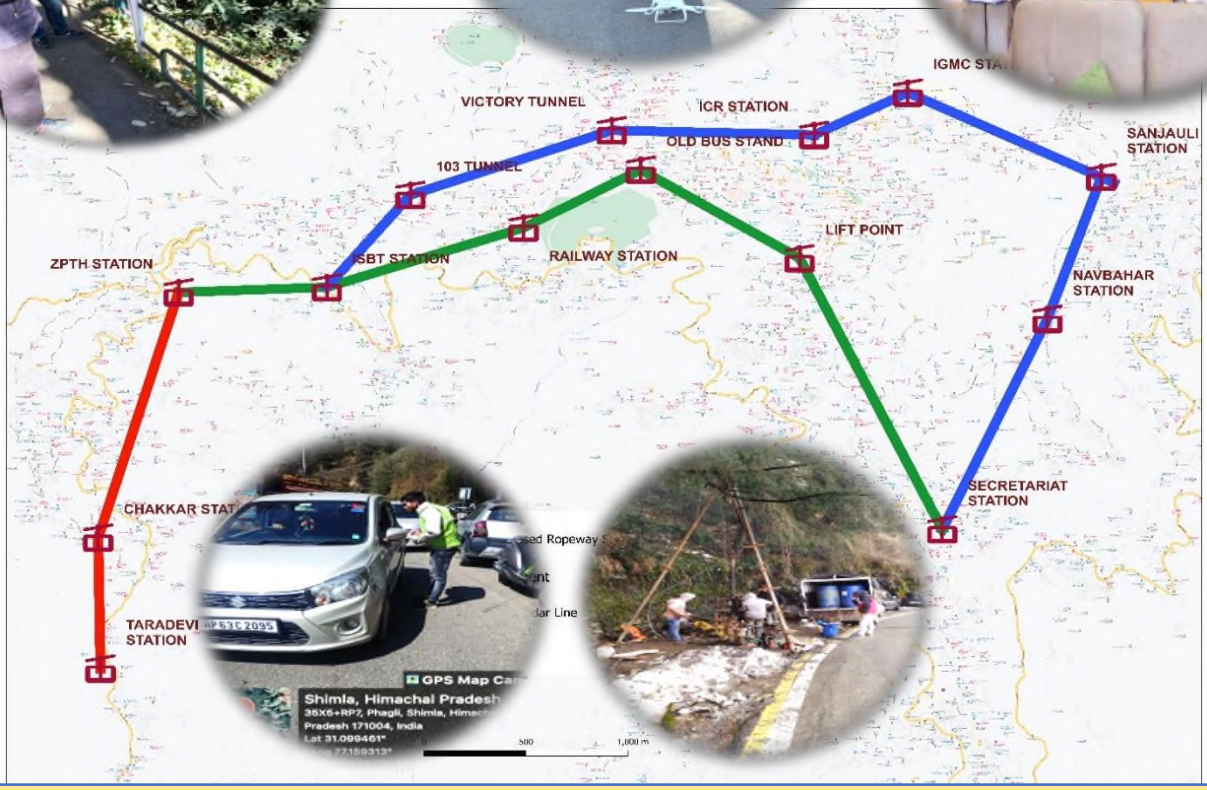
ROPEWAYS AND RAPID TRANSPORT SYSTEM DEVELOPMENT CORPORATION H.P. LIMITED (RTDC)

GOVERNMENT OF HIMACHAL PRADESH

DPR FOR CONSTRUCTION & IMPLEMENTATION OF INNOVATIVE URBAN TRANSPORTATION (ROPEWAYS, LIFTS, ESCALATORS ETC.) IN SHIMLA CITY



ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) REPORT

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WAPCOS (A Government of India Undertaking)

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INTRODUCTION

1.1 INTRODUCTION

Himachal Pradesh is experiencing a rapid increase in urbanization. This has created a situation where demand of infrastructure has far outstripped the supply. The state is famous for its natural beauty and serenity and has always been a top tourist destination for domestic as well as foreign tourists. Huge inflow of floating population coupled with the rise in domestic population has led to increase in the per capita resource utilization in the past few years.

One of the major reasons for rise in the per capita resource utilization is the drop in the mobility infrastructure in the city. Being a hilly state, the state has typical challenges in providing affordable, fast and safe mobility.

Against this backdrop, the Himachal Pradesh Government has constituted the Ropeways & Rapid transport System Development Corporation HP Ltd. (RTDC), with a long-term objective for development of Rapid transport system. The main aim is to provide suitable alternatives which would aid in controlling the spiking growth of vehicular traffic resulting congestion in populous cities of Himachal Pradesh.

As part of this vision, RTDC has decided to undertake development and operation/ maintenance of alternative mobility options for the cities of Shimla, Manali and Dharamshala. The scope of the project is to assess, evaluate and identify the possibilities of mobility innovations in these cities. The three cities are important from the perspective of tourism as well as a growing local population. Being hill cities, with appreciable contour differences, it serves as both a challenge and opportunity. The challenge is to provide a safe, economical and sustainable mobility option in cities with existing population and contours, while an opportunity to improving the quality of life of millions of local residents and tourists and being the harbinger of development and high-quality jobs.

WAPCOS Ltd. (A Government of India Enterprise) under the Ministry of Jal Shakti has been selected by the Ropeways & Rapid Transport System Development Corporation (RTDC), as the consultant for the project.

The concept plan has been approved by the Government of Himachal Pradesh, and it recommended the development of ropeway system for a length to be implemented in 3 Phases as given below:

Phase – I : 30.8 km
Phase – II : 19.14 km
Phase – III : 33.16 km

Total : 83.1 km

RTDC (HP) LTD has currently planned to develop ropeway for a stretch of 13.82 Km with 15 (fifteen) stations as part of Phase 1 of Ropeway system. The present document is an ESIA Report prepared for this planned route of 13.82 Km.

1.2 OBJECTIVES OF THE PROJECT

Through the implementation of innovative mobility solution of ropeways, the project is aimed to accomplish the following objectives:

- Improvement in the mobility needs for the city residents in the backdrop of rising local population and tourist inflow
- Enhance the carrying capacity of the cities to enable long term economic potential of the state.
- Enable sustainable growth and development of the state by increasing the connectivity.
- Enable job creation through direct employment to execute, operate, manage and maintain this state-of-the-art mobility solution as well as increase the state's productivity.
- Enhance the state's stature of being the best tourist destination for Indian and Global tourists.

1.3 NEED FOR ESIA STUDY

The commissioning of any development project can lead to significant impacts on environmental resources of the project area and its surroundings. An aerial ropeway project too can result in wide range of impacts on the environment through construction activities, reclamation, excavation, O&M etc. However, by proper planning at the inception stage and incorporating appropriate migratory measures in the planning, design, construction and operation phases, adverse impacts can be minimized to a large extent, whereas beneficial impacts can be maximized.

The preparation of ESIA report and implementation of ESMP is an essential tool for effectively managing these adverse effects. The objective of Environmental and Social Impact Assessment (ESIA) is to ascertain the baseline environmental conditions and then assess the impacts as a result of the proposed project during various phases of the project cycle. The ESIA study includes the impacts resulting from pre-construction, construction and operation phases. The ESIA study need to be conducted for this project.

WAPCOS Ltd. has been appointed as a Consultant to prepare the Environmental Impact and Social Assessment (ESIA) Report as a part of DPR. The proposed project being an Aerial Ropeway falls under the activity 7 (g) of the EIA notification, 2006. However, as per MoEF&CC Notification dated 27th April, 2022, the aerial ropeway project (category 7 (g)) have been excluded from EIA Notification and thus the proposed project do not require EC from MoEF&CC or any agency.

1.4 SCOPE OF ESIA STUDY

ESIA Study would be prepared as per the requirement of the Lending Bank/Bilateral/ Multilateral Agency. The ESIA studies will be conducted, in accordance with the applicable World Bank/NDB requirements on environmental, social, health and safety management. The potential impacts of each activity/intervention is to be identified and appropriate Environment and Social mitigations and actions are to be formulated for E&S risk and impact management.

The specific objectives of the ESIA study are to:

- Conduct site investigations to collect primary data and review all available relevant secondary data to establish a comprehensive environmental and social baseline for the Direct and Indirect Project Area of Influence
- Define the area of influence, screen, identify and assess potential positive and adverse environmental and social impacts, including direct, indirect, induced, environmental and social impacts associated with the proposed ropeway project.
- Suggest feasible measures to avoid, reduce, mitigate, manage and/or compensate for such impacts, including the institutional arrangements and required capacity building to implement all such measures
- Ensure that impacts on vulnerable communities are avoided, minimized, mitigated and/or compensated, and that mechanisms are designed to ensure their meaningful participation during project planning and implementation.

1.5 STAGES IN AN ESIA STUDY

The major thrust of the ESIA study shall be to assess the impacts of various activities of proposed ropeway project on various aspects of environment. The study shall cover the impacts on water quality, noise, air quality, terrestrial ecology, wildlife and avi-fauna, etc. The study will include collection of baseline data, prediction of impacts and formulation of Environmental Management Plan (EMP) for amelioration of adverse impacts.

The purpose of this section is to enumerate the steps involved in an Environmental and Social Impact Assessment (ESIA) Study. The same are given in following paragraphs.

Screening and Scoping: The purpose of Environmental and Social Screening is to prepare the Checklist of likely Environmental and Social issues due to the proposed ropeway development project. The major issues to be highlighted or need specific attention will be finalized at this stage. Based on the issues identified a Scoping for the sensitive issues/impacts will be proposed

An exhaustive list of all likely impacts drawing information from as many sources as possible shall be prepared to assess the impacts due to various activities of proposed project. The next step shall be to select a manageable number of attributes, which are likely to be affected as a

result of the proposed ropeway project. Various criteria applied for selection of the important impacts are as follows:

- magnitude
- extent
- significance
- special sensitivity

Baseline Study: Before the start of the project, it is essential to ascertain the baseline levels of appropriate environmental parameters, which could be significantly affected by the implementation of the project. The planning of baseline survey shall emanate from short listing of impacts prepared during identification/scoping. The baseline study shall involve both field work and review of existing documents, which is necessary for identification of data which may already have been collected for other purposes.

Impact Prediction: is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur as a result of the proposed project. An attempt shall generally be made to forecast future environmental conditions quantitatively to the extent possible. But for certain parameters which cannot be quantified, the general approach shall be to discuss such intangible impacts in qualitative terms so that planners and decision makers are aware of their existence as well as their possible implications.

Environmental and Social Management Plan: an Environmental and Social Management Plan (ESMP) shall be formulated to maximize the positive environmental impacts and minimize the negative ones. After selection of suitable environmental mitigation measures, the cost required for implementation of various management measures will be estimated, to have an idea of their cost-effectiveness.

Environmental Monitoring Programme: An Environmental Monitoring Programme for implementation during project construction and operation phases shall be suggested to oversee the environmental safeguards, to ascertain the agreement between prediction and reality and to suggest remedial measures not foreseen during the planning stage but arising during operation and to generate data for further use.

1.6 SCOPING AND SCREENING

Screening and scoping exercise has been done for the proposed Shimla Ropeway project. The potential impacts on environmental and social attributes were identified based on the reconnaissance survey, FGDs and Stakeholder consultation etc. The identified risks were evaluated qualitatively based on the significance of risks on a scale of 1 to 4 with the help of Scoping Matrix.

Based on the identified risks, the project has been categorized as Category ‘B’ project for which a detailed ESIA study needs to be conducted.

For conducting the ESIA study the emphasis shall be given to following aspects:

- Assessment of physico- chemical parameters (Water, Soil, Air and Noise)
- Assessment of impacts on environmental and social parameters
- Preparation of Environment Management Plan (EMP) of physico- chemical parameters for implementation during construction and operation phases along with budgetary provisions
- Preparation of Environment Management Plan (EMP) for Biological parameters.
- Environmental and Social Management Plan (ESMP) including Environmental Monitoring Programme for construction and operation phases with budgetary provisions.

1.7 OUTLINE OF THE REPORT

Chapter- 1 Introduction : presents an overview of the need for the project, objectives and need for ESIA study, scope of work and deliverables, etc.

Chapter- 2 Project Description: covers the details of project components of the proposed ropeway project

Chapter- 3 Legal and Policy Framework describes the legal and policy framework applicable to the project.

Chapter- 4 Stakeholder Consultation and Disclosure describes the stakeholder consultation carried out during the study period, and its disclosure for review during appraisal process.

Chapter- 5 Description of Environment describes the environmental and social baseline status of the project area based on the primary and secondary data sources.

Chapter- 6 Impact Assessment and Mitigation Measures describes the impacts due proposed project on environmental, and social biological parameters and mitigation measures for minimising adverse impacts and maximising positive impacts.

Chapter- 7 Risk Assessment and Disaster Management Plan describes the risk assessment & disaster management plan for construction and operation phases

Chapter- 8 Environmental Monitoring Programme covers the details of various environmental parameters to be monitored, frequency of monitoring and cost estimates for implementation during construction and operation phases.

Chapter- 9 Environmental & Social Management Plan (ESMP) including cost estimates for implementation.

Chapter- 10 Conclusion list the key conclusions of ESIA study.

CHAPTER-2
PROJECT DESCRIPTION

CHAPTER-2

PROJECT DESCRIPTION

2.1 GENERAL

Shimla, the capital of the state of Himachal Pradesh, is located in the northern part of the country. The city is bounded by districts like Mandi, Kullu, Kinnaur, Solan and Sirmaur, it is also the former summer capital of the British India. Shimla is blessed with immense natural splendour, and sites which are excellent tourist spots.

The city holds great importance from the perspective of the requirement of the tourists visiting the city, which are the prominent source of revenue and job creation for the locals in the city. Therefore, the vision is to cater to the local population which consists of workers, traders, government employees, commercial establishments and the tourists visiting the city not just from India, but from all over the world.

The transport options presently available in the city includes HPRTC buses and private buses. Integrating and complementing these modes with alternative mobility option will further enhance the efficiency and convenience of the overall transportation system of the city.

About 35% of trips in the city are carried on foot, termed as 'walk trips'. This indicates the willingness of the locals and tourists to walk and enjoy the beautiful scenic views. Hence, the proposed alternate mobility option should enable the users to feel the city with its beautiful views and natural beauty.

Since the average trip length of the city is 3.7 km, the city demands an environment friendly, non-intrusive, emissions free and an efficient mobility network rather than the expensive and polluting transport systems.

The elevation in the city varies from 700 m to 2400 m, above mean sea level making the mobility in the city more challenging. This also provides an opportunity to opt for a mode which can overcome steep variations in elevation, without disturbing the natural landscape.

According to the Comprehensive Mobility Plan, Shimla – 2012, the trips associated with Public Transport declined from 65% in 2005-2006 to 49% in 2010-2011, primarily due to the substantial growth in the private vehicle ownership and ridership.

The main objective is to cause a modal shift from the increasing private share of vehicles to the alternative mobility option provided which is expected to be environment friendly, user oriented, sustainable and can climb terrain easily. Thus, there is an immense need of alternative public transport system to address the traffic congestion and increasing tourist demand.

2.2 PROJECT DESCRIPTION

Assessment of Shimla city based on topography, connectivity, linkages and other major locations of the area has been done before identifying the station locations. The elevation in the study area vary ranges from 1210 m to 2605 m above mean sea level.

- Based on the existing city infrastructure and projection of the tourist and local population, a detailed mobility assessment has been done to calculate the passenger flow of the entire network. According to Census 2011, Shimla city has a local population of 1.69 lakh, which is growing at an average geometric decadal growth rate of 28.04%. There is a significant tourist inflow in Shimla every year. The total tourist inflow in the year 2012 was 33.2 lakh, which is increasing every year with an annual average growth rate of 13.25%. Thus the local population, visitors and tourists are the primary target beneficiaries under the Shimla Ropeway Project.
- The Shimla Ropeway Alignment is having 15 Ropeway Stations spread across the heart of Shimla city covering all major places where mass movement is high and congestion on the roads seems a major challenge. The length of Shimla Ropeway Alignment is 13.82 Km divided into 3 sub alignments represented by red, green and blue colour, divided into 7 sections. The route map of Phase-I is enclosed as Figure-2.1.
- Station area planning and alignment finalization has been done on the basis of few site-specific parameters, such as:
  - Land Ownership – preferably Government Ownership
  - Forestation – Low density of trees preferred
  - Accessibility – easily accessible
  - Clearance from existing built-up – minimum 10 m vertical and horizontal clearance is maintained
  - Multi-modal integration – Integration of other transportation modes with the ropeway system
  - Area Requirement – 1500 sq.m to 4000 sq.m depending upon the type of station.
  - Slope along the alignment – maximum slope which can be achieved by mono-cable gondola system is 4 5 degree.

2.2.1 Alignment Aspects

The alignment of the stations has been done keeping in view of the aspects of:

- Connecting the circular road
- Loop System
- Targeting Main tourist points/Airport/Bus Terminal/Railway Station
- Minimal Interchanges
- Scope for future expansion
- Availability of Government Land
- Minimum R&R issues
- Minimum Environmental Issues
- To cater Maximum population
- Minimum Privacy Aspects
- Minimum Religious site Impacts
- Meteorological study

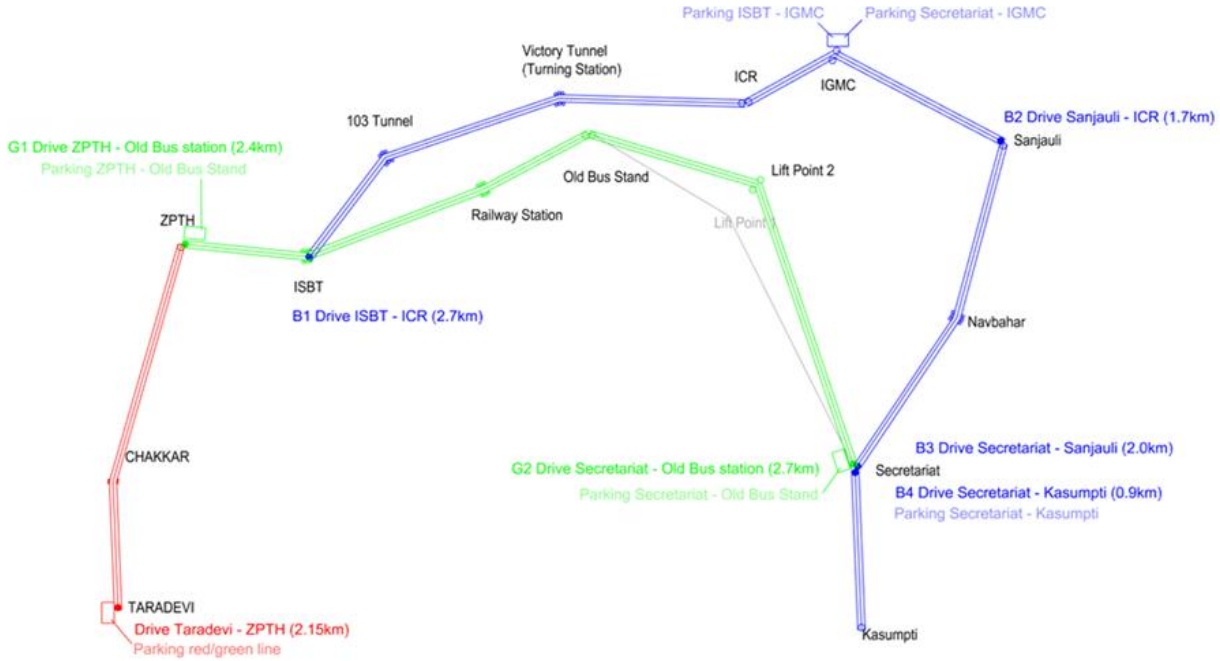

Figure-2.1: Phase 1 Route Map

The proposed stations briefly described in the following paragraphs:

i. Chakkar

It is one of the most prominent congestion points on Circular Road. It is in proximity to district court of Shimla, with various religious places, colleges and hotels in its vicinity as well.

ii. ZPTH

This station is an important point for the entry for tourists in Shimla. A massive multi-storied parking has already been constructed here. Many Private buses stops and parked here. Due to an elevation difference of this point with Boileauganj, a walkway has been proposed between the two.

iii. ISBT

It is the main passenger inflow point from different cities through buses. Therefore, it is very prominent from the perspective of tourists. A multi-story parking is also available for the private vehicles to get parked.

iv. 103 Tunnel

It is a major point of connectivity for both tourist and local population. The peak traffic is noted from 10:00 am to 12 noon and subsequently from 04:00 pm to 08:00 pm. Also, being near to the Himachal Pradesh State Library, it is thronged by the bibliophiles of the city. It is also popular among tourists interested in having a view of the valley.

v. Victory Tunnel

It is a major congestion point by virtue of its location. It is near to passport office and the congestion due to traffic inflow from NH-5. It also serves as an important point from the point of view of tourists since most of the hotels are in its proximity.

vi. Shimla Railway Station

Shimla Railway station is located at an altitude of 2,075m above mean sea level. This small station connected with various other intermediate stations, ending at Kalka station in Haryana. The 762mm narrow-gauge Kalka-Shimla Railway was constructed and opened in the year 1903. The station comes under the jurisdiction of Ambala railway division and declared as UNESCO World Heritage Site. Many tourists travelled through this railway line in order to experience the natural beauty of Himalayas.

vii. Ice Skating Ring

Shimla is home to the Ice-Skating Rink. It is a naturally formed rink and is also the largest and the only naturally formed rink found in South Asia, where people of all ages can practice skating. This area attracts a large crowd throughout the year. Not only the locals but tourists from all over the world visit this naturally formed rink to spend some quality time with their loved ones. The place is also used for hosting an annual carnival and a national-level competition. The ice rink is located close to Lakkar Bazar, a street shopping place where people can buy souvenirs or warm clothes. The place is mainly famous for wooden toys and showpieces. The vendors here sell a wide range of wooden artifacts. Lakkar bazar is also lying in the way connecting Mall Road to Sanjauli Chowk.

viii. IGMC

Indira Gandhi Medical College and Hospital (IGMCH), formerly Himachal Pradesh Medical College (HPMC), is a state-owned medical college and hospital in Shimla is situated in the Snowdown neighbourhood of Lakkar Bazar. This is the eminent and big medical college in the whole state of Himachal Pradesh. Not only locals but people from vast corners of the state visits this hospital for medical treatment. IGMC also lies in the way connecting Sanjauli with Mall Road via Lakkar Bazar.

ix. Sanjauli

At an average altitude of 2,398 metres (7,867 ft) from mean sea level, in the north-western ranges of the Himalayas, Sanjauli, a major populous locality of the city of Shimla is located. Sanjauli is the main suburb of the city. It is area of unique architecture, having a wide and long market area from Sanjauli Chowk to the tunnel. It is also situated atop a hill and one of the highly populated areas of Shimla, since it extends over a large distance. Many educational institutions and health care centres and colleges are also situated here which not only boost the population of this place but also force shopkeepers to introduce new-fangled and contemporary things in the market. This area sometimes also called as Milan of Shimla.

Sanjauli is also accessible from Mall Road by another path which comes through the Lakkar Bazaar bus stand. The congestion is due to the local market and local population especially from Siddhartha Enclave.

x. Navbahar

Navbahar is the village lying in the region named as Chota Shimla in Shimla. Navbahar is known as mini-Switzerland of Shimla as most of the area is covered with forest and receives heavy snow fall during winters. Most of the eminent hotels are present here which attract a sizable tourist. This area is also holding few education institutions and St. Bedes is one of among them, due to this students crowd can be seen there. The Navbahar Horticultural farms provide an educational experience into how the horticultural activities take place.

xi. Secretariat

It is an important location for the administration of Shimla. The congestion is mainly due to moment of private vehicles. This station will be beneficial for the employees and locals who visit the secretariat for their work.

xii. Lift Point

Lift point station plays an important role as it provides an alternate, easy, time saving and convenient option by transporting tourists and locals from the lowest point of Shimla i.e., the Cart Road to the highest point i.e. the Mall Road. Operated by Himachal Tourism, the lifts act as the lifeline of this city whose terrain can be challenging not just to senior citizens but to able-bodied, youthful tourists from the plains who simply can't deal with the steep inclines to get from one layer of the city to the other. There are few car parking also available near Lift point. A lower lift point already exists for the city. However, with the provision of a better mobility system, whose capacity is projected to run at 2000 PHPDT.

xiii. Old Bus Stand

Old bus stand station is lying along National Highway 22 connecting it with Chandigarh and many other places. Roadways Buses from various places in Himachal Pradesh arrives and departs from here. People from other districts of Himachal Pradesh visit their desired destination by changing transportation at old bus stand thus it acts as junction point for the people travelled to and travelling from Shimla. As city buses also arrive and depart from this place so congregations of local people can also be seen here. This station has a lot of hotels and other tourist accommodation in its proximity. It also serves as an important connection point of the 103 Tunnel with the circular road.

xiv. Kasumpti

At an elevation of 1,883 metres (6,178 ft), Kasumpti is a village in Shimla District in the Indian state of Himachal Pradesh. Kasumpti also lies in the region renowned as Chota Shimla. It is a high residential area with a good population. The population of Kasumpti is 21,345. Kasumpti is famous for many eminent hotels as well as several state Government departments

(Tourism, communication, etc.), Government and Non-Government offices. A large chunk of population visits this place every day. It constitutes of major traffic flow of local population and the employees.

xv. Tara Devi

Tara Devi ropeway station lies on the National Highway 5, connecting Chandigarh to Shimla. The planned ropeway station is at the base of the hill where Tara Devi Temple is situated. Tara Devi temple is one of the most visited religious places in Shimla. Around 12000 to 15000 devotees visit the temple on weekends. The tourists visiting Shimla also passes first through the Tara Devi Ropeway Station. There are few private parking also lies near ropeway station which provide tourists to park their vehicle in the outskirts of Shimla to avoid congested roads of city and travel to the Shimla using different modes of transportation.

2.2.3 Station Details

The location (co-ordinates) of stations, land ownership details and phase of construction are given in Table 2.1.

Table-2.1: Station details

S. No.	Station Name	Phase	Land Ownership	Co-ordinates
1.	103 Tunnel	1	Government	31°06'11.6"N 77°09'12.9"E
2.	Chakkar	1	Government	31°05'15.4"N 77°08'16.9"E
3.	ICR	1	Government	31°06'21.0"N 77°10'29.7"E
4.	IGMC 1	1	Government	31°06'28.6"N 77°10'57.0"E
5.	ISBT	1	Government	31°05'54.9"N 77°09'00.4"E
6.	Kasumpti	1	Government	31°04'43.5"N 77°10'50.0"E
7.	Lower Lift Point	1	Government	31°06'08.7"N 77°10'34.1"E
8.	Navbahar	1	Government	31°05'43.6"N 77°11'14.6"E
9.	Railway station	1	Indian Railway	31°06'09.9"N 77°09'40.8"E
10.	Sanjauli	1	Government	31°06'14.5"N 77°11'30.9"E
11.	Secretariat 1	1	Government	31°05'16.0"N 77°10'52.5"E
12.	Taradevi Station	1	Government	31°04'40.3"N 77°08'21.4"E
13.	Victory Tunnel	1	Government	31°06'19.9"N 77°09'46.7"E
14.	Old bus stand	1	Government	31°06'17.2"N 77°09'59.5"E
15.	ZPTH	1	Government	31°05'57.8"N 77°08'32.7"E

2.2.4 Ropeway Alignment Lines

The Shimla Ropeway Alignment is 13.82 Km long covering 15 stations spreading across the heart of Shimla city. The Ropeway Network is further divided into the 3 colour coded sub alignments and 7 drive sections. The bifurcation of the routes has been done on the basis of users and land use along the alignment in order to achieve the maximum efficiency of the system. PHPDT will vary in the range of 2500 to 3000 persons per hour per direction in Shimla during the year 2022-2035. This will rise further once the network will be operational and the experiences gained will be useful in further expansion.

A total network of 13.82 km has been divided in 3 sub alignments marked with 3 colour lines which is given in Tables 2.2 to Table-2.4 ,whereas it is depicted in Figures 2.2 to Figure 2.4

respectively..

2.2.4.1 Apple Line (Red): Taradevi Station to ZPTH Station:

- Total length of Alignment: 1.99 Km
- Average slope of the stretch: 21.9%, -19.9%
- Ground Elevation Ranging from 1845 m to 2005 m. (Above msl)

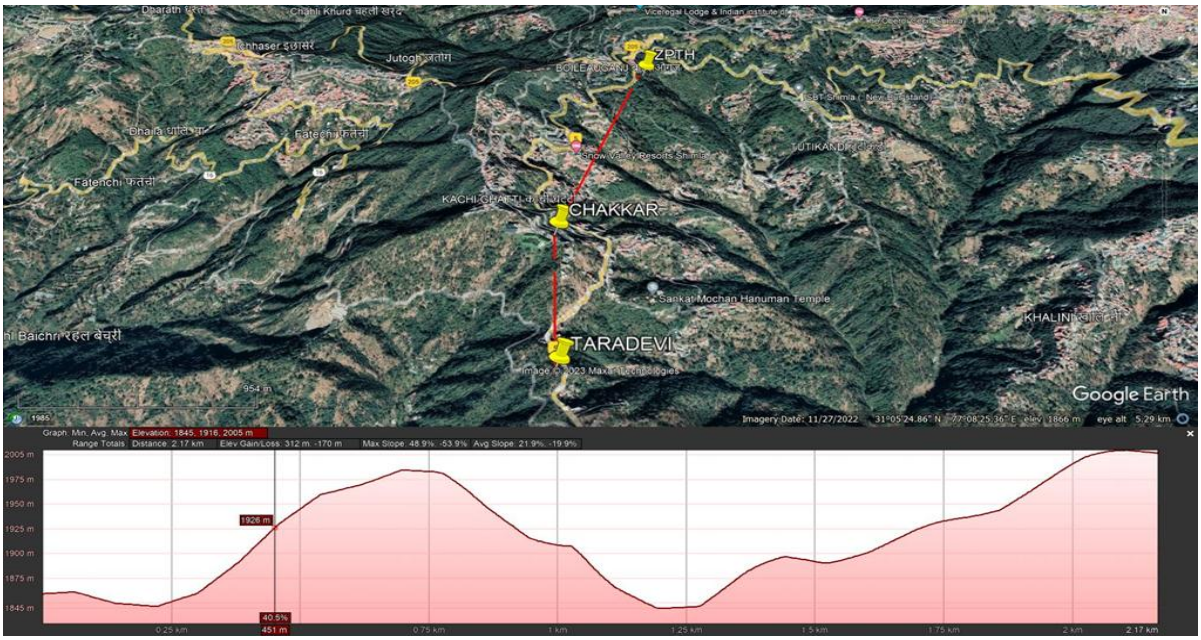

Figure -2.2.: Elevation profile of Taradevi Station to ZPTH Station

Table -2.2: Alignment details of Apple Line

S.No	Line Characteristics	Unit	Description
1.	Line Length	Km	1.99
2.	Number of Terminals	-	2
3.	Number of Intermediate stations	-	1
4.	Number of Turning Stations	-	0
5.	Station Land Availability	Available	
6.	Feasibility of the Alignment	Technically Feasible	

The alignment from Taradevi Station to ZPTH Station is having a total of three ropeway stations are found feasible. Among all stations lying along Apple Line, there are two Terminal Stations and one Intermediate Stations.

2.2.4.2 Deodar Cedar Line (Green): ZPTH Station to Secretariate Station:

- Total length of Alignment: 4.84 Km
- Average slope of the stretch: 19.3%, -15.4%
- Elevation Ranging from 1921 m to 2235 m. (Above msl)

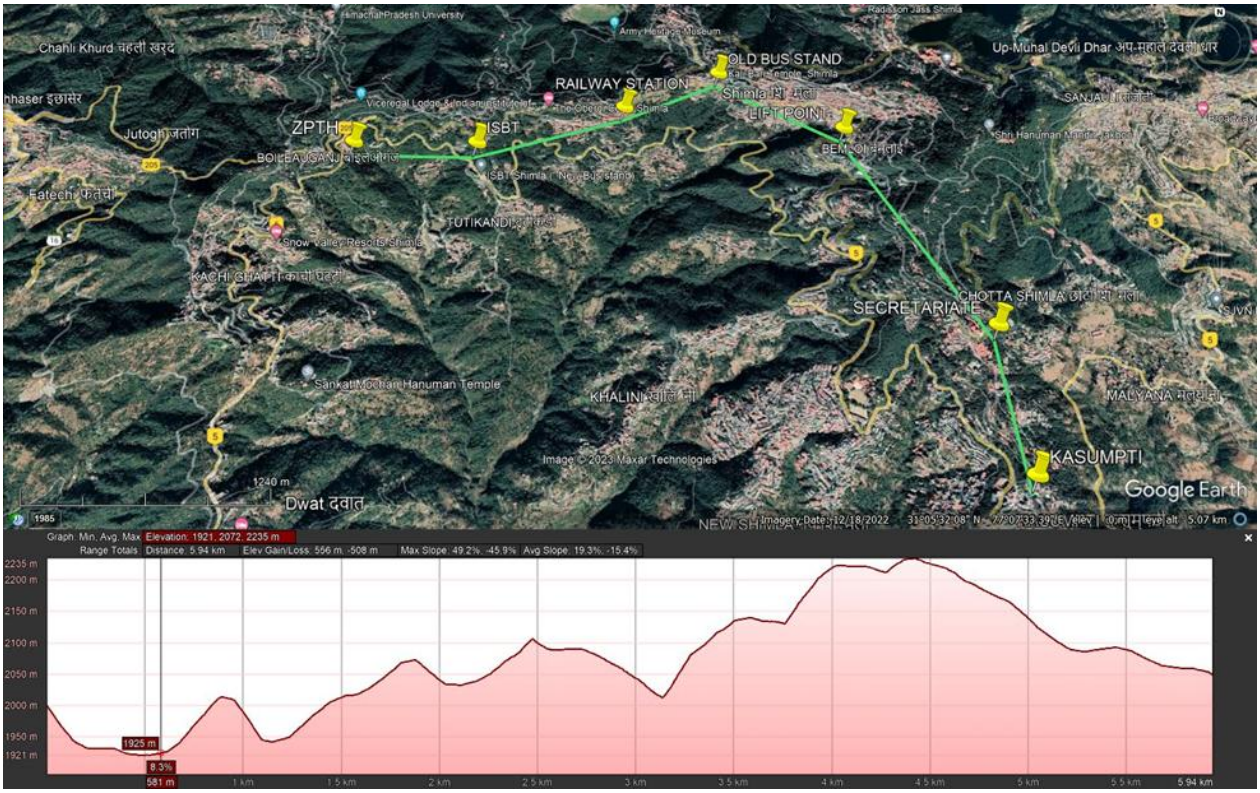

Figure- 2.3: Elevation profile of ZPTH Station to Kasumpti Station

Table -2.3: Alignment details of Deodar Cedar Line

S. No	Line Characteristics	Unit	Description
1.	Line Length	Km	4.84
2.	Number of Terminals	-	2
3.	Number of Intermediate stations	-	5
4.	Number of Turning Stations	-	0
5.	Station Land Availability	Available	
6.	Feasibility of the Alignment	Technically Feasible	

The alignment from ZPTH Station to Kasumpti is having a total of seven ropeway stations are found feasible. Among all stations lying along Deodar Cedar Line, there are two terminal ropeway stations and five intermediate ropeways stations.

2.2.4.3 Monal Line (Blue): ISBT Station to Kasumpti:

- Total length of Alignment: 5.99 Km
- Average slope of the stretch: 16.1%, -20%
- Elevation Ranging from 1986 m to 2317 m. (Above msl)

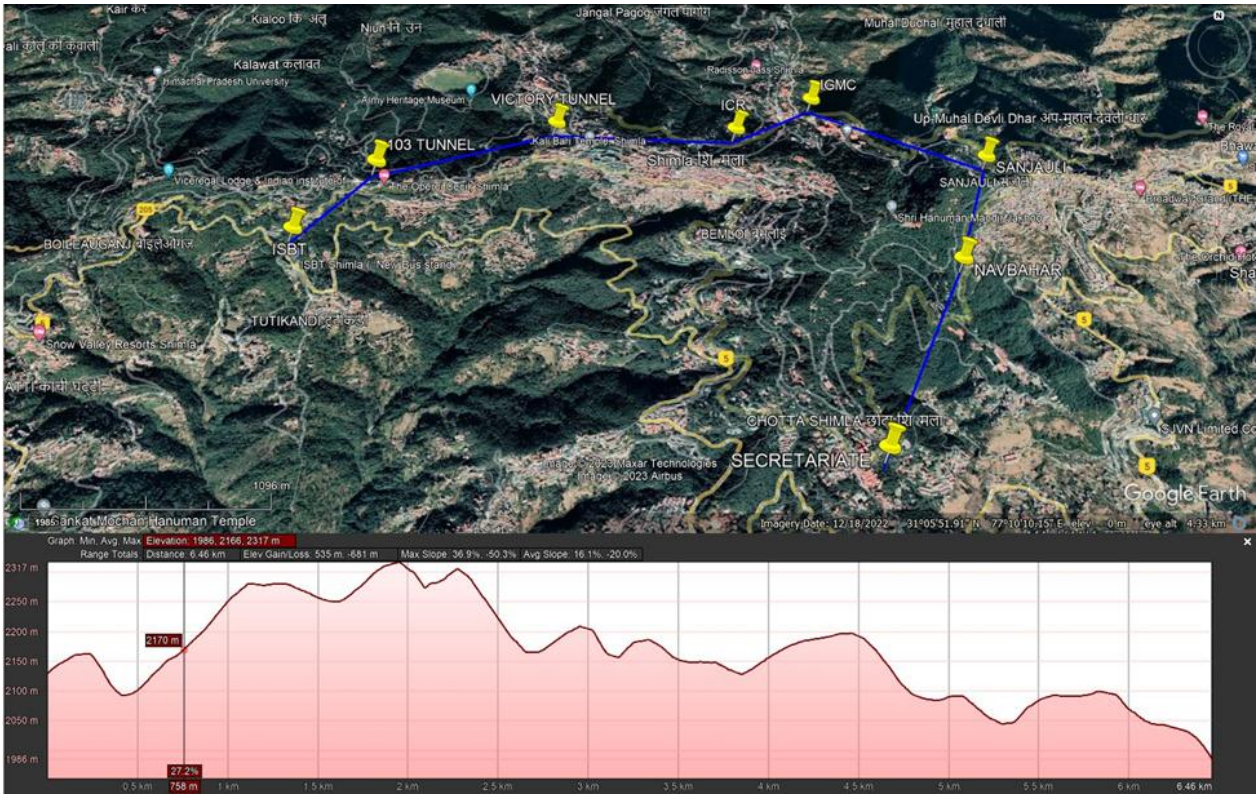

Figure 2.4: Elevation profile of ISBT to Secretariat

Table -2.4: Alignment details of Monal Line

S.No	Line Characteristics	Unit	Description
1.	Line Length	Km	5.99
2.	Number of Terminals	-	2
3.	Number of Intermediate stations	-	6
4.	Station Land Availability	Available	
5.	Feasibility of the Alignment	Technically Feasible	

The alignment from ISBT Station to Secretariate is having a total of eight ropeway stations. Among all stations lying along Monal Line, there are two terminal ropeway stations and six intermediate ropeways stations.

2.2.5 Station Space Requirements

Table-2.5: Station types and area requirements

S.No	Station	Area (In Sqm)			
		Built Up Area	Ropeway Station	Amenities	Addition Floors
1	Taradevi	3807	1900	426	1481
2	Chakkar	3740	1403	682	1655
3	ZPTH	5816	1454	1454	2908
4	ISBT	4995	2335	1330	1330
5	Railway	9198	1533	3066	4599
6	Old Bus Stand	7785	1557	3114	3114
7	Lift	5208	1736	1736	1736
8	Secretariat	13440	3360	3360	6720
9	Kasumpti	4481	989	2095	1397
10	103 Tunnel	3963	1321	1321	1321

S.No	Station	Area (In Sqm)			
		Built Up Area	Ropeway Station	Amenities	Addition Floors
11	Victory Tunnel	1438	496	471	471
12	ICR	5276	1319	1319	2638
13	IGMC	3957	1319	1319	1319
14	Sanjauli	9698	1438	2360	5900
15	Navbahar	5200	1300	2600	1300
Total		**88002**	**23460**	**26652**	**37889**
Avg Area Per Station in Sqm		**5867**	**1564**	**1777**	**2526**

2.2.6 Components of Station

- **In Station Vehicle Structure**

This refers to the area within which the Gondola/cabins usually operate in a ropeway station. The movement space for gondolas is surrounded by the platform, and the track ropes are often diverted to a vehicle housing structure in one or both terminals and a maintenance bay in the terminal or an intermediate station.

- **Operating Rooms**

This is typically located in one terminal where an unobstructed view of the ropeway operation is possible. An attendant or passenger can access this room from the platform during the emergency through a communication system.

- **Concourse**

As in the subway stations, this is the central area where passengers gather at a place before entering the platform or other facilities within the Ropeway station area.

- **Platform**

Boarding and De-boarding areas are main components of the Platform level. Passengers are guided to and from the boarding and de- boarding areas respectively with the help of sign boards and markings.

2.2.7 Ropeway Technologies viable for Shimla

After the study of existing traffic and transportation scenario of the city, case studies and the types of ropeways, the following technologies are proposed to be applied for the mobility of the city:

- Mono-cable Detachable Gondola

A simplistic description about the attributes of these ropeways are given in Table-2.6.

Table-2.6 Ropeway type attribute Description

Characteristics	Type of Ropeway	
	Mono-cable Detachable Gondola	**Tri-cable Detachable Gondola**
Grip	Detachable Grip	Detachable Grip
Cables	Single cable: which provides both support and propulsion	Three cables: Two of the cables provide support while the third is for propulsion
Speed	22-26 Km/hr	27-30 Km/hr
Capacity	2000-4500 persons/hr/direction	6000-8000 persons/hr/direction
Towers	Supported by cylindrical towers	Supported by large lattice towers
Cost	INR 40-150 Cr./km	INR 80-180 Cr./km
Max Wind Speed	70 Km/ Hr	100 Km/ Hr

Since, majority of the movements in the study area will cater to the ridership lower than 3500 PHPDT, a **mono-cable system** will prove to be the most effective and economical for the proposed network.

CHAPTER – 3
LEGAL AND POLICY FRAMEWORK

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LEGAL AND POLICY FRAMEWORK

3.1 LEGAL AND POLICY FRAMEWORK

The Project is being implemented through RTDC LTD, H.P financed by New Development Bank (NDB) and would comply with the Environmental and Social Framework of NDB. The NDB environmental and social safeguards frameworks for this project include the following:

Environmental Safeguards: To ensure environmental soundness and sustainability of projects and to support the integration of environmental considerations into the project decision-making process.

Involuntary Resettlement Safeguards: To avoid involuntary resettlement wherever possible; to minimize involuntary resettlement by exploring project and design alternatives; to enhance, or at least restore, the livelihoods of all displaced persons in real terms relative to pre-project levels; and to improve the standards of living of the displaced poor and other vulnerable groups.

Indigenous People Safeguards: To design and implement projects in a way that fosters full respect for Indigenous Peoples' identity, dignity, human rights, livelihood systems, and cultural uniqueness as defined by the Indigenous Peoples themselves so that they (i) receive culturally appropriate social and economic benefits, (ii) do not suffer adverse impacts as a result of projects, and (iii) can participate actively in projects that affect them.

Environment Categorization: NDB uses a classification system to reflect the significance of a project's potential environmental impacts. A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts. Projects are assigned to one of the following four categories: **High risks (A), Moderate risks (B), Low risks (C)** and **Category FI:** For Proposed projects funded through financial intermediaries (FI), such as banks, microfinance institutions, investment funds, insurance companies, mortgage companies, etc.

A list of National and State level legislations and regulations that could have a bearing on the Project during its design, implementation, and monitoring stages is covered in this Chapter.

3.2 APPLICABLE ACTS/GUIDELINES/POLICIES OF CENTRAL GOVERNMENT

The legislation of GoI and with respect to environmental and social management applicable to the project components have been reviewed. The relevance of national and state level legislation to the project is presented in Table-3.1.

Table-3.1: Relevance of National and State Level Legislation to the project

No.	National/State Legislation	Description on provisions related to the Project	Relevance to the Project
1	National Environment Policy 2005	• National Environment Policy deals with the issues related to the control and regulation of environmental degradation and underline the needs for water conservation for different use and appropriate management, including integrated water management considering ecological use as a means.	• ESIA and ESMP to examine the provisions of this policy, examine the clauses that are attracted and suggest remedial measures.
2	• Environmental (Protection) Act, 1986, • Environmental	• This Act empowers Central Government to take necessary action to protect the environment and in the prevention of environmental pollution. .	Applicable
3	The Biological Diversity Act, 2002	• This Act aims to integrate conservation, promotion and sustainable use of biological diversity into projects. The State Government can declare areas rich in biological diversity, or when biological resources are threatened by overuse, abuse or neglect, as areas of biological importance for preservation.	Applicable. .
4	The Wild Life (Protection) Act 1972, Amendment, 2002	• This Act provides for the protection of the country's wild animals, birds, and plant species, in order to ensure environmental and ecological security. Among other things, the Act lays down restrictions on	Applicable.

