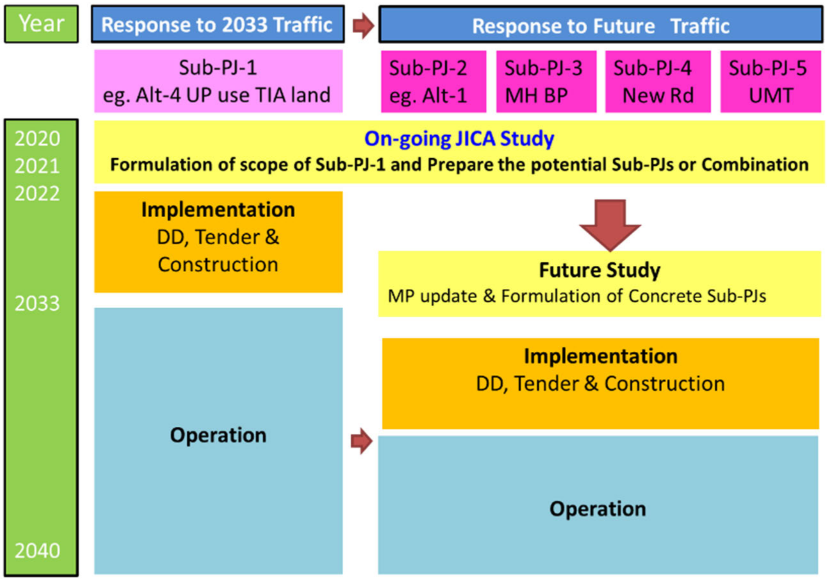
Construction Supervision Stage

- A public relation expert should be assigned through the construction stage of the Project because there are many stakeholders and it is important to notice the work schedule/activities that affect the road users who will pass the Project intersections in order to minimize adverse effects of the Project activities to the road users.

The recommendations to the future improvement of the Project intersections are as follows:

- In the Study, JST applied the step-wise approach with consensus of the Nepal side to alleviate traffic congestions at the Project intersections as shown as described in 7.4.3 with the reasons; i) uncertainty of ENCD project, ii) the possibility of application of other development projects, and iii) required large investment cost and land acquisition to realize. In addition, JST also recommended to determine the improvement approach after the revision of the Transport Master Plan in 2018, particularly revision of the traffic demand forecast model based on the new traffic survey results shown in Figure 22.2.1.
- Although construction of additional grade-separated structures for the Project intersections can be considered such as flyovers between RRN and RRS or diversion of the Project grade-separated structures to RRN from the exit of the underpass section, there are other

options to alleviate the traffic congestions at the Project intersections by not relying on the improvement by the grade-separated structures, such as construction of new road and bypass one, and introduction of urban mass-transit.



Source: JICA Survey Team

Figure 22.2.1 Image and Procedure of Step-wise Approach for Alleviating Traffic Congestion at Project Intersections

- Furthermore, it is highly recommended that improvement of the AG road sections for the Project by widening in order to maximize an effect of the Project in future to improve their LOS levels of F at all intersections in this Project due to the available land limitation although the Control Delays were improved by building the GS structures at all the intersections although the Project aimed at LOS of D for the AG road sections for the Project at the initial stage of the Study. JST strongly recommends that DOR should continue efforts to a negotiation with CAAN to transfer the lands, while observing the traffic congestion level in future.