No.	National/State Legislation	Description on provisions related to the Project	Relevance to the Project
		hunting many animal species. The Act was last amended in the year 2006.	
5	Noise Pollution (Regulation and Control) Rules, 2000	• Outlines the permitted noise level in various areas, including from those of vehicular traffic, generators, and construction activities is defined under these rules.	• All construction programmes need to ensure compliance. The standards are to be included in the bid documents for civil works Contracts for compliance.
6	Air (Prevention and Control of Pollution) Act, 1981, its Rules and amendments	• Prevention and Control of Air Pollution Boards have set up to monitor and manage activities that would lead to air pollution in and around the project area. Under the Act ambient air quality standards are to be maintained in residential, ecologically sensitive areas.	• During construction phase, likely use of diesel generators, movement of heavy transport on unpaved or semi-paved roads may cause air pollution. Bid documents for civil works contracts should include that ambient air quality standards to be maintained for compliance.
7	Water Prevention and Control of Pollution) Act, 1974, Amendment thereof	To prevent and control water pollution.	Applicable. Effluents expected to be generated during construction and operation phase of the project shall be treated as per standards, prior to disposal.
8	Solid Waste Management Rules, 2016	• The provisions of the Act prevent littering and mandate proper segregation, collection, storage and disposal of municipal solid waste.	Applicable The project will include provisions for proper disposal of solid wastes generated from various sources.
9	Hazardous & Other Wastes Management and Trans boundary Movement) Rules, 2016	Proper handling storage and disposal of hazardous waste.	Project has potential to generate hazardous waste (Used Oil) during both construction and operation phases. The same shall be handled as per the applicable rules of the Act. Various measures shall be included in the bid

No.	National/State Legislation	Description on provisions related to the Project	Relevance to the Project
			document for compliance by the contractor involved in construction.
10	E- Waste Management Rules 2016	The e-waste especially unused cables, electrical switches may be generated during construction and unused computers, laptops, cables etc. during operation of terminal.	Provisions in the bid document be made for disposal of e-waste by contractor. During implementation project proponent will implement the provision of this Act for proper disposal of e-waste.
11	Plastic Waste Management 2016	The plastic waste like polythene, plastic bags, plastic bottles etc. during project construction and operation phases.	Provisions in the bid document be made for disposal of plastic waste by contractor. In operation phase, project proponent will implement the provision of this Act for disposal of Plastic waste.
12	Construction and Demolition Waste Management Rules, 2016	• Rules and Regulations for handling of Construction & Demolition Waste	Applicable The project shall generate construction and demolition wastes, which shall be disposed as per the applicable norms.
13	RFCTLARR ACT,2013	Provides compensation to families who are affected or whose land has been acquired or livelihood has been affected, as a result of land acquisition. Provides adequate provision for rehabilitation and resettlement of the families affected	Currently acquisition of private land is not envisaged, hence it is not applicable. However, If , private land is to be acquired for any component then, the Act shall be applicable
14	The Ancient Monuments and Archaeological sites and Remains (Amendment and Validation) Act, 2010	• The act aims to protect the Ancient Monuments and Archaeological sites and Remains	Currently, no ancient monuments and archaeological sites etc. are falls in the proposed alignment hence not applicable. However, during construction phase if, any encounter

No.	National/State Legislation	Description on provisions related to the Project	Relevance to the Project
			especially during the excavation in that case all the provisions are applicable.
15	Labour laws	• All legislation governing the labour including child and women labour, wages and compensation, working condition and worker welfare will have a bearing on the project	• Bid documents for the Contractor shall include adequate provisions to ensure strict compliance with applicable labour laws and regulations
16	National Policy on Safety, Health and Environment at Workplace	• Policy aims to secure health of strength of employees and ensure humane conditions of work, including maternity relief to women	Applicable. The provisions will be applicable to ensure that labour camps and working conditions are safe and humane.
17	Minimum Wages Act, 1948	• Act makes it mandatory for the employer to pay every employee in a scheduled employment under him wages at the rate not less than the minimum rates of wages fixed under the Act.	Applicable The project involves labour employment. Wages paid to the labour shall be documented in proper records shall be maintained. As far as possible, cash payment shall be discourage.
18	National Policy for Empowerment of Women**,** 2001	• Policy advocates for equal access to participation and decision making of women in social, political and economic life of the nation and mainstreaming a gender perspective in the development process.	Applicable The project shall provide equal access and opportunity to women in employment, remuneration, occupational health and safety, social security, etc.
19	Child Labour (Prohibition and Regulation) Act, 1986	• Act prohibits the engagement of children in certain employments and to regulate the conditions of work or children in certain other employments.	Applicable To prevent contractor from employing child labour who shall come under the purview of the Act; the project will include relevant

No.	National/State Legislation	Description on provisions related to the Project	Relevance to the Project
			provisions in the bid document for compliance of the provision of this Act.
20	Sexual Harassment at the workplace (Prevention, Prohibition and Redressal), 2013	Sexual harassment at the workplace is prohibited by law and can lead to disciplinary, civil, and criminal action. This means that an employer can act for a misconduct against an employee and can impose any penalty, including fines and dismissal, on any employee found guilty of sexual harassment.	Applicable
21	Right to Information (RTI) Act, 2005.	• The Act provides for setting out the practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority. Under the provisions of the Act, any India citizen may request information from a "public authority" (a body of Government) which is required to reply expeditiously or within thirty days.	Applicable RTDC Ltd is already complying the provision of the Act.

3.3 OTHER RELEVANT ACTS

- The Employees' Provident Funds and Miscellaneous Provisions act, 1952**:** The record of Provident Fund deduction along with wages of labour given by contractor to be kept in record.
- Equal Remuneration Act, 1976- Record of equal remuneration to men and women workers

for similar nature of work needs to be maintained by contractor. ***(****As per Clause no. 4 & 8 of Act).*

- Inter-State Migrant Workmen's (Regulation of Employment and condition of services) Act, 1979-Record of registration of inter-State migrant workmen needs to be maintained by contractor. *(As per Clause no. 4 & 23 of Act).*
- Central Motor Vehicle Act, 1988 and Central Motor Vehicle Rules, 1989**:** Record of Vehicles used in project to be maintained like date of registration, insurance papers, fitness certificate, PUC etc. *(As per Clause no. 115 & 139 of Act).*
- Public Liability Insurance Act and Rules, 1991- Contractors shall undertake the public liability Insurance for their work for a value commensurate with work involved. *(for immediate relief in case of any untoward incidence).*
- The Building and others construction workers (Regulation of Employment and conditions of services) Act, 1996: The record of welfare measures for labors, such as **canteens,** first-aid facilities, ambulance, housing accommodation for workers near the workplace are needs to be maintained by Contractors. *(As per Clause no. 30 of Act).*

3.4 ENVIRONMENTAL AND FOREST CLEARANCE

3.4.1 Environmental Clearance

The proposed project being an Aerial Ropeway falls under the activity 7 (g) of the EIA notification, 2006. However, as per MoEF&CC Notifications dated 27th April, 2022, the aerial ropeway project i.e. 7 (g) are excluded from EIA Notification and thus the proposed project do not require EC from MoEF&CC or any agency.

3.3.2 Forest Clearance

The state Government of Himanchal Pradesh requested MoEF&CC vide letter dated 20th April, 2019 for exclusion of Ropeway Projects from the ambit of Forest (Conservation) Act, 1980 and payment of NPV. The FAC, after through deliberation and discussions with Nodal Officer, Himachal Pradesh, recommended to accept the request of Government of Himachal Pradesh (letter dated 5th August, 2019) with following specific conditions:

- Dispensation shall be allowed for construction of ropeways to be utilized by public.
- Lowest point of the proposed ropeway shall be at least 5 meters above the tree line.
- The forest area under ropeway passage shall not be included in the total area requested for diversion for the project under the provisions of FCA, 1980.
- Forest area under the terminal stations and intermediate towers shall be considered for diversion under the provisions of FCA 1980.

- User agency shall have no claim on the forest land under the ropeway.
- Permission of laying the ropeway above 5 meter of tree line do not give any right to the user agency to use the forest land, under the ropeway, for any non-forestry purpose in future without approval under FCA, 1980.

CHAPTER- 4
STAKEHOLDERS CONSULTATION AND DISCLOSURE

CHAPTER- 4

STAKEHOLDERS CONSULTATION AND DISCLOSURE

4.1 INTRODUCTION

The stakeholder consultation process helps in positive support of general public and due to involvement of locals in the decision making process. These consultations help to acknowledge the Project Affected Persons (PAPs), if any, about the project. The relevant information is exchanged, observations, suggestions given by the people are documented.

4.2 STAKEHOLDER MAPPING

Stakeholder mapping has been done to list the key stakeholders and classified under categories as detailed in Table-4.1. The consultation with stakeholders has been done at various stages of Project implementation.

The stakeholder consultations were conducted through:

- **Formal consultations-**The consultations were taken up with formal communications and identified stakeholders.
- **Stakeholders Meeting**– The consultations were done through meetings with key important stakeholders.
- **Focus Group Discussions (FGD):** conducted through interaction with specific stakeholders using structured formats.

Table-4.1: Stakeholder Mapping and Analysis

Stakeholder	Rationale	Relevance to the project	Strategy for engaging the Stakeholder
Category -1- Transporters			
Taxi Associations/ Tour and Travels Operators	Impacts on livelihood	Increase in income due to influx of more tourist than usual	Consultations
Himachal Road Transport Corporation	Impacts on livelihood	May be decrease in revenue and employment due to shifting of local commuters to new mode of transportation	Consultations
Category -2- Government Offices			
District Administration	Primary Support	Project facilitation	Consultations
Revenue Department	Details of land ownership/ transfer/ Land aquisition	Land details and transfer	Official communication
Public Works Department (PWD) and Central Public	Change in land use/	Impacts on structures, land, properties	Official communication

Stakeholder	Rationale	Relevance to the project	Strategy for engaging the Stakeholder
Works Department (CPWD)	property/ structures		
Police Department	Primary Support	Project facilitation	Consultations
Forest Department	Wherever forest land impacted	Land transfer	Official communication
Horticulture Department	Wherever land impacted	Land transfer	Official communication
State Disaster Management Authority	Supportive intervention	Up-dation of strategic planning, guidelines, awareness campaign,	Consultations
Tourism and Civil Aviation Department	Supportive intervention	Up-dation and integration of information, civic amenities and facilities.	Consultations
Shimla District and Session Court	Supportive intervention	Project facilitation	Consultations
Labour Welfare Department	Supportive intervention	Project facilitation	Consultations
State Pollution Control Board	Supportive intervention	Review and information of existing environmental monitoring and pollution abatement measures	Consultations
Northern Railway (Kalka-Shimla)	Impact on land/ structures	Verification of land/ structures of Northern Railways vis-à-vis proposed ropeway alignment	Official communication
Fire Services	Primary Support	Project facilitation	Consultations
Himachal Waqf Board	Impact on land/ structures	Verification and identification of land structures	Consultations
Shimla Smart City Limited	Impacts on Land, structures, mobility	Impacts on ongoing projects	Official communication
Himachal Pradesh State Electricity Board Limited	Impacts on existing structures	Assessment of shifting of utilities	Official communication
Shimla Jal Prabandhan Nigam Limited	Impacts on existing structures	Assessment of utilities to be Shifted	Official communication

Stakeholder	Rationale	Relevance to the project	Strategy for engaging the Stakeholder
Town and Country Planning Department	Change in land use	Assessment of policies and land use	Official communication
Directorate of Energy	Impacts on existing energy load	Assessment of energy requirement, suggestion for energy conversation measures	Official communication
Department of Environment Science and Technology	Supportive intervention	Review and suggestion for different clearances	Consultations
Municipal Corporation	Change of land use/ property/ structures	Impacts on structures, land, properties, support for municipal services during construction and operation	Official communication
Jal Shakti Vibhag	Impacts on existing structures	Impacts if any, on existing and proposed developments	Official communication
BSNL Limited	Impacts on existing structures	Assessment of shifting of utilities	Official communication
Category -3- Community leaders/ Village level officers			
Gaon Panchayat Leaders	Facilitation Support	Opinion about the project	Questionnaire/ Interviews
Various Village level/ ward level relevant officers	Data facilitation and supports	Providing village level information	Questionnaire/ Interviews
Category-4- Civil society organizations, Associations, Academics and Media			
Non-Government Organizations (NGOs)	Project support	Supportive interventions	Consultations
Educational Institutes	Project support	Supportive interventions	Consultations
Hotel and Restaurant Association	Project support	Supportive interventions	Consultations
Traders Market Association	Project support	Suggestions during planning and implementation for enhancement of trade	Consultations
Media	Media Supports	IEC supports	Consultation/ contract
Category-5- Commuter and users			
Commuters/ Students/ Tourists	Primary stakeholder	Beneficiaries of the project	FGDs

4.3 FOCUS GROUP DISCUSSIONS (FGDS)

In addition to the Stakeholders Consultation Meeting a series of Focus Group Discussions (FGDs) were also organized at each terminal sites with Commuters, Traders, Hoteliers and members of influential Bodies.

4.3.1 Approach and Methodology

The Focus Group Discussions (FGDs) were organized with key stakeholders to get their views and suggestions on proposed station locations. Daily commuters, tourist, nearby shopkeepers/ vendors, members of union/ associations were purposively selected for the discussions. The team members were trained enough to ensure that all participants are comfortable and engaged with the discussions, and that their opinions were noted down.

4.3.2 Tools Used

A semi structured schedule **Annexure-I** was used to collect the first hand information from the selected groups.

4.3.3 Focus Group Discussions (FGDs) at Proposed Stations

Focus Group Discussions (FGDs) with different groups of people was done in the month of March'2023 (28.03.2023 and 31.03.2023) to ascertain their views on the proposed project.

Primary assessment was carried out by means of consultations and Focus Group Discussions in order to analyze social factors that are to be taken into consideration for project planning. This exercise is carried out to identify ways to mitigate any adverse social impacts and enhance positive ones. The team of experts interacted with different groups of people like daily commuters, taxi operators, hoteliers, students, women groups (housewives, working executives, shop owners etc.), traffic police personnel and small vendors etc. in the month of March, 2023 to ascertain their views on the proposed project. The perception and concerns raised in the Focus Group Discussions (FGDs) are presented in the section below.

4.4 PERCEPTION OF THE PROPOSED PROJECT BY THE PEOPLE

Discussions/ Consultations were held in the study area to understand the perception and concerns of the locals with regard to the proposed ropeway project. The city of Shimla being the capital of the state of Himachal Pradesh and top most tourist destination, educational hub is currently facing traffic congestion. The limited space available for expansion of existing roads has created more bottlenecks for decongestion. In order to streamline initiatives and interventions for the selected areas which are already decongested were selected for interaction purpose. Developmental needs and aspirations of the people were understood. The respondents were very positive about the proposed project and expressed the following views for the project:

- Proposed Ropeway will provide an alternative mode of transport and it will decrease the travel time

- Scope for development of road network in the city is very limited due to unavailability of land, which is why other mode of transportation are required.

- Number of vehicles plying on roads will reduce and it will be helpful in traffic decongestion on the road.

- Amongst the locals, students and employees expressed that currently they generally start early in the morning to reach on time to their respective destinations due to traffic congestion. The proposed project will save their time.

- Currently the volume of customers visiting the Mall Road, Victory tunnel area is reduced due to restrictions on movement of vehicles. Hoteliers feels that the upcoming project will increase the volume of customers due to direct connectivity by ropeway project.

- Taxi/Bus operators expressed concerns on their business, may be due to reduction in commuters. The income of local transporters will be increased during construction period whereas it will be reduced temporarily during operation phase.

- Additional parking facilities to be created by ropeways will be helpful for reducing the load on existing parking lots.

- People expressed concern about the impact of scenic beauty of Shimla, and suggested take care during planning, design, construction and operation phases.

- Fare of ropeway facility should be affordable and at par to existing fares of public transport.

- During snow season, public transport (buses/ taxi) gets affected and sometimes tends to be closed. Under these circumstances the ropeway facility will be of great help to locals.

The Concerns raised in the Focus Group Discussions (FGDs) organized are presented in Table-4.2 and photographs are enclosed as **Annexure-II:**

Table-4.2: Focus Group Discussions (FGDs)

Focused Group	Concerns Raised	Response & mitigation Measures
Regular Commuters (Students, Working professionals, Women)	• Concessional monthly ticket card to save money and time • Preference for elderly and physically challenged • Washroom facility at stations • Parking area must be well developed • Safety of the commuters • Frequency of cable cars	• Suggestions are noted and will be considered. • Fare of proposed ropeway facilities will be competitive and at par with the existing public transport system. • Parking facilities near the stations will be developed as per land availability • Washrooms and other sanitary facilities will be provided.

Focused Group	Concerns Raised	Response & mitigation Measures
		• Safety of the commuters will be given top most priority.
Occasional Commuters (Tourist of all age groups including youth, women, aged persons and children)	• Increase in number of rounds during tourists seasons • Washroom facility at station specially for women	• During season time and peak hours of the day frequency of cable car will be increased • Construction of new and proper washrooms and drinking water facility are also proposed
Shopkeepers and Hoteliers	• Parking area must be well developed • The shop keepers at proposed station reported that the construction of ropeway will result in increase of tourists which in turn will affect in their income.	• Parking area will be well developed • Up gradation will be beneficial to shopkeepers/ hoteliers as well as commuters
Taxi & Tour operators	• The proposed project will decrease the demand of local taxi	• Opportunities are anticipated during construction and operation of the project.

4.5 CONSULTATION MEETINGS

Several consultation meetings with different stakeholders and officials of line departments were done during site visits. Specific details of the meetings are presented in following sections.

4.5.1 Institutional Stakeholders Consultation on 24th April 2023

Stakeholders consultation were carried out as an integral part of the social and environmental assessment process of the project with an objective to inform and educate stakeholders about the proposed actions and to receive and record perceptions about the project. It assisted in identification of the likely issues and problems associated with the project as well as the needs and concerns of the population likely to be impacted. This participatory process helped in reducing the concerns in general and enabling participation of the line departments in particular in development process.

- **Conference Hall, Hotel Holiday Home, Shimla on April 24, 2023**

  A stakeholder's consultation meeting was organized on 24.04.2023 at conference hall, Hotel Holiday Home, Shimla by RTDC. The meeting commenced with brief introduction about RTDC, ESIA study and objectives of stakeholder's consultation meeting.

The details about the project were presented by RTDC and experts from WAPCOS explained about the importance of stakeholders meeting in ESIA study for the proposed project.

Invitation letter, summary of feedback, interaction with institutional stakeholders and participants list are enclosed as **Annexures - III, IV, V** and **VI** and photographs of stakeholder's consultation meeting are given in **Annexure- VII.**

4.5.2 Stakeholder Suggestions and Design Considerations

The project proponents assured that the feasible suggestions given by stakeholders will be incorporated into the design/planning and implementation of the project.

4.6 PLANNED INFORMATION DISCLOSURE

The Project Management Unit (PMU) will ensure that relevant information about environmental and social issues are made available in a timely manner, in an accessible place, and in a form and language(s) understandable to the public and other stakeholders. The purpose of such disclosure is that the public can provide meaningful inputs into project/subproject design and implementation.

This ESIA/ESMP will be disclosed at the state level in the project website. Printed copies will be made available upon request at the RTDC. Further, the executive summary of the ESIA Report will be available in English and will also be available as an easy-to-download document on the project website. The website disclosure will be kept up-to-date throughout project implementation. In addition, the ESIA/ESMP (in hard copy) will be made available for public access at the Block office, local body offices and District administration. The documents will also be circulated to Departments of concerned stakeholders.

CHAPTER-5
DESCRIPTION OF THE ENVIRONMENT

CHAPTER-5

DESCRIPTION OF THE ENVIRONMENT

5.1 General

Before the start of any Environmental Impact Assessment study, it is necessary to identify the baseline levels of relevant environmental parameters which are likely to be affected as a result of the construction and operation of the proposed project. A similar approach has been adopted for conducting ESIA study for the proposed ropeway project located at Shimla, Himanchal Pradesh. Thus, planning of baseline survey commenced with the shortlisting of impacts and identification of parameters for which the data needs to be collected.

5.2 Study Area

The Study Area (refer Figure-5.1) considered for the Environmental Assessment study shall comprise of the following:

- Area within 500 m radius from the project alignment for primary data
- Area to be acquired for various project appurtenances.
- Area within Row of 20 meter along the alignment.
- Area within 10 km periphery of proposed alignment of ropeway and terminal stations for secondary data

The baseline status has been divided into following three categories:

- Physico-chemical aspects
- Ecological aspects
- Socio Economic aspects

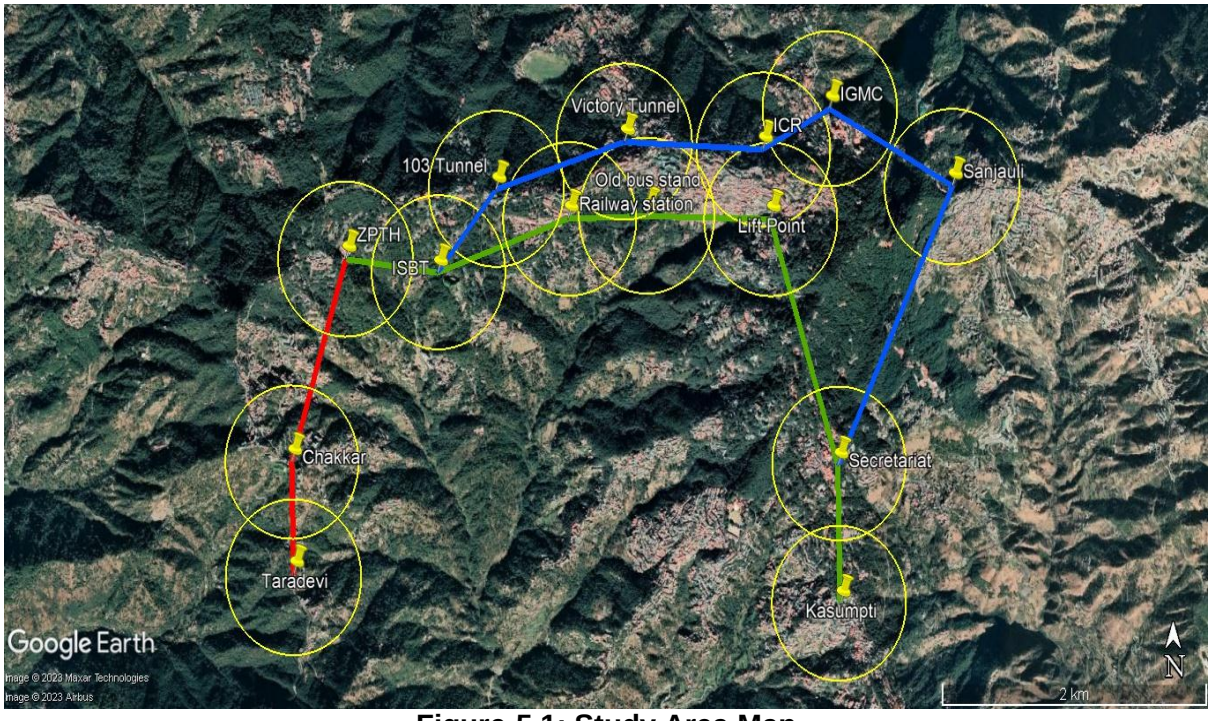


Figure-5.1: Study Area Map

5.3 Physico-Chemical Aspects

5.3.1 Meteorology

The climate in Shimla is predominantly cool during winters and moderately warm during summer. Temperatures typically range from −4 °C to 31 °C over the course of a calander year. The average rainfall in the region is 900 mm. The average temperature varies from 15^{o} to 20^{o}C and increases even above 30^{o}C in the months of May-June. The Chilly winds from the upper Himalayas make winters in Shimla cold. In the last week of December Shimla generally receives snowfall.

The nearest Indian Meteorological Department (IMD) station located to project site is Shimla. Climatological data of Shimla (31° 06' N and 77° 10' E), published by the IMD, based on daily observations at 08:30 and 17:30 hour IST for a 30-year period (1981-2010), is presented in the following section on meteorological conditions of the region. The data collected from IMD station at Shimla has been used to describe the meteorological conditions in the project area and is summarized in Table-5.1.

Table-5.1: Average Meteorological Conditions

Month	Temperature (^{o}C)		Monthly Total Rainfall (mm)	Relative Humidity (%)	
	Maximum	Minimum		At 8.30 hrs	At 17.30 hrs
January	10.9	2.8	66.4	54	67
February	11.9	3.7	75.3	55	65
March	15.8	7	81.2	50	57
April	20.5	11.4	60.8	46	47
May	24.1	14.6	90.3	49	48
June	24.8	16.2	181.9	64	62
July	22.6	15.9	329.8	86	85
August	22	15.5	320.4	88	88
September	22.1	14.1	142.3	75	79
October	20.3	11.1	36.7	53	63
November	16.7	7.8	18.4	48	61
December	13.5	5.1	24.2	46	60
Total			**1427.7**		
Average	**18.8**	**10.4**		**60**	**65**

Source: India Meteorological Department station at Shimla

Temperature

The average daily temperature ranges from 10.4^{o}C to 18.8^{o}C. The month wise temperature variations at Shimla is depicted in Figure-5.2.

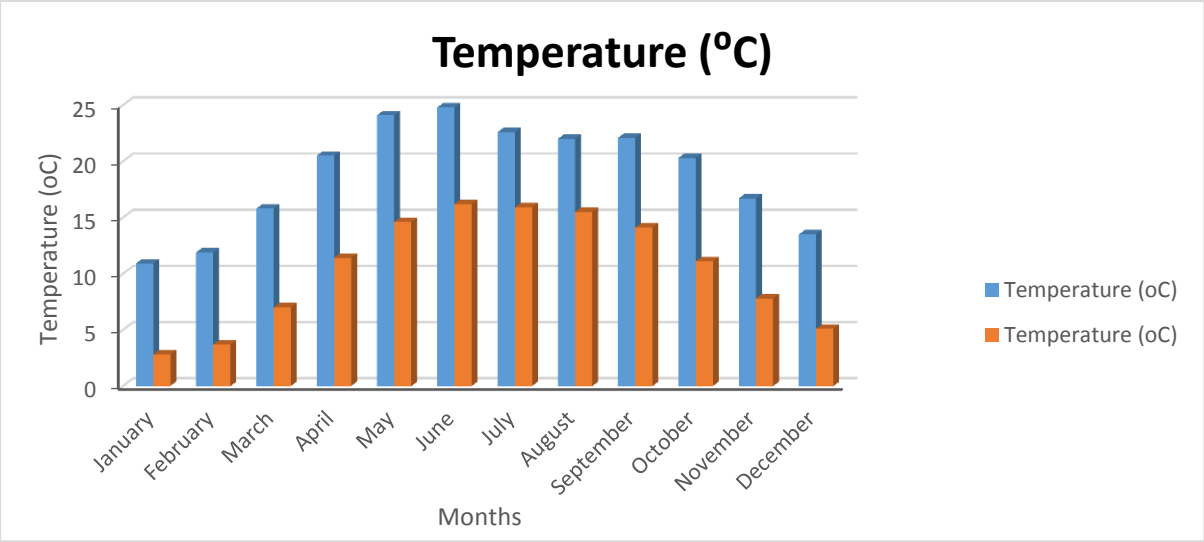


Figure-5.2: Month-wise Variation of Maximum and Minimum Temperatures at Shimla

Rainfall

The average annual rainfall at Shimla is 1427.7 mm. The month wise rainfall received at IMD station Shimla is depicted in Figure-5.3.

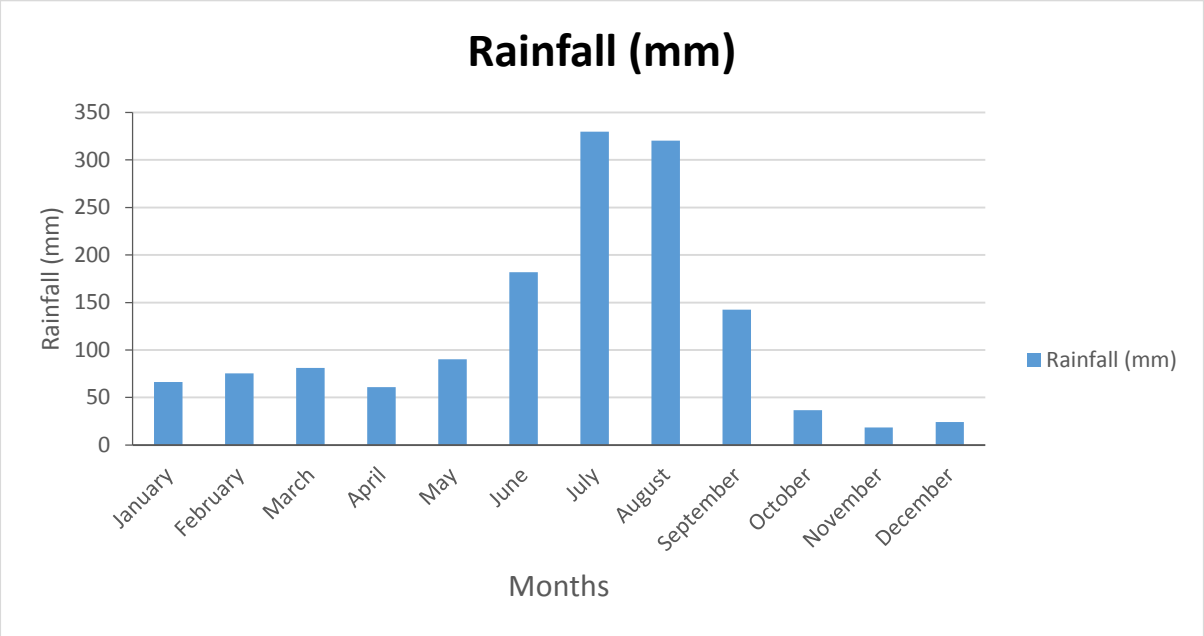


Figure-5.3: Month wise Rainfall received at Shimla

Humidity

At Shimla, mean relative humidity at 08:30 hours is 60% and 65% at 17:30 hours. The month wise relative humidity observed at IMD station Shimla is depicted in Figure-5.4.

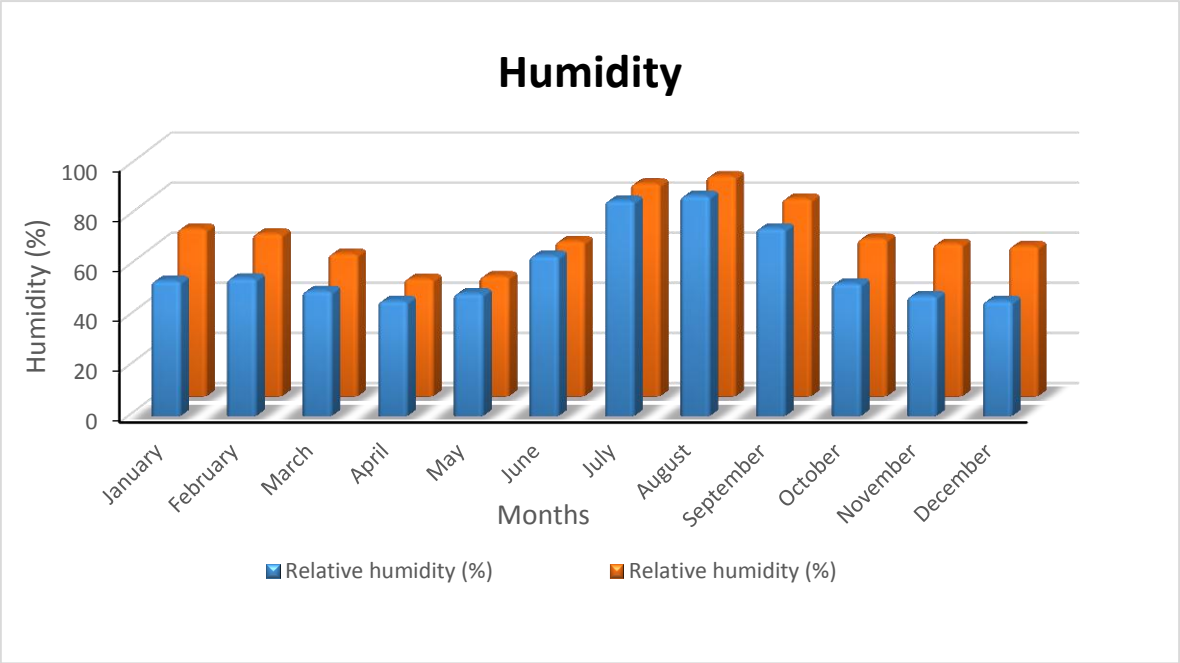


Figure-5.4: Month wise variations in Humidity at Shimla

5.3.2 Geology and Seismicity

Soil is generally sandy loam in valley areas of Shimla district and in rest of the hilly and mountainous areas soil is skeletal. The soil depth is generally shallow except in areas having good vegetative cover. It is generally dry, shallow and deficient in organic matter. Shimla city falls under Lower Neoproterozoic zone.

The Jaunsar Group, Shimla Group and Batal Formation of Haimanta Group represent the Lower Neoproterozoic division. The city of Shimla falls under the Shimla Group, which comprises of earlier Chail Formation, The Shimla series is represented by Shale, Slate, quartzite, greywacke and local conglomerates is well exposed in Sanjauli-Dhalli area.

The Shimla Group is divisible into four formations namely, Basantpur, Kunihar, Chhaosa and Sanjauli. The Basantpur Formation is characterized by the abundant interbeds of limestone and dolomite within argillite and siltstone whereas Kunihar Formation comprises lenticular interbeds of stromatolite-bearing limestone with fissile shales. The Chhaosa Formation is characterized by a thick rhythmic sequence of shale, siltstone and greywacke. The Sanjauli Formation is divisible into Lower and Upper Members, on the basis of characteristic lithological associations. Lower member is characterized by an association of coarse gritty sandstone and greywacke. The Upper Sanjauli Member comprises conglomerate and arkose arenite exposed on the Kandaghat-Chail road. Shimla town is situated in Seismic Zone IV as per IS 1893. The Geological map of Shimla District is given in Figure-5.5 (Source: Report of Central Ground Water Board).

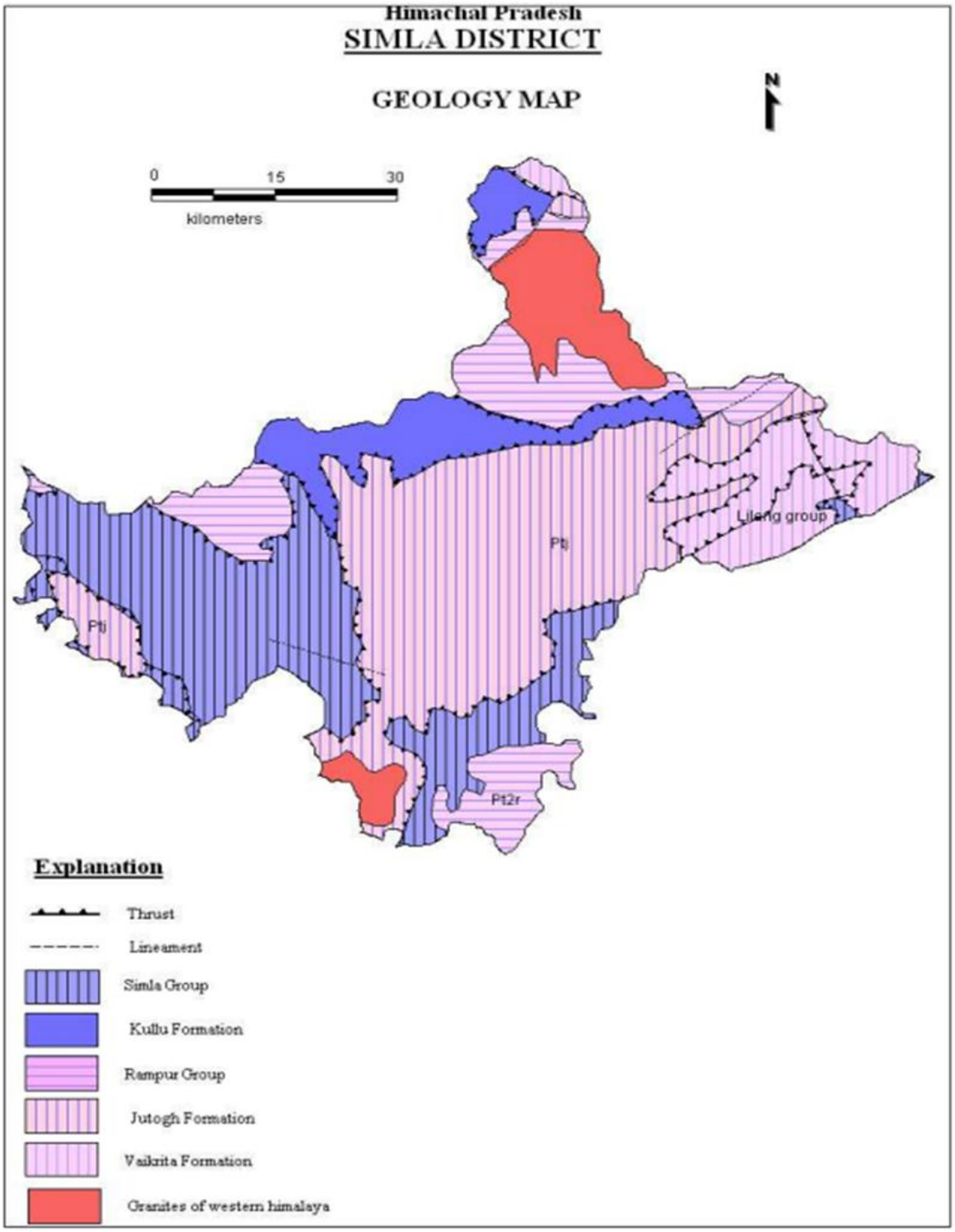


Figure-5.5: Geological Map of Shimla District

5.3.3 Hydrogeology

The major parts of Shimla district are hilly and mountainous with highly dissected and undulating terrain. These areas are underlain by consolidated hard rock's of Proterozoic period. Ground water potential in such areas is very low due to its hydrogeomorphic set up. Springs are the main ground water structures that provide water for domestic and irrigation in major rural and urban centers.

The springs, locally called "*Chasma"* are mainly gravity, contact or fracture type. The springs located along major thrust/fault or structurally weak planes are highyielding. The discharge

of these springs varies from seepages to as high as ten litres per second (lps). *Bowries*, a type of dug well, are another structures constructed in the hill slopes to tap the seepages. Such *Bowries* are very common and observed all over the district.

Simla district is drained by streams/rivers forming part of the drainage basins of the Sutlej, the Yamuna, the Pabbar and Tons rivers. However, major part of the district is drained by tributaries of Sutlej River. The Sutlej River is the longest river traversing along the north western boundary of the area and Giri river which is a tributary of the Yamuna River originates from the eastern part and runs in the south-west direction. Whereas, tributaries of Tons river, flows in the southern parts and the Pabbar river in the eastern parts of the district. In general the density of drainage is moderate to high.

The Kufri-Dhalli-Sanjauli-Ridge-Tutu spinal is a drainage divide of Shimla city. The tributaries on southern side go to Yamuna and, those on northern side to Satluj. Shimla has 13 major nallahs and number of minor nallahs. The Shimla being a hill town, natural drains carries the water to valleys in to khads, which are used as source of water supply for Shimla. There are no major water bodies both natural and artificial within Shimla city. The river Satluj is also 21 km away from Shimla city

5.3.4 Land use

The assessment is based on the land use distribution available in the records of Town and Country Planning Department Govt. of Himachal Pradesh for February 2022. Land use survey conducted in 2004 gives the land use distribution in the Shimla District. The distribution of land uses is divided among residential, commercial, industrial, public &semi-public, Parks and open spaces, Traffic and Transportation, Agriculture, Forest, Water bodies and undeveloped lands. The Land use 2004 as per Shimla Development Area is given in Table-5.2 and presented in Figure-5.6.

Table-5.2: The Land use in Shimla Development Area

S. No.	Land Use Category	Area (Hectare)	% of urban Area	% Area
1.	Residential	903.13	61.19	9.07
2.	Commercial	25.22	1.71	0.25
3.	Industrial	9.00	0.62	0.09
4.	Tourism	21.70	1.47	022
5.	Public & semi-public	138.78	9.40	1.39
6.	Parks & open spaces	6.00	0.41	0.06
7.	Traffic & Transportation	371.93	25.20	3.75
Total		**1475.76**	**100.00**	
8.	Agriculture	2174.75		21.85
9.	Forest	6080.15		61.12
10.	Water bodies and Undeveloped land	219.34		2.20
Grand Total		**9950.00**		**100.00**

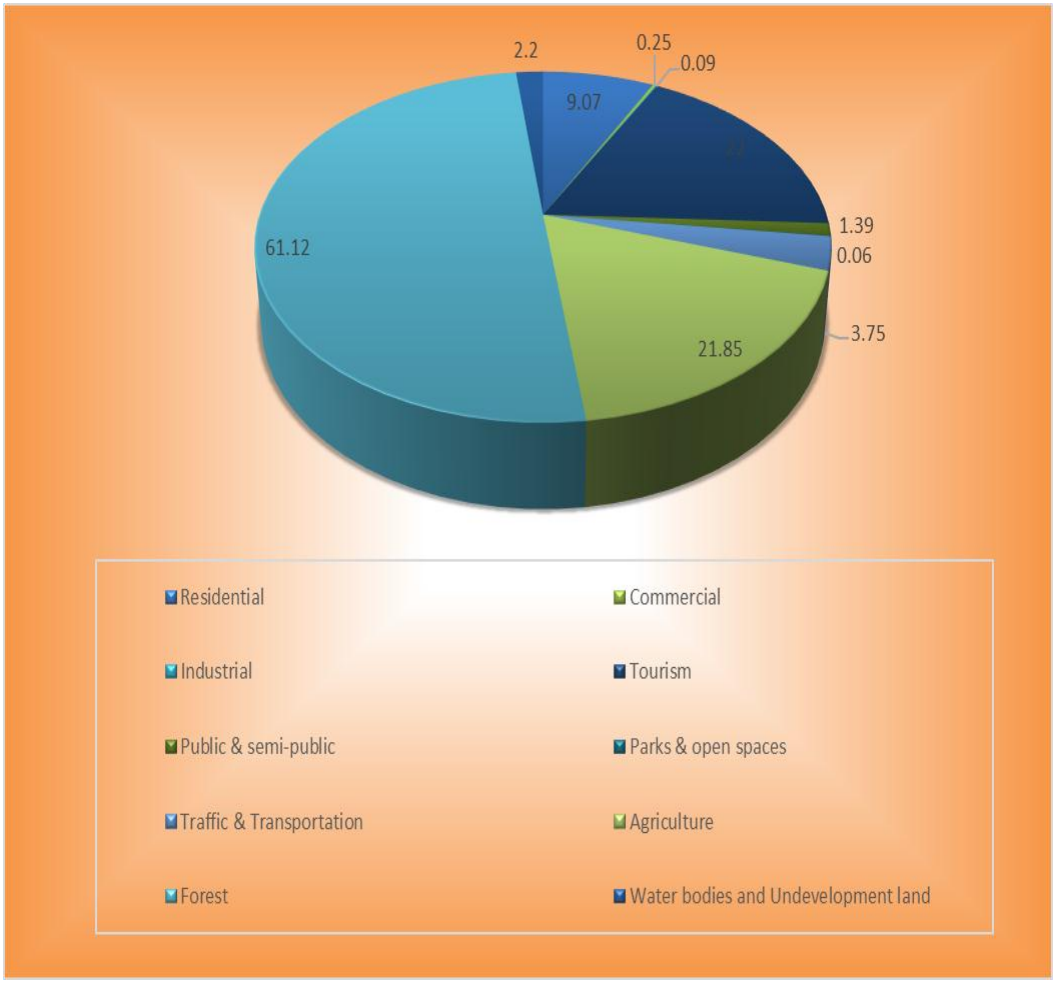


Figure-5.6: Land Use Pattern of Shimla Development Area

5.3.5 Soils

Soil is the product of geological, chemical and biological interactions. The soils in the region vary according to altitude and climate. Shimla district presents an intricate mosaic of high mountain ranges, hills and narrow deep valleys with altitude ranging from 1000 to 3000 m above MSL. Soil is generally sandy loam in valley areas of the district and in rest of the hilly and mountainous areas soil is skeletal. The soil depth is generally shallow except in areas having good vegetative cover. It is generally dry, shallow and deficient in organic matter. Landslides are the common features in mountainous terrains. Soils are rich in nutrients and thus are fertile.

As a part of field studies, soil samples were collected from 15 locations in the study area. The depth of locations ranged from 20 to 50 cm below the ground. Testing of soil has been done as per IS: 2720. Sampling locations are listed in Table-5.3. The results of the analysis of soil sampling conducted are given in Table-5.4. The sampling location map is enclosed as Figure-5.7.

Table-5.3: Details of Locations of Soil Sampling

S. No.	Sample Code	Date of Sampling	Location/Site Name	Coordinates
1	S1	30/05/2023	TARA DEVI	31° 4'49.18"N, 77° 8'18.52"E
2	S2	01/06/2023	CHAKKAR	31° 5'15.01"N, 77° 8'17.92"E
3	S3	30/05/2023	ZTPH	31° 5'54.36"N, 77° 8'34.50"E
4	S4	30/05/2023	ISBT	31° 5'55.47"N, 77° 9'0.58"E
5	S5	01/06/2023	103 TUNNEL	31° 6'12.60"N, 77° 9'15.75"E
6	S6	31/05/2023	RAILWAY STATION	31° 6'7.50"N, 77° 9'38.33"E
7	S7	31/05/2023	OLD BUS STAND	31° 6'16.66"N, 77° 9'54.83"E
8	S8	01/06/2023	VICTORY TUNNEL	31° 6'23.68"N, 77° 9'54.11"E
9	S9	02/06/2023	ICR	31° 6'21.26"N, 77°10'31.67"E
10	S10	01/06/2023	LIFT POINT	31° 6'11.95"N, 77°10'32.16"E
11	S11	02/06/2023	IGMC	31° 6'28.88"N, 77°10'51.60"E
12	S12	01/06/2023	SANJAULI	31° 5'52.55"N, 77°11'6.17"E
13	S13	01/06/2023	NAV BAHAR	31° 5'43.19"N, 77°11'15.06"E
14	S14	01/06/2023	SECRETARIAT	31° 5'15.10"N, 77°10'54.31"E
15	S15	01/06/2023	KASUMPTI	31° 4'46.60"N, 77°10'53.25"E

The pH in various soil samples ranged from 7.12 to 8.72, which indicates the neutral range having slight alkalinity. The low Electrical conductivity (EC) value ranging between 216 to 421 µS/cm in 1:1 suspension indicates that low salt content in soils. The bulk density ranged from 0.72 to 1.29 g/cm^3, which indicates that below the average. Soils with low bulk density are generally more suitable for agriculture, since the high pore space has a greater potential to store water and allow roots to grow more readily. The soil type in this area is majorly sandy loam.

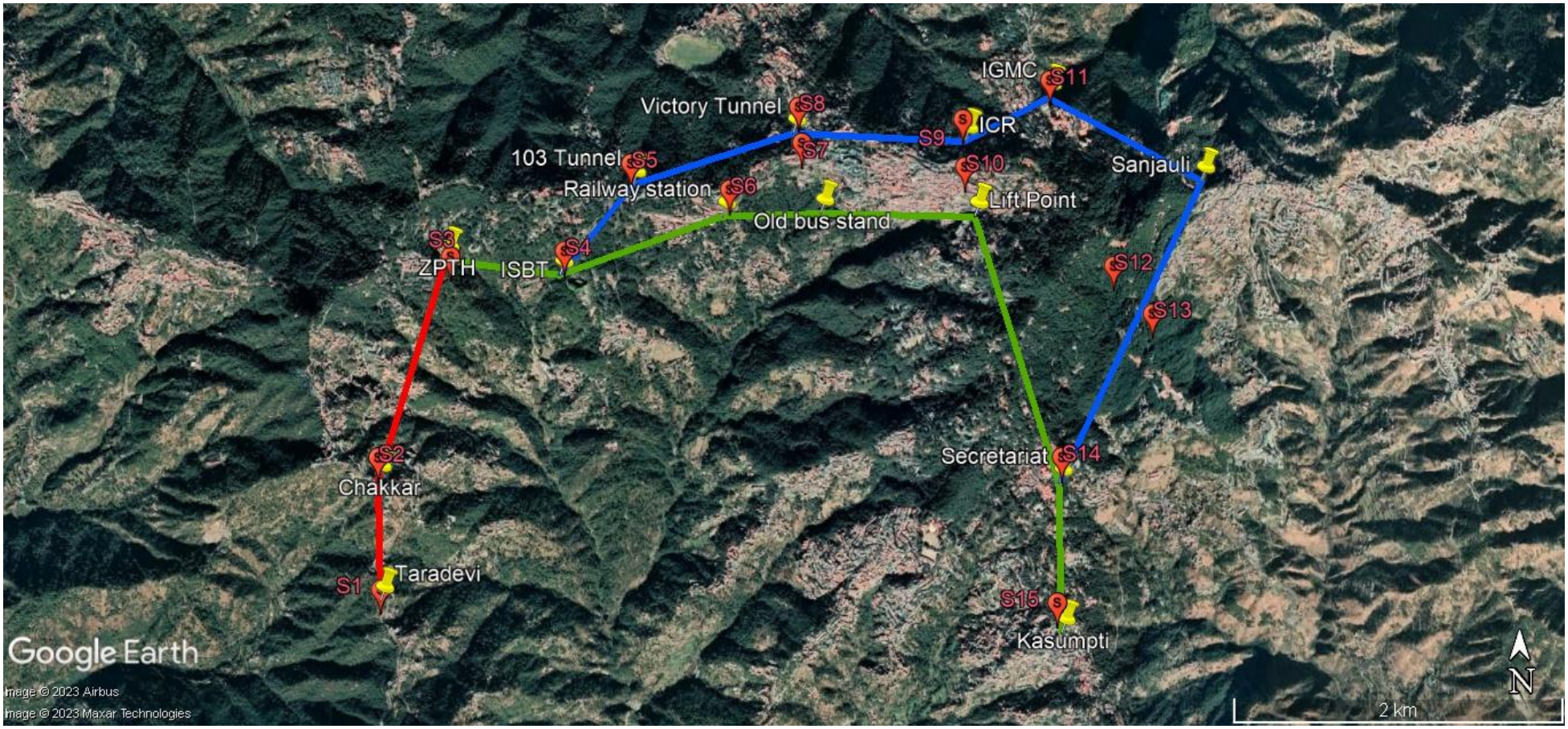


Figure-5.7: Soil Sampling Location Map

Table-5.4: Results of soil sampling analysis of study area

Parameter		S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	S13	S14	S15
pH (1:5 Suspension)		7.12	7.48	7.69	7.56	7.52	7.48	7.89	7.66	7.51	8.19	8.01	8.72	8.22	7.99	8.01
Electrical Conductivity		416	216	362	412	319	321	382	354	395	388	410	419	372	421	365
Calcium (as Cal)		1329	1265	1098	879	875	1552	1219	1510	938	845	852	845	868	849	810
Magnesium (as Mg)		251	169	183	129	110	252	219	262	179	226	232	221	229	219	219
Sodium (as Na)		172	119	141	149	169	162	148	171	123	159	142	142	160	142	142
Available Potassium (as K)		209	182	219	221	295	249	232	328	189.8	220	229	218	228	216	226
Salinity @ 25^{o}C (1:1 Suspension)		281	222	265	282	315	285	221	279	252	245	242	255	242	232	232
Organic Matter		2.01	1.65	2.21	2.62	2.52	2.32	1.98	2.39	1.92	2.10	2.09	2.16	2.19	2.19	2.16
Sodium Absorption Ratio		0.36	0.31	0.28	0.29	0.51	0.49	0.38	0.32	0.29	0.31	0.39	0.35	0.36	0.28	0.29
Nitrogen		0.147	0.138	0.142	0.121	0.16	0.14l	0.131	0.146	0.122	0.099	0.101	0.100	0.098	0.101	0.101
Available Potassium (as P_2O_5)		22.8	20.32	23.59	20.29	25.06	21.79	25.20	22.60	18.10	13.90	13.42	13.12	13.10	12.90	13.75
Bulk Density		I.I I	I.I I	1.08	I. 11	1.10	I.I 1	1.29	1.09	0.88	0.81	0.89	0.89	0.72	0.78	0.72
Organic Carbon		1.42	1.12	1.12	1.32	1.62	I.69	1.28	1.42	I.IO	1.26	1.29	1.29	1.21	1.21	I.II
Particle Size Distribution	Sand	61.8	62.2	62.8	60.8	57.8	60.8	58.9	62.8	61.6	57.2	54.5	55.8	56.2	55.2	54.2
	Clay	28.2	19.8	15.9	18.5	23.2	24.9	23.6	28.6	13.9	18.5	18.8	17.5	19.9	18.5	19.2
	Silt	10.0	18.0	21.3	20.7	19.0	14.3	17.5	8.6	24.5	24.3	26.7	26.7	23.9	26.3	26.6
Exchangeable Sodium Percentage		3.99	4.32	4.10	4.15	4.56	3.62	2.79	4.09	2.32	3.83	3.75	3.89	3.76	4.10	4.12

Figure-5.8: Soil sampling locations

5.3.6 Water quality

Water sample were collected from project sites (nearby tap/hand pump or flowing water from the hills). As a part of the field studies, water samples were collected at 15 locations in the study area. Sampling locations are listed in Table-5.5. The results of the analysis of water sampling are given in Table-5.6. The drinking water quality standards are enclosed as **Annexure-VIII.** The sampling location map is enclosed as Figure-5.9.

Table-5.5: Water quality sampling locations

S. No.	Sample Code	Date of Sampling	Location/Site Name	Co-ordinates	Surface/ Ground Water
1	SW1	01/06/2023	Tara Devi	31° 4'37.13"N, 77° 8'23.02"E	Tap Water
2	SW2	02/06/2023	Chakkar	31° 5'15.01"N, 77° 8'17.92"E	Tap Water
3	SW3	02/06/2023	ZTPH	31° 5'52.20"N, 77° 8'24.66"E	Tap Water
4	SW4	30/05/2023	ISBT	31° 5'54.19"N, 77°10'56.49"E	Tap Water
5	SW5	01/06/2023	103 Tunnel	31° 6'12.60"N, 77° 9'15.75"E	Tap Water
6	SW6	31/05/2023	Railway Station	31° 6'9.31"N, 77° 9'39.06"E	Tap Water
7	SW7A	02/06/2023	Isbt	31° 6'0.18"N, 77° 9'42.07"E	Flowing Water From Hills
8	SW7B	02/06/2023	Railway Station	31° 5'57.96"N, 77° 9'22.71"E	Flowing Water From Hills
9	SW8	02/06/2023	Victory Tunnel	31° 6'23.68"N, 77° 9'54.11"E	Tap Water
10	SW9	02/06/2023	ICR	31° 6'21.26"N, 77°10'31.67"E	TAP WATER
11	SW10	01/06/2023	Lift Point	31° 6'11.95"N, 77°10'32.16"E	FLOWING WATER FROM HILLS
12	SW11	02/06/2023	IGMC	31° 6'27.77"N, 77°10'49.76"E	Tap Water
13	SW12	02/06/2023	Sanjauli	31° 5'52.55"N, 77°11'6.17"E	TAP WATER
14	SW13	01/06/2023	Nav Bahar	31° 5'49.53"N, 77°11'6.17"E	Hand Pump
15	SW14	02/06/2023	Secretariat	31° 5'15.10"N, 77°10'54.31"E	TAP WATER
16	SW15	01/06/2023	Kasumpti	31° 4'46.74"N, 77°10'53.61"E	TAP WATER

The pH in various water samples ranged from 7.23 to 8.19, which indicates that neutral range having slightly alkalinity. The Electrical Conductivity (EC) ranged from 212 to 744.74 µS/cm, which indicates the mid-range conductivity is the normal background for most major water resources. Overall, all sample water has low electrical conductivity which is reflected from the low concentration of most of the ionic species which are well within the permissible

limit used for drinking water. Turbidity in all samples is less than one NTU, which also indicates the good quality of water. The total hardness ranged from 72 to150 mg/l, this results indicates that the moderately hard water, suitable for drinking and other purposes.

The Biochemical Oxygen Demand (BOD) represents the amount of dissolved oxygen (DO) consumed by biological organisms when they decompose organic matter in water. The chemical oxygen demand (COD) is the amount of oxygen consumed when the water sample is chemically oxidised. All parameters for BOD, COD and DO observed in the results within the permissible limits, therefore, water quality observed is suitable for drinking purposes. Total Dissolved Solids (TDS) level varied from 116.6 to 409.6 mg/l which represents the total concentration of dissolved salts in water. The heavy metal concentration in the study area is below the permissible limit used for drinking purposes. It can be concluded that water quality was observed to be quite good, as parameters are well below the permissible limits specified for meeting drinking requirements.

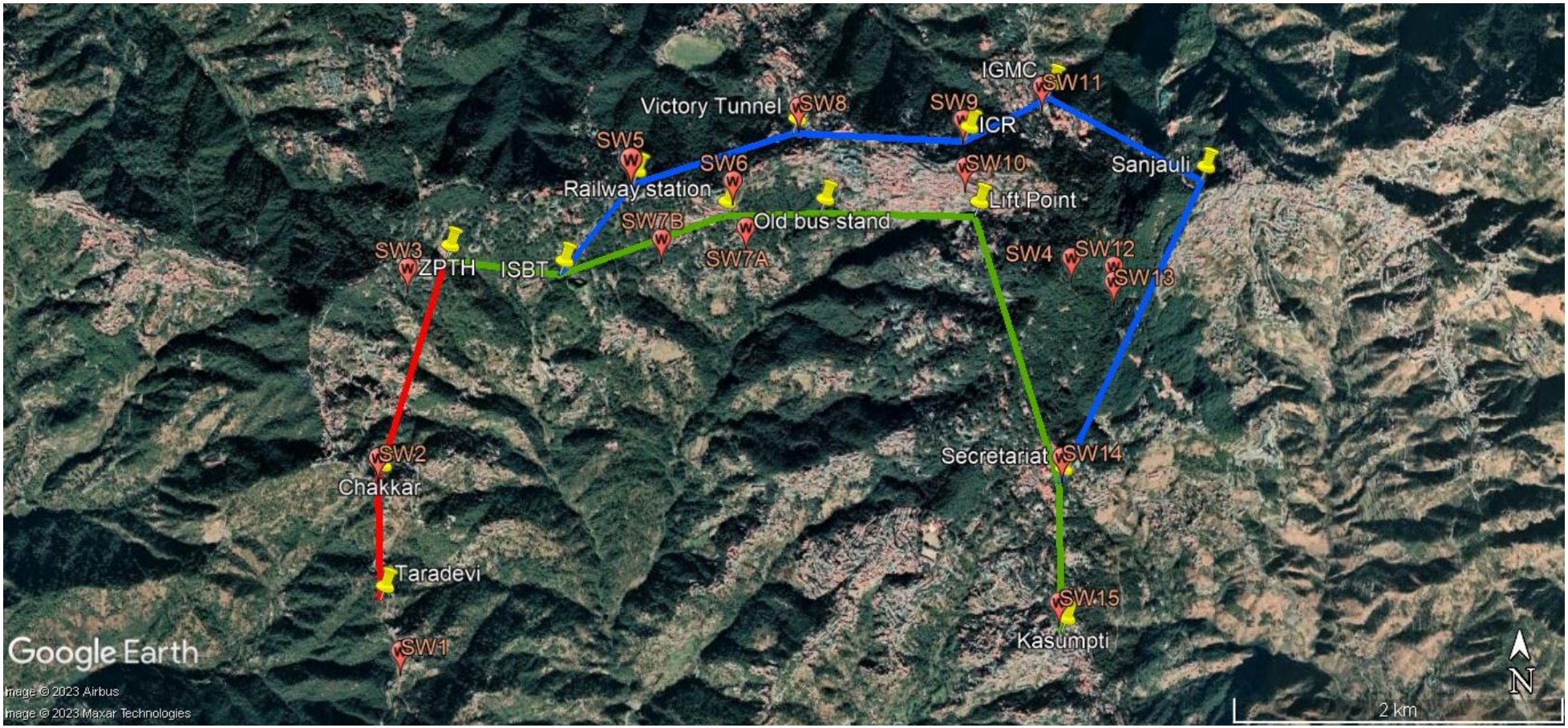


Figure-5.9: Water quality sampling location map

Table-5.6: Results of Water quality sampling in the study area

Parameter	SW1	SW2	SW3	SW4	SW5	SW6	SW7A	SW7B	SW8	SW9	SW10	SW11	SW12	SW13	SW14	SW15
pH	7.7	8.11	7.48	8.19	7.87	8.00	7.60	7.23	7.82	7.39	7.30	8.01	7.92	7.42	7.88	8.02
Colour	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Electrical Conductivity	413	356.56	558.54	407.63	433.45	380.2	502.90	744.72	377.09	354.18	330.54	374.90	349.45	212	332	372
Turbidity	<1.0	<1.0	<1.0	<1.0	<l.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Hardness (as $CaC0_3$)	150.0	140	140	146.0	134	138	126	138	134	90	124	136	136	72	114	130
Fluoride (as F)	0.21	0.12	0.19	0.14	0.12	0.13	0.11	0.11	0.15	0.12	0.16	0.19	0.10	0.19	0.19	0.19
Dissolve Oxygen	6.4	5.2	7.19	7.6.	6.92	6.56	6.41	6.51	6.64	5.95	6.62	6.41	6.51	6.59	4.9	6.62
Chloride (as CI)	20.0	21	39	22	22	23	48	46	21	28	31	21	24	20	42	24
Calcium (as Cal	44.8	41.6	42.4	46.4	41.6	41.6	35.2	64	44.0	28.8	37.6	38.4	40.8	19.2	39.2	38.4
BOD (3 days at 27uC J)	5.5	4.2	8.9	5.2	5.6	3.9	3.2	2.9	3.7	3.9	3.6	3.2	3.1	3.5	4.2	4.2
Nitrate (as $N0_3$)	2.42	2.32	3.2	2.18	2.21	2.10	2.09	2.02	2.19	1.98	2.11	2.01	2.1	2.19	2.19	2.18
Total Dissolved Solid	258	220	348.0	265	278	209.4	276.6	409.6	207.4	194.8	181.8	206.2	193.0	116.6	183.0	204.6
Sulphate (as $S0_4$)	10.8	11.2	12.2	10.2	9.6	7.46	6.32	5.59	6.52	6.52	7.12	6.32	5.6	5.6	6.59	5.2
Magnesium (as Mg)	5.83	8.74	8.26	7.29	7.29	8.26	9.23	9.23	5.83	4.37	7.29	9.72	8.26	5.83	3.88	8.26
Phosphate (as P)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Sodium (as Na)	18	15	48.9	22	32.8	22	15.6	18	15	15.6	16	19	19	29	29	20
Potassium (as K)	2.S	4.56	3.9	2.1	2.1	1.40	1.32	1.20	1.10	1.10	1.12	I.JO	1.10	1.20	1.39	I.I I
COD (as O_2)	5.6	12.6	26.8	19	19.8	18.0	16.3	16.0	19.0	19.2	20.0	16.0	20.0	16.0	19.0	20.1
Residual Sodium Carbonate	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Carbonate	19	72.6	72.3	42.8	65.2	42.0	32.2	32.9	29.0	28.2	32.6	32.0	29.0	32.0	32.0	42.9
Total	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05

Parameter	SW1	SW2	SW3	SW4	SW5	SW6	SW7A	SW7B	SW8	SW9	SW10	SW11	SW12	SW13	SW14	SW15
Chromium (as Cr)																
Iron (as Fe)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Manganese (as Mn)	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Copper (as Cu)	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc (as Zn)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic (as As)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium (as Cd)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Cyanide (as CN)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Lead (as Pb)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (as Se)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mercury (Hg)	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Total Suspended Solid	<1.0	<1.0	<l.0	<l.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Alkalinity (as $CaC0_3$)	36.0	58	50.0	58.0	56.0	58	38	74	54	28.0	46	35.0	54	32	42	54
Silica (as $Si0_2$)	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Total Kjeldhal Nitrogen (TKN)	2.80	2.62	1.28	1.48	2.28	1.19	1.12	1.12	1.21	I.I I	I.I I	I.I I	1.29	1.29	1.29	1.12
Ammonical-Nitrogen	0.45	0.38	J.J	0.28	1.2	0.22	0.23	0.21	0.24	0.29	0.29	0.29	0.12	0.29	0.12	0.29

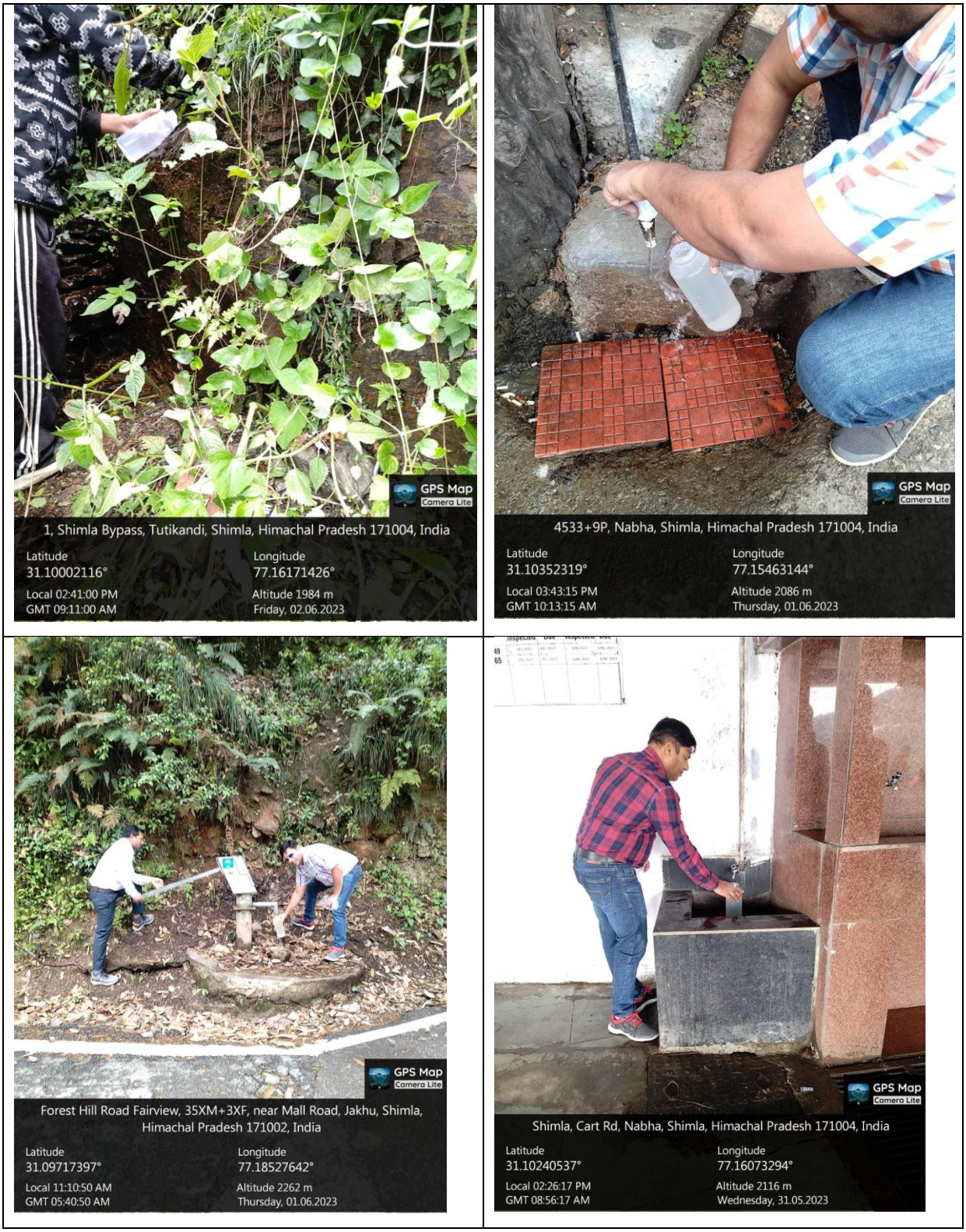


Figure-5.10: Water sampling locations

5.3.7 Ambient Air Quality

Assessment of ambient air quality is of paramount importance to understand the background of air quality before starting of any activity. The air quality data is useful for prediction of air

quality when the proposed project is commissioned. It also helps for taking necessary air pollution control measures. As a part of field studies, ambient air quality was monitored at 10 locations (Refer Table-5.7) in the study area. The sampling locations are shown in Figure-5.11. The results and summary of ambient air quality monitoring are given in Tables-5.8.The Ambient Air Quality standards is given in **AnnexureIX.**

Table-5.7: Air Quality sampling locations

S. No.	Sampling Location code	Station	Coordinates
1.	AAQ1	Chakkar	31° 5'15.45"N , 77° 8'17.95"E
2.	AAQ2	ZPTH	31° 5'58.32"N , 77° 8'33.32"E
3.	AAQ3	ISBT	31° 5'55.10"N , 77° 8'59.74"E
4.	AAQ4	103 tunnel	31° 6'13.31"N, 77° 9'16.39"E
5.	AAQ5	IGMC	31° 6'30.32"N, 77°10'51.50"E
6.	AAQ6	Sanjauli	31° 6'13.83"N, 77°11'26.22"E
7.	AAQ7	Secretariat	31° 5'15.06"N, 77°10'53.61"E
8.	AAQ8	Kasumpti	31° 4'45.63"N, 77°10'54.31"E
9.	AAQ9	Lift Point	31° 6'1.56"N, 77°10'28.02"E
10.	AAQ10	Old Bus Stand	31° 6'16.87"N, 77° 9'59.12"E

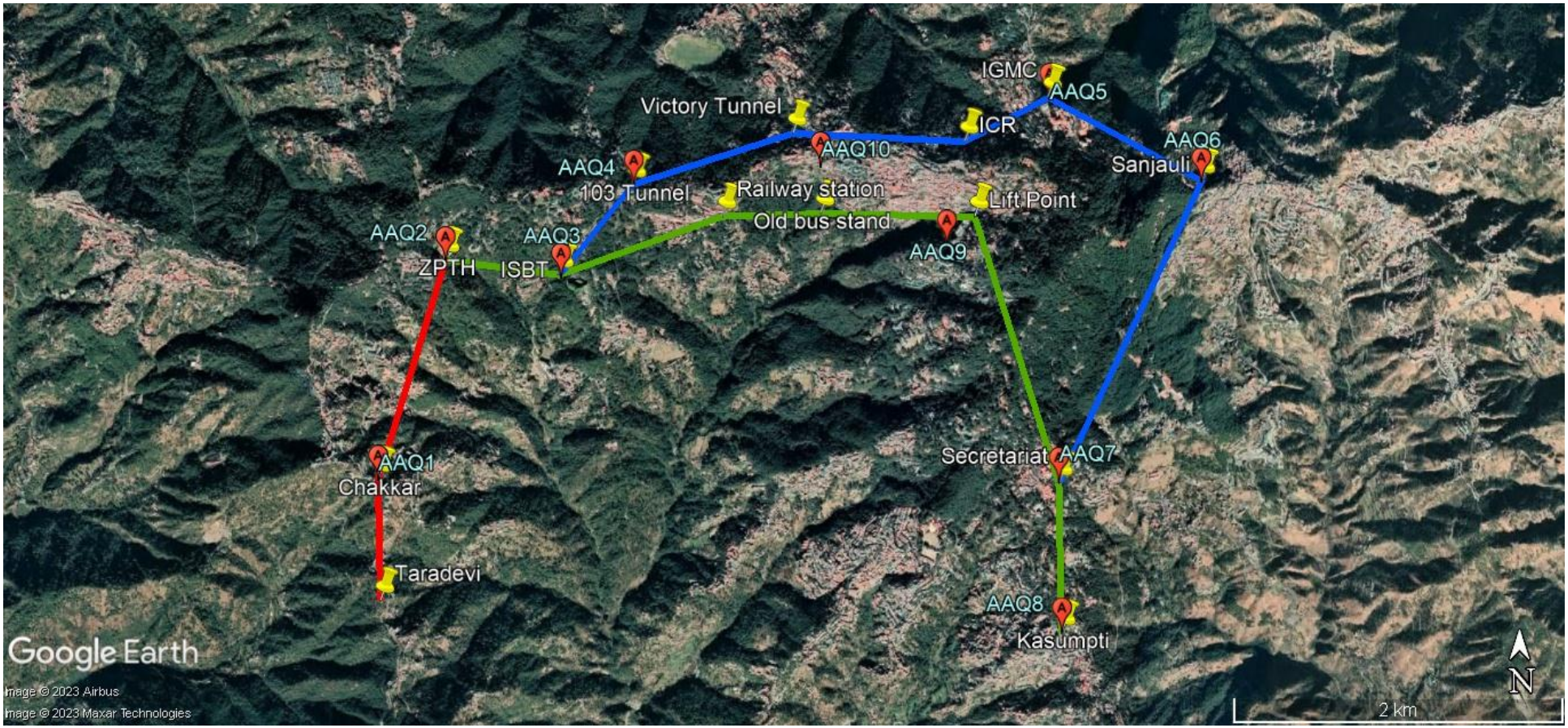


Figure-5.11: Air Quality sampling location map

Table-5.8: Ambient air quality status in study area

Sampling Location	Particulate matter (PM_{10}) in $\mu g/m^3$	Particulate matter (PM 2.5) in $\mu g/m^3$	Sulphur dioxide(SO2) in $\mu g/m^3$	Nitrogen Dioxide (NO2) in µg/m3	Carbon Monoxide (CO) mg/m3	Ozone (O3) µg/m3	Ammonia (NH3) µg/m3	Lead (Pb) µg/m3	Nickel (Ni) ng/m3	Arsenic (As) ng/m3	Benzene (C6H6) µg/m3	Benzo(a) Pyrene (BaP) ng/m3
ZPTH												
19/20.05.2023	58.0	33.5	<6.0	18.6	0.16	<20.0	24.6	<0.01	<5.0	<1.0	<4.2	<0.5
20/21.05.2023	61.3	38.9	6.3	21.7	0.19	25.3	31.2	<0.01	<5.0	<1.0	<4.2	<0.5
Chakkar												
20/21.05.2023	66.2	36.8	6.5	23.2	0.22	<20.0	36.2	<0.01	<5.0	<1.0	<4.2	<0.5
21/22.05.2023	69.1	41.2	<6.0	15.4	0.26	<20.0	24.6	<0.01	<5.0	<1.0	<4.2	<0.5
ISBT												
20/21.05.2023	84.6	50	7.5	30.2	0.43	28.6	42.5	<0.01	<5.0	<1.0	<4.2	<0.5
21/22.05.2023	78	45	6.9	27.6	0.36	22.3	36.2	<0.01	<5.0	<1.0	<4.2	<0.5
Tunnel												
20/21.05.2023	71.2	44.4	7.2	25.4	0.32	20.8	37.4	<0.01	<5.0	<1.0	<4.2	<0.5
21/22.05.2023	65.6	38.1	6.7	22.7	0.25	<20.0	30.2	<0.01	<5.0	<1.0	<4.2	<0.5
Lift Point												
20/21.05.2023	60.3	40	6.4	21.5	0.24	<20.0	31.7	<0.01	<5.0	<1.0	<4.2	<0.5
21/22.05.2023	64.4	36.4	6.2	23.8	0.28	<20.0	35.4	<0.01	<5.0	<1.0	<4.2	<0.5
Old Bus Stand												
20/21.05.2023	78.5	35.7	7	27.6	0.37	27.5	33.2	<0.01	<5.0	<1.0	<4.2	<0.5
21/22.05.2023	83.2	43.7	7.8	32.5	0.42	26.8	44.7	<0.01	<5.0	<1.0	<4.2	<0.5
IGMC												
22/23.05.2023	65.5	38.9	6.3	20.8	0.38	22.5	37.4	<0.01	<5.0	<1.0	<4.2	<0.5
23/24.05.2023	56	33.3	<6.0	17.3	0.16	<20.0	28.7	<0.01	<5.0	<1.0	<4.2	<0.5
Sanjauli												
22/23.05.2023	75.4	35	6.7	25.6	0.27	23.2	35.2	<0.01	<5.0	<1.0	<4.2	<0.5
23/24.05.2023	64.6	35.3	6.2	24.3	0.23	<20.0	33.8	<0.01	<5.0	<1.0	<4.2	<0.5

Sampling Location	Particulate matter (PM_{10}) in $\mu g/m^3$	Particulate matter (PM 2.5) in $\mu g/m^3$	Sulphur dioxide(SO2) in $\mu g/m^3$	Nitrogen Dioxide (NO2) in µg/m3	Carbon Monoxide (CO) mg/m3	Ozone (O3) µg/m3	Ammonia (NH3) µg/m3	Lead (Pb) µg/m3	Nickel (Ni) ng/m3	Arsenic (As) ng/m3	Benzene (C6H6) µg/m3	Benzo(a) Pyrene (BaP) ng/m3
Secretariat												
22/23.05.2023	67.9	42.1	6.6	22.7	0.21	<20.0	35.2	<0.01	<5.0	<1.0	<4.2	<0.5
23/24.05.2023	59.4	40	<6.0	19.6	0.14	<20.0	26.5	<0.01	<5.0	<1.0	<4.2	<0.5
Kasumpti												
22/23.05.2023	57.1	38.1	<6.0	15.6	0.17	<20.0	24.3	<0.01	<5.0	<1.0	<4.2	<0.5
23/24.05.2023	50.2	28.6	<6.0	16.8	0.18	<20.0	28.4	<0.01	<5.0	<1.0	<4.2	<0.5

Observations on PM_{10} levels

The average concentration of PM_{10} at various monitoring stations is 66.8 μg/m^3. The highest PM_{10} value was recorded as 84.6 μg/m^3 at ISBT and lowest value of 50.2 μg/m^3 was recorded at Kasumpti. The PM_{10} values monitored during the field survey were well below the permissible limit of 100 μg/m^3 for industrial, residential, rural and other areas.

Observations on $PM_{2.5}$ levels

The average concentration of $PM_{2.5}$ at various monitoring stations monitored was 38.8 μg/m^3. The highest $PM_{2.5}$ value was recorded as 50.0 μg/m^3 at ISBT and lowest value of 28.6 μg/m^3 was recorded at Kasumpti. The $PM_{2.5}$ values monitored during the field survey were well below permissible limit of 60 μg/m^3 for industrial, residential, rural and other areas.

Observations on SO_2 levels

The average concentration of SO_2 at various stations monitored is 6.7 μg/m^3. The highest SO_2 value was recorded as 7.8 μg/m^3 at Old Bus stand. The average concentration of SO_2 at various stations in the study area was well below the prescribed limits of 80 μg/m^3 specified for industrial, residential, rural and other areas.

Observations on NO_2 levels

The average NO_2 concentration at various sampling stations is 22.6 μg/m^3. The highest NO_2 value was recorded as 32.5 μg/m^3 at Old Bus stand. The average concentration of NO_2 at various stations in the study area was observed to be well below the prescribed limit of 80 μg/m^3 specified for industrial, residential, rural and other areas.

Figure-5.12: Air quality sampling locations

5.3.8 Ambient Noise Levels

Baseline noise data has been measured using a weighted sound pressure level meter. The survey was carried out in calm surrounding. Sound Pressure Level (SPL) measurement in the outside environment was made using sound pressure level meter. The noise levels were monitored at 15 locations (Table-5.9) and day and night time equivalent noise level were estimated. Noise sampling locations are given in Figure-5.13. Results of noise sampling are given in Table-5.10.

Table-5.9: Noise sampling locations

S. No.	Sampling Location code	Sampling Location	Coordinates
1	ANQ1	Taradevi, Shimla	N 31°04'51.5820" E 77°08'18.33"
2	ANQ2	ZPTH, Shimla	N 31°05'55.6512" E 77°08'32.8668"
3	ANQ3	Chakkar, Shimla	N 31°05'16.3104" E 77°08'16.0224"
4	ANQ4	ISBT, Shimla	N 31°05'50.1900" E 77°09'05.8032"
5	ANQ5	103 Tunnel, Shimla	N 31°06'13.3128" E 77°09'18.2952"
6	ANQ6	Railway Station, Shimla	N 31°06'11.1312" E 77°09'28.8972"
7	ANQ7	Victory Tunnel, Shimla	N 31°06'24.6384" E 77°09'50.8932"
8	ANQ8	Lift Point, Shimla	N 31°06'00.2808" E 77°10'27.7176"
9	ANQ9	Old Bus Stand, Shimla	N 31°06'14.6520" E 77°10'04.5012"
10	ANQ10	ICR, Shimla	N 31°06'22.7556" E 77°10'34.1760"
11	ANQ11	IGMC, Shimla	N 31°06'26.8452" E 77°90'50.5020"
12	ANQ12	Sanjauli, Shimla	N 31°06'12.1788" E 77°11'28.8240"
13	ANQ13	Navbhahar, Shimla	N 31°05'42.6984" E 77°11'14.6544"
14	ANQ14	Secretariat, Shimla	N 31°05'16.9548" E 77°10'53.4288"
15	ANQ15	Kasumpti, Shimla	N 31°04'45.9552" E 77°10'53.7960"

Table-5.10: Equivalent Noise Levels in the study area

S No.	Sampling Date	Sampling Location	Results Leq dB(A)					
			Day Time	MAX (day)	MIN (day)	Night Time	MAX (Night)	MIN (Night)
1	19/20.05.2023	Taradevi, Shimla	52.3	57.6	39.7	38.9	40.1	37.8
2	20/21.05.2023	ZPTH, Shimla	54.1	61	40.4	39.2	41.2	38.1

S No.	Sampling Date	Sampling Location	Results Leq dB(A)					
			Day Time	MAX (day)	MIN (day)	Night Time	MAX (Night)	MIN (Night)
3	20/21.05.2023	Chakkar, Shimla	55.2	62.1	36.9	37.8	40.9	35.8
4	20/21.05.2023	ISBT, Shimla	58.5	63.1	39.2	40.7	43.9	38.5
5	20/21.05.2023	103 Tunnel, Shimla	53.6	59.1	36.9	38	42.1	35.6
6	20/21.05.2023	Railway Station, Shimla	57	63.4	37.8	39.1	40.6	36.5
7	21/22.05.2023	Victory Tunnel, Shimla	52.9	57.6	36.9	38.3	42.3	35.7
8	20/21.05.2023	Lift Point, Shimla	51.3	55.3	40.5	38.6	41.2	36.2
9	21/22.05.2023	Old Bus Stand, Shimla	57.2	63.6	41.2	41.5	47.5	37.2
10	22/23.05.2023	ICR, Shimla	51.1	59.6	39.6	39.2	42.9	36.5
11	22/23.05.2023	IGMC, Shimla	50.2	54.6	39.2	37.9	40.4	36.5
12	22/23.05.2023	Sanjauli, Shimla	52.9	58.1	36.4	37.7	40.9	35.6
13	22/23.05.2023	Navbhahar, Shimla	49.2	55.7	39.6	38.8	41.3	36.1
14	22/23.05.2023	Secretariat, Shimla	54	61.8	42.4	40.6	43.5	38.6
15	22/23.05.2023	Kasumpti, Shimla	54.7	63.4	37.8	38.8	42.5	36.5

The day time equivalent noise level at various sampling stations ranged from 49.2 to 58.5 dB(A), and night time equivalent noise level ranged from 37.7 to 41.5 dB(A).

The results shows that the amibnient noise qulaity is within the permisible limits for commercial area as per National Noise Standards **(Annexure X).**

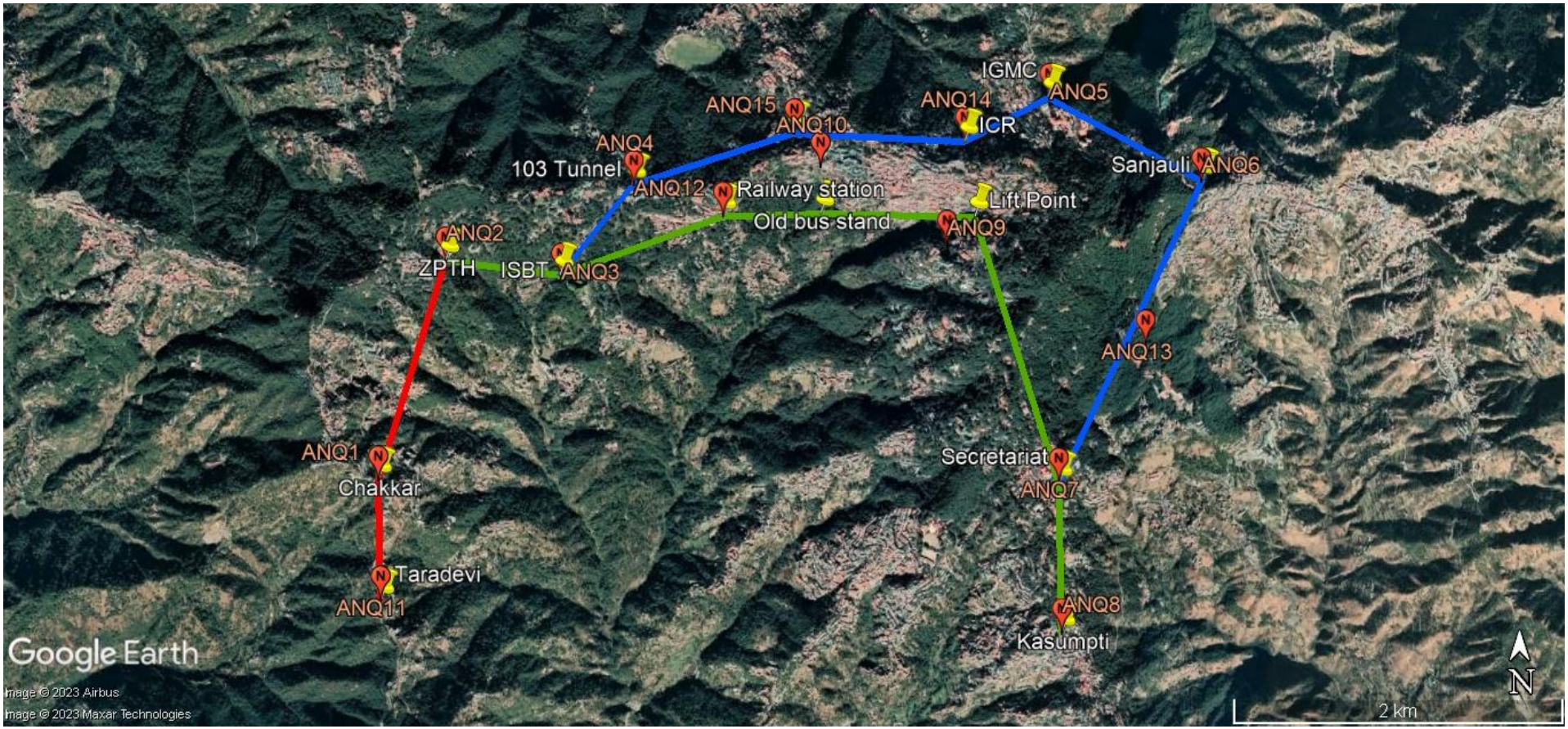


Figure-5.13: Noise Quality sampling location map

Figure-5.14: Noise sampling locations

5.4 Ecological Aspects

The baseline setting for biological environment have been covered in this Chapter following floral and faunal accounts of the area. Flora is categorized into three groups as herb, shrub and tree species. Terrestrial fauna include insect (butterflies), reptile, amphibian, bird and mammal. Field survey was conducted for baseline study of existing biological environment in May, 2023.

5.4.1 Forest type and it compositions in the study area

The natural scenery which comprises the flora and the fauna of Shimla has always been the main attraction for the tourist who visits this beautiful city. The climate is very cold and adds the luster to the vegetation. Due to its unique geographical location and diverse topography it's a paradise for the nature lovers. Geographical area is 5131 sq km, very dense forest is 736 sq km, moderate dense forest is 1030 sq km and open forest is 624 sq km. Shimla is surrounded by the dense forests of the oaks, Deodar, Pine and the rhododendron. Its forests are very dense and spread all over the region. The types of vegetation in any area are determined by climatic, edaphic and biotic factors coupled with altitude. The wide variations in climate and topography of the State have resulted in various types of forest growth. Based on classification of forest, according to Champion & Seth (1968), the forest types in study area are as follows:

- Himalayan Subtropical Pine Forests
- Deodar Forest
- Himalayan Moist Temperate Forests

Himalayan Subtropical Pine Forests

The vegetation of the Himalayan subtropical pine forests consists of pure *Pinus roxhurghii*. This forest is found between elevations 1500 to 2000m which receives annual rainfall in the range of 100 to 250 cm. The pine forests in the Himalayas frequently receives the fire and the burnt slopes supports the growth of rich grasses such as *Arundinella setosa*, *Festuca* species, *Carex paniculata*, *Pennisetum flaccidum*, *Chrysopogon zizanioides*, *Themeda anathera*, and *Cymbopogon distans* and a number of shrubs such as species of *Berberis* species, *Buddleja asiatica*, *Rubus* species etc. The common herb were- *Artemisia* species, *Erigeron Canadensis*, *Fragaria nubicola*, *Jacobaea erratica*, *Potentilla indica*, *Rumex* species, *Taraxacum campylodes* etc.

Deodar Forest

Deodar forests are forests dominated by Cedrus deodara, other tree species include *Quercus* species, *Picea smithiana*, *Abies pindrow*, *Pinus* species *Prunus cornuta*, *Robina pseudoacacia*, etc. The common herb species reported include- *Ainsliaea aptera*, *Vicia pannonica*, *Artemisia* species, *Rumex* species, *Potentilla indica*, *Sonchus arvensis*, Bidens *pilosa*, *Thalictrum foliolosum* etc. The common shrub were- *Rubus ellipticus*,

Berberis lyceum, *Boehmeria macrophylla*, *Buddleja asiatica*, *Ageratina adenophora*, *Urtica* speciesetc. The common grasses were- *Carex paniculata*, *Pennisetum flaccidum*, *Cenchrus* species, *Chrysopogon zizanioides*, *Dactylis glomerata* etc.

Himalayan Moist Temperate Forests

Mainly composed of coniferous species. Species occur in this forest mostly pure strands. The height of trees layers from 30 to 50 m. The temperate zone of the Himalayas between 1500 and 2000 metres. The common tree species in these forest include- *pines, cedars, silver firs, spruce, etc.* They form high but fairly open forest with shrubby undergrowth including *Berberis* species*, Buddleja asiatica, Rubus* species*,* and *rhododendrons.* The common herb and grass species observed include- *Carex paniculata, Bidens pilosa, Thalictrum foliolosum Pennisetum flaccidum, Cenchrus species, Chrysopogon zizanioides, Dactylis glomerata Ainsliaea aptera, Vicia pannonica, Artemisia* species*, Rumex* species*, Potentilla indica, Sonchus arvensis, Arundinella setosa, Festuca* species *etc.*

5.4.2 Field Studies

As a part of the ESIA study, ecological survey was conducted at various sites in the month of May, 2023. The objectives of the ecological survey were to:

- Prepare a checklist of flora in the study area.
- Listing a rare/endangered species if may.
- Determine frequency, density, abundance and IVI of different vegetation components.
- Calculate species diversity indices of different plant communities in the study area.
- Identification of economically important plant species like medicinal plants, timber, fuel wood etc. and listing accordingly.

A total of sixteen sampling sites were selected in the project area, considering the extent of the project area. The sampling sites selected for terrestrial ecological survey in the project sampling sites are listed in Table-5.11.

Table-5.11: Sampling sites selected for Terrestrial Ecological Survey

S.No.	Study sites	Station name	Co-ordinates
1.	Site-1	Taradevi Station and adjoining areas	31°04'50.6"N 77°08'18.6"E
2.	Site-2	ISBT and adjoining areas	31°05'55.2"N 77°09'00.7"E
3.	Site-3	ZPTH and adjoining areas	31°05'57.5"N 77°08'32.1"E
4.	Site-4	Old bus stand and adjoining areas	31°06'17.1"N 77°09'58.4"E
5.	Site-5	Railway station and adjoining areas	31°06'07.2"N 77°09'38.4"E
6.	Site-6	Sanjauli and adjoining areas	31°06'13.0"N 77°11'25.4"E
7.	Site-7	Navbahar and adjoining areas	31°05'41.5"N 77°11'14.7"E
8	Site-8	Secretariat and adjoining areas	31°05'15.0"N 77°10'53.8"E
9.	Site-9	Kasumpti and adjoining areas	31°04'46.5"N 77°10'54.6"E
10	Site-10	Chakkar and adjoining areas	31°05'16.9"N 77°08'16.9"E
11.	Site-11	103 Tunnel and adjoining areas	31°06'12.5"N 77°09'15.6"E
12.	Site-12	Victory Tunnel and adjoining areas	31°06'23.5"N 77°09'54.0"E
13.	Site-13	Lower Lift Point and adjoining areas	31°06'01.2"N 77°10'29.6"E

S.No.	Study sites	Station name	Co-ordinates
14.	Site-14	Upper Lift Point and adjoining areas	31°06'06.9"N 77°10'34.8"E
15.	Site-15	IGMC and adjoining areas	31°06'29.4"N 77°10'51.6"E
16.	Site-16	ICR and adjoining areas	31°06'21.7"N 77°10'31.2"E

5.4.3 Methodology applied for the study

For assessing the floral diversity in the study area both floristic survey and quantitative analysis of vegetation were undertaken. The quantitative analysis of vegetation was done by using quadrats as sampling units. The quadrats were laid randomly in identified sites of the project area. The vegetation analysis was undertaken by collecting numerical community data for trees, shrubs and herbs from the randomly laid quadrats. To asses the vegetation patches, 25 random quadrates laid down each for trees, shrubs and herbs on the ground. The 10m x 10m size was laid for trees, 5 x 5 m for shrubs and 1 x 1m for herbs respectively. The details are given in Table 5.12.

During the survey, individuals within the quadrats were identified up to the species level, and the numbers of individuals of each species in each quadrat were counted. The CBH of all trees having girth of more than 30 cm (> 30 cm) was measured. All individuals with 10 to 30 cm were considered as shrubs and saplings. Vegetation composition was evaluated by analyzing the frequency, density, abundance, basal area and Importance Value Index (IVI) according to Mishra, (1968) and Curtis and McIntosh.

Table-5.12: Number and size of quadrats laid at different sites

S.No.	Station name	Vegetation components	Number of quadrat laid	Size of quadrat
1.	Taradevi Station and adjoining areas	Tree Shrub Herb	25 25 25	10m x 10m 5m x 5m 1m x 1m
2.	ISBT and adjoining areas	Tree Shrub Herb	25 25 25	10m x 10m 5m x 5m 1m x 1m
3.	ZPTH and adjoining areas	Tree Shrub Herb	25 25 25	10m x 10m 5m x 5m 1m x 1m
4.	Old bus stand and adjoining areas	Tree Shrub Herb	25 25 25	10m x 10m 5m x 5m 1m x 1m
5.	Railway station and adjoining areas	Tree Shrub Herb	25 25 25	10m x 10m 5m x 5m 1m x 1m
6.	Sanjauli and adjoining areas	Tree Shrub Herb	25 25 25	10m x 10m 5m x 5m 1m x 1m
7.	Navbahar and adjoining areas	Tree	25	10m x 10m

S.No.	Station name	Vegetation components	Number of quadrat laid	Size of quadrat
		Shrub	25	5m x 5m
		Herb	25	1m x 1m
8.	Secretariat and adjoining areas	Tree	25	10m x 10m
		Shrub	25	5m x 5m
		Herb	25	1m x 1m
9.	Kasumpti and adjoining areas	Tree	25	10m x 10m
		Shrub	25	5m x 5m
		Herb	25	1m x 1m
10.	Chakkar and adjoining areas	Tree	25	10m x 10m
		Shrub	25	5m x 5m
		Herb	25	1m x 1m
11.	103 Tunnel and adjoining areas	Tree	25	10m x 10m
		Shrub	25	5m x 5m
		Herb	25	1m x 1m
12.	Victory Tunnel and adjoining areas	Tree	25	10m x 10m
		Shrub	25	5m x 5m
		Herb	25	1m x 1m
13.	Lower Lift Point and adjoining areas	Tree	25	10m x 10m
		Shrub	25	5m x 5m
		Herb	25	1m x 1m
14.	Upper Lift Point and adjoining areas	Tree	25	10m x 10m
		Shrub	25	5m x 5m
		Herb	25	1m x 1m
15.	IGMC and adjoining areas	Tree	25	10m x 10m
		Shrub	25	5m x 5m
		Herb	25	1m x 1m
16.	ICR and adjoining areas	Tree	25	10m x 10m
		Shrub	25	5m x 5m
		Herb	25	1m x 1m

Based on the quadrat data, frequency, density, cover (basal area), IVI and diversity index for each species were calculated using the following formula:

Frequency: Frequency is the number of times a plant species occurs in a given number of quadrats. Frequency is usually expressed as a percentage and is sometimes called a Frequency Index.

$$\text{Frequency}(\%) = \frac{\text{Number of quadrats in which the species occured}}{\text{Total number of quadrats studied}} * 100$$

Density: Density in plant ecology is defined as the number of individuals of a given species that occurs within a given sample unit or study area. Density is often used in a vegetation survey to describe a species' status in a plant community.

For tree,

$$\text{Density} = \frac{\text{Total number of individual of a the species in all the quadrats}}{\text{Total number of quadrats studied}} * 50$$

For shrub,

$$\text{Density} = \frac{\text{Total number of individual of a the species in all the quadrats}}{\text{Total number of quadrats studied}} * 100$$

For herb,

$$\text{Density} = \frac{\text{Total number of individual of a the species in all the quadrats}}{\text{Total number of quadrats studied}} * 10{,}000$$

Abundance: It is the study of the number of individuals of different species in the community per unit area. By quadrats method, samplings are made at random at several places and the number of individuals of each species was summed up for all the quadrats divided by the total number of quadrats in which the species occurred. It is represented by the equation:

$$\text{Abundance} = \frac{\text{Total number of individul of a the species in all the quadrats}}{\text{Total number of quadrats in which the species occured}}$$

Basal Area:

Basal area ($m^2 ha^{-1}$) = Mean total basal area of all the individuals of the species per quadrat per hectare.

Importance Value Index

This index is used to determine the overall importance of each species in the community structure. In calculating this index, the percentage values of the relative frequency, relative density and relative dominance are summed up together and this value is designated as the Importance Value Index or IVI of the species.

Relative density: Relative density is the study of numerical strength of a species in relation to the total number of individuals of all the species and can be calculated as:

$$\text{Relative density} = \frac{\text{Number of individual of the species}}{\text{Total number of individual in all the species}} * 100$$

Relative frequency: The degree of dispersion of individual species in an area in relation to the number of all the species occurred.

$$\text{Relative frequency} = \frac{\text{Frequency of occurance}}{\text{Total frequency of all occurence of all species}} * 100$$

Relative dominance: Dominance of a species is determined by the value of the basal cover. Relative dominance is the coverage value of a species with respect to the sum of coverage of the rest of the species in the area.

$$\text{Relative domainace} = \frac{\text{Total basal area of the species}}{\text{Total basal area of all the species}} * 100$$

The total basal area was calculated from the sum of the total diameter of immerging stems. In trees, poles and saplings, the basal area was measured at breast height (1.5 meters) and by using the formula πr^2. The importance value index (IVI) for different trees species were determined by summing up the Relative Density, Relative Frequency and Relative dominance. The Relative Density and Relative Frequency values were used to calculate the

IVI of shrubs and herbs. The importance value index is a measure of the relative contribution of a species to the community.

Diversity Index

To assess diversity of floral elements and structure of the plant community in different study sites, various diversity indices were computed. A diversity index is a mathematical measure of species diversity in a community. They provide more information about community composition than simply species richness (i.e., the number of species present); they also take the relative abundances of different species into account. Three species diversity indices viz., Shannon index of general diversity (H), Dominance index (D) and Evenness index (e) were computed using PAST software.

Shannon Index

It is an index used to measure diversity in categorical data. In a basic sense, it is the information entropy of the distribution in a given area treating species as symbols and their relative population sizes as the probability. The diversity index takes into account the number of individuals as well as number of taxa. It varies from 0 for communities with only a single taxon to high values for communities with many taxa, each with few individuals. The advantage of this index is that it takes into account the number of species and the evenness of the species. The index is increased either by having additional unique species, or by having greater species evenness. Higher values of Shannon index indicate that a particular community has more information.

$$\mathrm{H} = \frac{ni}{N} \ln\left(\frac{ni}{N}\right)$$

Dominance Index

Dominance index is always ranges from 0 - 1, indicates species dominance within community gives greater weight to common species. In addition, the value of Dominance closer to 1 indicates areas dominated by single or few species. The value of Dominance had followed an opposite trend of diversity. The value of D Ranges from 0 (all taxa are equally present) to 1 (one taxon dominates the community completely).

It is calculated as:-

$$\mathrm{D} = \sum\left(\left(\frac{ni}{n}\right)^2\right)$$

Whereas ni is number of individuals of taxon i. The value of D Ranges from 0 (all taxa are equally present) to 1 (one taxon dominates the community completely).

Buzas and Gibson's Evenness Index

The distribution of individuals among the species, referred to as evenness. Evenness compares the similarity of the population size of each of the species present. As species richness and evenness increase, so diversity increases.

It was calculated using the formula: $\frac{e^H}{S}$ where H is the Shannon's index and S represents the number of species. It indicates the relative abundance or proportion of individuals among the species.

5.4.4 Results of Floral Diversity

5.4.4.1 Floristic diversity

During the field study, a total of 128 plant species were recorded from study areas. The results of the present study reveals that herb group of plant contributed highest number of species with 46 species followed by tree with 27 species, grass with 19 species, shrub and climber with 17 species, bamboo and fern with 1 species. The details of number of floral species recorded at various sampling sites listed in Table-5.13 and graphical analysis shown in Figure-5.15**.**

Table-5.13: Total number of tree, shrub, herb, bamboo, fern, grass and climber were recorded in the Study Areas

Habit	Number of species
Bamboo	1
climber	17
Grass	19
Herb	46
Fern	1
Shrub	17
Tree	27
Total	**128**

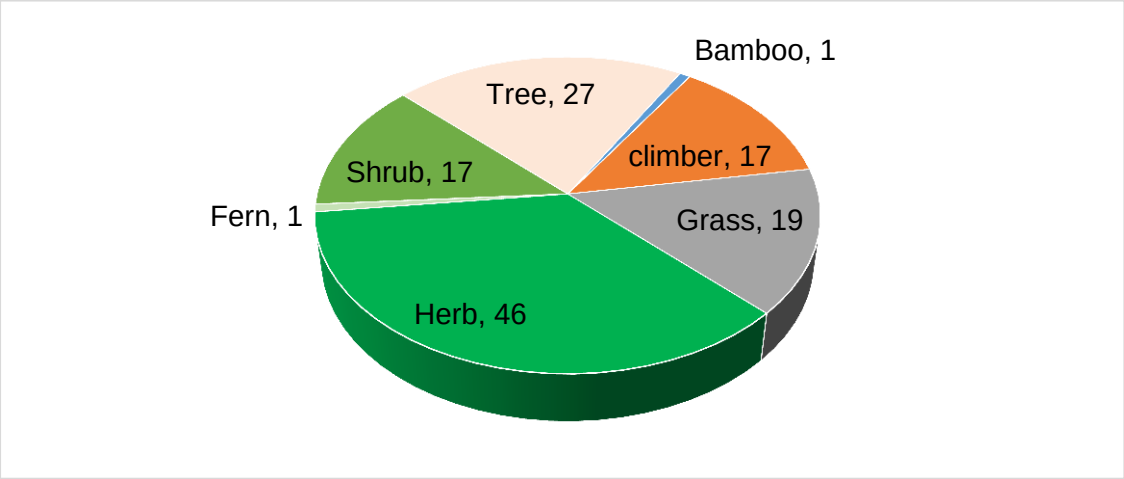


Figure-5.15: Graphical analysis the number of tree, shrub, herb, bamboo, fern, grass and climber were recorded in the study areas

5.4.4.2 Plant list

From the floristic survey and with the help of secondary data (discussion with local people), a total of 128 plant species recorded belong to 51 families from study areas, listed in Table-5.14. The most dominant families were- Poaceae (19), Asteraceae (16), Urticaceae (7),

Fabaceae (6) and Lamiaceae (5), graphical analysis shown in Figure-5.16. Photos of Floral diversity in the study area are given in **Annexure-XI.**

Table-5.14: Plant species recorded from the Study Areas

Botanical name	Common/local name	Family	Habitat	IUCN
Acer acuminatum Wall. ex D.Don	Himalayan maple	Sapindaceae	Tree	LC
Aesculus indica (Wall. ex Cambess.) Hook.	Khanir	Sapindaceae	Tree	LC
Agave americana L.	Kamal cactus	Asparagaceae	Shrub	LC
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	Pamakani	Asteraceae	Shrub	NA
Ailanthus altissima (Mill.) Swingle	Ailanthus	Simaroubaceae	Tree	NA
Ainsliaea aptera DC.	Ghatti	Asteraceae	Herb	NA
Alnus nepalensis D.Don	Utis	Betulaceae	Tree	LC
Anaphalis species	-	Asteraceae	Herb	NA
Anisomeles indica (L.) Kuntze	Catmint	Lamiaceae	Herb	NA
Artemisia annua L.	Majtari	Asteraceae	Herb	NA
Artemisia vulgaris L.	Mastaru	Asteraceae	Herb	NA
Arundinella setosa Trin.	-	Poaceae	Grass	NA
Begonia grandis Dryand.	-	Begoniaceae	Herb	NA
Bellis sylvestris Cirillo	-	Asteraceae	Herb	NA
Berberis lycium Royle	Kushmal	Berberidaceae	Shrub	LC
Berberis wilsoniae Hemsl.	-	Berberidaceae	Shrub	NA
Betula pubescens Ehrh.	Bhoj patra	Betulaceae	Tree	LC
Bidens pilosa L.	Bur marigold	Asteraceae	Herb	NA
Boehmeria macrophylla Hornem.	-	Urticaceae	Shrub	NA
Boehmeria nivea (L.) Gaudich.	Ramie	Urticaceae	Shrub	NA
Buddleja asiatica Lour.	Bhati	Scrophulariaceae	Shrub	LC
Bupleurum petroleum L.	-	Apiaceae	Herb	NA
Callistemon lanceolatus (Sm.) Sweet	Bottle brush	Myrtaceae	Tree	NA
Canna indica L.	Sarvajjaya	Cannaceae	Herb	NA
Carex paniculata L.	Greater tussock-sedge	Cyperaceae	Grass	LC
Cedrus deodara (Roxb. ex D.Don) G.Don	Devda	Pinaceae	Tree	LC
Celtis sinensis Pers.	Celtis	Cannabaceae	Tree	LC
Celtis tetrandra Roxb.	Khirk	Ulmaceae	Tree	LC
Cenchrus ciliaris L.	Sirhu	Poaceae	Grass	LC
Cenchrus echinatus L.	Narik	Poaceae	Grass	LC
Chenopodium album L.	Bathua	Chenopodiaceae	Herb	NA
Chrysopogon zizanioides (L.) Roberty	Vetivergrass	Poaceae	Grass	NA

Botanical name	Common/local name	Family	Habitat	IUCN
Cissampelos pareira L.	Padhi	Marnisperaceae	Climber	NA
Cissus repanda (Wight & Arn.) Vahl	Pani bel	Vitaceae	Climber	NA
Coriaria japonica A.Gray	-	Coriariaceae	Climber	NA
Cornus macrophylla Wall.	Dogwoods	Cornaceae	Tree	LC
Cupressus torulosa D.Don	Himalayan cypress	Cupressaceae	Tree	LC
Cuscuta reflexa Roxb.	Amarbel	Convulvulaceae	Climber	LC
Cymbopogon distans (Nees ex Steud.) W.Watson	-	Poaceae	Grass	NA
Cynodon dactylon (L.) Pers.	Doob	Poaceaea	Grass	NA
Dactylis glomerata L.	Cocksfoot	Poaceae	Grass	NA
Datura stramonium L.	Dhatura	Solanaceae	Herb	NA
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	Siaru	Urticaceae	Shrub	LC
Delairea odorata Lem.	-	Asteraceae	Climber	NA
Digitaria stricta Roth	Finger grass	Poaceae	Grass	NA
Dioscorea deltoidea Wall. ex Griseb.	Yam	Dioscoreaceae	Climber	NA
Doronicum kamaonense (DC.) Alv.Fern.	Kaunl	Asteraceae	Herb	NA
Drepanostachyum falcatum (Nees) Keng f.	-	Poaceae	Bamboo	NA
Dryopteris cristata (L.) A. Gray	Crested woodfern	Dryopteridaceae	Fern	NA
Eleusine indica (L.) Gaertn.	Balraja	Poaceae	Grass	LC
Eragrostis superba Peyr.	Sawtooth love grass	Poaceae	Grass	NA
Erigeron canadensis L.	Horseweed	Asteraceae	Herb	NA
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	Kanjolya	Polygonaceae	Herb	NA
Festuca flavescens Bellardi	-	poaceae	Grass	NA
Festuca rubra L.	-	Poaceae	Grass	DD
Ficus palmata Forssk.	Anjir	Moraceae	Tree	LC
Fragaria nubicola (Lindl. ex Hook.f.) Lacaita	Aakhe	Rosaceae	Herb	NA
Gentiana cruciata L.	-	Gentianaceae	Herb	NA
Girardinia diversifolia (Link) Friis	Burkarla	Urticaceae	Shrub	NA
Grevillea robusta A.Cunn. ex R.Br.	Silk oak	Proteaceae	Tree	LC
Hedera helix L.	Mithiari	Araliaceae	Climber	NA
Impatiens parviflora DC.	Gul-mehndi	Balsaminaceae	Herb	NA
Ipomoea nil (L.) Roth	Morning glory	Convolvulaceae	Climber	NA
Isodon rugosus (Wall. ex Benth.) Codd	Chilchhri	Lamiaceae	Herb	NA

Botanical name	Common/local name	Family	Habitat	IUCN
Jacobaea erratica (Bertol.) Fourr.	-	Asteraceae	Shrub	NA
Juniperus polycarpos var. seravschanica (Kom.) Kitam.	Bethar	Cupressaceae	Tree	NA
Justicia adhatoda L.	Vasaka	Acanthaceae	Shrub	LC
Leucanthemum monspeliense (L.) H.J.Coste	-	Asteraceae	Herb	NA
Lolium perenne L.	Ryegrass	Poaceae	Grass	NA
Lunaria rediviva L.	-	Brassicaceae	Herb	NA
Lycium europaeum L.	-	Solanaceae	Shrub	NA
Mallotus philippensis (Lam.) Müll.Arg.	Kamala	Euphorbiaceae	Tree	LC
Malva pusilla Sm.	-	Malvaceae	Herb	NA
Mikania micrantha Kunth	Bitter vine	Asteraceae	Climber	NA
Modiola caroliniana (L.) G.Don	Carolina bristlemallow	Malvaceae	Herb	NA
Morus nigra L.	White mulberry	Moraceae	Tree	NA
Myrtus communis L.	Myrtle	Myrtaceae	Tree	LC
Nepeta laevigata (D.Don) Hand.-Mazz.	Neugra	Lamiaceae	Herb	NA
Oplismenus undulatifolius (Ard.) Roem. & Schult.	wavyleaf basketgrass	Poaceae	Grass	NA
Oxalis corniculata L.	Amrul	Oxalidaceae	Herb	NA
Oxalis latifolia Kunth	-	Oxalidaceae	Herb	NA
Oxalis stricta L.	sheep's clover	Oxalidaceae	Herb	NA
Oxalis purpurea L.	-	Oxalidaceae	Herb	NA
Parthenocissus quinquefolia (L.) Planch.	Woodbine	Vitaceae	Climber	NA
Parthenocissus semicordata (Wall.) Planch.	Pan bel	Vitaceae	Climber	NA
Paspalum scrobiculatum L.	Kodra	Poaceae	Grass	NA
Pennisetum flaccidum Griseb.	Himalayan fountain grass	Poaceae	Grass	LC
Pennisetum pedicellatum Trin.	Desho grass	Poaceae	Grass	LC
Picea smithiana (Wall.) Boiss.	Rai	Pinaceae	Tree	LC
Pinus roxburghii Sarg.	Dhupasarala	Pinaceae	Tree	LC
Populus × *canadensis* Moench	-	Salicaceae	Tree	NA
Populus deltoides Marshall	Cottonwood	Salicaceae	Tree	LC
Potentilla indica (Jacks.) Th.Wolf	Bhumla	Rosaceae	Herb	NA
Pueraria montana var. lobata (Willd.) Sanjappa & Pradeep	-	Fabaceae	Climber	NA
Quercus glauca Thunb.	Bann	Fagaceae	Tree	LC
Quercus oblongata D.Don	Ban oak	Fagaceae	Tree	NT
Robinia pseudoacacia L.	Robinia	Fabaceae	Tree	LC

Botanical name	Common/local name	Family	Habitat	IUCN
Robinia hispida L.	Bristly locust	Fabaceae	Tree	LC
Rubia cordifolia L.	Manjit	Rubiaceae	Climber	NA
Rubus ellipticus Sm.	Hinsalu	Rosaceae	Shrub	LC
Rumex hastatus D. Don	Churki	Polygonaceae	Herb	NA
Rumex nepalensis Spreng.	Khatura	Polygonaceae	Herb	NA
Rumex obtusifolius L.	Bitter dock	Polygonaceae	Herb	NA
Salvia glutinosa L.	Sage	Lamiaceae	Herb	NA
Salvia moorcroftiana Wall. ex Benth.	Kalijari	Lamiaceae	Herb	NA
Smilax aspera L.	Bindweed	Smilacaceae	Climber	NA
Smilax tamnoides L.	-	Smilacaceae	Climber	NA
Solanum americanum Mill.	-	Solanaceae	Herb	NA
Sonchus arvensis L.	Gutweed	Asteraceae	Herb	NA
Spartium junceum L.	rush broom	Fabaceae	Herb	LC
Spilanthes acmella (L.) L.	Akarkara	Asteraceae	Herb	NA
Stephania glabra (Roxb.) Miers	Gindaru	Menispermaceae	Climber	NA
Taraxacum campylodes G.E.Haglund	Dhoodhali	Asteraceae	Herb	NA
Thalictrum foliolosum DC.	Mamiri	Ranunculaceae	Herb	NA
Themeda anathera (Nees ex Steud.) Hack.	-	Poaceae	Grass	NA
Tinospora sinensis (Lour.) Merr.	Gulancha	Menispermaceae	Climber	NA
Trachycarpus fortunei (Hook.) H.Wendl.	Chusan palm	Arecaceae	Tree	NA
Trifolium repens L.	White clover	Fabaceae	Herb	NA
Ulmus wallichiana Planch.	Himalayan elm	Ulmaceae	Tree	VU
Urtica ardens Link	Himalayan nettle	Urticaceae	Shrub	NA
Urtica dioica L.	Bichhu booti	Urticaceae	Shrub	LC
Urtica parviflora Roxb.	Kandali	Urticaceae	Shrub	NA
Valeriana hardwickii Wall.	Nihani	Caprifoliac eae	Herb	NA
Verbascum thapsus L.	Gidar tamaku	Scrophulariaceae	Herb	NA
Vicia pannonica Crantz	Hungarian vetch	Fabaceae	Herb	LC
Viola pilosa Blume	Banaksha	Violaceae	Herb	NA
Vitex negundo L.	Nirgundi	Verbenaceae	Shrub	LC
Xiphidium caeruleum Aubl.	Soskia	Haemodoraceae	Herb	NA

Note- Least Concern (LC), Not Applicable (NA)

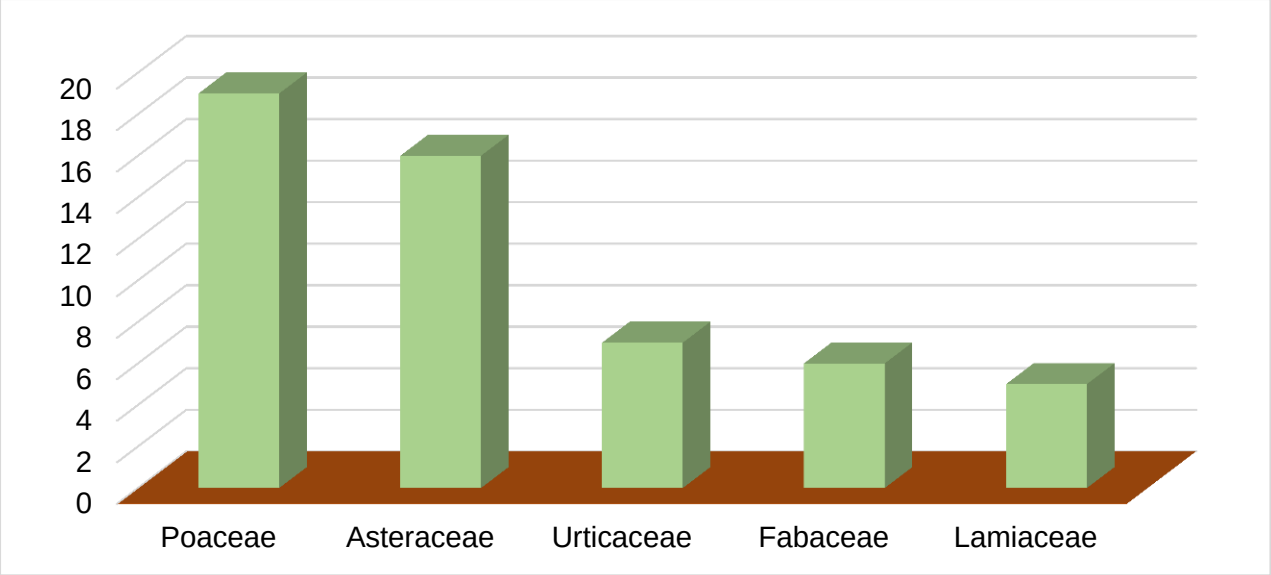


Figure-5.16: Graphical analysis of the dominant families at the various sampling site in the Study Area

5.4.4.3 Medicinal Plants

The list of some of the medicinally important plant species observed in the study area and their uses are given in Table-5.15.

Table-5.15: Medicinal plant species recorded from the Study Areas

Botanical Name	Common/ Local Name	Uses
Ageratina adenophora	Pamakani	Wound, itching, measles, skin diseases and uterine bleeding
Anisomeles indica	Catmint	Dyspepsia, abdominal pain, colic, allergies, inflammation, and rheumatic arthritis
Artemisia annua	Majtari	Fevers, inflammation, headaches, bleeding, and malaria
Artemisia vulgaris	Mastaru	Digestive problems, irregular menstruation, and high blood pressure
Berberis lycium	Kushmal	Liver disorders, abdominal problems, skin diseases, oral ulcers, kidney, conjunctivitis, piles, leprosy, jaundice, rheumatism, and bone
Buddleja asiatica	Bhati	Fever, coughs, colds, sore throats, headaches, stomach aches
Cissampelos pareira	Padhi	Ulcer, wound, rheumatism, fever, asthma, cholera, diarrhoea
Cynodon dactylon	Doob	Cough, cramps, diarrhea, dropsy, dysentery, epilepsy, headache, snakebite, sores, stones, tumors, and urogenital disorders
Datura stramonium	Dhatura	Worm infestation, toothache, and fever
Debregeasia saeneb	Siaru	Bone fractures, boils, diarrhea accompanied with blood, carbuncles, pimples, dermatitis, skin rash, eczema, and tumors

Botanical Name	Common/ Local Name	Uses
Dioscorea deltoidea	Yam	Abdominal pain, wounds, intestinal worms, and anemia
Girardinia diversifolia	Burkarla	Tuberculosis, headache, joint aches, diabetes, asthma, gastritis, headache, joint pain, tuberculosis, gonorrhea and delivery problems
Impatiens parviflora	Gul-mehndi	Ringworm, and nettle stings
Ipomoea nil	Morning glory	Diabetes, high blood pressure and heart disease
Justicia adhatoda	Vasaka	Cough, colds, asthma, bronchitis, and tuberculosis
Mikania micrantha	Bitter vine	Asthma, fever, cough, and arthritis
Rumex nepalensis	Khatura	Swollen gums, pimples ringworm, and relieve headache
Smilax aspera	Bindweed	Leprosy, tumors, cancer, psoriasis and rheumatism
Sonchus arvensis	Gutweed	Kidney stone
Stephania glabra	Gindaru	Asthma, abdominal pains and dysentery
Thalictrum foliolosum	Mamiri	Snakebite, jaundice, and rheumatism
Tinospora sinensis	Gulancha	Piles, ulcerated wounds, liver complaints, chronic rheumatism and muscle relaxant
Urtica ardens	Himalayan nettle	Gout, anemia, and prostate hypertrophy
Urtica parviflora	Kandali	Goiter, cough, allergies, alopecia and fevers

5.4.4.4 Economically Important Plants

The forests are endowed with many plant species with timber, food, fiber, fodder, fuel wood yielding species, and ornamental use. During floristic survey and discussion with local people common economically important plants species recorded used by local people in the study areas were- *Acer acuminatum*, *Aesculus indica*, *Agave Americana*, *Ailanthus altissima*, *Arundinella setosa*, *Arundinella setosa*, *Berberis lyceum*, *Callistemon lanceolatus*, *Cenchrus ciliaris*, *Cedrus deodara*, *Digitaria stricta*, *Cupressus torulosa*, *Festuca flavescens*, *Trachycarpus fortune*, *Rubus ellipticus*, *Pennisetum flaccidum*, *Grevillea robusta*, *Chenopodium album*, *Themeda anathera*, *Picea smithiana*, *Populus deltoids*, *Quercus oblongata*, *Cymbopogon distans*, *Robinia pseudoacacia*, and *Cynodon dactylon*.

5.4.5 Identification of RET plant species

RET plant species are not observed in the land to be acquired for various project appurtenances.

5.4.6 Eco-Sensitive Zones

- **Shimla Water Catchment Sanctuary**

Shimla Water Catchment Sanctuary is observed near Sanjauli station site, which is about 2.80 km from the proposed station. The actual owner of this sanctuary area was the Rana of

Koti. The land was leased to Shimla Municipal Corporation in 1878. In 1952, the area was declared as a Protected Forest and in 1990, it was designated wildlife sanctuary. Till 2006, the sanctuary was taken care of by the Shimla Municipal Corporation but in 2009, Shimla Wildlife Division got the charge of the sanctuary. The Shimla Water Catchment Sanctuary is spreaded over an area of 10.25 sq km and there is no zoning done in this sanctuary. The co-ordinates of the sanctuary are 31º 05´12" to 31º07´11"N and 77º 12´54" to 77º 16´04"E respectively. This sanctuary receives rainfall of 1600 mm annually and is situated on the northern side of Kufri which is about 8 km away on the east of Shimla Town. From the Shimla City, the sanctuary is at a 20 minutes drive through Sanjauli-Dhalli Tunnel.

This sanctuary is connected to the Chail Sanctuary through a forest corridor. Chail Santuary is located on the south of the Shimla Water Catchment Sanctuary. There is a steep catchment in this sanctuary that is the main water source for Simla. The sanctuary has 9 perennial streams flowing through it, and the most important one are the God Ki Nala and Churat Nala. This sanctuary surrounds the Charabara village on three sides. A large tank was built more than 100 years ago to store stream water during rains so that it could be used to supply water to the city.

The maximum area of the sanctuary is covered with Cedar, Oak and Pine trees. The flora in this sanctuary mainly consists of temperate coniferous trees. More than half of the sanctuary area is covered with grasses but vascular herbs and ferns are also found here.

- **Shimla Reserve Forest Wildlife Sanctuary**

Shimla Reserve Forest Wildlife Sanctuary is located at a distance of 5.2 km from Sanjauli Station. The Reserve Forest Sanctuary Shimla is one of the best places for people who love being close to nature. The forest area mainly has many Himalayan cedar trees. You will get to see different flora and fauna in this place. You will get to see the barking deer, gorel, flying squirrel, pine marten, porcupine and leopard in this place. You will also find different types of birds in this area.

The santuary is a man made reservoir, which provides drinking water to Simla town. In the year 1901 the work for this reservoir was completed. This is a gravity feed water supply scheme. The Forest Department is in charge of this sanctuary. This sanctuary lies in an area of 951 hectares. The altitude range varies in this place. It is not just the wildlife and plants due to which people visit this place. This is also one of the best places for some fun adventurous activities. One can do trekking, mountaineering and such other activities in this sanctuary. It is a place which is best for all types of people that are nature lovers as well people who like adventure

It must be mentioned that both these Sanctuaries are far away from the proposed project alignment and hence there is no impact of this project on it.

5.4.7 Quantitative Analysis of various sampling sites

Site-1: Taradevi Station and adjoining areas

Trees

A total of 3 tree species were recorded from study areas. The density of tree species recorded was 50 individuals ha^{-1}. In terms of density, *Pinus roxburghii* were the dominant tree species with 42 individuals ha^{-1} followed by *Cedrus deodara* with 6 individual's ha^{-1}. The total basal area of tree species recorded were 52.44 $m^2 ha^{-1}$ at the sampling site. In terms of basal area *Pinus roxburghii* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Pinus roxburghii* was the dominant tree species (IVI= 253.10) followed by *Cedrus deodara* (IVI= 35.84). The details are given in Table-5.16.

Table-5.16: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from sampling sites at Taradevi Station and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	8	6	7.26	35.84	1.09	1.5
Grevillea robusta A.Cunn. ex R.Br.	4	2	1.08	11.06	0.10	1
Pinus roxburghii Sarg.	68	42	44.1	253.10	4.85	1.24
Total	**80**	**50**	**52.44**	**300.00**	**6.04**	**3.74**

Note- Primary source

Shrubs

A total of 15 shrub species were recorded from study areas. The density of shrub species recorded was 232 individuals (ha^{-1}). In terms of density, *Debregeasia saeneb* was the dominant species with 44 individuals ha^{-1} followed by *Hedera helix* with 32 individuals ha^{-1} in are the dominant species. In terms of importance value index (IVI), *Debregeasia saeneb* was the dominant species (IVI= 27.21) followed by *Hedera helix* (IVI= 20.10). The details are given in Table-5.17.

Table-5.17: Frequency, density, abundance and IVI for the shrub species recorded from sampling site at Taradevi Station and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Boehmeria nivea (L.) Gaudich.	12	20	11.27	1.67
Buddleja asiatica Lour.	20	28	17.16	1.4
Cissus repanda (Wight & Arn.) Vahl	12	16	10.05	1.33
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	32	44	27.21	1.375
Hedera helix L.	24	32	20.10	1.33
Isodon rugosus (Wall. ex Benth.) Codd	12	20	11.27	1.67

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Justicia adhatoda L.	12	16	10.05	1.33
Rubus ellipticus Sm.	16	20	12.99	1.25
Smilax tamnoides L.	24	28	18.88	1.17
Stephania glabra (Roxb.) Miers	8	8	5.89	1
Urtica parviflora Roxb.	12	20	11.27	1.67
Vitex negundo L.	8	8	5.89	1
Coriaria japonica A.Gray	12	20	11.27	1.67
Rubus ellipticus Sm.	16	28	15.43	1.75
Buddleja asiatica Lour.	12	20	11.27	1.67
Total	**232**	**328**	**200.00**	**21.275**

Note- Primary source

Herbs

A total of 19 herb species were recorded from the study area. The density of herb species recorded was 61200 individuals (ha^{-1}). In terms of density, *Spartium junceum* was the dominant species with 6400 individuals ha^{-1} followed by *Leucanthemum monspeliense with* 6000 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Spartium junceum* was the dominant species (IVI= 21.35) followed by *Eragrostis superba (*IVI= 18.06). The details are given in Table-5.18.

Table-5.18: Frequency, density, abundance and IVI for the herb species recorded from sampling site at Taradevi Station and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Anisomeles indica (L.) Kuntze	32	4800	15.76	1.5
Artemisia annua L.	32	5600	17.07	1.75
Bellis sylvestris Cirillo	32	4400	15.11	1.38
Bupleurum petraeum L.	12	2000	6.24	1.67
Callistemon lanceolatus (Sm.) Sweet (Sapling)	4	400	1.64	1
Digitaria stricta Roth	20	2800	9.53	1.4
Eleusine indica (L.) Gaertn.	24	3200	11.17	1.33
Eragrostis superba Peyr.	36	5600	18.06	1.56
Grevillea robusta A.Cunn. ex R.Br. (Sapling)	8	1200	3.94	1.5
Leucanthemum monspeliense (L.) H.J.Coste	32	6000	17.72	1.88
Lolium perenne L.	12	1200	4.93	1
Malva pusilla Sm.	16	2800	8.54	1.75
Nepeta laevigata (D.Don) Hand.-Mazz.	12	2000	6.24	1.67
Salvia moorcroftiana Wall. ex Benth.	12	1600	5.58	1.33
Sonchus arvensis L.	28	4400	14.12	1.57

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Spartium junceum L.	44	6400	21.35	1.45
Spilanthes acmella (L.) L.	20	2800	9.53	1.4
Taraxacum campylodes G.E.Haglund	16	2000	7.23	1.25
Verbascum thapsus L.	12	2000	6.24	1.67
Total	**404**	**61200**	**200.00**	**28.05**

Note- Primary source

Site-2: ISBT and adjoining areas

Trees

A total of 4 tree species were recorded from the sampling sites. The density of tree species recorded was 56 individuals ha^{-1}. In terms of density, *Pinus roxburghii* were the dominant tree species with 24 individuals ha^{-1} followed by *Cupressus torulosa* with 16 individual's ha^{-1}. The total basal area of tree species recorded were 58.14 m ^{2} ha $^{-1}$ at the study areas. In terms of basal area *Pinus roxburghii* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Pinus roxburghii* was the dominant tree species (IVI= 125.00) followed by *Cupressus torulosa* (IVI= 85.43). The details are given in Table-5.19.

Table-5.19: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at ISBT and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^{2}ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	20	14	15.12	77.32	2.12	1.4
Cupressus torulosa D.Don	20	16	17.76	85.43	1.95	1.6
Pinus roxburghii Sarg.	32	24	23.28	125.00	4.42	1.5
Robinia hispida L.	4	2	1.98	12.24	0.24	1
Total	**76**	**56**	**58.14**	**300.00**	**8.73**	**5.50**

Note- Primary source

Shrubs

A total of 18 shrub species were recorded from study areas. The density of shrub species recorded was 476 individuals (ha^{-1}). In terms of density, *Debregeasia saeneb* was the dominant species with 60 individuals ha^{-1} followed by *Berberis lycium* with 52 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Debregeasia saeneb* was the dominant species (IVI= 24.00) followed by *Berberis lycium* (IVI= 21.05). The details are given in Table-5.20.

Table-5.20: Frequency, density, abundance and IVI for the shrub species recorded from sampling sites at ISBT and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Berberis lycium Royle	32	52	21.05	1.63
Boehmeria macrophylla Hornem.	20	20	10.53	1
Buddleja asiatica Lour.	12	20	8.00	1.67
Cissampelos pareira L.	16	24	10.11	1.5
Cissus repanda (Wight & Arn.) Vahl	16	20	9.26	1.25
Coriaria japonica A.Gray	16	24	10.11	1.5
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	36	60	24.00	1.67
Girardinia diversifolia (Link) Friis	4	8	2.95	2
Hedera helix L.	8	12	5.05	1.5
Ipomoea nil (L.) Roth	12	20	8.00	1.67
Isodon rugosus (Wall. ex Benth.) Codd	20	28	12.21	1.40
Justicia adhatoda L.	16	20	9.26	1.25
Lycium europaeum L.	20	28	12.21	1.4
Parthenocissus quinquefolia (L.) Planch.	16	28	10.95	1.75
Rubia cordifolia L.	8	12	5.05	1.5
Rubus ellipticus Sm.	28	44	18.10	1.57
Stephania glabra (Roxb.) Miers	8	12	5.05	1.5
Urtica dioica L.	28	44	18.10	1.57
Total	**316**	**476**	**200.00**	**27.32**

Note- Primary source

Herbs

A total of 32 herb species were recorded from study area. The density of herb species recorded was 78800 individuals (ha^{-1}). In terms of density, *Fagopyrum acutatum* was the dominant species with 6000 individuals ha^{-1} followed by *Chrysopogon zizanioides with* 5200 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 14.09) followed by *Rumex hastatus (*IVI= 12.06). The details are given in Table-5.21.

Table-5.21: Frequency, density, abundance and IVI for the herb species recorded from sampling sites at ISBT and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ainsliaea aptera DC.	12	2000	4.70	1.67
Anaphalis sp	8	800	2.45	1
Anisomeles indica (L.) Kuntze	12	2000	4.70	1.67
Artemisia annua L.	20	2800	7.15	1.4
Bidens pilosa L.	16	2000	5.42	1.25
Carex paniculata L.	32	4400	11.34	1.38

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Cenchrus ciliaris L.	20	2400	6.64	1.2
Chrysopogon zizanioides (L.) Roberty	32	5200	12.35	1.63
Cynodon dactylon (L.) Pers.	20	2800	7.15	1.4
Dactylis glomerata L.	12	1600	4.19	1.33
Digitaria stricta Roth	16	2000	5.42	1.25
Eragrostis superba Peyr.	20	2800	7.15	1.4
Erigeron canadensis L.	8	800	2.45	1
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	36	6000	14.09	1.67
Festuca flavescens Bellardi	12	1600	4.19	1.33
Jacobaea erratica (Bertol.) Fourr.	20	3600	8.17	1.8
Leucanthemum monspeliense (L.) H.J.Coste	28	4400	10.62	1.57
Lunaria rediviva L.	12	2000	4.70	1.67
Malva pusilla Sm.	8	800	2.45	1
Oxalis corniculata L.	12	2000	4.70	1.67
Paspalum scrobiculatum L.	32	3600	10.32	1.13
Pennisetum flaccidum Griseb.	20	2400	6.64	1.2
Rumex hastatus D. Don	36	4400	12.06	1.22
Rumex obtusifolius L.	8	1200	2.96	1.5
Salvia glutinosa L.	12	2000	4.70	1.67
Sonchus arvensis L.	16	2400	5.92	1.5
Spilanthes acmella (L.) L.	4	800	1.73	2
Taraxacum campylodes G.E.Haglund	12	2000	4.70	1.67
Thalictrum foliolosum DC.	16	2000	5.42	1.25
Verbascum thapsus L.	12	1200	3.68	1
Vicia pannonica Crantz	8	1200	2.96	1.5
Rubus ellipticus Sm.	24	3600	8.89	1.5
Total	**556**	**78800**	**200.00**	**45.40**

Note- Primary source

Site-3: ZPTH and adjoining areas

Trees

A total of 3 tree species were recorded from study areas. The density of tree species recorded was 34 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 18 individuals ha^{-1} followed by *Quercus oblongata* with 10 individual's ha^{-1}. The total basal area of tree species recorded were 36.94 m^2 ha^{-1} at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree

species (IVI= 158.65) followed by *Quercus oblongata* (IVI= 89.44). The details are given in Table-5.22.

Table-5.22: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at ZPTH and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	24	18	18.9	158.65	2.65	1.5
Pinus roxburghii Sarg.	8	6	5.94	51.91	0.65	1.5
Quercus oblongata D.Don	12	10	12.1	89.44	1.45	1.67
Total	**44**	**34**	**36.94**	**300.00**	**4.75**	**4.67**

Note- Primary source

Shrubs

A total of 16 shrub species were recorded from study areas. The density of shrub species recorded was 384 individuals (ha^{-1}). In terms of density, *Debregeasia saeneb* was the dominant species with 48 individuals ha^{-1} followed by *Urtica dioica* with 44 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Debregeasia saeneb* was the dominant species (IVI= 24.62) followed by *Urtica dioica* (IVI= 22.06). The details are given in Table-5.23.

Table-5.23: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at ZPTH and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Cissampelos pareira L.	12	20	9.75	1.67
Coriaria japonica A.Gray	12	16	8.71	1.33
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	32	48	24.62	1.5
Delairea odorata Lem.	8	12	6.16	1.5
Dioscorea deltoidea Wall. ex Griseb.	16	28	13.35	1.75
Girardinia diversifolia (Link) Friis	20	24	13.83	1.2
Hedera helix L.	12	20	9.75	1.67
Isodon rugosus (Wall. ex Benth.) Codd	12	16	8.71	1.33
Justicia adhatoda L.	16	24	12.31	1.5
Mikania micrantha Kunth	16	20	11.27	1.25
Parthenocissus semicordata (Wall.) Planch.	12	12	7.67	1
Stephania glabra (Roxb.) Miers	4	4	2.56	1
Urtica ardens Link	20	28	14.87	1.4
Urtica dioica L.	28	44	22.06	1.57
Vitex negundo L.	24	36	18.47	1.5
Rubus ellipticus Sm.	20	32	15.91	1.6
Total	**264**	**384**	**200.00**	**22.77**

Note- Primary source

Herbs

A total of 25 herb species were recorded from the study area. The density of herb species recorded was 69600 individuals (ha^{-1}). In terms of density, *Fagopyrum acutatum* was the dominant species with 6800 individuals ha^{-1} followed by *Bellis sylvestris* and *Rumex hastatus* with 6000 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 16.91) followed by *Bellis sylvestris* and *Rumex hastatus (*IVI= 16.66). The details are given in Table-5.24.

Table-5.24: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at ZPTH and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ainsliaea aptera DC.	12	1200	4.40	1
Bellis sylvestris Cirillo	36	6000	16.66	1.67
Bidens pilosa L.	16	2800	7.59	1.75
Carex paniculata L.	12	2000	5.55	1.67
Cenchrus ciliaris L.	16	2400	7.02	1.5
Chenopodium album L.	8	1200	3.51	1.5
Dactylis glomerata L.	12	2000	5.55	1.67
Datura stramonium L.	8	1200	3.51	1.5
Digitaria stricta Roth	12	2000	5.55	1.67
Eragrostis superba Peyr.	20	2800	8.49	1.4
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	32	6800	16.91	2.13
Festuca rubra L.	16	2400	7.02	1.5
Fragaria nubicola (Lindl. ex Hook.f.) Lacaita	8	1200	3.51	1.5
Oxalis latifolia Kunth	24	3600	10.53	1.5
Oxalis stricta L.	16	2400	7.02	1.5
Paspalum scrobiculatum L.	8	1200	3.51	1.5
Pennisetum flaccidum Griseb.	20	2800	8.49	1.40
Rumex hastatus D. Don	36	6000	16.66	1.67
Rumex obtusifolius L.	20	2800	8.49	1.4
Salvia glutinosa L.	12	2000	5.55	1.67
Salvia moorcroftiana Wall. ex Benth.	20	3200	9.06	1.6
Sonchus arvensis L.	28	3600	11.42	1.29
Taraxacum campylodes G.E.Haglund	24	3200	9.95	1.33
Thalictrum foliolosum DC.	12	1600	4.98	1.33
Vicia pannonica Crantz	20	3200	9.06	1.6
Total	**448**	**69600**	**200.00**	**38.23**

Note- Primary source

Site-4: Old Bus Stand and adjoining areas

Trees

A total of 4 tree species were recorded from the sampling sites. The density of tree species recorded was 32 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 26 individuals ha^{-1} followed by *Pinus roxburghii, Populus* × *Canadensis and Ficus palmata* with 2 individual's ha^{-1}. The total basal area of tree species recorded were 36.94 m^2 ha^{-1} at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree species (IVI= 237.12) followed by *Pinus roxburghii* (IVI= 21.01). The details are given in Table-5.25.

Table-5.25: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Old Bus Stand and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	28	26	31.72	237.12	4.76	1.86
Pinus roxburghii Sarg.	4	2	2.1	21.93	0.27	1
Populus × *canadensis* Moench	4	2	1.76	21.01	0.16	1
Ficus palmata Forssk.	4	2	1.36	19.93	0.10	1
Total	**40**	**32**	**36.94**	**300.00**	**5.28**	**4.86**

Note- Primary source

Shrubs

A total of 19 shrub species were recorded from study areas. The density of shrub species recorded was 516 individuals (ha^{-1}). In terms of density, *Urtica dioica* was the dominant species with 52 individuals ha^{-1} followed by *Isodon rugosus* with 44 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Urtica dioica* was the dominant species (IVI= 20.19) followed by *Isodon rugosus* (IVI= 16.39). The details are given in Table-5.26.

Table-5.26: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Old Bus Stand and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	12	20	7.25	1.67
Buddleja asiatica Lour.	24	36	13.72	1.5
Cissampelos pareira L.	8	8	3.80	1
Cissus repanda (Wight & Arn.) Vahl	20	28	11.04	1.4
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	20	36	12.59	1.8

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Delairea odorata Lem.	16	20	8.37	1.25
Dioscorea deltoidea Wall. ex Griseb.	12	16	6.47	1.33
Girardinia diversifolia (Link) Friis	28	32	14.07	1.14
Hedera helix L.	20	28	11.04	1.4
Ipomoea nil (L.) Roth	12	20	7.25	1.67
Isodon rugosus (Wall. ex Benth.) Codd	28	44	16.39	1.57
Justicia adhatoda L.	24	36	13.72	1.5
Lycium europaeum L.	12	20	7.25	1.67
Mikania micrantha Kunth	20	28	11.04	1.4
Parthenocissus quinquefolia (L.) Planch.	12	20	7.25	1.67
Rubus ellipticus Sm.	24	36	13.72	1.5
Urtica ardens Link	16	16	7.60	1
Urtica dioica L.	36	52	20.19	1.44
Urtica parviflora Roxb.	12	20	7.25	1.67
Total	**356**	**516**	**200.00**	**27.58**

Note- Primary source

Herbs

A total of 26 herb species were recorded from study area. The density of herb species recorded was 70800 individuals (ha^{-1}). In terms of density, *Festuca flavescens* was the dominant species with 6400 individuals ha^{-1} followed by *Fagopyrum acutatum* with 5200 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Festuca flavescens* was the dominant species (IVI= 16.38) followed by *Fagopyrum acutatum (*IVI= 13.77). The details are given in Table-5.27.

Table-5.27: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Old Bus Stand and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	16	2800	7.62	1.75
Artemisia annua L.	20	3600	9.67	1.8
Bidens pilosa L.	12	2000	5.58	1.67
Chenopodium album L.	24	3600	10.59	1.5
Chrysopogon zizanioides (L.) Roberty	24	3600	10.59	1.50
Cynodon dactylon (L.) Pers.	8	800	2.96	1
Digitaria stricta Roth	20	3200	9.11	1.6
Doronicum kamaonense (DC.) Alv.Fern.	12	1600	5.01	1.33
Eragrostis superba Peyr.	8	2000	4.66	2.5
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	28	5200	13.77	1.86

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Festuca flavescens Bellardi	32	6400	16.38	2
Festuca rubra L.	12	2000	5.58	1.67
Nepeta laevigata (D.Don) Hand.-Mazz.	8	1200	3.53	1.5
Oplismenus undulatifolius (Ard.) Roem. & Schult.	16	2000	6.49	1.25
Oxalis corniculata L.	8	1200	3.53	1.5
Oxalis stricta L.	20	2800	8.54	1.4
Paspalum scrobiculatum L.	12	1600	5.01	1.33
Pennisetum pedicellatum Trin.	20	3600	9.67	1.8
Rumex hastatus D. Don	24	4400	11.72	1.83
Rumex nepalensis Spreng.	20	3600	9.67	1.80
Salvia glutinosa L.	20	2800	8.54	1.4
Salvia moorcroftiana Wall. ex Benth.	28	3600	11.51	1.29
Sonchus arvensis L.	20	3600	9.67	1.80
Vicia pannonica Crantz	12	2400	6.14	2
Viola pilosa Blume	4	400	1.48	1
Xiphidium caeruleum Aubl.	8	800	2.96	1
Total	**436**	**70800**	**200.00**	**41.08**

Note- Primary source

Site-5: Railway Station and adjoining areas

Trees

A total of 2 tree species were recorded from study areas. The density of tree species recorded was 36 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 34 individuals ha^{-1} followed by *Pinus roxburghii* with 2 individual's ha^{-1}. The total basal area of tree species recorded were 42.56 m ^{2} ha $^{-1}$ at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree species (IVI= 279.51) followed by *Pinus roxburghii* (IVI= 20.49). The details are given in Table-5.28.

Table-5.28: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Railway Station and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^{2}ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	36	34	40.46	279.51	7.28	1.89
Pinus roxburghii Sarg.	4	2	2.1	20.49	0.32	1
Total	**40**	**36**	**42.56**	**300.00**	**7.60**	**2.89**

Note- Primary source

Shrubs

A total of 24 shrub species were recorded from study areas. The density of shrub species recorded was 560 individuals (ha^{-1}). In terms of density, *Debregeasia saeneb* was the dominant species with 44 individuals ha^{-1} followed by *Ageratina adenophora* with 36 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Debregeasia saeneb* was the dominant species (IVI= 15.86) followed by *Ageratina adenophora* (IVI= 12.43). The details are given in Table-5.29.

Table-5.29: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Railway Station and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Agave americana L.	4	8	2.43	2
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	24	36	12.43	1.5
Boehmeria nivea (L.) Gaudich.	20	28	10.00	1.4
Buddleja asiatica Lour.	12	16	5.86	1.33
Cissampelos pareira L.	20	28	10.00	1.4
Cissus repanda (Wight & Arn.) Vahl	12	20	6.57	1.67
Coriaria japonica A.Gray	8	12	4.14	1.5
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	32	44	15.86	1.38
Girardinia diversifolia (Link) Friis	12	20	6.57	1.67
Hedera helix L.	16	16	6.86	1
Ipomoea nil (L.) Roth	24	36	12.43	1.5
Isodon rugosus (Wall. ex Benth.) Codd	12	20	6.57	1.67
Justicia adhatoda L.	28	36	13.43	1.29
Lycium europaeum L.	24	28	11.00	1.17
Mikania micrantha Kunth	12	20	6.57	1.67
Parthenocissus semicordata (Wall.) Planch.	12	16	5.86	1.33
Parthenocissus quinquefolia (L.) Planch.	16	16	6.86	1
Pueraria montana var. lobata (Willd.) Sanjappa & Pradeep	24	32	11.71	1.33
Rubia cordifolia L.	16	28	9.00	1.75
Rubus ellipticus Sm.	12	16	5.86	1.33
Smilax tamnoides L.	20	28	10.00	1.4
Urtica dioica L.	24	36	12.43	1.5
Urtica parviflora Roxb.	8	12	4.14	1.5
Vitex negundo L.	8	8	3.43	1
Total	**400**	**560**	**200.00**	**34.28**

Note- Primary source

Herbs

A total of 35 herb species were recorded from study area. The density of herb species recorded was 90000 individuals (ha^{-1}). In terms of density, *Artemisia vulgaris, Bidens pilosa,* and *Fagopyrum acutatum* was the dominant species with 5200 individuals ha^{-1} followed by *Rumex hastatus* with 4800 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 11.86) followed by *Artemisia vulgaris (*IVI= 11.18). The details are in Table-5.30.

Table-5.30: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Railway Station and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Anisomeles indica (L.) Kuntze	12	1600	3.80	1.33
Artemisia annua L.	24	2800	7.17	1.17
Artemisia vulgaris L.	32	5200	11.18	1.63
Bellis sylvestris Cirillo	32	3600	9.41	1.13
Bidens pilosa L.	28	5200	10.51	1.86
Cenchrus ciliaris L.	20	3200	6.93	1.6
Cynodon dactylon (L.) Pers.	4	800	1.56	2
Dactylis glomerata L.	12	2800	5.14	2.33
Datura stramonium L.	4	400	1.12	1
Digitaria stricta Roth	12	2400	4.69	2
Doronicum kamaonense (DC.) Alv.Fern.	24	3200	7.61	1.33
Dryopteris cristata (L.) A. Gray	16	2000	4.92	1.25
Eleusine indica (L.) Gaertn.	20	2800	6.49	1.4
Eragrostis superba Peyr.	12	3600	6.03	3
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	36	5200	11.86	1.44
Festuca flavescens Bellardi	12	1600	3.80	1.33
Festuca rubra L.	16	2800	5.81	1.75
Fragaria nubicola (Lindl. ex Hook.f.) Lacaita	16	2400	5.37	1.5
Gentiana cruciata L.	24	3600	8.05	1.5
Impatiens parviflora DC.	16	2000	4.92	1.25
Nepeta laevigata (D.Don) Hand.-Mazz.	12	2000	4.25	1.67
Oplismenus undulatifolius (Ard.) Roem. & Schult.	12	2000	4.25	1.67
Oxalis stricta L.	12	2000	4.25	1.67
Paspalum scrobiculatum L.	4	800	1.56	2
Pennisetum pedicellatum Trin.	16	2000	4.92	1.25
Potentilla indica (Jacks.) Th.Wolf	12	1600	3.80	1.33
Rumex hastatus D. Don	32	4800	10.74	1.5

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Rumex nepalensis Spreng.	20	3600	7.38	1.8
Rumex obtusifolius L.	16	2800	5.81	1.75
Salvia moorcroftiana Wall. ex Benth.	16	1600	4.48	1
Sonchus arvensis L.	12	2000	4.25	1.67
Spilanthes acmella (L.) L.	8	800	2.24	1
Thalictrum foliolosum DC.	12	2000	4.25	1.67
Trifolium repens L.	28	3600	8.73	1.29
Valeriana hardwickii Wall.	8	1200	2.68	1.5
Total	**592**	**90000**	**200.00**	**54.55**

Note- Primary source

Site-6: Sanjauli and adjoining areas

Trees

A total of 4 tree species were recorded from study areas. The density of tree species recorded was 70 individuals ha^{-1}. In terms of density, *Quercus oblongata* were the dominant tree species with 32 individuals ha^{-1} followed by *Cedrus deodara* with 28 individual's ha^{-1}. The total basal area of tree species recorded were 69.84 m^2 ha^{-1} at the study areas. In terms of basal area *Quercus oblongata* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Quercus oblongata* was the dominant tree species (IVI= 137.82) followed by *Cedrus deodara* (IVI= 119.60). The details are given in Table-5.31.

Table-5.31: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Sanjauli and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Alnus nepalensis D.Don	8	6	4.56	23.43	0.36	1.5
Cedrus deodara (Roxb. ex D.Don) G.Don	36	28	29.4	119.60	5.00	1.56
Picea smithiana (Wall.) Boiss.	8	4	3.56	19.14	0.39	1
Quercus oblongata D.Don	44	32	32.32	137.82	3.88	1.45
Total	**96**	**70**	**69.84**	**300.00**	**9.63**	**5.51**

Note- Primary source

Shrubs

A total of 17 shrub species were recorded from study area. The density of shrub species recorded was 516 individuals (ha^{-1}). In terms of density, *Rubus ellipticus* was the dominant species with 56 individuals ha^{-1} followed by *Debregeasia saeneb* with 48 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Debregeasia saeneb* was the dominant species (IVI= 15.86) followed by *Debregeasia saeneb* (IVI= 19.19). The details are given in Table-5.32.

Table-5.32: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Sanjauli and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Boehmeria macrophylla Hornem.	24	28	12.02	1.17
Buddleja asiatica Lour.	16	20	8.27	1.25
Cissampelos pareira L.	12	20	7.17	1.67
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	36	48	19.19	1.33
Delairea odorata Lem.	28	36	14.67	1.29
Dioscorea deltoidea Wall. ex Griseb.	12	20	7.17	1.67
Girardinia diversifolia (Link) Friis	24	32	12.79	1.33
Hedera helix L.	28	36	14.67	1.29
Ipomoea nil (L.) Roth	20	28	10.92	1.4
Isodon rugosus (Wall. ex Benth.) Codd	24	36	13.57	1.5
Justicia adhatoda L.	16	24	9.05	1.5
Lycium europaeum L.	12	20	7.17	1.67
Parthenocissus semicordata (Wall.) Planch.	12	16	6.40	1.33
Rubus ellipticus Sm.	36	56	20.74	1.56
Stephania glabra (Roxb.) Miers	16	28	9.82	1.75
Urtica ardens Link	20	24	10.15	1.2
Urtica dioica L.	28	44	16.22	1.57
Total	**364**	**516**	**200.00**	**24.47**

Note- Primary source

Herbs

A total of 34 herb species were recorded from study area. The density of herb species recorded was 76000 individuals (ha^{-1}). In terms of density, *Carex paniculata* was the dominant species with 5600 individuals ha^{-1} followed by *Bellis sylvestris* with 5200 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Carex paniculata* was the dominant species (IVI= 14.19) followed by *Bellis sylvestris (*IVI= 13.66).The details are given in Table-5.33.

Table-5.33: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Sanjauli and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Anaphalis sp	4	400	1.28	1
Anisomeles indica (L.) Kuntze	8	1200	3.09	1.5
Artemisia vulgaris L.	16	2800	6.71	1.75
Bellis sylvestris Cirillo	36	5200	13.66	1.44
Bidens pilosa L.	12	2000	4.90	1.67
Carex paniculata L.	36	5600	14.19	1.56
Cenchrus ciliaris L.	20	2800	7.47	1.4
Dactylis glomerata L.	12	1600	4.38	1.33
Digitaria stricta Roth	8	2000	4.15	2.5
Doronicum kamaonense (DC.) Alv.Fern.	4	400	1.28	1
Dryopteris cristata (L.) A. Gray	8	1200	3.09	1.5
Eleusine indica (L.) Gaertn.	12	1600	4.38	1.33
Eragrostis superba Peyr.	16	2800	6.71	1.75
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	12	1600	4.38	1.33
Festuca flavescens Bellardi	8	1200	3.09	1.5
Festuca rubra L.	12	1600	4.38	1.33
Gentiana cruciata L.	12	2000	4.90	1.67
Impatiens parviflora DC.	28	3600	10.04	1.29
Jacobaea erratica (Bertol.) Fourr.	20	2800	7.47	1.4
Leucanthemum monspeliense (L.) H.J.Coste	36	4400	12.61	1.22
Lolium perenne L.	8	1200	3.09	1.5
Malva pusilla Sm.	20	2800	7.47	1.4
Modiola caroliniana (L.) G.Don	12	1200	3.85	1
Nepeta laevigata (D.Don) Hand.-Mazz.	24	3600	9.28	1.5
Pennisetum pedicellatum Trin.	20	2800	7.47	1.4
Potentilla indica (Jacks.) Th.Wolf	4	400	1.28	1
Rumex obtusifolius L.	16	2000	5.66	1.25
Salvia moorcroftiana Wall. ex Benth.	12	1600	4.38	1.33
Sonchus arvensis L.	12	1600	4.38	1.33
Spilanthes acmella (L.) L.	20	3600	8.52	1.8
Thalictrum foliolosum DC.	16	2400	6.19	1.5
Trifolium repens L.	24	3200	8.76	1.33
Valeriana hardwickii Wall.	12	2000	4.90	1.67
Verbascum thapsus L.	8	800	2.57	1
Total	**528**	**76000**	**200.00**	**48.49**

Note- Primary source

Site-7: Navbahar and adjoining areas

Trees

A total of 3 tree species were recorded from study areas. The density of tree species recorded was 62 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 34 individuals ha^{-1} followed by *Quercus oblongata* with 16 individual's ha^{-1}. The total basal area of tree species recorded were 64.98 m^2 ha^{-1} at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree species (IVI= 176.19) followed by *Quercus oblongata* (IVI= 73.90). The details are given in Table-5.34.

Table-5.34: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Navbahar and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	52	34	40.46	176.19	7.69	1.31
Celtis tetrandra Roxb.	16	12	8.04	49.91	0.56	1.5
Quercus oblongata D.Don	20	16	16.48	73.90	2.14	1.6
Total	**88**	**62**	**64.98**	**300.00**	**10.39**	**4.41**

Note- Primary source

Shrubs

A total of 20 shrub species were recorded from study area. The density of shrub species recorded was 508 individuals (ha^{-1}). In terms of density, *Buddleja asiatica* was the dominant species with 60 individuals ha^{-1} followed by *Girardinia diversifolia* with 52 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Girardinia diversifolia* was the dominant species (IVI= 21.21) followed by *Buddleja asiatica* (IVI= 20.35). The details are given in Table-5.35.

Table-5.35: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Navbahar and adjoining areas.

Botanical name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	16	24	9.60	1.5
Berberis lycium Royle	12	20	7.60	1.67
Boehmeria nivea (L.) Gaudich.	24	32	13.62	1.33
Buddleja asiatica Lour.	28	60	20.35	2.14
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	12	28	9.17	2.33
Delairea odorata Lem.	16	20	8.82	1.25
Dioscorea deltoidea Wall. ex Griseb.	12	28	9.17	2.33
Girardinia diversifolia (Link) Friis	36	52	21.21	1.44

Botanical name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Hedera helix L.	16	24	9.60	1.5
Ipomoea nil (L.) Roth	16	20	8.82	1.25
Isodon rugosus (Wall. ex Benth.) Codd	12	12	6.02	1
Justicia adhatoda L.	8	12	4.80	1.5
Parthenocissus quinquefolia (L.) Planch.	28	44	17.20	1.57
Rubus ellipticus Sm.	12	20	7.60	1.67
Smilax aspera L.	4	8	2.79	2
Smilax tamnoides L.	20	28	11.61	1.4
Stephania glabra (Roxb.) Miers	12	16	6.81	1.33
Urtica ardens Link	16	28	10.39	1.75
Urtica dioica L.	16	20	8.82	1.25
Urtica parviflora Roxb.	12	12	6.02	1
Total	**328**	**508**	**200.00**	**31.23**

Note- Primary source

Herbs

A total of 27 herb species were recorded from study area. The density of herb species recorded was 68400 individuals (ha^{-1}). In terms of density, *Rumex hastatus* was the dominant species with 5200 individuals ha^{-1} followed by *Fagopyrum acutatum* with 4800 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 14.10) followed by *Rumex hastatus (*IVI= 13.90). The details are given in Table-5.36.

Table-5.36: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Navbahar and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ainsliaea aptera DC.	12	1600	4.70	1.33
Anisomeles indica (L.) Kuntze	16	2800	7.24	1.75
Bidens pilosa L.	28	3600	10.77	1.29
Canna indica L.	8	1200	3.33	1.5
Carex paniculata L.	24	3200	9.40	1.33
Cenchrus ciliaris L.	28	3600	10.77	1.29
Cenchrus echinatus L.	8	1200	3.33	1.5
Cynodon dactylon (L.) Pers.	12	2000	5.29	1.67
Digitaria stricta Roth	20	2800	8.03	1.4
Dryopteris cristata (L.) A. Gray	28	3200	10.19	1.14
Erigeron canadensis L.	16	2400	6.66	1.5
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	36	4800	14.10	1.33
Festuca flavescens Bellardi	8	1200	3.33	1.5
Malva pusilla Sm.	16	2000	6.07	1.25
Modiola caroliniana (L.) G.Don	4	400	1.37	1

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Nepeta laevigata (D.Don) Hand.-Mazz.	12	2000	5.29	1.67
Oplismenus undulatifolius (Ard.) Roem. & Schult.	20	2800	8.03	1.4
Oxalis latifolia Kunth	12	2000	5.29	1.67
Paspalum scrobiculatum L.	20	2400	7.45	1.2
Pennisetum flaccidum Griseb.	28	3600	10.77	1.29
Rumex hastatus D. Don	32	5200	13.90	1.63
Salvia moorcroftiana Wall. ex Benth.	8	1200	3.33	1.5
Sonchus arvensis L.	20	2800	8.03	1.4
Spilanthes acmella (L.) L.	28	3200	10.19	1.14
Thalictrum foliolosum DC.	24	3200	9.40	1.33
Verbascum thapsus L.	32	3200	10.98	1.00
Vicia pannonica Crantz	8	800	2.74	1
Total	**508**	**68400**	**200.00**	**37.00**

Note- Primary source

Site-8: Secretariat and adjoining areas

Trees

A total of 3 tree species were recorded from study areas. The density of tree species recorded was 62 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 38 individuals ha^{-1} followed by *Morus nigra* with 14 individual's ha^{-1}. The total basal area of tree species recorded were 61.98 m ^{2} ha $^{-1}$ at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree species (IVI= 194.25) followed by *Morus nigra* (IVI= 63.17). The details are given in Table-5.37.

Table-5.37: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Secretariat and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^{2}ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	48	38	45.22	194.25	8.14	1.58
Celtis sinensis Pers.	12	10	7.1	42.58	0.36	1.67
Morus nigra L.	20	14	9.66	63.17	0.48	1.4
Total	**80**	**62**	**61.98**	**300.00**	**8.98**	**4.65**

Note- Primary source

Shrubs

A total of 22 shrub species were recorded from study area. The density of shrub species recorded was 416 individuals (ha^{-1}). In terms of density, *Urtica dioica* was the dominant species with 68 individuals ha^{-1} followed by *Debregeasia saeneb* with 44 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Urtica dioica* was the

dominant species (IVI= 27.45) followed by *Debregeasia saeneb* (IVI= 17.62).The details are given in Table-5.38**.**

Table-5.38: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Secretariat and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Cissampelos pareira L.	16	16	8.10	1
Cissus repanda (Wight & Arn.) Vahl	8	12	4.91	1.5
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	28	44	17.62	1.57
Delairea odorata Lem.	12	12	6.07	1
Dioscorea deltoidea Wall. ex Griseb.	8	12	4.91	1.5
Girardinia diversifolia (Link) Friis	12	16	6.94	1.33
Hedera helix L.	8	12	4.91	1.5
Ipomoea nil (L.) Roth	12	12	6.07	1
Isodon rugosus (Wall. ex Benth.) Codd	16	20	8.96	1.25
Lycium europaeum L.	8	12	4.91	1.5
Mikania micrantha Kunth	12	16	6.94	1.33
Parthenocissus semicordata (Wall.) Planch.	16	20	8.96	1.25
Parthenocissus quinquefolia (L.) Planch.	24	28	13.01	1.17
Rubia cordifolia L.	24	32	13.87	1.33
Rubus ellipticus Sm.	32	36	17.06	1.13
Smilax tamnoides L.	12	20	7.80	1.67
Stephania glabra (Roxb.) Miers	8	8	4.05	1
Tinospora sinensis (Lour.) Merr.	12	20	7.80	1.67
Urtica ardens Link	8	12	4.91	1.5
Urtica dioica L.	44	68	27.45	1.55
Urtica parviflora Roxb.	12	20	7.80	1.67
Vitex negundo L.	12	16	6.94	1.33
Total	**344**	**464**	**200.00**	**29.74**

Note- Primary source

Herbs

A total of 25 herb species were recorded from study area. The density of herb species recorded was 72800 individuals (ha^{-1}). In terms of density, *Fagopyrum acutatum* was the dominant species with 6400 individuals ha^{-1} followed by *Leucanthemum monspeliense* with 4400 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 17.38) followed by *Leucanthemum monspeliense (*IVI= 12.29). The details are given in Table-5.39.

Table-5.39: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Secretariat and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Artemisia annua L.	28	3600	10.41	1.29
Bidens pilosa L.	20	2800	7.75	1.4
Cenchrus echinatus L.	12	1600	4.54	1.33
Chenopodium album L.	20	2800	7.75	1.4
Cynodon dactylon (L.) Pers.	16	2800	6.97	1.75
Digitaria stricta Roth	20	2800	7.75	1.40
Dryopteris cristata (L.) A. Gray	20	2800	7.75	1.4
Eragrostis superba Peyr.	24	3600	9.63	1.5
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	44	6400	17.38	1.45
Festuca rubra L.	12	2000	5.09	1.67
Fragaria nubicola (Lindl. ex Hook.f.) Lacaita	20	2800	7.75	1.40
Impatiens parviflora DC.	20	2800	7.75	1.4
Leucanthemum monspeliense (L.) H.J.Coste	32	4400	12.29	1.375
Nepeta laevigata (D.Don) Hand.-Mazz.	20	2800	7.75	1.4
Oplismenus undulatifolius (Ard.) Roem. & Schult.	12	1600	4.54	1.33
Oxalis latifolia Kunth	8	1200	3.21	1.5
Oxalis stricta L.	12	2000	5.09	1.67
Paspalum scrobiculatum L.	20	2800	7.75	1.4
Pennisetum flaccidum Griseb.	28	3600	10.41	1.29
Rumex obtusifolius L.	36	5200	14.17	1.44
Salvia glutinosa L.	12	2000	5.09	1.67
Salvia moorcroftiana Wall. ex Benth.	16	2000	5.87	1.25
Solanum americanum Mill.	12	2000	5.09	1.67
Thalictrum foliolosum DC.	20	2800	7.75	1.4
Verbascum thapsus L.	28	3600	10.41	1.29
Total	**512**	**72800**	**200.00**	**36.06**

Note- Primary source

Site-9: Kasumpti and adjoining areas

Trees

A total of 3 tree species were recorded from study areas. The density of tree species recorded was 68 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 36 individuals ha^{-1} followed by *Celtis sinensis* with 22 individual's ha^{-1}. The total basal area of tree species recorded were 64.74 m^2 ha^{-1} at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In

terms of importance value index (IVI), *Cedrus deodara* was the dominant tree species (IVI= 171.39) followed by *Celtis sinensis* (IVI= 78.42). The details are given in Table-5.40.

Table-5.40: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Kasumpti and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	44	36	45.72	171.39	8.69	1.64
Celtis sinensis Pers.	28	22	10.12	78.42	0.51	1.57
Robinia pseudoacacia L.	20	10	8.9	50.19	0.62	1
Total	**92**	**68**	**64.74**	**300.00**	**9.82**	**4.21**

Note- Primary source

Shrubs

A total of 13 shrub species were recorded from study area. The density of shrub species recorded was 344 individuals (ha^{-1}). In terms of density, *Debregeasia saeneb* was the dominant species with 48 individuals ha^{-1} followed by *Berberis lyceum, Delairea odorata, Justicia adhatoda* and Parthenocissus *semicordata* with 36 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Debregeasia saeneb* was the dominant species (IVI= 26.65) followed by *Berberis lyceum, Delairea odorata, Justicia adhatoda* and Parthenocissus *semicordata* (IVI= 21.58).The details are given in Table-5.41.

Table-5.41: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Kasumpti and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Berberis lycium Royle	28	36	21.58	1.29
Boehmeria macrophylla Hornem.	20	24	14.91	1.2
Coriaria japonica A.Gray	4	4	2.75	1
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	32	48	26.65	1.5
Delairea odorata L.	28	36	21.58	1.29
Drepanostachyum falcatum (Nees) Keng f.	12	16	9.41	1.33
Girardinia diversifolia (Link) Friis	24	32	18.83	1.33
Justicia adhatoda L.	28	36	21.58	1.29
Lycium europaeum L.	12	20	10.58	1.67
Parthenocissus semicordata (Wall.) Planch.	28	36	21.58	1.29
Rubus ellipticus Sm.	12	20	10.58	1.67
Urtica ardens Link	12	20	10.58	1.67
Urtica dioica L.	12	16	9.41	1.33
Total	**252**	**344**	**200.00**	**17.84**

Note- Primary source

Herbs

A total of 24 herb species were recorded from study area. The density of herb species recorded was 60800 individuals (ha^{-1}). In terms of density, *Bellis sylvestris* was the dominant species with 6000 individuals ha^{-1} followed by *Leucanthemum monspeliense* with 5200 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Bellis sylvestris* was the dominant species (IVI= 17.90) followed by *Leucanthemum monspeliense (*IVI= 16.59). The details are given in Table-5.42.

Table-5.42: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Kasumpti and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Anisomeles indica (L.) Kuntze	12	2000	5.97	1.67
Artemisia vulgaris L.	12	1600	5.31	1.33
Bellis sylvestris Cirillo	36	6000	17.90	1.67
Bidens pilosa L.	24	2800	9.96	1.17
Cynodon dactylon (L.) Pers.	12	2000	5.97	1.67
Dactylis glomerata L.	12	2400	6.63	2
Eragrostis superba Peyr.	16	1600	6.20	1
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	36	4800	15.93	1.33
Festuca flavescens Bellardi	20	2800	9.07	1.4
Jacobaea erratica (Bertol.) Fourr.	12	1600	5.31	1.33
Leucanthemum monspeliense (L.) H.J.Coste	36	5200	16.59	1.44
Malva pusilla Sm.	12	1200	4.65	1
Oxalis stricta L.	12	1600	5.31	1.33
Paspalum scrobiculatum L.	8	1200	3.76	1.5
Pennisetum flaccidum Griseb.	24	3200	10.62	1.33
Rumex hastatus D. Don	32	3600	13.06	1.13
Rumex obtusifolius L.	36	4400	15.27	1.22
Salvia glutinosa L.	16	2000	6.86	1.25
Salvia moorcroftiana Wall. ex Benth.	12	1600	5.31	1.33
Sonchus arvensis L.	20	2800	9.07	1.4
Thalictrum foliolosum DC.	28	3600	12.17	1.29
Verbascum thapsus L.	8	1200	3.76	1.5
Vicia pannonica Crantz	8	1200	3.76	1.5
Xiphidium caeruleum Aubl.	4	400	1.55	1
Total	**448**	**60800**	**200.00**	**32.79**

Note- Primary source

Site-10: Chakkar and adjoining areas

Trees

A total of 4 tree species were recorded from study areas. The density of tree species recorded was 64 individuals ha^{-1}. In terms of density, *Pinus roxburghii* were the dominant tree species with 30 individuals ha^{-1} followed by *Populus* × *Canadensis* and *Celtis sinensis* with 14 individual's ha^{-1}. The total basal area of tree species recorded were 49.6 $m^2 ha^{-1}$ at the study areas. In terms of basal area *Pinus roxburghii* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Pinus roxburghii* was the dominant tree species (IVI= 151.15) followed by *Populus* × *canadensis* (IVI= 66.35). The details are given in Table-5.43.

Table-5.43: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Chakkar and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Pinus roxburghii Sarg.	36	30	29.4	151.15	4.12	1.67
Populus × *canadensis* Moench	20	14	9.66	66.35	0.68	1.4
Myrtus communis L.	8	6	3.96	27.36	0.24	1.5
Celtis sinensis Pers.	16	14	6.58	55.14	0.33	1.75
Total	**80**	**64**	**49.6**	**300.00**	**5.36**	**6.32**

Note- Primary source

Shrubs

A total of 19 shrub species were recorded from study area. The density of shrub species recorded was 392 individuals (ha^{-1}). In terms of density, *Debregeasia saeneb* and *Rubus ellipticus* was the dominant species with 36 individuals ha^{-1} followed by *Isodon rugosus* with 32 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Debregeasia saeneb* was the dominant species (IVI= 19.57) followed by *Rubus ellipticus* (IVI= 18.27). The details are given in Table-5.44.

Table-5.44: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Chakkar and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	12	20	9.00	1.67
Berberis lycium Royle	24	24	13.91	1
Boehmeria nivea (L.) Gaudich.	16	28	12.34	1.75
Buddleja asiatica Lour.	16	20	10.30	1.25
Cissampelos pareira L.	8	8	4.64	1
Coriaria japonica A.Gray	16	20	10.30	1.25

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	32	36	19.57	1.13
Delairea odorata Lem.	8	12	5.66	1.5
Dioscorea deltoidea Wall. ex Griseb.	12	16	7.98	1.33
Girardinia diversifolia (Link) Friis	12	12	6.96	1
Hedera helix L.	12	12	6.96	1
Ipomoea nil (L.) Roth	16	20	10.30	1.25
Isodon rugosus (Wall. ex Benth.) Codd	28	32	17.25	1.14
Justicia adhatoda L.	20	28	13.64	1.4
Lycium europaeum L.	8	12	5.66	1.5
Rubus ellipticus Sm.	28	36	18.27	1.29
Urtica dioica L.	20	28	13.64	1.4
Urtica parviflora Roxb.	8	8	4.64	1
Vitex negundo L.	12	20	9.00	1.67
Total	**308**	**392**	**200.00**	**24.52**

Note- Primary source

Herbs

A total of 25 herb species were recorded from study area. The density of herb species recorded was 78000 individuals (ha^{-1}). In terms of density, *Fagopyrum acutatum* was the dominant species with 6800 individuals ha^{-1} followed by *Leucanthemum monspeliense* with 5200 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 17.05) followed by *Leucanthemum monspeliense (*IVI= 12.92). The details are given in Table-5.45.

Table-5.45: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Chakkar and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Anisomeles indica (L.) Kuntze	24	2800	7.76	1.17
Bidens pilosa L.	28	3600	9.48	1.29
Carex paniculata L.	32	3600	10.17	1.13
Chrysopogon zizanioides (L.) Roberty	32	4400	11.20	1.38
Cynodon dactylon (L.) Pers.	28	3600	9.48	1.29
Dactylis glomerata L.	20	2800	7.06	1.40
Digitaria stricta Roth	28	3600	9.48	1.29
Dryopteris cristata (L.) A. Gray	12	2000	4.65	1.67
Eleusine indica (L.) Gaertn.	20	2400	6.55	1.2
Erigeron canadensis L.	24	3200	8.27	1.33
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	48	6800	17.05	1.42
Jacobaea erratica (Bertol.) Fourr.	12	1600	4.13	1.33
Leucanthemum monspeliense (L.)	36	5200	12.92	1.44

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
H.J.Coste				
Lolium perenne L.	12	1600	4.13	1.33
Pennisetum flaccidum Griseb.	28	3600	9.48	1.29
Pennisetum pedicellatum Trin.	12	2000	4.65	1.67
Potentilla indica (Jacks.) Th.Wolf	20	2800	7.06	1.4
Rumex nepalensis Spreng.	32	4800	11.71	1.50
Rumex obtusifolius L.	28	3200	8.96	1.14
Salvia moorcroftiana Wall. ex Benth.	20	2800	7.06	1.40
Sonchus arvensis L.	32	3600	10.17	1.125
Taraxacum campylodes G.E.Haglund	24	3600	8.78	1.5
Thalictrum foliolosum DC.	12	2800	5.67	2.33
Verbascum thapsus L.	8	1200	2.93	1.5
Viola pilosa Blume	4	400	1.21	1
Total	**576**	**78000**	**200.00**	**34.51**

Note- Primary source

Site-11: 103 Tunnel and adjoining areas

Trees

A total of 4 tree species were recorded from study areas. The density of tree species recorded was 66 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 38 individuals ha^{-1} followed by *Quercus oblongata* with 18 individual's ha^{-1}. The total basal area of tree species recorded were 72.46 m ^{2} ha $^{-1}$ at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree species (IVI= 176.56) followed by *Quercus oblongata* (IVI= 79.44). The details are given in Table-5.46.

Table-5.46: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at 103 Tunnel and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^{2}ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	44	38	48.26	176.56	8.69	1.73
Cupressus torulosa D.Don	4	2	1.74	10.19	0.19	1
Quercus oblongata D.Don	24	18	17.1	79.44	1.88	1.5
Trachycarpus fortunei (Hook.) H.Wendl.	12	8	5.36	33.80	0.27	1.33
Total	**84**	**66**	**72.46**	**300.00**	**11.03**	**5.56**

Note- Primary source

Shrubs

A total of 18 shrub species were recorded from study area. The density of shrub species recorded was 456 individuals (ha^{-1}). In terms of density, *Urtica dioica, Tinospora sinensis, Debregeasia saeneb* and *Rubus ellipticus* was the dominant species with 36 individuals ha^{-1} followed by *Buddleja asiatica* with 32 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Urtica dioica,* and *Rubus ellipticus* was the dominant species (IVI= 15.85) followed by *Tinospora sinensis* (IVI= 14.71). The details are given in Table-5.47.

Table-5.47: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at 103 Tunnel and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Boehmeria macrophylla Hornem.	20	28	11.82	1.4
Buddleja asiatica Lour.	28	32	14.97	1.14
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	32	36	16.99	1.13
Delairea odorata Lem.	12	16	6.92	1.33
Dioscorea deltoidea Wall. ex Griseb.	16	20	8.93	1.25
Girardinia diversifolia (Link) Friis	20	28	11.82	1.4
Hedera helix L.	8	12	4.90	1.5
Ipomoea nil (L.) Roth	16	20	8.93	1.25
Justicia adhatoda L.	24	28	12.96	1.17
Lycium europaeum L.	12	16	6.92	1.33
Mikania micrantha Kunth	16	24	9.81	1.5
Rubia cordifolia L.	20	28	11.82	1.4
Rubus ellipticus Sm.	28	36	15.85	1.29
Smilax aspera L.	12	20	7.80	1.67
Stephania glabra (Roxb.) Miers	16	16	8.05	1
Tinospora sinensis (Lour.) Merr.	24	36	14.71	1.5
Urtica ardens Link	20	24	10.94	1.2
Urtica dioica L.	28	36	15.85	1.29
Total	**352**	**456**	**200.00**	**23.74**

Note- Primary source

Herbs

A total of 20 herb species were recorded from study area. The density of herb species recorded was 65200 individuals (ha^{-1}). In terms of density, *Fagopyrum acutatum* was the dominant species with 6000 individuals ha^{-1} followed by *Rumex hastatus* and *Thalictrum foliolosum* with 5200 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 19.55) followed by *Thalictrum foliolosum (*IVI= 15.73). The details are given in Table-5.48**.**

Table-5.48: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at 103 Tunnel and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ainsliaea aptera DC.	20	3200	9.22	1.6
Artemisia annua L.	32	4400	13.65	1.38
Bellis sylvestris Cirillo	28	3600	11.56	1.29
Carex paniculata L.	12	1200	4.43	1
Cenchrus echinatus L.	8	800	2.95	1
Cynodon dactylon (L.) Pers.	28	3600	11.56	1.29
Dactylis glomerata L.	28	3600	11.56	1.29
Digitaria stricta Roth	20	3600	9.83	1.8
Dryopteris cristata (L.) A. Gray	20	2800	8.60	1.4
Eleusine indica (L.) Gaertn.	20	3600	9.83	1.8
Eragrostis superba Peyr.	32	4400	13.65	1.38
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	48	6000	19.55	1.25
Festuca rubra L.	12	1600	5.04	1.33
Fragaria nubicola (Lindl. ex Hook.f.) Lacaita	20	2800	8.60	1.4
Jacobaea erratica (Bertol.) Fourr.	24	2800	9.47	1.17
Nepeta laevigata (D.Don) Hand.-Mazz.	20	2800	8.60	1.4
Rumex hastatus D. Don	28	5200	14.01	1.86
Sonchus arvensis L.	20	2800	8.60	1.4
Thalictrum foliolosum DC.	36	5200	15.73	1.44
Verbascum thapsus L.	8	1200	3.56	1.5
Total	**464**	**65200**	**200.00**	**27.96**

Note- Primary source

Site-12: Victory Tunnel and adjoining areas

Trees

A total of 2 tree species were recorded from study areas. The density of tree species recorded was 56 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 34 individuals ha^{-1} followed by *Quercus oblongata* with 22 individual's ha^{-1}. The total basal area of tree species recorded were 58.94 m^2 ha^{-1} at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree species (IVI= 187.72) followed by *Quercus oblongata* (IVI= 112.28). The details are given in Table-5.49.

Table-5.49: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Victory Tunnel and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	44	34	36.72	187.72	6.61	1.55
Quercus oblongata D.Don	24	22	22.22	112.28	2.44	1.83
Total	**68**	**56**	**58.94**	**300.00**	**9.05**	**3.38**

Note- Primary source

Shrubs

A total of 17 shrub species were recorded from study area. The density of shrub species recorded was 376 individuals (ha^{-1}). In terms of density, *Rubus ellipticus* was the dominant species with 44 individuals ha^{-1} followed by *Girardinia diversifolia* with 36 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Rubus ellipticus* was the dominant species (IVI= 22.23) followed by *Justicia adhatoda* (IVI= 20.10). The details are in Table-5.50.

Table-5.50: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Victory Tunnel and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Boehmeria macrophylla Hornem.	20	24	12.96	1.2
Cissampelos pareira L.	12	12	7.14	1
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	24	28	15.34	1.17
Delairea odorata Lem.	8	12	5.82	1.5
Dioscorea deltoidea Wall. ex Griseb.	12	16	8.20	1.33
Girardinia diversifolia (Link) Friis	28	36	18.78	1.29
Hedera helix L.	20	24	12.96	1.2
Isodon rugosus (Wall. ex Benth.) Codd	16	16	9.52	1
Justicia adhatoda L.	32	36	20.10	1.13
Lycium europaeum L.	12	20	9.27	1.67
Rubia cordifolia L.	8	12	5.82	1.5
Rubus ellipticus Sm.	32	44	22.23	1.38
Stephania glabra (Roxb.) Miers	12	16	8.20	1.33
Urtica ardens Link	8	12	5.82	1.5
Urtica dioica L.	24	28	15.34	1.17
Urtica parviflora Roxb.	12	12	7.14	1
Vitex negundo L.	24	28	15.34	1.17
Total	**304**	**376**	**200.00**	**21.52**

Note- Primary source

Herbs

A total of 22 herb species were recorded from study area. The density of herb species recorded was 62400 individuals (ha^{-1}). In terms of density, *Fagopyrum acutatum* was the dominant species with 5600 individuals ha^{-1} followed by *Rumex nepalensis* and *Thalictrum foliolosum* with 5200 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 16.94) followed by *Sonchus arvensis (*IVI= 15.56). The details are given in Table-5.51.

Table-5.51: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Victory Tunnel and adjoining areas

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ainsliaea aptera DC.	24	3600	11.08	1.5
Bidens pilosa L.	20	1600	6.99	0.80
Bellis sylvestris Cirillo	36	4400	15.02	1.22
Dactylis glomerata L.	28	3600	11.96	1.29
Datura stramonium L.	4	400	1.53	1
Eragrostis superba Peyr.	16	2800	8.03	1.75
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	36	5600	16.94	1.56
Festuca flavescens Bellardi	8	800	3.05	1
Leucanthemum monspeliense (L.) H.J.Coste	28	3200	11.32	1.14
Lolium perenne L.	8	1200	3.69	1.5
Malva pusilla Sm.	12	2000	5.86	1.67
Modiola caroliniana (L.) G.Don	16	2800	8.03	1.75
Nepeta laevigata (D.Don) Hand.-Mazz.	20	2400	8.27	1.20
Paspalum scrobiculatum L.	24	3200	10.44	1.33
Pennisetum flaccidum Griseb.	20	3600	10.19	1.80
Rumex hastatus D. Don	28	3600	11.96	1.29
Rumex nepalensis Spreng.	32	4800	14.77	1.50
Salvia moorcroftiana Wall. ex Benth.	8	1200	3.69	1.5
Sonchus arvensis L.	36	4800	15.66	1.33
Verbascum thapsus L.	24	3600	11.08	1.5
Vicia pannonica Crantz	16	2000	6.74	1.25
Xiphidium caeruleum Aubl.	8	1200	3.69	1.5
Total	**452**	**62400**	**200.00**	**30.38**

Note- Primary source

Site-13: Lower Lift Point and adjoining areas.

Trees

A total of 7 tree species were recorded from study areas. The density of tree species recorded was 110 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 34 individuals ha^{-1} followed by *Aesculus indica* with 22 individual's ha^{-1}.

The total basal area of tree species recorded were 108.52 m^2 ha^{-1} at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree species (IVI= 95.01) followed by *Aesculus indica* (IVI= 60.94). The details are given in Table-5.52.

Table-5.52: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Lower Lift Point and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Aesculus indica (Wall. ex Cambess.) Hook.	32	22	23.76	60.94	1.90	1.38
Ailanthus altissima (Mill.) Swingle	8	6	4.5	14.36	0.32	1.5
Alnus nepalensis D.Don	8	4	3.52	11.64	0.21	1
Cedrus deodara (Roxb. ex D.Don) G.Don	44	34	41.14	95.01	6.17	1.55
Celtis sinensis Pers.	20	14	9.38	33.28	0.56	1.4
Quercus oblongata D.Don	36	18	18.18	54.54	1.64	1
Robinia pseudoacacia L.	20	12	8.04	30.22	0.56	1.2
Total	**168**	**110**	**108.52**	**300.00**	**11.36**	**9.02**

Note- Primary source

Shrubs

A total of 19 shrub species were recorded from study area. The density of shrub species recorded was 340 individuals (ha^{-1}). In terms of density, *Rubus ellipticus* and *Urtica dioica* was the dominant species with 36 individuals ha^{-1} followed by *Girardinia diversifolia* with 32 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Rubus ellipticus* was the dominant species (IVI= 22.35) followed by *Urtica dioica* (IVI= 20.88). The details are given in Table-5.53.

Table-5.53: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Lower Lift Point and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Boehmeria macrophylla Hornem.	8	12	6.47	1.5
Buddleja asiatica Lour.	12	16	9.12	1.33
Cissampelos pareira L.	16	20	11.76	1.25
Cissus repanda (Wight & Arn.) Vahl	12	20	10.29	1.67
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	8	8	5.29	1
Girardinia diversifolia (Link) Friis	28	32	19.71	1.14
Hedera helix L.	12	20	10.29	1.67
Ipomoea nil (L.) Roth	8	12	6.47	1.5
Justicia adhatoda L.	12	16	9.12	1.33

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Lycium europaeum L.	8	8	5.29	1
Mikania micrantha Kunth	12	12	7.94	1
Pueraria montana var. lobata (Willd.) Sanjappa & Pradeep	12	12	7.94	1
Rubia cordifolia L.	20	24	14.41	1.2
Rubus ellipticus Sm.	32	36	22.35	1.13
Smilax tamnoides L.	16	16	10.59	1
Tinospora sinensis (Lour.) Merr.	12	20	10.29	1.67
Urtica ardens Link	8	12	6.47	1.5
Urtica dioica L.	28	36	20.88	1.29
Urtica parviflora Roxb.	8	8	5.29	1
Total	**272**	**340**	**200.00**	**24.17**

Note- Primary source

Herbs

A total of 29 herb species were recorded from study area. The density of herb species recorded was 57600 individuals (ha^{-1}). In terms of density, *Fagopyrum acutatum* was the dominant species with 5200 individuals ha^{-1} followed by *Artemisia annua* with 4800 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 16.57) followed by *Artemisia annua (*IVI= 15.88). The details are given in Table-5.54.

Table-5.54: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Lower Lift Point and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Anisomeles indica (L.) Kuntze	8	1200	3.97	1.5
Artemisia annua L.	32	4800	15.88	1.5
Bellis sylvestris Cirillo	28	3600	12.85	1.29
Bidens pilosa L.	16	2400	7.94	1.5
Carex paniculata L.	12	2000	6.30	1.67
Cenchrus ciliaris L.	16	2000	7.25	1.25
Cynodon dactylon (L.) Pers.	12	1600	5.61	1.33
Dactylis glomerata L.	12	2000	6.30	1.67
Digitaria stricta Roth	8	800	3.28	1
Dryopteris cristata (L.) A. Gray	16	2000	7.25	1.25
Eleusine indica (L.) Gaertn.	8	800	3.28	1
Erigeron canadensis L.	12	2000	6.30	1.67
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	32	5200	16.57	1.63
Festuca rubra L.	8	800	3.28	1
Impatiens parviflora DC.	12	1600	5.61	1.33
Malva pusilla Sm.	12	2000	6.30	1.67

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Nepeta laevigata (D.Don) Hand.-Mazz.	16	2000	7.25	1.25
Oplismenus undulatifolius (Ard.) Roem. & Schult.	4	400	1.64	1
Oxalis stricta L.	4	400	1.64	1
Paspalum scrobiculatum L.	20	3200	10.27	1.6
Rumex hastatus D. Don	32	4400	15.19	1.38
Rumex nepalensis Spreng.	8	1200	3.97	1.5
Salvia glutinosa L.	16	1600	6.55	1
Salvia moorcroftiana Wall. ex Benth.	20	2000	8.19	1
Sonchus arvensis L.	4	400	1.64	1
Thalictrum foliolosum DC.	12	1600	5.61	1.33
Valeriana hardwickii Wall.	16	2400	7.94	1.5
Verbascum thapsus L.	12	1200	4.91	1
Vicia pannonica Crantz	16	2000	7.25	1.25
Total	**424**	**57600**	**200.00**	**38.05**

Note- Primary source

Site-14: Upper Lift Point and adjoining areas

Trees

A total of 5 tree species were recorded from study areas. The density of tree species recorded was 104 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 42 individuals ha^{-1} followed by *Quercus oblongata* with 34 individual's ha^{-1}. The total basal area of tree species recorded were 99.82 m ^{2} ha $^{-1}$ at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree species (IVI= 125.22) followed by *Quercus oblongata* (IVI= 94.37). The details are given in Table-5.55.

Table-5.55: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at Upper Lift Point and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^{2}ha^{-1})	IVI	Volume (m^3)	Abundance
Cedrus deodara (Roxb. ex D.Don) G.Don	52	42	45.36	125.22	7.71	1.61538462
Celtis sinensis Pers.	8	4	3.04	12.95	0.15	1
Populus deltoides Marshall	20	14	9.38	38.01	0.66	1.4
Quercus oblongata D.Don	36	34	34.34	94.37	4.12	1.89
Robinia pseudoacacia L.	16	10	7.7	29.45	0.54	1.25
Total	**132**	**104**	**99.82**	**300.00**	**13.1796**	**7.15**

Note- Primary source

Shrubs

A total of 19 shrub species were recorded from study area. The density of shrub species recorded was 416 individuals (ha^{-1}). In terms of density, *Debregeasia saeneb* was the dominant species with 36 individuals ha^{-1} followed by *Justicia adhatoda* and *Ipomoea nil* with 32 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Debregeasia saeneb* was the dominant species (IVI= 18.38) followed by *Ipomoea nil* (IVI= 16.03). The details are given in Table-5.56.

Table-5.56: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at Upper Lift Point and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Ageratina adenophora (Spreng.) R.M.King & H.Rob.	16	20	10.36	1.25
Buddleja asiatica Lour.	20	28	13.68	1.4
Cissampelos pareira L.	16	24	11.32	1.5
Cissus repanda (Wight & Arn.) Vahl	12	20	8.97	1.67
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	28	36	18.38	1.29
Dioscorea deltoidea Wall. ex Griseb.	16	28	12.29	1.75
Drepanostachyum falcatum (Nees) Keng f.	12	16	8.01	1.33
Girardinia diversifolia (Link) Friis	12	20	8.97	1.67
Hedera helix L.	8	12	5.66	1.5
Ipomoea nil (L.) Roth	24	32	16.03	1.33
Isodon rugosus (Wall. ex Benth.) Codd	12	20	8.97	1.67
Justicia adhatoda L.	24	32	16.03	1.33
Lycium europaeum L.	12	16	8.01	1.33
Parthenocissus quinquefolia (L.) Planch.	16	20	10.36	1.25
Rubus ellipticus Sm.	16	24	11.32	1.5
Smilax tamnoides L.	12	20	8.97	1.67
Stephania glabra (Roxb.) Miers	16	28	12.29	1.75
Urtica dioica L.	8	12	5.66	1.5
Urtica parviflora Roxb.	8	8	4.70	1
Total	**288**	**416**	**200.00**	**27.69**

Note- Primary source

Herbs

A total of 22 herb species were recorded from study area. The density of herb species recorded was 63600 individuals (ha^{-1}). In terms of density, *Trifolium repens* was the dominant species with 5600 individuals ha^{-1} followed by *Bellis sylvestris* with 5200 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Trifolium repens* was

the dominant species (IVI= 18.81) followed by *Bellis sylvestris (*IVI= 15.45). The details are given in Table-5.57.

Table-5.57: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at Upper Lift Point and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Artemisia annua L.	12	1200	4.61	1
Bellis sylvestris Cirillo	32	5200	15.45	1.625
Bidens pilosa L.	20	2800	8.95	1.4
Cynodon dactylon (L.) Pers.	12	2000	5.87	1.67
Digitaria stricta Roth	20	2800	8.95	1.4
Dryopteris cristata (L.) A. Gray	12	2000	5.87	1.67
Eleusine indica (L.) Gaertn.	20	2800	8.95	1.4
Eragrostis superba Peyr.	28	3200	11.40	1.14
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	32	5200	15.45	1.63
Festuca rubra L.	8	1200	3.70	1.5
Lunaria rediviva L.	16	2000	6.78	1.25
Malva pusilla Sm.	16	2400	7.41	1.5
Oplismenus undulatifolius (Ard.) Roem. & Schult.	12	2000	5.87	1.67
Oxalis stricta L.	20	3600	10.21	1.8
Rumex nepalensis Spreng.	28	4400	13.28	1.57
Salvia glutinosa L.	16	2400	7.41	1.5
Salvia moorcroftiana Wall. ex Benth.	16	2400	7.41	1.5
Sonchus arvensis L.	24	3200	10.49	1.33
Taraxacum campylodes G.E.Haglund	20	2400	8.32	1.2
Thalictrum foliolosum DC.	12	2000	5.87	1.67
Trifolium repens L.	44	5600	18.81	1.27
Xiphidium caeruleum Aubl.	20	2800	8.95	1.4
Total	**440**	**63600**	**200.00**	**32.09**

Note- Primary source

Site-15: IGMC and adjoining areas.

Trees

A total of 6 tree species were recorded from study areas. The density of tree species recorded was 106 individuals ha^{-1}. In terms of density, *Cedrus deodara* were the dominant tree species with 36 individuals ha^{-1} followed by *Robinia pseudoacacia* with 22 individual's ha^{-1}. The total basal area of tree species recorded were 106.52 m^2 ha^{-1} at the study areas. In terms of basal area *Cedrus deodara* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Cedrus deodara* was the dominant tree

species (IVI= 107.88) followed by *Robinia pseudoacacia* (IVI= 58.12). The details are given in Table-5.58.

Table-5.58: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at IGMC and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^2ha^{-1})	IVI	Volume (m^3)	Abundance
Aesculus indica (Wall. ex Cambess.) Hook.	16	12	11.76	34.13	0.82	1.5
Cedrus deodara (Roxb. ex D.Don) G.Don	44	36	44.28	107.88	7.08	1.64
Celtis sinensis Pers.	12	10	6.8	24.64	0.34	1.67
Populus deltoides Marshall	12	8	6.08	22.08	0.36	1.33
Quercus oblongata D.Don	20	18	22.86	53.15	1.83	1.8
Robinia pseudoacacia L.	32	22	14.74	58.12	0.88	1.38
Total	**136**	**106**	**106.52**	**300**	**11.33**	**9.31**

Note- Primary source

Shrubs

A total of 19 shrub species were recorded from study area. The density of shrub species recorded was 316 individuals (ha^{-1}). In terms of density, *Rubus ellipticus* was the dominant species with 36 individuals ha^{-1} followed by Vitex negundo and *Ipomoea nil* with 28 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Rubus ellipticus* was the dominant species (IVI= 22.50) followed by *Vitex negundo* (IVI= 16.80). The details are given in Table-5.59.

Table-5.59: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at IGMC and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Boehmeria macrophylla Hornem.	12	12	8.56	1
Boehmeria nivea (L.) Gaudich.	8	8	5.71	1
Buddleja asiatica Lour.	12	20	11.09	1.67
Cissus repanda (Wight & Arn.) Vahl	12	16	9.83	1.33
Coriaria japonica A.Gray	8	12	6.97	1.5
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	8	8	5.71	1
Delairea odorata Lem.	16	20	12.68	1.25
Dioscorea deltoidea Wall. ex Griseb.	20	24	15.53	1.2
Hedera helix L.	12	12	8.56	1
Ipomoea nil (L.) Roth	8	8	5.71	1
Pueraria montana var. lobata (Willd.) Sanjappa & Pradeep	16	20	12.68	1.25

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Rubia cordifolia L.	12	16	9.83	1.33
Rubus ellipticus Sm.	28	36	22.50	1.29
Smilax aspera L.	8	12	6.97	1.5
Stephania glabra (Roxb.) Miers	12	16	9.83	1.33
Tinospora sinensis (Lour.) Merr.	12	12	8.56	1
Urtica ardens Link	16	20	12.68	1.25
Urtica dioica L.	12	16	9.83	1.33
Vitex negundo L.	20	28	16.80	1.4
Total	**252**	**316**	**200.00**	**23.64**

Note- Primary source

Herbs

A total of 24 herb species were recorded from study area. The density of herb species recorded was 71200 individuals (ha^{-1}). In terms of density, *Rumex obtusifolius* was the dominant species with 6800 individuals ha^{-1} followed by *Bellis sylvestris* with 6000 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Rumex obtusifolius* was the dominant species (IVI= 19.31) followed by *Bellis sylvestris (*IVI= 15.74). The details are given in Table-5.60.

Table-5.60: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at IGMC and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Artemisia annua L.	20	2800	8.00	1.4
Bidens pilosa L.	12	2000	5.25	1.67
Bellis sylvestris Cirillo	36	6000	15.74	1.67
Cenchrus echinatus L.	4	800	1.94	2
Cynodon dactylon (L.) Pers.	16	2800	7.18	1.75
Digitaria stricta Roth	20	2800	8.00	1.4
Doronicum kamaonense (DC.) Alv.Fern.	4	400	1.37	1
Dryopteris cristata (L.) A. Gray	28	3600	10.75	1.29
Eleusine indica (L.) Gaertn.	12	2000	5.25	1.67
Eragrostis superba Peyr.	24	3600	9.93	1.5
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	4	800	1.94	2
Jacobaea erratica (Bertol.) Fourr.	8	1200	3.31	1.5
Malva pusilla Sm.	8	1600	3.87	2
Modiola caroliniana (L.) G.Don	12	1600	4.69	1.33
Nepeta laevigata (D.Don) Hand.-Mazz.	24	3200	9.37	1.33
Pennisetum flaccidum Griseb.	36	4800	14.06	1.33
Pennisetum pedicellatum Trin.	24	3200	9.37	1.33
Rumex hastatus D. Don	36	5200	14.62	1.44
Rumex obtusifolius L.	48	6800	19.31	1.42

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Sonchus arvensis L.	28	3600	10.75	1.29
Thalictrum foliolosum DC.	24	3200	9.37	1.33
Trifolium repens L.	44	6000	17.37	1.36
Verbascum thapsus L.	24	3200	9.37	1.33
Vicia pannonica Crantz	16	2800	7.18	1.75
Total	**492**	**71200**	200.00	**34.70**

Note- Primary source

Site-16: ICR and adjoining areas.

Trees

A total of 3 tree species were recorded from study areas. The density of tree species recorded was 76 individuals ha^{-1}. In terms of density, *Aesculus indica* were the dominant tree species with 56 individuals ha^{-1} followed by *Cedrus deodara* with 26 individual's ha^{-1}. The total basal area of tree species recorded were 74.62 m ^{2} ha $^{-1}$ at the study areas. In terms of basal area *Aesculus indica* has maximum basal area as compared to other tree species. In terms of importance value index (IVI), *Aesculus indica* was the dominant tree species (IVI= 148.66) followed by *Cedrus deodara* (IVI= 107.14). The details are given in Table-5.61.

Table-5.61: Frequency, density, basal area, abundance, volume and IVI for the tree species recorded from Sampling Sites at ICR and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	Basal Area (m^{2}ha^{-1})	IVI	Volume (m^3)	Abundance
Aesculus indica (Wall. ex Cambess.) Hook.	56	38	33.44	148.66	2.68	1.36
Cedrus deodara (Roxb. ex D.Don) G.Don	32	26	31.46	107.14	5.66	1.63
Populus deltoides Marshall	16	12	9.72	44.20	0.68	1.5
Total	**104**	**76**	**74.62**	**300**	**9.02**	**4.48**

Note- Primary source

Shrubs

A total of 22 shrub species were recorded from study area. The density of shrub species recorded was 428 individuals (ha^{-1}). In terms of density, *Urtica dioica* and *Debregeasia saeneb* was the dominant species with 36 individuals ha^{-1} followed by *Girardinia diversifolia* and *Mikania micrantha* and *Ipomoea nil* with 28 individual's ha^{-1} in the shrub canopy layer. In terms of importance value index (IVI), *Debregeasia saeneb* was the dominant species (IVI= 17.08) followed by *Urtica dioica* (IVI= 15.82). The details are given in Table-5.62.

Table-5.62: Frequency, density, abundance and IVI for the shrub species recorded from Sampling Sites at ICR and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Berberis wilsoniae Hemsl.	16	20	9.61	1.25
Boehmeria nivea (L.) Gaudich.	12	16	7.44	1.33
Cissampelos pareira L.	8	12	5.27	1.5
Cissus repanda (Wight & Arn.) Vahl	12	16	7.44	1.33
Coriaria japonica A.Gray	8	12	5.27	1.5
Debregeasia saeneb (Forssk.) Hepper & J.R.I.Wood	28	36	17.05	1.29
Delairea odorata Lem.	12	12	6.51	1
Dioscorea deltoidea Wall. ex Griseb.	16	20	9.61	1.25
Girardinia diversifolia (Link) Friis	20	28	12.71	1.4
Hedera helix L.	8	12	5.27	1.5
Ipomoea nil (L.) Roth	4	4	2.17	1
Justicia adhatoda L.	20	28	12.71	1.4
Lycium europaeum L.	16	20	9.61	1.25
Mikania micrantha Kunth	20	28	12.71	1.4
Parthenocissus semicordata (Wall.) Planch.	16	24	10.55	1.5
Rubia cordifolia L.	16	20	9.61	1.25
Rubus ellipticus Sm.	20	28	12.71	1.4
Smilax aspera L.	8	12	5.27	1.5
Stephania glabra (Roxb.) Miers	12	12	6.51	1
Urtica dioica L.	24	36	15.82	1.5
Urtica parviflora Roxb.	12	12	6.51	1
Vitex negundo L.	16	20	9.61	1.25
Total	**324**	**428**	**200.00**	**28.80**

Note- Primary source

Herbs

A total of 22 herb species were recorded from study area. The density of herb species recorded was 62000 individuals (ha^{-1}). In terms of density, *Fagopyrum acutatum* was the dominant species with 6800 individuals ha^{-1} followed by *Rumex hastatus* with 5600 individual's ha^{-1} in the herb. In terms of importance value index (IVI), *Fagopyrum acutatum* was the dominant species (IVI= 23.00) followed by *Rumex hastatus (*IVI= 17.37). The details are given in Table-5.63.

Table-5.63: Frequency, density, abundance and IVI for the herb species recorded from Sampling Sites at ICR and adjoining areas.

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Artemisia annua L.	20	2800	9.15	1.4
Bellis sylvestris Cirillo	24	3600	11.36	1.5

Botanical Name	Frequency (%)	Density (Individual ha^{-1})	IVI	Abundance
Bidens pilosa L.	12	1600	5.36	1.33
Carex paniculata L.	28	3600	12.29	1.29
Cynodon dactylon (L.) Pers.	16	2000	6.93	1.25
Digitaria stricta Roth	16	2800	8.22	1.75
Dryopteris cristata (L.) A. Gray	12	1200	4.71	1
Fagopyrum acutatum (Lehm.) Mansf. ex K.Hammer	52	6800	23.00	1.31
Jacobaea erratica (Bertol.) Fourr.	4	800	2.22	2
Nepeta laevigata (D.Don) Hand.-Mazz.	12	2000	6.00	1.67
Oplismenus undulatifolius (Ard.) Roem. & Schult.	8	1200	3.79	1.5
Oxalis stricta L.	16	2800	8.22	1.75
Paspalum scrobiculatum L.	20	2800	9.15	1.4
Pennisetum flaccidum Griseb.	20	2800	9.15	1.4
Rumex hastatus D. Don	36	5600	17.37	1.56
Rumex nepalensis Spreng.	8	1200	3.79	1.5
Salvia glutinosa L.	16	2000	6.93	1.25
Sonchus arvensis L.	28	4400	13.58	1.57
Spilanthes acmella (L.) L.	8	1200	3.79	1.5
Taraxacum campylodes G.E.Haglund	28	3600	12.29	1.29
Thalictrum foliolosum DC.	32	4800	15.15	1.5
Verbascum thapsus L.	16	2400	7.57	1.5
Total	**432**	**62000**	**200.00**	**32.21**

Note- Primary source

5.4.8 Diversity Index

Species diversity index can be considered as a measure of environmental quality and indicates the well-being of any ecosystem. To assess diversity of floral elements and structure of the plant community in different study sites, various diversity indices were computed. A diversity index is mathematical measures of species diversity in a community. They provide more information about community composition than simply species richness (i.e., the number of species present); they also take the relative abundances of different species into account. Three species diversity indices viz., Shannon index of general diversity (H), dominance index (D) and Evenness index (e) were computed using PAST software.

5.4.8.1 Shannon-Wiener Diversity Index

Shannon Weinner index (H′) is an index used to measure diversity in categorical data. In a basic sense, it is the information entropy of the distribution in a given area treating species as symbols and their relative population sizes as the probability. The diversity index takes into account the number of individuals as well as number of taxa. Value of Shannon Weinner

index (H′) more than 2 is indicates higher species diversity while its value around 1 or less than 1 indicates low diversity. Higher values of Shannon index also indicate that a particular community has more information. Diversity index (H) increases in value as the number of species increases. Thus, higher the value of (H) the greater is the species diversity in the community. In the present study species diversity ranged between 0.2146 to 1.764 for tree species, 2.46 to 3.088 for shrub species and 2.787 to 3.371 for herb species recorded from all study sites is shown in Table-5.64 and graphical analysis is depicted in Figure-5.17.

Table-5.64: Shannon-Wiener index recorded in the study area for trees, shrubs and herbs various sampling sites:

Project Sampling Site	Shannon-Wiener Diversity Index		
	Tree	Shrub	Herb
Site-1	0.5296	2.626	2.787
Site-2	1.187	2.757	3.332
Site-3	1.003	2.656	3.091
Site-4	0.6886	2.867	3.123
Site-5	0.2146	3.088	3.436
Site-6	1.098	2.773	3.371
Site-7	0.9969	2.876	3.189
Site-8	0.9303	2.931	3.149
Site-9	0.9837	2.46	3.03
Site-10	1.242	2.855	3.126
Site-11	1.034	2.843	2.902
Site-12	0.67	2.741	2.96
Site-13	1.764	2.838	3.191
Site-14	1.352	2.887	3.01
Site-15	1.659	2.861	3.025
Site-16	1.005	2.998	2.955

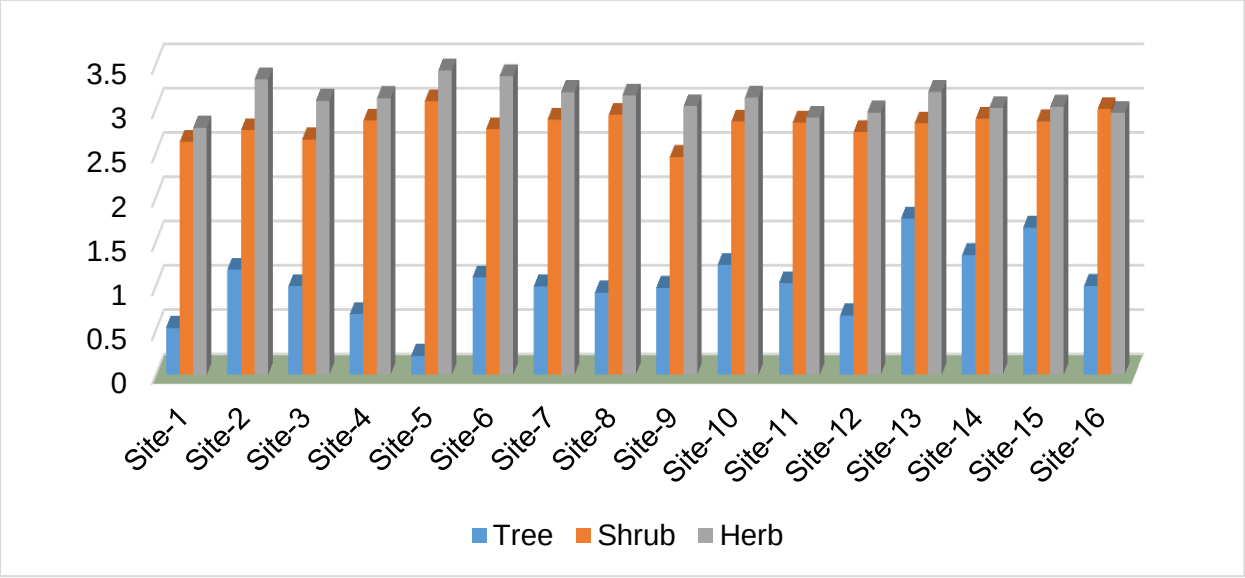


Figure-5.17: Shannon-Wiener index recorded in the study area for trees, shrubs and herbs various sampling sites

5.4.9 Dominance Index

Dominance index is always ranges from 0 - 1, indicates species dominance within community gives greater weight to common species. In addition, the value of Dominance closer to 1 indicates areas dominated by single or few species. The value of Dominance had followed an opposite trend of diversity. From the present observations, the species diversity ranged between 0.2147 to 0.7216 for tree species, 0.05372 to 0.0914 for shrub species and 0.0353 to 0.06856 for herbs in all study sites. Dominance is also used for the estimation of heterogeneity of various sites, shown in Table-5.65 and graphical analysis is depicted in Figure-5.18.

Table-5.65: Dominance index recorded in the study area for trees, shrubs and herbs various sampling sites

Project Sampling Site	Dominance index		
	Tree	Shrub	Herb
Site-1	0.7216	0.07763	0.06856
Site-2	0.3291	0.07139	0.04007
Site-3	0.3979	0.07661	0.05146
Site-4	0.6719	0.06075	0.04849
Site-5	0.8951	0.04798	0.0353
Site-6	0.3796	0.06628	0.03867
Site-7	0.4048	0.06318	0.04449
Site-8	0.4527	0.06391	0.04607
Site-9	0.4066	0.0914	0.05454
Site-10	0.3242	0.06185	0.0471
Site-11	0.4215	0.06063	0.0586
Site-12	0.523	0.07017	0.0563
Site-13	0.1947	0.06464	0.04736
Site-14	0.2988	0.05843	0.05328
Site-15	0.2147	0.06201	0.05397
Site-16	0.392	0.05372	0.05848

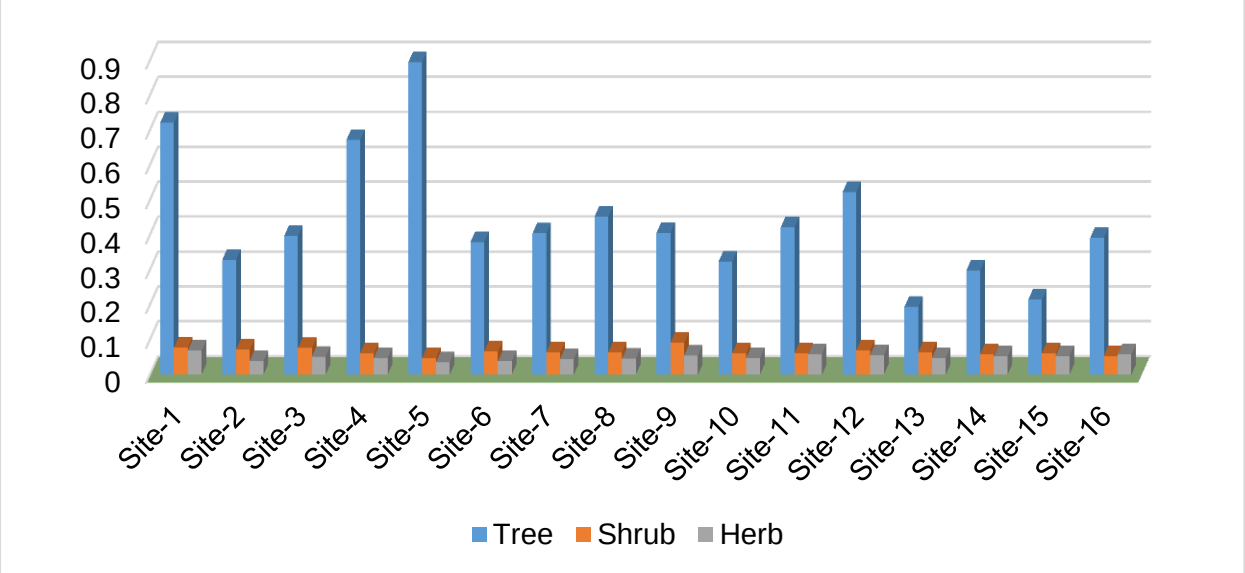


Figure-5.18: Graphical analysis of Dominance index recorded in the study area for trees, shrubs and herbs various sampling sites

5.4.10 Buzas and Gibsons Evenness Index

Evenness compares the similarity of the population size of each of the species present. As species richness and evenness increase, so diversity increases. In the present study Pielou's evenness (J) ranged between 0.4977 to 0.9771 for tree species, 0.8519 to 0.9442 for shrub species and 0.8386 to 0.9325 for herb species in all study sites. The value of species diversity (H') and evenness shows that decreased diversity in the some sites may be due to dominance of very few species, shown in Table-5.66 and graphical analysis is depicted in Figure-5.19.

Table-5.66: Buzas and Gibsons Evenness index recorded in the study area for trees, shrubs and herbs various sampling sites

Project Sampling Site	Buzas and Gibsons Evenness index		
	Tree	Shrub	Herb
Site-1	0.5661	0.9212	0.8542
Site-2	0.819	0.8754	0.8744
Site-3	0.9086	0.8902	0.8801
Site-4	0.4977	0.9254	0.8737
Site-5	0.6197	0.914	0.8871
Site-6	0.7499	0.9415	0.8559
Site-7	0.9033	0.8867	0.8984
Site-8	0.8451	0.8519	0.9325
Site-9	0.8914	0.9001	0.8627
Site-10	0.8656	0.9144	0.911
Site-11	0.703	0.954	0.9108
Site-12	0.9771	0.9115	0.8772
Site-13	0.8339	0.899	0.8386
Site-14	0.7731	0.9442	0.9221
Site-15	0.8753	0.9201	0.8579
Site-16	0.9106	0.9114	0.8726

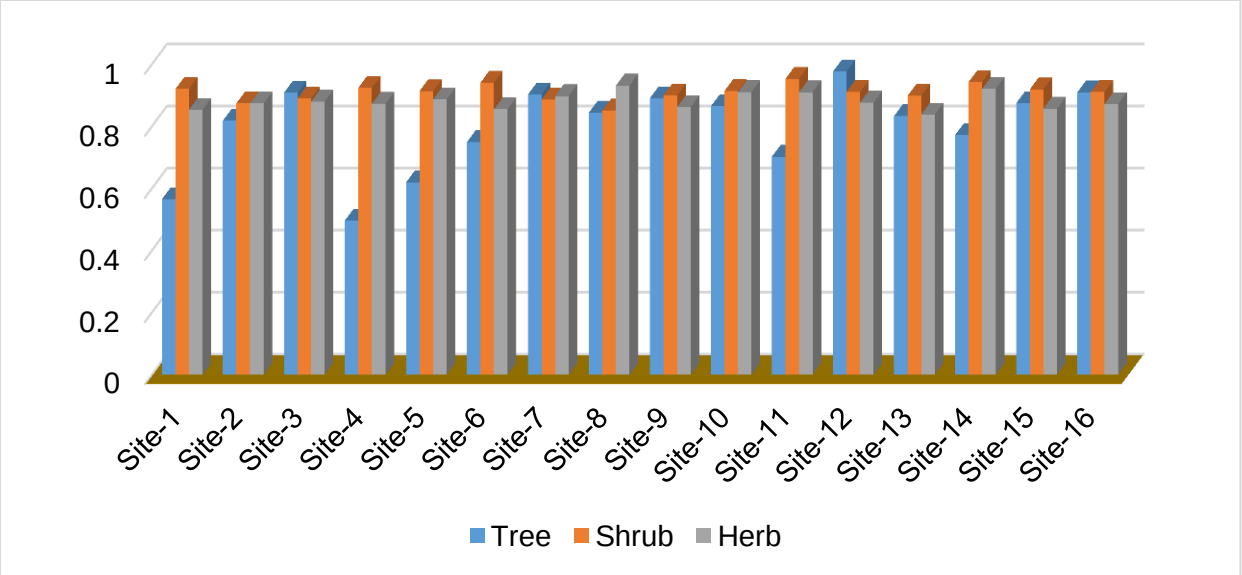


Figure-5.19: Buzas and Gibsons Evenness index recorded in the study area for trees, shrubs and herbs various sampling sites

5.4.11 Terrestrial Fauna

The information of the faunal diversity in and around study sites were identified by direct observation during field survey and signs of their pellets, scats, pugmarks and claw marks were also considered. The avifauna and butterflies of the study sites have been documented through direct observations, random walks and opportunistic observations during early morning (6:00 to 10:00 hrs.) and evening (17:00 to 19:00 hrs) for birds using a pair of binoculars and noon (11:00 to 14:00) for butterflies were carried out during the field surveys. Dicussions with the villagers and local people were also made to generate information about faunal diversity. The various secondary data sources also were consulted. On the basis of on-site observations as well as secondary data, a check list of terrestrial fauna has beens prepared. The ecological status of the wild animals was categorized following IUCN Red Data Book, 1994. The terrestrial fauna in the study site are represented by mammal, Avian-fauna, butterflies and Herpteofauna.

5.4.11.1 Mammals

The direct sighting of most of these species in the project influenced area has not observed, listed in Table-5.67, the presence is only supported from secondary data in the upper reaches and viewed from the information supplied by the locals. *Macaca mulatta (*Rhesus monkey), *Herpestes edwardsii* (Mongoose), *Semnopithecus entellus (*Languor), *Sus scrofa* (Wild Boar) and *Lepus nigricollis* (Common hare) were cited near to agricultural field at the fringes of forests in human habitation for searching the food.

Table-5.67: Mammal species reported from the study areas

Zoological name	Common name	Family	IUCN status	WPA,1972 status
Felis chaus	Jungle cat	Felidae	Least Concern	-
Muntiacus muntjak	Barking deer	Cervidae	Least Concern	Schedule- III
Canis aureus	Gidder	Canidae	Least Concern	-
Vulpes bengalensis	Indian fox	Canidae	Least Concern	-
Macaca mulatta	Rhesus monkey	Cercopithecidae	Least Concern	Schedule-II
Semnopithecus entellus	Languor	Cercopithecidae	Least Concern	Schedule-II
Sus scrofa	Wild boar	Suidae	Least Concern	Schedule-III
Lepus europaeus	Sheru	Leporidae	Least Concern	-
Pteromyini Petaurista	Flying squirrel	Sciuridae	-	-
Viverra zibetha	Indian civet	Viverridae	Least Concern	-
Axis axis	Chital	Cervidae	Least Concern	-
Herpestes edwardsii	Common mongoose	Herpestidae	Least Concern	Schedule-II
Rattus norvegicus	Common rat	Muridae	Least Concern	Schedule-IV

Zoological name	Common name	Family	IUCN status	WPA,1972 status
Lepus nigricollis	Common hare	Leporidae	Least Concern	Schedule-IV
Rattus rattus	House rat	Muridae	Least Concern	Schedule-IV
Bandicota indica	Large bandicoot rat	Muridae	Least Concern	Schedule-IV

5.4.11.2 Avian-fauna

From field survey, a total 41 avian-fauna recorded from study area belong to 22 families, listed in Table-5.68. Based on intrection with the villagers and locals information on avi-fauna in the study area were also collected. The common avi-fauna recorded in the study areas were- *Acridotheres tristis* (Common Myna)*, Chloris spinoides* (Himalayan Greenfinch), *Columba livia* (Kabootar), *Parus major (*Great Tits), *Terpsiphone paradisi* (Himalayan flycatcher), *Coracias benghalensis* (Indian roller), *Phalacrocorax fuscicollis* (Indian Cormorant), *Corvus macrorhynchos* (Jungle crow*), Passer domesticus* (House Sparrow)

Table-5.68: Avian-fauna diversity recorded from the study area

Zoological name	Common name	Family	IUCN status	WPA,1972 status
Accipiter badius	Shikra	Accipitridae	Least Concern	-
Acorn woodpecker	Woodpecker	Picidae	Least Concern	-
Acridotheres tristis	Common Myna	Sturnidae	Least Concern	-
Alectoris chukar	Chakor	Phasianidae	Least Concern	-
Chloris spinoides	Himalayan Greenfinch	Fringillidae	Least Concern	-
Columba livia	Kabootar	Columbidae	Least Concern	
Corvus splendens	Crow	Corvidae	Least Concern	Schedule-V
Coturnix coturnix	Common Quail	Phasianidae	Least Concern	Schedule-IV
Eudynamys scolopaceus	Koel	Cuculidae	Least Concern	Schedule-IV
Francolinus francolinus	Kala Tittar	Phasianidae	Least Concern	-
Lophophorus impejanus	Monal	Phasianidae	Least Concern	-
Parus major	Great Tits	Paridae	Least Concern	-
Passer domesticus	House Sparrow	Passeridae	Least Concern	Schedule-IV
Spilopelia chinensis	Spotted Dove	Columbidae	Least Concern	-
Terpsiphone paradisi	Himalayan flycatcher	Monarchidae	Least Concern	-
Tragopan melanocephalus	Western Horned	Phasianidae	vulnerable	-

Zoological name	Common name	Family	IUCN status	WPA,1972 status
	Tragopan			
Milvus migrans	Black kite	Accipitridae	Least Concern	Schedule-IV
Coracias benghalensis	Indian roller	Coraciidae	Least Concern	Schedule-IV
Dicrurus leucophaeus	Ashy Drongo	Dicruridae	Least Concern	Schedule-IV
Acridotheres tristis	Common Myna	Sturnidae	Least Concern	Schedule-IV
Phalacrocorax fuscicollis	Indian Cormorant	Phalacrocoracidae	Least Concern	Schedule-IV
Catreus wallichii	Chehar	Phasianidae	vulnerable	-
Pucrasia macrolopha	Palash	Phasianidae	Least Concern	-
Melanoperdix niger	Black partridge	Phasianidae	vulnerable	-
Scolopax rusticola	Wood cook	Scolopacidae	Least Concern	-
Hypsipetes madagascariensis	Black bulbul	Pycnonotidae	Least Concern	-
Corvus macrorhynchos	Jungle crow	Corvidae	Least Concern	-
Cuculus canorus	Cuckoo	Cuculidae	Least Concern	-
Clamator jacobinus	Pied crested cuckoo	Cuculidae	Least Concern	-
Picus squamatus	Kathphora	Picidae	Least Concern	-
Nucifraga caryocatactes	Nut cracker	Corvidae	Least Concern	-
Accipiter nisus	Sparrow hawk	Accipitridae	Least Concern	-
Glaucidium brodiei	Collared pigmy owl	Strigidae	Least Concern	-
Megalaima virens	Great hill barbet	Megalaimidae	Least Concern	-
Enicurus maculatus	Spotted forktail	Muscicapidae	Least Concern	-
Muscicapa ceylonensis	Sooty fly catches	Muscicapidae		-
Phylloscopus trochilus	Willow warbler	Phylloscopidae	Least Concern	-
Parus monticolus	Green backed Tit	Paridae	Least Concern	-
Motacilla alba	Masked wagtail	Motacillidae	Least Concern	-
Nectarinia asiatica	Purple sun bird	Nectarinidae	Least Concern	-
Carpodacus rubicilloides	Streaked Finch	Fringillidae	Least Concern	-

5.4.11.3 Butterflies

Shimla region bears rich biodiversity of flora and fauna. The floral richness of this area comprises of varieties of shrubs, herbs and grasses bearing attractive coloured flowers laden with scented nectar to attract and support butterflies. Each butterfly is plant specific and visits specific species of plants for nectar. The floral biodiversity itself indicates the species of butterflies that can be predicated in that area.

A total of 23 butterfly species were recorded from the different areas, which belong to- Nymphalidae, Lycanidae, Pieridae, Papilionidae and Hesperidae listed in Table-5.69.

Table-5.69: Butterfly diversity recored from the study area

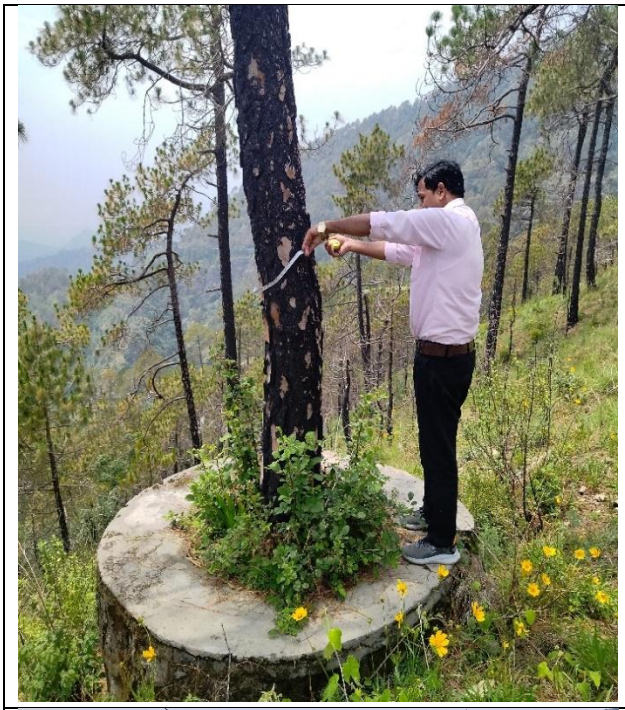
Zoological name	Common name	Family	IUCN status
Aglais cashmirensis	Small Tortoise Shell	Nymphalidae	-
Arhopala rama	Dark Oakblue	Lycanidae	-
Athene emolus	Ciliate Blue	Lycanidae	-
Athyma opalina	Himalayan sergeant	Nymphalidae	-
Belenois aurota	Pioneer White	Pieridae	Least Concern
Colias erate	Pale clouded yellow	Pieridae	-
Colias fieldii	Dark clouded yellow	Pieridae	-
Danaus chrysippus	Plain Tige	Nymphalidae	Least Concern
Elymnias hypermnestra	Common Palm fly	Nymphalidae	-
Eurema hecabe	Common grass yellow	Pieridae	Least Concern
Eurema laeta	Spotless grass yellow	Pieridae	-
Junonia orithiya	Blue pansy	Nymphalidae	-
Lethe rohria	Common tree brown	Nymphalidae	-
Neptis hylas	Common sailor	Nymphalidae	-
Parantica aglea	Glassy tiger	Nymphalidae	-
Parnassius hardwickii	Common blue appollo	Papilionidae	-
Phalanta phalantha	Common leopard	Nymphalidae	-
Phalantha phalantha	common leopard	Nymphalidae	-
Pieris brassicae	Large cabbage White	Pieridae	-
Pieris rapae	Cabbage white	Pieridae	-
Polanthus dara	Himalayan dart	Hesperidae	-
Vanessa carduii	Painted lady	Nymphalidae	-
Ypthima asterope	Lesser threering	Nymphalidae	Least Concern

5.4.11.4 Herpteofauna

From primary field survy, discussion with local people and with the help of literature, a total 18 herpteofauna recorded belong to 11 family from study area, listed in Table-5.70. *Agama agama (*Agama), *Bungarus caeruleus (*Common krait), *Calotes versicolor* (Garden lizard), *Naja naja* (Indian cobra) and *Varanus bengalensis* (Common monitor) were the common species in the study area.

Table-5.70: Herpteofauna diversity recorded from the study areas

Zoological name	Common name	Family	IUCN status	WPA,1972 status
Agama agama	Agama	Agamidae	Least Concern	
Bungarus caeruleus	Common krait	Elapidae	Least Concern	Schedule-II
Calotes jerdoni	Forest lizard	Agamidae		
Calotes versicolor	Garden lizard	Agamidae	Least Concern	Schedule-IV
Chamaeleo zeylanicus	Asian chameleon	Chamaeleonidae	Least Concern	Schedule-IV
Corallus ruschenbergerii	-	Boidae	Least Concern	-
Duttaphrynus himalayanus	Himalayan toad	Bufonidae	Least Concern	-
Engystomops pustulosus	-	Leptodactylidae	Least Concern	-
Gloydius himalayanus	Himalayan pit viper	Viperidae	Least Concern	-
Hemidactylus mabouia	-	Gekkonidae	Least Concern	-
L*eptodactylus validus*	-	Leptodactylidae	Least Concern	-
Naja naja	Indian cobra	Elapidae	Least Concern	-
Pantherophis obsoletus	Rat snake	Colubridae	Least Concern	-
Plica caribbean	-	Tropiduridae	Least Concern	-
Rhinella marina	-	Bufonidae	Least Concern	-
T*antilla melanocephala*	-	Colubridae	Least Concern	-
Varanus bengalensis	Common monitor	Varanidae	Least Concern	Schedule-II
Vipera russeli	Viper	Viperidae	Least Concern	Schedule-II



Expert surveying the floral diversity in study area

5.5 SOCIO-ECONOMIC ASPECTS

Baseline Socio-economic environment scenario in the study area with respect to demographic and socio-economic conditions has been discussed in the subsequent sections. Baseline data has been collected from various sources such as, feasibility report, district census handbook' 2011, statistical abstract of Himachal Pradesh 2021-22 and other reliable documents and literature. The secondary data is supplemented by the primary data generated through Focus Group Discussions (FGDs) and stakeholder's consultation meeting in the month of March and April, 2023.

5.5.1 Demographic Profile of District Shimla

As per census 2011 the total population of Shimla is 814010 of which males and females are 425039 and 388971 respectively. The district demographic data is presented in Table 5.71:

Table 5.71: Demographic Profile of District Shimla:

Description	Shimla
Total Population	814010
Male	425039
Female	388971
Population Growth	12.67%
Sex ratio	915
Density per km^2	159
Area km^2	5131
Literacy	83.64%

Source: Census of India'2011

The details of scheduled caste and scheduled tribe population in Shimla summarized in Table 5.72

Table 5.72: Scheduled Caste and Scheduled Tribe population in Shimla District

Description	Shimla
Total Population	814010
Total Scheduled Caste Population	215777
Total Scheduled Tribe Population	8755

Source: Census of India'2011

5.5.2 Socio- Economic Profile of the Study Area

The proposed ropeway alignment will passes through the city of Shimla and it covers 18 wards of Shimla Municipal Corporation. The details are given in Table 5.73.

As a part of DPR preparation traffic survey was conducted in the month of February to April 2023 in the wards of Shimla Municipal Corporation where the proposed ropeway has been planned. The purpose of traffic survey was to assess the vehicular density, population and socio- economic status of the persons to be directly benefitted/ impacted due to the proposed project. Total of 3,836 persons were contacted during the survey. The socio-economic details collected through interviews have been compiled and presented in following sections.

The list of wards coming along the ropeway alignment is given in Table 5.73.

Table-5.73: Municipal wards coming along the ropeway alignment

S No.	Municipal Ward	Ward Number	Station/ Section of Alignment along the Ward
1	Ruldu Bhatta	2	ICR
2	Kaithu	3	ICR/Victory Tunnel
3	Annadale	4	ISBT – 103 Tunnel
4	Boileauganj	8	Chakkar - ZPTH
5	Kachi Ghatti	9	Taradevi -Chakkar
6	Tuti Kandi	10	ZPTH -ISBT
7	Nabha	11	ISBT-Railway Station
8	Phagli	12	Railway Station – Lift Point
9	Krishan Nagar	13	Lift Point
10	Ram Bazar Ganj	14	Old Bus Stand - Lift Point
11	Lower Bazar	15	Lift Point
12	Jhaku	16	ICR - IGMC
13	Benmore	17	Lift Point - Secretariat
14	Engine Ghar	18	Sanjauli
15	Sanjauli Chowk	19	Sanjauli
16	Shangti	24	Navbahar
17	Malyana	25	Navbahar - Secretariat
18	Chota Shimla	28	Kasumpti

The information collected and complied for the different indicators are given in following paragraphs.

Type of Residence

In all 995 residences were approached during the survey to assess the type of residences. It was noticed that 48.04% of the residences are in the category of apartments/ flats whereas, 51.96% comes in the category of independent houses. The details are presented in Table-5.74 and depicted in Figure-5.20

Table-5.74: Type of Residence

Municipal Ward	Apartment/ Flat	Independent House
Ruldu Bhatta	31	29
Kaithu	8	1
Annadale	35	21
Boileauganj	18	14
Kachi Ghatti	31	18
Tuti Kandi	35	28
Nabha	74	34
Phagli	22	20
Krishan Nagar	38	56
Ram Bazar Ganj	13	10
Lower Bazar	45	1
Jhaku	4	37

Benmore	29	17
Engine Ghar	9	51
Sanjauli Chowk	32	43
Shangti	19	56
Malyana	6	38
Chota Shimla	29	43
Total	**478**	**517**

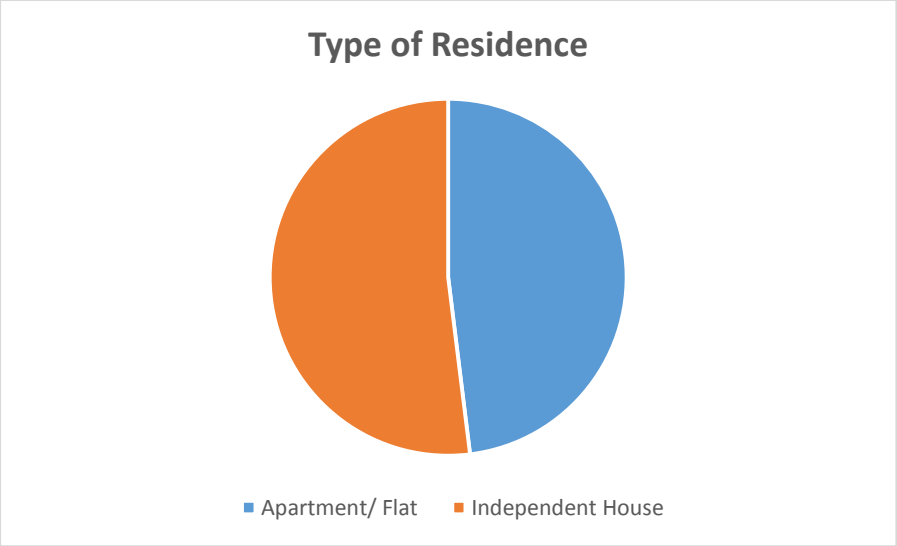


Figure 5.20: Type of Residence Surveyed

Socio-economic Profile

Amongst the 3836 persons interviewed, 2124 were male and 1712 were female respondent. The education level, occupation details, monthly income, monthly expenditure on transport and mode of transport are depicted in below section.

Educational Level

The details of educational status amongst the respondents are presented in Table 5.75 and depicted in Figure 5.21.

Table- 5.75: Educational Level of the Surveyed Persons

S No.	Educational Level	No. of Persons
1	Literate	54
2	Pre-primary	254
3	Primary	272
4	Secondary	653
5	Higher Secondary	1022
6	Technical Diploma	179
7	Graduate	838
8	Post Graduate	167
9	Others	397
	Total	**3836**

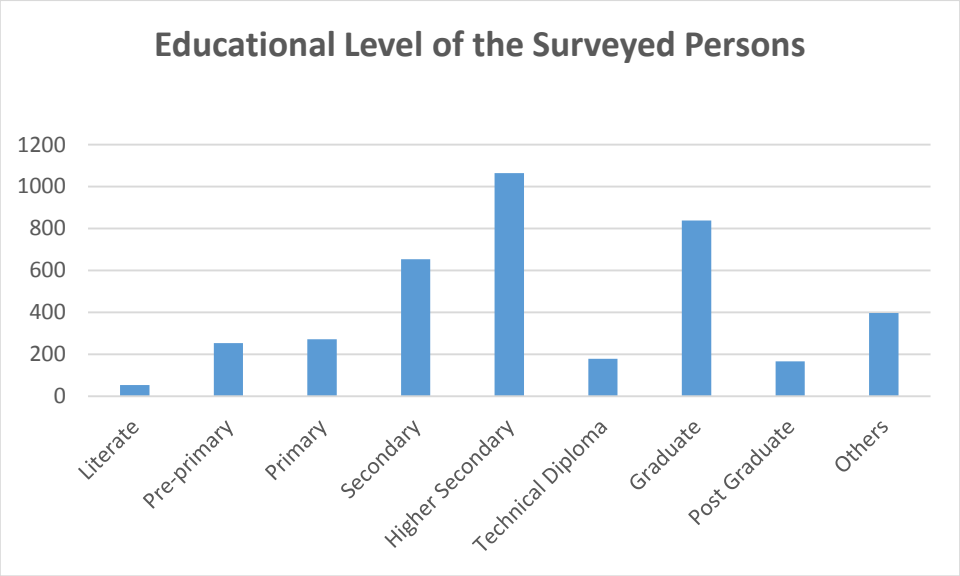


Figure 5.21: Educational Level of the Surveyed Persons

Occupational Profile

The details on occupational profile in the study area are given in Table 5.76. It is observed that 31.67% of the surveyed population are engaged in some form of economically productive activity or vocational activity and thus they falls under employed category. The occupational profile in the study area is shown in Figure 5.22.

Table-5.76: Occupation Details

S No.	Occupation	No. of Persons
	Employed	
1	Full Time Employed	928
2	Part Time Employed	122

S No.	Occupation	No. of Persons
3	Self Employed	121
4	Daily Wager	37
5	Resident maid/ Driver	07
	Sub Total	**1215**
	Un-employed	
6	Student	845
7	Un-employed	41
8	House-wife	579
9	Retired	05
10	Others	1151
	Sub Total	**2621**
	Total	**3836**

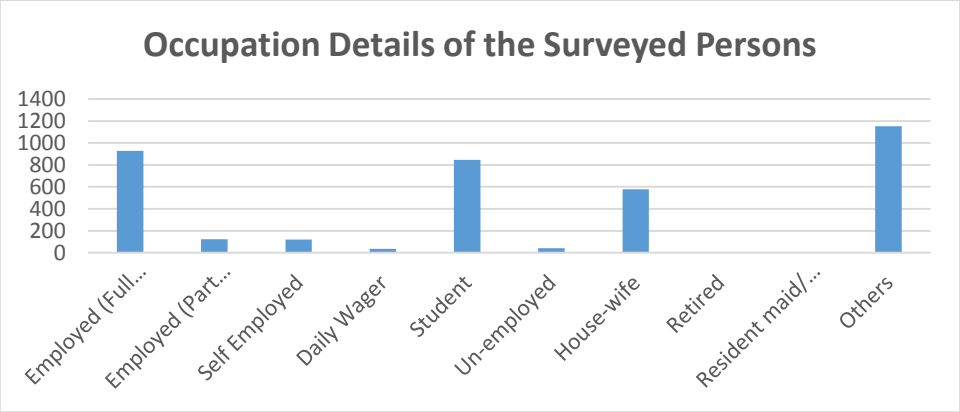


Figure-5.22: Occupation Details of the Surveyed Persons

Monthly Income

Monthly income was counted considering income from all sources. The majority of the respondent were hesitant for disclosing their income. It was noticed that 14.07% earn in the range of 20,000-40,000 whereas, only 1.30% are earning below 5000. The details are shown in Table 5.77 and depicted in Figure 5.23.

Table-5.77: Monthly Income of the Surveyed Persons

S No.	Monthly Income	No. of Persons
1	Upto-5000	50
2	5001-10000	76
3	10001-15000	228
4	15001-20000	363
5	20001-40000	540
6	40001-60000	116
7	Not disclosed/ No Income	2463

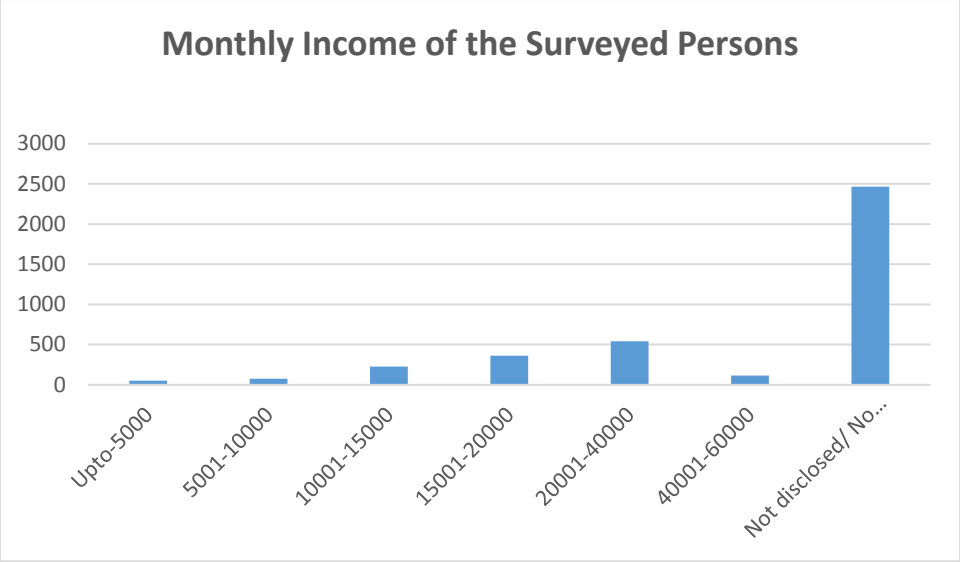


Figure-5.23: Monthly Income of the Surveyed Persons

Monthly Expenditure

Expenditure on Transport

About 50% of respondent were unable to disclose their monthly expenditure on transport. The rest of the respondent were spending on transportation for daily commuting. The expenditure is in the range of Rs. 100 to Rs. 2000 per month. The details are presented in Table 5.78 and depicted in Figure 5.24

Table-5.78: Monthly Expenditure on Transport

S No.	Monthly Expenditure on Transport	No. of Persons
1	100-1000	**901**
2	1001-2000	**786**
3	2001-3000	**184**
4	3001-4000	**243**
5	4001-5000	**44**
6	5001-6000	**22**
7	6001-7000	**152**
8	7001-8000	**5**
9	8001-12000	**2**
10	Not Disclosed	**1497**

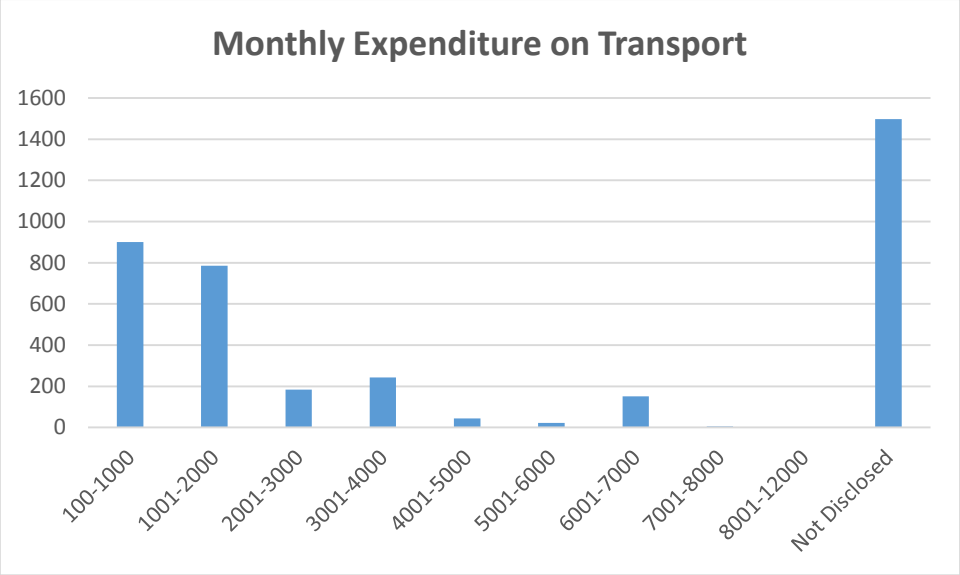


Figure-5.24: Monthly Expenditure on Transport

Mode of Transport

It was noticed that all sort of transportation mode like walking, auto rickshaw, two-wheeler, four-wheeler, state transport buses etc. are used by respondents regularly. However, the state transport buses is the preferred mode of transport. About 50% respondent do not fall in any category as their mode of transport changes as per the availability of time and money. The details are presented in Table 5.79 and depicted in Figure 5.25 respectively.

Table-5.79: Mode of Transport Preferred by the Surveyed Persons

S No.	Mode Of Transport Preferred	No. of Persons
1	Walk	**165**
2	Bicycle	**39**
3	Cycle Rickshaw	**20**
4	Taxi/ Cab	**31**
5	Auto Rickshaw	**0**
6	Shared Auto	**0**
7	Two-wheeler	**361**
8	Four-wheeler	**467**
9	State Transport Bus	**764**
10	Company Bus	**153**
11	Others	**1836**

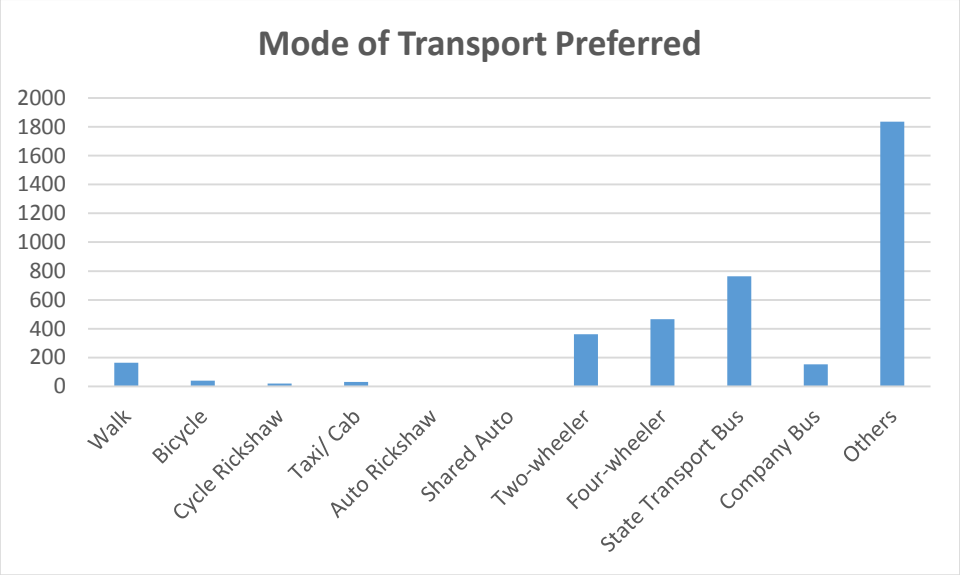


Figure-5.25: Mode of Transport Preferred by the Surveyed Persons

CHAPTER 6
ENVIRONMNENTAL IMPACT & MITIGATION MEASURES

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ENVIRONMNENTAL IMPACT & MITIGATION MEASURES

6.1 GENERAL

The commissioning of any development project leads to significant impacts on environmental resources of the project area and its surroundings. Aerial ropeway development may have a wide range of impacts on the environment through activities like construction work, reclamation, excavation and other related activities. However, by proper planning at the inception stage and incorporating appropriate migratory measures in the planning, design, construction and operation phases, adverse impacts can be minimized to a large extent, whereas beneficial impacts can be maximized. Aerial ropeway development and operation should therefore be planned with careful consideration of their environmental impacts.

The impact assessment as the name suggests, is a process to forecast the future environmental and social conditions of the project area that might be expected to occur because of implementation of the project activities. There are various methods for prediction of impacts due to various project activities to be implemented as part of the works. The impacts have been assessed considering the project details and the baseline environmental and social status. Suitable mitigation measures have been suggested to mitigate the adverse impact to the extent possible.

6.2 APPROACH AND METHODOLOGY

The basic approach envisaged for conducting the ESIA study for the proposed project is essentially a process to forecast the future environmental conditions of the project area that might be expected to occur considering the existing environmental scenario in and around the project area, components and the proposed activities of the project having significant environmental and social impacts and analysis of the project proposals with respect to relevant national, laws and ordinances as well as the Environmental and Social Framework (ESF) of National Development Bank (NDB).

The main approach for the process includes the following:

- Identification and analysis of positive and negative impacts, direct and indirect impacts, and short-term and long-term impacts likely to result from project intervention;
- Identification of feasible and cost-effective mitigation measures to minimize negative impacts and enhance positive impacts by incorporating in the engineering design.
- Identifying the possibilities towards the opportunities for environmental enhancement;

- Preparation of Environmental and Social Management Plan for effective implementation of environmental and social mitigation measures at different stages of the project.

6.2.1 Criteria for Determining Degree of Importance of Impacts

Many social and environment components cannot be reliably quantified due to inherent association of complex inter-relationships. Most impacts have been predicted qualitatively justifying its relevance for the project aspects. The significance of impacts based on the degree of importance are as follows:

- Area of Impact
- Duration
- Intensity
- Reversibility factors

6.2.2 Environmental Screening

The screening process are carried out to delineate the potential environmental and social impacts due to the project activities and defining the scope for further assessment depending upon its significance and extent of the impacts. The screening of impacts for the ESIA study is considered for pre-construction, construction & operation phases. The steps followed for screening are detailed below.

➢ **Categorization of Projects**

The categorization of projects is essential in identifying the environmental and social consequences with regards to the following which ultimately necessitates feasible approach for deciding suitable mitigation measures or long-term management measures:

- Severity
- Significance
- Duration

6.2.3 Categorization Criteria as per NDB

A project's category is determined by the category of its most environmentally sensitive component, including direct, indirect, cumulative, and induced impacts in the project's area of influence. Each proposed project is scrutinized as to its type, location, scale, and sensitivity and the magnitude of its potential environmental impacts. Projects are assigned to one of the following four categories: **High risks (A), Moderate risks (B), Low risks (C)** and **Category FI,** which includes projects funded through financial intermediaries (FI), such as banks, micro-finance institutions, investment funds, insurance companies, mortgage companies, etc.

Categorization of Project Activities

The NDB funded Shimla Ropeway Project, does not involve any land acquisition and hence there is no rehabilitation & resettlement. There is no loss of livelihood due to this proposed project. The construction activities mainly involves electro-mechanical components and hence the pollution of environmental parameters like air, noise water and soil will be minimal and restricted to the construction phase only. The diversion of about 40 ha of forest land is envisaged for which the proposal for Forest Clearance (FC) is already initiated by project proponents. The compensatory afforestation will be done for the loss of forest land as per the guidance of forest department. Hence this project falls in Category "B" i.e. moderate risk project.

The impacts on the various environmental components have been assessed during various phase of the project cycle namely due to the location, project design, possible accident, construction and operation. The environment component consider for the impact assessment are as follows:

- Land Environment,
- Water Environment,
- Air Environment,
- Noise Environment,
- Biological Environment and
- Socio-Economic Environment

6.3 IMPACTS ON LAND ENVIRONMENT

6.3.1 Land Acquisition

Impact on land: The ropeway project is proposed in government land which belongs to various govt. departments and mainly forest department. The diversion of 40 ha of forest area is required for the use of non-forest purpose. The construction of ropeway on forest land has irreversible impact by change of land use.

Mitigation Measures: The following measure are recommended:

- Compensatory plantation on 80 Ha (2x40 Ha) of degraded Forest Land will be carried out by the forest department. Requested amount for the compensatory plantation will be submitted to the Forest department by RTDC Ltd.

6.3.2 Impacts on Topography

Topography

The development of 15(fifteen) Terminal Stations and number of intermediate towers will change the topography of the area.

Mitigation measures: The location of terminal stations and towers have been selected on a mild slope or at plain area to keep the minimal cutting and filling having less impact on topography of the area. The level difference will be maintained for the natural flow of drainage.

6.3.3 Environmental Degradation due to Immigration of Labour Population

The project would require skilled or semi-skilled and unskilled labour population, who shall come from outside and will stay at site during project construction phase. The peak labour population likely to congregate in the project area during construction phase has been estimated as about 200. It is recommended to develop labour camps with adequate provisions for water supply, sanitation, solid waste management, etc. The same shall be included in the Tender Document and shall be mandatorily provided by the contractor(s), involved in construction activities. The fuel for labour camps or colonies shall be provided by the contractor during construction phase. The project proponent shall include the above, as mandatory provisions in the tender documents to avoid the environmental degradation due to immigration of labour population.

Siting and Operation of construction equipment

The sitting and operation of equipment may spoil the land, if properly not planed. This impact may be temporary but important in hilly places like Shimla where the land is precious. During construction phase, various types of equipment will be brought to the site. These include crushers, batching plant, drillers, earth movers, rock bolters, etc. Similarly, space will be required for storage of construction materials, etc. Efforts must be made for proper siting of these facilities.

Various criteria for selection of these sites would be:

- Proximity to the site of use
- Proximity from habitations
- Proximity to drinking water source

Efforts must be made to site the contractor's working space in such a way that the adverse impacts on environment are minimal, i.e. to locate the construction equipment, so that impacts on human and faunal population is minimal.

Soil erosion

Site clearance works will involve the removal of vegetation (mainly grasses, shrubs, tree), and a small portion of the available topsoil. The soil erosion will occur mainly during construction due to excavation of trenches for tower footings, office buildings etc.

Solid waste from labour camps

A labour camp is proposed to be constructed for housing labour population along with their families. The same is likely to generate municipal solid waste. The total population of labour camp is expected to about 800 (considering average family size as 4). Considering per capita solid waste generation as 210 gm per day, the solid waste likely to be generated from labour camps shall be of the order of 168 kg/day or 0.17 tons/day. The chemical characteristics of solid waste generated are given in Table-6.1. The composition of various waste materials is in the municipal solid waste is detailed in Table-6.2.

Table-6.1: Chemical characteristics of municipal waste

Component	Percentage by weight (%)
Moisture	19.52
Organic matter	25.14
Nitrogen (as Total Nitrogen)	0.66
Phosphorous (as P_2O_S)	0.56
Potassium (as K_2O)	0.69

Table-6.2: Composition of waste material in municipal refuse

Ingredient	Percentage by weight (%)
Paper	4.71
Rubber, Leather and synthetics	0.71
Glass	0.46
Metals	0.49
Total compostable matter	38.95
Inert matter	44.73
Others/ plastic	9.95
Total	**100**

Mitigation Measures

Solid Waste Management Plan

The labour colonies will generate substantial amount of municipal wastes. In view of the condition that might exist in the labour camps, most likely the solid wastes will contain majority of vegetable matter followed by paper cans and glasses. The total solid waste generation shall be 168 kg/day or 0.17 tonnes /day.

Various aspects of solid waste management include:

- Reuse/Recycling
- Refuse storage
- Collection and Transportation
- Disposal

Refuse storage

The labour colony shall have provisions to separately store the degradable and non-degradable solid waste. Two different coloured bins shall be supplied to each labour

family, who will segregate the waste generated by their family. Green and Biodegradable waste is to be deposited in one container and non-biodegradable waste in another container. In case of canteens, kitchens also, two different coloured dust-bins suitable to deposit the Biodegradable and non-biodegradable waste generated in their unit shall be provided. A sustained awareness programme will be conducted to educate workers about the segregation of degradable and bio-degradable wastes.

Collection of Household Waste

Every day, the trolleys will collect the waste at the door of each unit of labour camp and colonies. The trolleys will be provided with two compartments for depositing segregated waste separately. Each worker will be allotted at a fixed area. The collection will be on regular pre-informed timings and the arrival will be informed through blowing a whistle/horn. The solid waste so collected shall be disposed at a common storage point. One truck will be commissioned to collect the solid waste and dispose the same at sites designated for disposal of solid waste.

Segregation of waste

The awareness programmes shall be organized for waste segregation. Residents of labour camps shall be apprised of the benefits of waste segregation.

Disposal

The municipal solid waste generated from the labour camps will be disposed along with the solid waste disposal of Shimla city.

Generation of Muck / Construction waste

During construction phase significant amount of construction waste is likely to be generated. The construction waste including debris shall be stored separately at designated sites. The same shall be either reused or disposed to authorized vendors, as per the norms of construction and demolition waste handling rule 2016.

Drainage

The alignment of the proposed ropeway passes through the hilly area and no water bodies will be crossed. However, the construction debris, muck, not disposed it may clog the existing nallahs and drains in the Shimla city. Thus, it is recommended to take adequate measures for safe disposal of construction waste and muck generated during construction phase.

Operation Phase

Impacts on structures

No structures are likely to be affected due to the proposed project.

Impacts on existing roads, footpaths

Based on the planned alignment, it is anticipated that during construction phase, no existing footpath or roads will be affected.

Solid waste from terminals/stations

The municipal solid waste will be generated at terminal station due to passengers/staff/tourists etc. which shall be disposed properly. The solid waste shall be segragated in to bio-degradable and non-biodegradable bins. The solid waste so collected shall be transported to the nearest solid waste disposal site, which handles the municipal solid waste generated from Shimla city. Solid waste management plan shall be mandatorily included in the RFP for selection of Agency for operation of terminals. The client can also engage a separate agency to operate the utilities, and the contractor shall include the cost for the same in their bid for construction.

6.4 IMPACTS ON WATER ENVIRONMENT

Construction phase

Sewage from labour camps

The project construction is likely to last for a period of 5 years. The peak labour strength likely to be employed during project construction phase is about 200 workers and technical staff. Considering family size as 4, the peak influx or increase in labour population during construction phase , shall be about 800. Considering per capita water requirement as 135 lpcd and assuming that, 80% of the total water supplied will be generated as sewage generation shall be 86,400 litr/day or 86.4 m^3/day. During construction phase, normally large scale secondary treatment facilities are not commissioned, because they are likely to remain unutilized, once the construction activities are over.

Mitigation Measures

One community toilet shall be provided per 20 persons. The sewage from the community toilets shall be treated in package Sewage Treatment Plant (STP). The treated effluent from package sewage treatment plant shall be disposed by connecting the same to the nearest sewage network. This provision shall be mandatorily included in the RFP for selection of contraction for construction purposes.

Effluent from Fabrication Units and Workshops

The fabrication units and workshops which shall be functional during construction phase will generate effluents with high suspended solids, oil and grease etc. It is proposed to treat the

effluent from fabrication units and workshops in an oil and grease separator prior to disposal. This aspect shall from part of RFP for selection of contractor for construction purposes.

Operation phase

Sewage from terminals/stations

During operation phase, daily passenger traffic, will lead to sewage generation. The peak ridership is estimated as 0.97 lakh, 1.22 lakh, 1,57 lakh and 2,05 lakh in years 2028, 2038, 2048 and 2058 respectively. The details are given in Table-6.3. The water supply and sewage generation in various years is given in Table-6.4.

Table-6.3: Summary of Daily Ridership (Unit: lakh)

S. No.	Name of the Corridor	2028	2038	2048	2058
1.	Tara Devi – Old Bus Stand – Kasumpti	0.64	0.81	1.00	1.32
2.	ISBT – Sanjauli – Secretariat	0.33	0.41	0.57	0.73
	Total	**0.97**	**1.22**	**1.57**	**2.05**

Table-6.4: Water supply and sewage generation in various years

S. No.	Year	Daily Ridership (lakh)	Total Water requirement (mld)	Total sewage generation (mld)
1.	2028	0.97	1,455	1.16
2.	2038	1.22	1,830	1.46
3.	2048	1.57	2,355	1.88
4.	2058	2.05	3,075	2.46

It is proposed to develop a common sewage treatment plant with a capacity of 1.5 mld, which will cater the sewage treatment requirements upto year 2038. Subsequently, as per requirements, capacity of STP can be upgraded. The treated swage can be reused or disposed into the nearest sewerage network.

6.5 IMPACTS ON AIR ENVIRONMENT

Construction Phase

Pollution due to fuel combustion in various equipment

The operation of various construction equipment requires combustion of fuel, which is generally, diesel. The major pollutant which gets emitted as a result of combustion of diesel is SO_2. The SPM emissions are minimal due to low ash content in diesel. The short-term increase in SO_2, even assuming that all the equipment are operating at a common point, is quite low, i.e. of the order of less than $1\mu g/m^3$. Hence, no major impact is anticipated on this account on ambient air quality.

Fugitive Emissions from various sources

During construction phase, there will be increased vehicular movement. Lot of construction material like sand, fine aggregate are stored at various sites, during the project construction phase. Normally, due to blowing of winds, especially when the environment is dry, some of the stored material can get entrained in the atmosphere. However, such impacts are visible only in and around the storage sites. The impacts on this account are generally, insignificant in nature.

Pollution due to increased vehicular movement

During construction phase, there will be increased vehicular movement for transportation of various construction materials to the project site. Similarly, these will be increased traffic movement on account of disposal of muck or construction waste at the dumping site. The maximum increase in vehicle is expected to 50 vehicles per hour. Large quantity of dust is likely to be entrained due to the movement of trucks and other heavy vehicles. Similarly, marginal increase in Hydrocarbons, SO_2 and NOx levels are anticipated for a short duration. The increase in vehicular density is not expected to significant. In addition, these ground level emissions do not travel for long distances. Thus, no major adverse impacts are anticipated on this account.

Mitigation Measures

A. Control of Emissions

Minor air quality impacts will be caused by emissions from construction vehicles, equipment and DG sets, and emissions from transportation traffic. Frequent truck trips will be required during the construction period for removal of excavated material and delivery of select concrete and other equipment and materials. The following measures are recommended to control air pollution:

- Contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.
- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.

Air Pollution control due to DG sets

The Central Pollution Control Board (CPCB) has issued emission limits for generators upto 800 kW. The same are outlined in Table-6.5, and are recommended to be followed.

Table-6.5: Emission limits for DG sets prescribed by CPCB

Parameter	Emission limits (gm/kwhr)
NOx	9.2
HC	1.3
CO	2.5
PM	0.3
Smoke limit*	0.7

Note: * Light absorption coefficient at full load (m^{-1})

The above standards needs to be followed by the contractor operating the DG sets.

Dust Control

The project authorities will work closely with representatives from the community living in the vicinity of project area to identify areas of concern and to mitigate dust-related impacts effectively (e.g., through direct meetings, utilization of construction management and inspection program, and/or through the complaint response program). To minimize issues related to the generation of dust during the construction phase of the project, the following measures have been identified:

- Identification of construction limits (minimal area required for construction activities).
- When practical, excavated spoils will be removed as the contractor proceeds along the length of the activity.
- When necessary, stockpiling of excavated material will be covered or staged offsite location with muck being delivered as needed during the course of construction.
- Excessive soil on paved areas will be sprayed (wet) and/or swept and unpaved areas will be sprayed with water and/or mulched.
- Contractor will be required to cover stockpiled soils and trucks hauling soil, sand, and other loose materials (or require trucks to maintain at least two feet of freeboard).
- Contractor shall ensure that there is effective traffic management at site. The number of trucks/vehicles to move at various construction sites to be fixed. Three personnel will be earmarked for this purpose.
- Construction area and vicinity (access roads, and working areas) shall be swept with water sweepers on a daily basis or as necessary to ensure there is no visible dust. Five sweepers will be earmarked for this purpose

Operation phase

Reduction in Carbon Emissions

The commissioning of the proposed project would lead to reduction in trips by cars, two wheelers, trucks, etc. The reduction in car, two wheelers and bus trips in year 2029 would be 45,04,500, 7,61,310 and 1,37,13,810 (refer Table 78). This will lead to reduction in traffic on roads, decongestion, reduction in carbon emissions and health benefits. The reduction in carbon emissions in 2029, 2039, 2049 and 2059 would be 6,201.99 tonnes/year, 9,351.32 tonnes/year, 12,162.36 tonnes/year and 14,595.72 tonnes/year respectively (refer Table-6.6).

Table-6.6: Reduction in traffic movement due to commissioning of the Ropeways Project (Year 2029)

Parameter	Value
Total Trips/year	17,36,96,565.00
Car trips switching to Ropeways	45,04,500.00
Two-wheeler trips switching to Ropeways	7,61,310.00
Bus trips switching to Ropeways	1,37,13,810.00

Table-6.7: Reduction in Carbon Emissions

Year	Total Pollution Savings (in Tons)	All vehicles (in Tons)	Pollution Reduction
	CO_2	CO_2	%
2029	4,650.75	35,782.78	13.0%
2030	4,809.83	37,654.73	12.8%
2031	4,973.80	38,614.54	12.9%
2032	5,142.85	39,600.07	13.0%
2033	5,317.16	40,612.06	13.1%
2034	5,496.89	41,651.29	13.2%
2035	5,682.26	42,718.55	13.3%
2036	5,873.45	43,814.65	13.4%
2037	6,070.68	44,940.45	13.5%
2038	6,274.15	46,096.82	13.6%
2039	6,484.09	47,284.65	13.7%
2040	6,636.80	48,440.93	13.7%
2041	6,793.44	49,565.57	13.7%
2042	6,954.18	50,719.70	13.7%
2043	7,119.16	51,904.22	13.7%
2044	7,288.57	53,120.07	13.7%
2045	7,462.58	54,368.20	13.7%
2046	7,641.39	55,649.64	13.7%
2047	7,825.21	56,965.42	13.7%
2048	8,014.26	58,316.61	13.7%
2049	8,208.77	59,704.35	13.7%
2050	8,466.97	61,187.78	13.8%
2051	8,733.23	62,525.52	14.0%
2052	9,007.82	63,896.12	14.1%

Year	Total Pollution Savings (in Tons)	All vehicles (in Tons)	Pollution Reduction
2053	9,291.01	65,300.50	14.2%
2054	9,583.11	66,739.56	14.4%
2055	9,884.41	68,214.28	14.5%
2056	10,195.24	69,725.61	14.6%
2057	10,515.91	71,274.59	14.8%
2058	10,846.78	72,862.24	14.9%
2059	11,188.19	74,489.64	15.0%

6.6 IMPACTS ON NOISE ENVIRONMENT

Construction phase

Impacts due to operation of construction equipment

The noise level due to operation of various construction equipment is given in Table-6.8.

Table-6.8: Noise level due to operation of various construction equipment

Equipment	Noise level dB(A)
Earth moving	
Compactors	70-72
Loaders and Excavator	72-82
Dumper	72-92
Tractors	76-92
Scrappers, graders	82-92
Pavers	86-88
Truck	84-94
Material handling	
Concrete mixers	75-85
Movable cranes	82-84
Stationary	
Pumps	68-70
Generators	72-82
Compressors	75-85
Others	
Vibrators	69-81
Saws	74-81

Under the worst-case scenario, considered for prediction of noise levels during construction phase, it has been assumed that all these equipment generate noise from a common point.

The increase in noise levels due to operation of various construction equipment is given in Table-6.9.

Table-6.9: Increase in noise levels due to operation of various construction equipment

Distance (m)	Ambient noise levels dB (A)	Increase in noise level due to construction activities dB(A)	Increased noise level due to construction activities dB(A)	Increase in ambient noise level due to construction activities dB(A)
100	44	74	74	30
200	44	69	69	25
500	44	65	65	21
1000	44	61	61	17
1500	44	58	58	14
2000	44	54	54	10

It would be worthwhile to mention here that in absence of the data on actual location of various construction equipment, all the equipment have been assumed to operate at a common point. This assumption leads to over-estimation of the increase in noise levels. Also, it is a known fact that there is a reduction in noise level as the sound wave passes through a barrier. The transmission loss values for common construction materials are given in Table-6.10.

Table-6.10: Transmission loss for common construction materials

Material	Thickness of construction material (inches)	Decrease in noise level dB(A)
Light concrete	4	38
	6	39
Dense concrete	4	40
Concrete block	4	32
	6	36
Brick	4	33
Granite	4	40

The walls of various houses will attenuate at least 30 dB(A) of noise. In addition there are attenuation due to the following factors.

- Air absorption
- Rain
- Atmospheric inhomogeneties.
- Vegetal cover

Thus, no increase in noise levels is anticipated as a result of various activities, during the project construction phase. The noise generated due to blasting is not likely to have any effect on habitations. However, blasting can have adverse impact on wildlife, especially along the alignment of the tunnel portion. It would be worthwhile to mention that no major wildlife is

observed in and around the project site. Hence, no significant impact is expected on this account.

Impacts due to increased vehicular movement

During construction phase, there will be significant increase in vehicular movement for transportation of construction material. During construction phase, increase in vehicular movement is expected to increase up to a maximum of 10 to 12 trucks/hour.

As mentioned earlier, there will be significant attenuation due to various factors, e.g. absorption by construction material, air absorption, atmospheric inhomogeneties, and vegetal cover. Thus, no significant impact on this account is anticipated.

Impacts on labour

The effect of high noise levels on the operating personnel, has to be considered as this may be particularly harmful. It is known that continuous exposures to high noise levels above 90 dB(A) affects the hearing acuity of the workers/operators and hence, should be avoided. To prevent these effects, it has been recommended by Occupational Safety and Health Administration (OSHA) that the exposure period of affected persons be limited as per the maximum exposure period specified in Table-6.11.

Table-6.11: Maximum Exposure Periods specified by OSHA

Maximum equivalent continuous Noise level dB(A)	Unprotected exposure period per day for 8 hrs/day and 5 days/week
90	8
95	4
100	2
105	1
110	½
115	¼
120	No exposure permitted at or above this level

Noise generated due to drilling

The noise levels monitored at a 10 m distance from the source and operator's cabin is given in Table-6.12.

Table-6.12: Noise generated due to drilling

Equipment	Noise level at source dB(A)
Standing idle (inside cabin)	70-72
Standing idle (10 m radius)	72-74
On load (inside cabin)	78-80
On load (10 m radius)	82-84

The noise levels during various construction activities have been compared to various standards prescribed by Occupational Safety and Health Administration (OSHA), which are being implemented in our country through rules framed under Factories Act. It can be observed (Refer Table-6.11) that for an 8 hour duration, equivalent noise level exposure should be less than 90 dB(A).

The Director General of Mines Safety in its circular no. DG(Tech)/18 of 1975, has prescribed the noise level in mining operations for workers in 8 hour shift period with unprotected ear as 90 dB(A) or less. Similar norms can be considered for construction phase of the proposed ropeway project as well. The workers who are expected to be exposed to noise levels greater than 90 dB(A), shall not work in these areas beyond 6 to 8 hours. In addition, they also need to be provided with ear plugs. Thus, increased noise levels due to drilling are not expected to adversely affect the workers operating the drill or involved in other activities closely.

Mitigation Measures

A. Noise Control Measures

The contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards. The construction equipment will be required to use available noise suppression devices and properly maintained mufflers.

- Vehicles to be equipped with mufflers recommended by the vehicle manufacturer.
- Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- Use of temporary sound fences or barriers to be evaluated.
- Notification will be given to residents within 300 feet (about 90 m) of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.
- Monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.
- Provision with ear muffs or plugs for the workers, so as to attenuate the noise level near the crusher by at least 15 dB(A).
- Working hours of the laborers working on dredgers will decided considering the guidelines of Occupational Safety and Health Administration (OSHA)
- To prevent other psychological and physiological impacts as mentioned in literature, the exposure period of affected persons be limited as recommended by OSHA limits in the Table-6.11.

B. Noise Control Measures for DG sets

The following Noise Standards for DG sets are recommended for the running of DG sets during construction:

- The maximum permissible sound pressure level for new diesel generator sets with rated capacity upto 1000 KVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- The Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75 dB(A) at 1m sound levels specified by CPCB, Ministry of Environment & Forests. An amount of Rs. 5.0 lakh is earmarked for this purpose.
- The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- The DG set should also be provided with proper exhaust muffler with insertion loss of minimum 25 dB(A).
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures.
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use.

Operation Phase

Impacts due to operation of ropeways

During the operation phase, noise generated from the operation of the project essentially relates to the use of mechanical equipment at the terminal, and the wheel chatter from the cable car runners passing over the ropeway.

During the operation phase, conveyer belt, generator, hoist and winch for the proposed ropeway project can be considered as the major noise pollution sources. The moving trolleys of ropeway system gives some noise. Most of the stations and towers are proposed on government land, (forest land), however, at some places it passes through the residential and commercial establishments where the noise due to moving ropeways will disturb the residents staying in high rise building.

However, the modern ropeways systems do not generate significant noise, hence, impacts on this account are not expected to be significant.

Impacts due to reduction in Traffic

The commissioning of the proposed project would lead to reduction in trips by cars, two wheelers, trucks, etc. The reduction in car, two wheelers and bus trips in year 2029 would be 45,04,500, 7,61,310 and 1,37,13,810 (refer Table-6.6). The reduction in vehicular movement would lead to significant reduction in noise levels on road, and will be a significant positive impact on the overall quality of life for the residents

The mining trolleys of ropeway system gives same noise. Most of the stations and towards are proposed on “government land, (forest land), however, at some places it passes through the residential and commercial establishments where the noise due to moving ropeways will disturb the residents staying in high rise building.

Mitigation Measures

After using above approach to estimate potential impacts from construction noise, the next step is to identify control measures. Three categories of noise control measures are discussed below:

Design consideration and project layout

- Construct noise barriers, such as temporary walls or piles of excavated materials between noisy activities and noise-sensitive receivers.
- Re-route truck traffic away from residential streets, if possible. Select streets with fewer homes, if no alternatives are available.
- Site equipment on the construction plot as far away from noise-sensitive sites as possible.
- Construct walled enclosures around especially noisy activities or clusters of noisy equipment’s
- Plantation of trees, vegetation as well as the existing forest cover near the alignment will also reduce the noise.
- Proposed station buildings as well as the existing houses, buildings etc. will act as barrier and could be helpful in reducing the noise.

Sequence of operations

- Combine noisy operations to occur in the same time period. The total noise level produced will not be significantly greater than the level produced if the operations were performed separately.
- Avoid nighttime activities. Sensitivity to noise increase during the nighttime hours in residential neighborhoods.
- Proper O&M of moving trolleys and all electro-mechanical equipment’s will minimize the sound.

Alternative construction methods

- Avoid impact pile driving where possible in noise-sensitive areas. Drilled piles or use of a sonic or vibratory pile driver are quieter alternatives where geological conditions permit their use.
- Use specially quieted equipment, such as quieted and enclosed air compressor, mufflers on engines.
- Select quieter demolition methods, where possible.

6.7 IMPACTS ON SOCIO-ECONOMIC ENVIRONMENT

Construction Phase:

Impacts due to influx of labour force

During construction of ropeway, groups of local labours will be hired from the nearby villages but few technical staffs will also be engaged from outside. Both locals and technical staffs will be working together for construction. The increase in labour population is not expected to be significant impact on local demography, pressure on infrastructure facilities, etc.

Impacts due to land acquisition

Based on the present level of information, the private land acquisition is not required and hence no impacts due to land acquisition.

Socio-cultural Disruption

During construction of ropeway, groups of local labours will be hired from the nearby villages but few technical staffs will also be engaged from outside. Both local villagers and technical staffs will be working together for construction. This may create disruption in social interactions and other activities of the villagers which is quite negligible.

Health Impacts

The construction of proposed ropeway project may take longer time, during which manpower will be required for construction activities. A large force of labours may be required during construction of the project. Adverse health impacts are expected in the project area where construction and camps of workers and camp followers (families of workers and other service providers) are concentrated. These impacts would mainly result in sexually transmitted disease i.e HIV/AIDS, traffic and construction related accidents.

Cultural Conflicts

Although the proposed construction activities shall be huge and time consuming, it is proposed that most of the labor requirement shall be fulfilled from the nearby wards or villages. It is reported that due to presence of Chandi Devi temple, the local laborers will be very much familiar with the presence of outsiders such as tourists, devotees, pilgrims and other workers. Thus, the cultural conflict between local villagers and devotees as well as tourists has not been

anticipated.

Operation phase

The key benefits of the project include:

- Employment Opportunities
- Benefits to Economy
- Reduction in Traffic Congestion
- Quick Service and Safety
- Traffic Noise Reduction
- Less Fuel consumption
- Reduced air pollution

Other Socio-economic impacts

Apart from these there are other impacts on socio-economic environment due to the proposed project.

The anticipated positive and negative impacts due to proposed Shimla ropeway project are as follows:

Positive Impacts

- Provide Eco-friendly overhead transport solution for decongestion of existing roads
- Ease of travel for local inhabitants and as well as tourists thereby improving the ease of living.
- Considerably reduce the accidents and thus fatalities as this is the safest mode of transport after Air travel.
- Earn carbon credit, enhance tourism potential and generate employment opportunities thereby leading to overall socio-economic development of area.
- Improved connectivity between various places by providing direct aerial and congestion free connectivity.
- Reduce the traffic burden of the roads as an alternative mode of transportation.
- Work as a feeder for other modes of transportation system.
- Private land is not required hence, least rehabilitation & resettlement costs

Negative Impacts

- Pollution of air and noise quality during the construction phase
- Disposal of untreated effluents from labour colonies/camps and construction activities may lead to pollution of nearby water resources.
- Traffic congestion, hindrance to movement of pedestrian during the construction activities.
- Loss of trees which needs to be cut for the proposed towers/stations.
- Loss of Biodiversity.
- Spillage of construction material near the construction and on the approach roads if, the vehicle carrying construction materials are not properly covered during transportation.
- Disposal of Municipal Solid Waste as well as Construction and Demolition Waste (C&D) near the labour camps, and construction sites.
- Social conflicts due to influx of labour from outside area.
- Temporary reduction in revenue of Government Road Transport Departments due to reduction in passengers. However, transport department needs to arrange the frequency

and number of their fleets in co-ordination with Ropeway Authorities so that in long term the State transport department will also get more revenue due to increase in tourist passengers.

6.8 IMPACTS ON BIOLOGICAL ENVIRONMENT

Construction phase

Impact on flora

The project has several impacts on the biodiversity, which are listed as below:

- Degradation of biodiversity due to construction activities, and due to construction camps if, located near the forest areas.
- Impacts on faunal species due to noise due to construction and transport activities
- Temporary reduction in access to summer and winter ranges of ungulates, breeding sites and nesting habitats of birds.

Mitigation Measures

- The loss of forest will be compensated by afforestation. The proposal for diversion of forest areas is under preparation. It is proposed to afforest double the amount of entire land being acquired for the project. Thus, a total of (40 x2) 80 ha of land needs to be afforested. The afforestation work is to be done by the Forest Department. In addition, further compensation shall have to be paid for NPV of the forest and cost for the trees. The same shall be finalized at the time of forestry clearance. A large number of indigenous plant species should be planted in consultation with the concern authority. It is recommended to plant at least three times the number of plants to be felled.
- Noise reduction measures like minimizing the haul distances, reduction in idling time etc will be followed during construction to reduce vehicular noise and noise for construction machinery.
- Dumping of construction waste at forest land be strictly avoided. The excess excavated material will be utilized for restoration of low lying areas.
- Utilizing green and reusable technology.
- Water sprinkling will be done on haul roads to control fugitive emissions.
- Material will be covered during transportation.
- Any kind of littering at the work sites shall be avoided.

Provision of Free Fuel

The project proponent in association with municipal administration shall make necessary arrangements for supply of kerosene/LPG. The fuel would be supplied at sub-sidised rates to the local/contract labour for which provision should be kept in the cost estimate by the contractor as part of its bid for project construction.

Operation Phase

The alignment of proposed ropeway has been planned with sufficient vertical and horizontal clearances. The ropeway cabins will move above the tree line and there will be at least 5 m vertical clearance from bottom of cabin up to the top of tree line. Thus, no direct impacts are envisages on flora during operation phase.

Mitigation Measures

The pruning of trees, and surveillance and monitoring of growth of vegetation in the ROW of proposed ropeway alignment is essential during operation phase.

6.9 IMPACTS ON TERRESTRIAL FAUNA

Construction Phase

Disturbance to protected areas, if any

The nearest protected areas are Shimla Water Catchment Wildlife Sanctuary and Shimla Reserve forest Sanctuary which are about 2.8 km and 5.23 km respectively away from Sanjauli station. The major impacts due to the project are not envisaged on these protected areas.

Disturbance to wildlife

The project is located in an urban setting, and wildlife is not observed / reported from the project are. Hence, no adverse impacts on this account are anticipated.

Operation Phase

The ropeway alignment is far away from the ground level and hence there is no disturbance to wildlife.

Mitigation Measures

The maintenance of all electro-mechanical parts of ropeway is recommended to minimize the sound of moving trolleys.

CHAPTER-7
RISK ASSESSMENT AND DISASTER MANAGEMENT

CHAPTER-7
RISK ASSESSMENT AND DISASTER MANAGEMENT

7.1 INTRODUCTION

The Government of India launched the Parvatmala project to boost transportation in hilly regions of the country in the budget of 2022. Aerial ropeway is an electro-mechanical system, which facilitates transport of passengers and materials over difficult and abnormal terrain bringing about comparative ease and economy vis-à-vis other means of transport. It envisages a network of aerial ropeways to achieve greater last mile connectivity. RTDC has decided to undertake development and operation/maintenance of alternative mobility options for the cities of Shimla, Manali and Dharamshala which all three are hill cities.

The ropeway projects are safe, reliable, fuel efficient and safe mode of travel. It will be helpful in the decongestion of city of Shimla which is already facing lot of problems traffic jam, overcrowding, insufficient space for parking etc. Being a hilly state with lack of land availability has restricted it for alternative modes like air and water travel.

Though, ropeways are considered as safest mode of travel, it involves certain risks during construction as well as operational phases. The risk analysis and disaster management plan acts as a preventive measure to mitigate the risks and it will also assist the project proponents, planners in planning and implementation stages.

The Risk Assessment (RA) and Disaster Management Plan (DMP) has been prepared as a part of ESIA. The scope of this RA is for report pertains to 14.69 Km part of Phase 1 of the project with having 15 ropeway stations**.** The part of phase 1 network has been divided in **7** route lines which connects major residential settlements, commercial complexes, workplaces, and tourist attractions. The operational life has been considered as 30 years. There is parking space which have been proposed under the project at 10 locations.

7.2 HAZARD IDENTIFICATION

7.2.1 Technical Hazards

There are several complexities in the ropeway project. There could be several scenarios which should be considered during the design and planning of the ropeway.

- Slipping of cables of the rails at the upper tower station
- Cabins losing hold with the cable.
- Collision of cabins due to the above and other factors.
- Snapping of rope wire
- Power system failure
- Operator errors
- Unruly behaviour of passenger inside cabin
- Surge and rush of passengers at the facility

- Malfunction of cabin cars and parts such as doors, handles,
- Hanging of cabin cars in the middle of travel due to power or any system failure.

Apart from above technical possibilities, there are other factors which could malfunction of cable cars and the entire systems such as:

- Natural hazards like earthquakes, landslides, strong winds, hailstorm, etc
- Fire incidents
- Menace of animals
- Soil stability
- Falling of vegetation on the system – cable, cable car, wires, etc.

The above two set of hazard scenarios demonstrate that detailed investigation of failure modes is essential to prevent any incident or disaster for the ropeway project.

Hazards for this project can also be classified as:

- On-site- actual site of transportation and operation
- Off-site- peripheral services such as at bus station, parking and amenities such as lifts and walkways.

These hazards would vary in their intensity and frequency. However, these should be considered at planning as well as for implementation phases.

In addition to the above, the hazards could be of different nature such as:

- Chemicals - oil and grease spill,
- Electrical - fires, spark
- Ergonomic and physical – falls, trips, slips, fear of height, etc.
- Mechanical – bearing fault, cable fault, other mechanisms, etc.
- Human induced – errors, sabotage, terrorism, etc.

7.2.2 Natural hazards

Landslides

Another form of the natural hazards in the state is the frequent occurrences of landslides. The hills and mountains of Himachal Pradesh are liable to suffer landslides during monsoons and also in high intensity earthquakes. The vulnerability of the geologically young and not so stable steep slopes in various Himalayan ranges, has been increasing at a rapid rate in the recent decade due to inappropriate human activity like deforestation, road cutting, terracing and changes in agriculture crops requiring more intense watering etc. Although widespread floods problems do not exist in the state because of topographical nature, continuing attention is necessary to reduce flood hazards in the state, which are increasing and causing large-scale damage. Besides, the increase of road connectivity and number of vehicles plying on these roads in the State, the number of road accidents and loss of precious human lives is increasing day by day. The landslide hazard map of Himanchal Pradesh is shown in Figure 7.1.

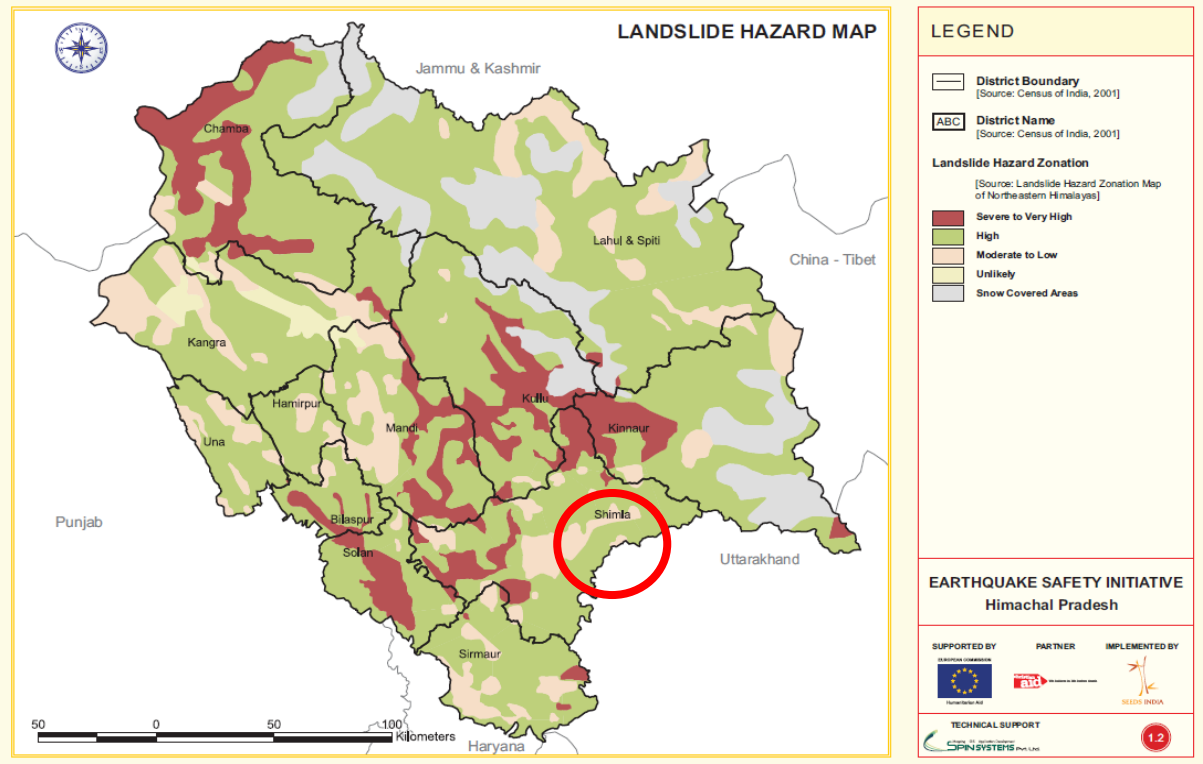


Figure-7.1 Landslide Hazard Map, HP

(Source: Vulnerability Atlas, H.P 2018)

Earthquake

Earthquake hazard map for Himachal Pradesh is reproduced in Figure 7.2. Shimla lies is in Zone IV.

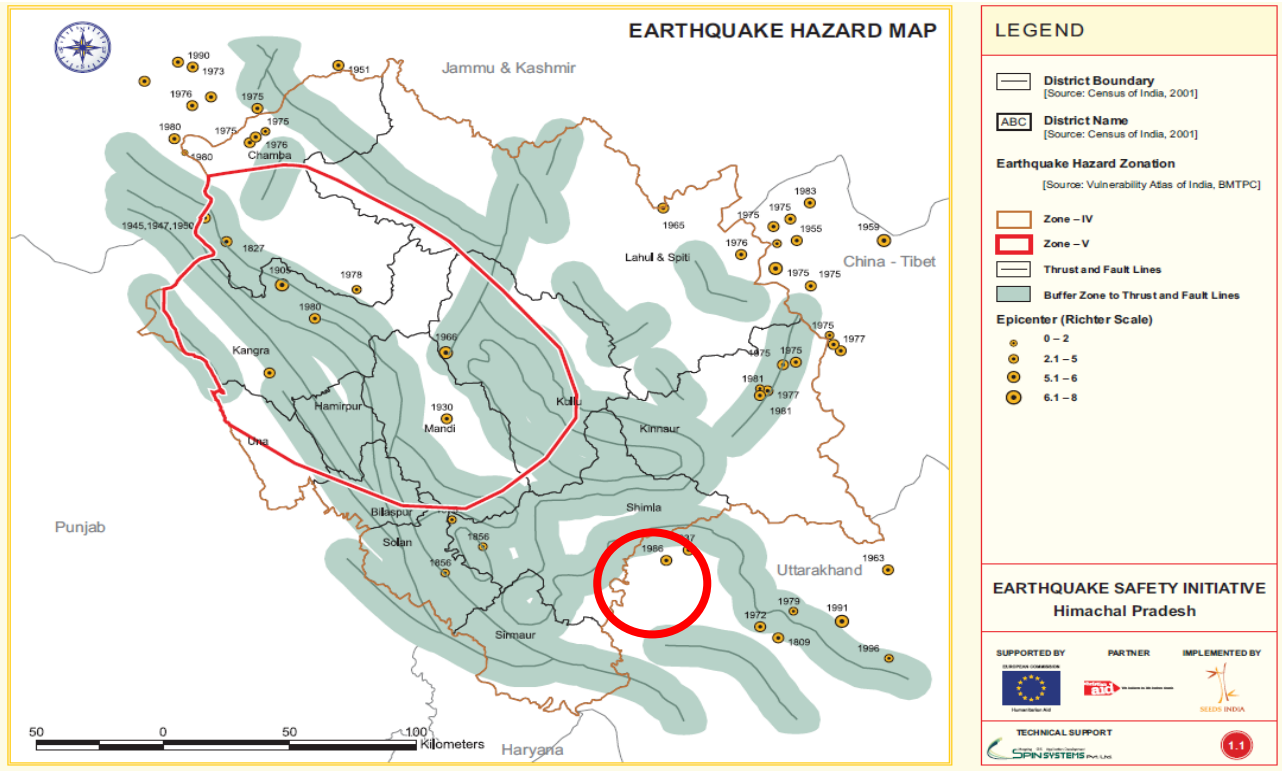


Figure-7.2 Earthquake Hazard Map, HP

(Source: Vulnerability Atlas, H.P 2018)

Forest fires

Probable areas prone to forest in the state of Himachal Pradesh fires are provided in Figure-7.3. It is observed from the figure that the Shimla is also prone to forest fire.

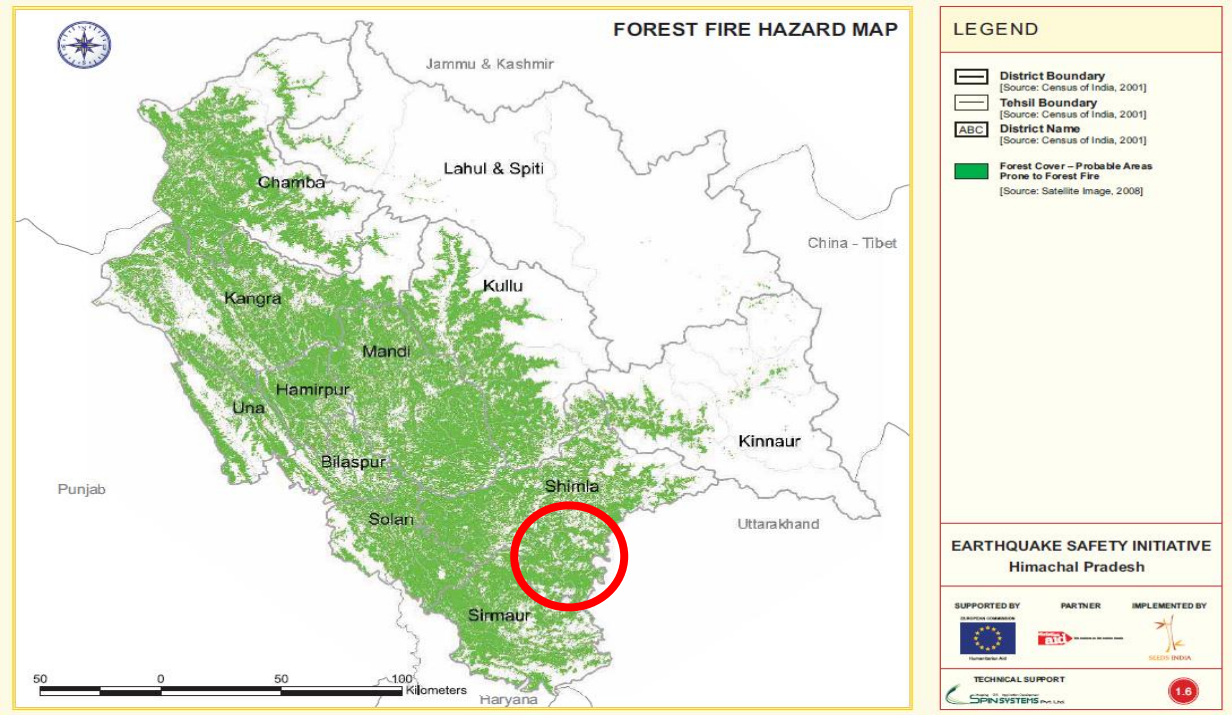


Figure-7.3 Forest Fire Hazard Map, HP

(Source: Vulnerability Atlas, H.P 2018)

7.2.3 Historical References

There have been several incidents involved with ropeways in India. These could serve as learning lessons for the present proposed project. Notables are:

- Gujarat, 2003
- Darjeeling, 2003
- Uttarakhand, 2014
- Mandakini, 2016
- Andhra Pradesh, 2016, Kailasagiri Hill Park
- Gulmarg, 2017
- Jammu, 2019
- Chhattisgarh, 2021, Dongargarh
- Himachal, 2022, Parwanoo
- Jharkhand, 2022, Trikut hills
- Madhya Pradesh, 2022, Sharda Shrine, Maihar
- Uttarakhand, 2022, Surkanda Devi Temple and Kaddukhal

Globally, there have been several incidents involving cable car such as Italy (1976), Singapore (1983), Georgia (1990), Italy (1998), France (1999).

7.3 RISK ASSESSMENT

Risk assessment is an essential part of risk management and is the overall process of risk identification, risk analysis, and risk evaluation (ISO 31000: 2009). It estimates the severity and likelihood of harm to any human life and the environment.

With the wide application of material ropeway in engineering, the structural components of ropeway are affected by various human factors and natural factors in the operation process, which inevitably lead to the defects such as fatigue, wear, deformation, corrosion, and fracture, easily causing safety hazards and safety accidents.

The comprehensive risk assessment considers the stage of development, intended use of the Passenger Ropeway, anticipated skill and training of personnel, additional risk exposure and reasonably foreseeable events or misuse. However, the scope varies from one project to another.

Adequate safety measures shall be followed as per IS specification such as door locks, rescue equipment. Appropriate rescue equipment shall be provided to facilitate rescue operation of passengers from Cabins of line.

Overall Vulnerability

Vulnerability matrix was developed based on the qualitative weightage which was given in the scale of 0-5 for different hazards such as earthquakes, landslides, avalanches, industrial hazards, construction type and density of population. District wise matrix was prepared by evaluating the risk severity. The evaluation also gives weightage to the density of population likely to be affected. The matrix also includes the evaluation of hazards likely to be induced on account of development of projects.

The overall vulnerability of Himachal Pradesh is depicted in Figure-7.4. Shimla is categorised as a region with high vulnerability.

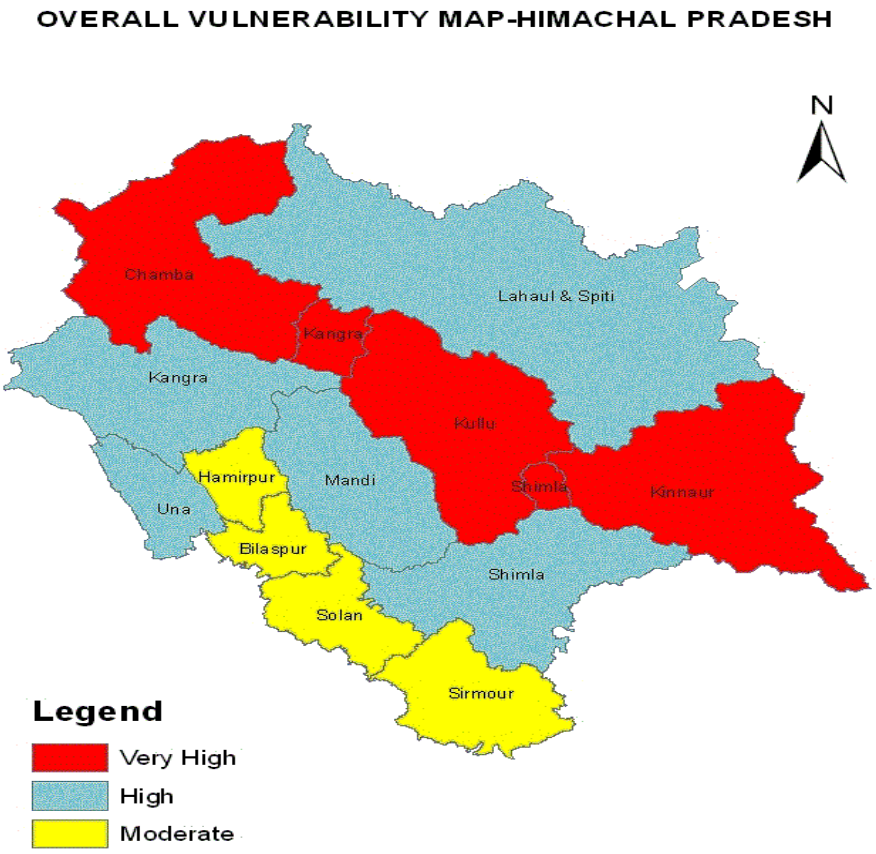


Figure 7.4 Vulnerability Map, HP

(Source: Vulnerability Atlas, H.P 2018)

Risk Reduction Measures

- The Gondolas/ Cabins would have door lock, which cannot be opened by the passengers.
- Two separate brakes are provided in each of the drives of ropeway system i.e. Emergency & Service break.
- In the event of main supply power failure, full capacity D.G. sets will be provided to supply power to run drive motors.
- Independent rescue arrangement to effect evacuation of stranded passenger from cabins online.
- Standby Diesel Engine would be provided to run ropeway at slow speed to rescue passengers from line in case of failure of drive motor.
- The Ropeway Main Drive Motors will be tripped if:
  - Set rope speed exceeds by 5%
  - Wind speed exceeds the set limit.
  - Heavy Rains
- All safety devices as per the ropeway system chosen must be provided. In addition, emergency stop buttons would be provided at convenient points to stop the cabin lift in the event of any emergency.
- Line Security Devices
- Line safety devices (Break fork switches) are installed on each trestle, hold downs and pressure frames (PF) which immediately stop the ropeway in the unlikely event of rope derailment.
- Rope catcher is provided on the incoming side of mount beams on line trestles, hold down, P.F. and Stations to arrest / support the hauling rope in case of deropement.

- There should be a programmable controlled digital variable speed drive panel. The ropeway will run smoothly by means of a powerful speed and controlled power circuits.
- There will be smooth controlled start and stop of the ropeway. Different sensors, safety devices feedback element, speed monitoring, failure of deceleration at a designated distance and annunciation needs to be provided.
- Control Panels and Distribution Boards needs to be provided at all stations for operation as well as maintenance purposes. Control relays and interlocks will be provided for rescue engine, emergency motor and brake operation.
- The main drive motors must be tripped automatically in the following scenarios:
  - In case of any safety fault occurred at line and stations.
  - In case there is variation of desired speed ratio between motor shaft, drive sheave or deflection sheaves at station.
  - In case there is failure of deceleration at a predetermined distance of cabin movement.
- Anemometers should be provided to monitor the wind speed and to provide trip signal to main drive-in case wind speeds exceeds a pre-determined set speed.
- Both the stations and line safety devices must be operative during running the ropeway with diesel engine. Battery back should also be provided for opening of service and emergency brakes.

Construction Phase

During the construction phase of a ropeway project, construction equipment like dozers, trucks, scrappers, concrete mixers, cranes, generators, pumps, etc. will be used. However, it shall be temporary and mostly confined to the site. PPE and PPA such as Helmet, safety shoes, Earmuffs etc will be provided to the construction worker. Hence, insignificant impacts due to construction machinery are envisaged.

During washing of cable cars, lubricants oil & greases may contaminate water environment and it will impact on flora & fauna.

Operation Phase

Some of the hazards identified during the construction/operation phase of a ropeway project include ground collapse-accidents, physical hazards, occupational hazards, dust inhalation, eye injury, body part injury, flood/water inrush, falls from height, mechanical hazard – tools handling, hazardous manual task, tower cable alignment, etc.

Control Measures

Some of the control measures for the hazards identified during the construction/operation phase of a ropeway project include the use of benching or the installation of ground support (e.g. shoring) during Tower foundation, use of PPE/PPA, life jacket, communication system at piling site, provision of dedicated vehicles during emergency situation, dewatering pump systems to remove water if, any accumulated on ground reduction of the area of earth cuts on fills below, provide physical support for exposed soil or rock faces.

DG set Fuel (Low Sulphur Diesel), and lubricating oil and waste lubricants will be the Hazardous waste in the project. These would be disposed of as per Hazardous Waste (Management, Handling & Transboundary) Movement Rules, 2008 and its amendments.

7.4 DISASTER MANAGEMENT PLAN

7.4.1 Emergency Operation Centre

Emergency Operation Centre plays a vital role in the Emergency Operation activation. It coordinates the flow of information with respect to activities associated with relief operations. During the normal times it maintains a systematic database of the resources available, important phone numbers, names and addresses of important government and non-government officials, international bodies, NGOs. During crisis it is expected to function as a centre for decision-making and help in flow of information horizontally and vertically to the respected departments for smoother relief operations.

7.4.2 Operation and Maintenance

A systematic routine maintenance and inspection schedule, based on maintenance and inspection plan, which shall be specified by the designer, shall be developed and set down in writing by the manufacturer of the passenger ropeway. The schedule shall include the specification of lubricant and frequency of lubrication of each element involving moving parts. It shall stipulate that parts showing excessive wear shall be replaced immediately. Condemning limits or tolerances shall be defined. It shall include a schedule for checking and tightening all bolts, especially on rope attachments. Where appropriate for any passenger ropeway, suitable records of the rates of deterioration (such as corrosion, erosion, etc.) shall be maintained. During a periodic inspection, a Safety Officer may inspect towers, sheave assemblies, brakes and braking functions, and the operation of main drives, auxiliary drives, and evacuation drives where applicable.

7.4.3 Safety Management Plans

Under a safety management plan, the licensed contractor will be required, as per terms and conditions of licensing, to submit the names of the people and their corresponding qualifications that will provide service and maintain the installed passenger ropeway equipment. Contractors will need to have this safety management plan in place at each area where passenger ropeways or passenger conveyors are operating.

The NDRF has also decided to train its rescuers in specific ropeway rescue skills apart from purchasing an assortment of tools like pulleys and carabiners to be used for transporting the salvager and evacuating stranded people from the car hanging in the air.

Electrical Protection: All overhead electrical power transmission wiring shall be protected in such way that, in case of collapse or breakage of the power line, it will not come into contact with chairs, cars, cables, or passengers.

7.4.4 Disaster Communication

The HAM radio operator map is provided in Figure 7.5. Shimla has around 14 HAM radio operators. The list is given in Table 7.1.

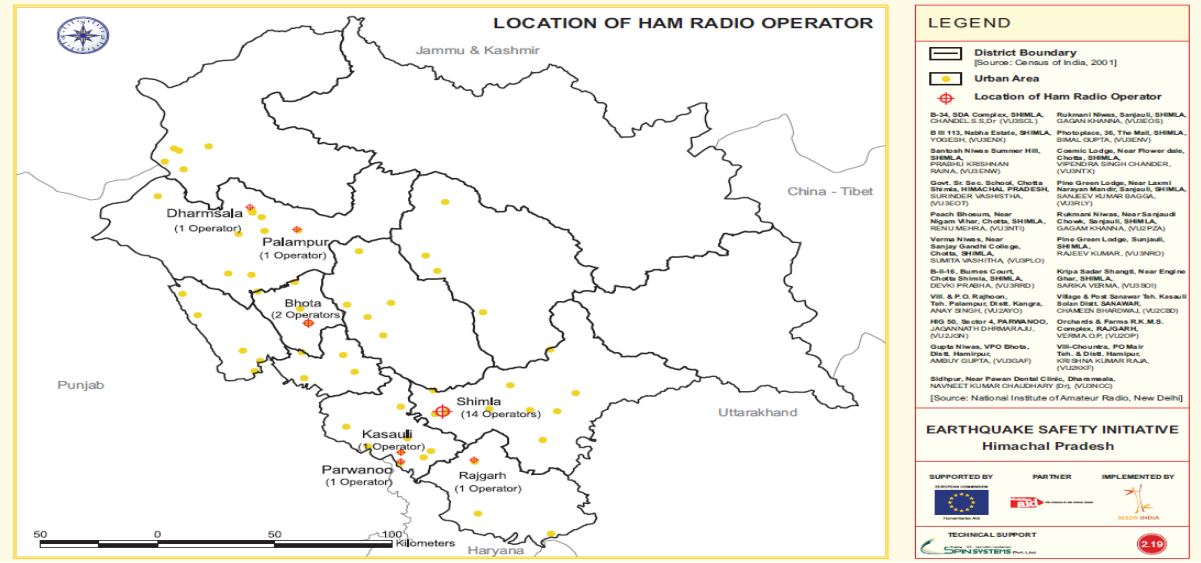


Figure-7.5 Location of Ham Radio Operator

Table-7.1: HAM Radio Operator, Shimla

S. No	Location of HAM Radio Operator
1.	B-34, SDA Complex, Shimla, Chandel S S Dr. (VU3SCL)
2.	B III 113, Nabha Estate, Shimla , Yogesh (VU3ENX)
3.	Santosh Niwas Summer Hill Shimla, Prabhu Krishanan Raina (VU3ENW)
4.	Govt. Sr. Sec. School, Chotta Shimla, Himachal Pradesh, Surinder Vashistha (VU3EOT)
5.	Peach Bhosum Near Nigma Vihar, Chota Shimla Renu Mehra (VU3NTI)
6.	Verma Niwas Near Sanjay Gandhi College Chotta Shimla Sumita vashitha (VU3PLO)
7.	B-II-16,Burnes Court Chotta Shimla , Devki Prabha (VU3RRD)
8.	Rukmani Niwas, Sanjauli, Shimla Gagan Khanna (VU3EOS)
9.	Photoplace, 36, The Main Shimla, Bimal gupta (VU3ENV)
10.	Cosmic Lodge, Near Flower Dale Chota Shimla Vipendra Singh Chander (VU3NXT)
11.	Pine Green Lodge, Near Laxmi Narayan Mandir, Sanjauli, Shimla, Sanjeev Kumar Bagga (VU3RLY)
12.	Rukmani Niwas Near Sanjauli Chowk, Sanjauli, Shimla, Gagam Khanna (VU2PZA)
13.	Pine Green Londge, Sunjauli, Shimla, Rajeev Kumar (VU3NRO)
14.	Kripa Sadar Shangti, Near Engine Ghar, Shimla, Sarika Verma (VU3SOI)

7.4.5 Hazard Identification and Preventive measures

The likely hazards, preventive measures and action to be taken is given in Table-7. 2.

Table-7.2: Hazard identification, preventive measures and action

Hazard Identification	Preventive measures	Action
Platform & Steps	• Walk, don't run. Talk, don't call out. • Stand back from edge of platform. • Students to stay within their designated groups. • Juniors to use the handrails or be with elders and parents.	**For minor injuries:** • First Aid kit available from Ticket Booth **For major injuries: phone 100/ 112**
Cable Car	• Be seated if, possible. • Hold on to handrails while standing. • Do not move around the Cable Car or dis- tract the driver's attentions while the Cable Car is in motion. • Do not swing from handrails.	• Teachers and adult helpers maintain control of their designated group. • In case of emergency be directed by staff or emergency services.
Individual medical condition	• The support staff is responsible for the specific medical needs of passengers and ensuring medication is available. • Where groups are on an organized tour specific individual medical needs and treatment plans should be disclosed to the operator prior to visiting the Cable Car.	**For minor injuries:** • First Aid kit available from Ticket Booth or at designated places. • Adult helpers to look after groups. **For major injuries: phone 100 and 112**
Evacuation of building	• Exits from both the Cable Car and Terminals are clearly marked. • Staff will lead group out via closest or quickest exit in event of evacuation.	• Staff lead practiced evacuation procedures. • Unless directed otherwise by staff or Emergency Services, evacuate using the closest exits.
Cable Car	• Do not play inside the cable car • Do not jump and dance inside the cable car. • Do not lean towards the window.	• Please use the panic button in case of cable malfunction. • Please call the operator in case of emergency.

Communication from cable car.

The cable cars should be fitted with adequate communication facilities for any emergency. Panic buttons could be installed inside the car.

7.4.6 District Disaster Management Committee (DDMC)

The contact person, telephone numbers etc. in case of emergency to be contact are given in Table-7.3 whereas, the services and their helpline number is given in Table-7.4

Table-7.3: Contact person and telephone numbers of DDMC

Name	Designation	Office	Mobile
Sh. Aditya Negi (IAS)	DC cum Chairman DRDA	0177-2655988	9459626586
Ms. Jyoti Rana	Additional District Magistrate(P)-cum-CEO,DDMA	0177-2653436	——-

Table-7.4: Services and their helpline number

S. No.	Name of Service	Toll Free Number
01	District Disaster Management Toll Free Number	1077,2800880-81-82-83
02	Fire Station	101
03	Patient Vehicle	102
04	Police	100
05	Traffic Police	2652217
06	Police Control Room	2621714
07	CID Control Room	2622408
08	Fire Station, Chotta Shimla	2623269
09	Fire Station Boileuganj	2830664
10	Secretariat Control Room BMC (SAIL)	262204,94180-20129,2621586

7.4.6 Provisions for implementation of DMP

An amount of Rs 50.0 lakh to be earmarked for implementation of DMP.

CHAPTER 8
ENVIRONMENTAL MONITORING PROGRAMME

CHAPTER 8

ENVIRONMENTAL MONITORING PROGRAMME

8.1 ENVIRONMENTAL MONITORING PROGRAMME

Environmental Monitoring Programme is to ensure that the intended environmental protection goals are achieved and result in desired benefits of the project. The broad objectives of the environment monitoring program are to:

- Monitor impacts on the surrounding environment and the effectiveness of mitigation measures during the construction and operation phase.
- Ensure that the environmental control systems, installed are effective.
- Comply to the provisions of relevant environmental regulations.
- Monitor air quality at selected locations to assess the impact.
- Monitor water quality at selected locations to assess the impact.
- Monitor noise level at Sensitive zones.
- Terrestrial Ecological Status

The Environmental Monitoring Programme is a vital process for the Environmental Management of infrastructure project. It is important to check the effectiveness of mitigation measures. This helps in signaling the potential problems that would result from the construction and operation of the proposed project and will allow for prompt implementation of corrective measures. This section outlines a suggested program of sampling, analysis and monitoring frequency. Compliance monitoring will provide data on the quantity and quality of various discharges to the environment.

8.2 WATER QUALITY

Construction Phase

The surface water quality can be monitored thrice a year (pre-monsoon, monsoon and post-monsoon seasons). 10 samples at different places along the ropeway alignment shall be collected. The proposed parameters to be monitored include; pH, electrical conductivity, turbidity, total dissolved solids, total hardness, chlorides, sulphates, nitrates, Faecal Coliform. The cost of analysis of one sample is expected to be Rs. 3,000. Thus, total cost for analysis of 30 samples is expected to be Rs. 0.90 lakh/year. Considering the construction phase to last for a period of 5 years and an escalation cost of 10% every year, the total cost over the entire construction period of 5 years works out to Rs. 5.49 lakh.

It is proposed to treat effluent from sewage treatment plants (STP). The frequency of monitoring could be twice per month both at inlet and outlet for three seasons. The parameters to be monitored include pH, Bio-chemical Oxygen Demand, Total Suspended Solids and Total Dissolved Solids. The cost of analysis of one sample is expected to be Rs. 3,000. Thus, total cost for analysis of 48 samples is expected to be Rs. 1.44 lakh/year. Considering the construction phase to last for a period of 5 years and an escalation cost of

10% every year, the total cost over the entire construction period of 5 years works out to Rs. 8.79 lakh. The analysis work can be done by any laboratory recognized by Himachal Pradesh Pollution Control Board.

Operation phase

The surface water quality can be monitored twice a year. 10 samples at different places along the ropeway alignment shall be collected. The proposed parameters to be monitored include; pH, electrical conductivity, turbidity, total dissolved solids, total hardness, chlorides, sulphates, nitrates, Faecal Coliform. The cost of analysis of one sample is expected to be Rs. 3,000. Thus, total cost for analysis of 20 samples is expected to be Rs. 0.60 lakh/year.

During project operation phase, a sewage treatment plant (STP) is proposed to be set up to treat the effluent. The frequency of monitoring could be twice per month both at inlet and outlet for one season. The parameters to be monitored include pH, Bio-chemical Oxygen Demand, Total Suspended Solids and Total Dissolved Solids. The cost of analysis of one sample is expected to be Rs. 3,000. Thus, total cost for analysis of 24 samples is expected to be Rs. 0.72 lakh/year. The analysis work can be done by any laboratory recognized by Himachal Pradesh Pollution Control Board.

8.3 AMBIENT AIR QUALITY

Construction Phase

The ambient air quality monitoring during construction phase can be carried out by an external agency, approved by Himachal Pradesh Pollution Control Board at 8 stations. Every year monitoring is to be done for three seasons namely, winter, pre-monsoon and Post-monsoon.

The frequency of monitoring could be twice a week for four consecutive weeks at each station for each season. The parameters to be monitored are PM_{10}, $PM_{2.5}$, SO_2 and NO_2.

Every year, ambient air quality is to be monitored for (8 stations*twice a week* four weeks*three seasons) 192 days. A total cost of Rs. 12.48 lakh @ Rs. 6500/day can be earmarked for this purpose. Considering the construction phase to last for a period of 5 years and an escalation cost of 10% every year, the total cost over the entire construction phase works out to Rs. 76.19 lakh.

Operation Phase

The ambient air quality monitoring during construction phase can be carried out by an external agency, approved by Himachal Pradesh Pollution Control Board at 8 stations for one season. The frequency of monitoring could be twice a week for four consecutive weeks at each station for each season. The parameters to be monitored are PM_{10}, $PM_{2.5}$, SO_2 and NO_2.

Every year, ambient air quality is to be monitored for (8 stations*twice a week* four weeks*one season) 64 days. A total cost of Rs. 4.16 lakh per year @ Rs. 6500/day can be earmarked for this purpose.

8.4 NOISE

Construction Phase

Noise emissions from vehicular movement, operation of various construction equipment may be monitored during construction phase at major construction sites. The frequency of monitoring shall be for three seasons in a year. For monitoring of noise level, an integrating Sound Level Meter will be required. An amount of Rs. 1.50 lakh can be earmarked for this purpose.

Operation Phase

Noise quality monitoring has not been recommended during project operation phase.

8.5 SOIL QUALITY

Construction Phase

The soil quality can be monitored twice a year (pre-monsoon and post-monsoon seasons). 1 sample along ropeway alignment at construction site and 1 sample at labour camp shall be collected. The proposed parameters to be monitored include; N, P, K and heavy metals. The cost of analysis of one sample is expected to be Rs. 3,000. Thus, total cost for analysis of 4 samples is expected to be Rs. 0.12 lakh/year. Considering the construction phase to last for a period of 5 years and an escalation cost of 10% every year, the total cost over the entire construction period of 5 years works out to Rs. 0.73 lakh. The analysis work can be done by any laboratory recognized by Himachal Pradesh Pollution Control Board.

Operation phase

The soil quality can be monitored once in a year during operation phase. 2 samples along ropeway alignment shall be collected. The proposed parameters to be monitored include; N, P, K and heavy metals. The cost of analysis of one sample is expected to be Rs. 3,000. Thus, total cost for analysis of 2 samples is expected to be Rs. 0.06 lakh/year. The analysis work can be done by any laboratory recognized by Himachal Pradesh Pollution Control Board.

8.6 Avi Fauna

Construction Phase

Assessment and presence of avi fauna species should be studied. The monitoring can be done for two seasons in a year. A provision of Rs. 6.0 lakh/year can be earmarked for this purpose. For a construction period of 5 years, and escalation @ 10% per year, total cost work out to Rs. 36.63 lakh. The study can be conducted by an external agency having an experience to conduct such studies.

Operation Phase

Assessment and presence of avi fauna species should be studied. The monitoring can be done for one season in a year. A provision of Rs. 3.0 lakh/year can be earmarked for this purpose. The study can be conducted by an external agency having an experience to conduct such studies.

8.7 SUMMARY OF ENVIRONMENTAL MONITORING PROGRAMME

The summary of Environmental Monitoring Programme for implementation during project construction and operation phases is given in Table-8.1 and Table-8.2 respectively.

Table-8.1: Summary of Environmental Monitoring Programme: Construction Phase

S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	No. of Samples	Location	Responsibility
1.	**Water**					
	Physico-chemical parameters	pH, EC, TDS, Turbidity, Phosphates, Nitrates, Sulphates, Chlorides, Faecal Coliform.	For three seasons in construction phase	10 samples at different places along the ropeway alignment.	As per RTDC LTD directions	Contractor
2	**Effluent from STP**	DO, BOD, COD	3 seasons during construction period	2 nos. at inlet and 2 nos. at outlet per month	At inlet and outlet of STP	Contractor
3.	**Ambient Air Quality**	$PM_{2.5}$, PM_{10}, SO_2 and NO_2	- For three seasons in construction phase - Twice a week for four consecutive weeks per season.	Upwind- 3 Downwind- 3 Near Project site- 2	As per RTDC LTD directions	Contractor
4.	**Noise Quality**	Equivalent Noise Level (Day and Night)	During peak construction activities	10-15 places including Construction sites and traffic junctions	As per RTDC LTD directions	Contractor
5.	**Soil Quality**	N, P, K and Heavy metals	2 samples pre-monsoon season and	Construction site- 1 Labour Camp- 1	As per RTDC LTD directions	Contractor

S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	No. of Samples	Location	Responsibility
			2 samples post-monsoon in construction phase			
6.	**Avi fauna**	Assessment and presence of avi fauna	Twice per year during construction period	--	As per RTDC LTD directions	RTDC LTD

Table-8.2: Summary of Environmental Monitoring Programme: Operation Phase

S. No.	Aspects	Parameters to be monitored	Frequency of monitoring	No. of Samples	Location	Responsibility
1.	**Water**					
	Physico-chemical parameters	pH, EC, TDS, Turbidity, Phosphates, Nitrates, Sulphates, Chlorides, Faecal Coliform.	For two seasons except monsoon	10 samples at different places along the ropeway alignment.	As per RTDC LTD directions	RTDC LTD
2	**Effluent from STP**	DO, BOD, COD	Once during operation phase	1 nos. at inlet and 1 nos. at outlet per month	At inlet and outlet of STP	RTDC Ltd.
3.	**Ambient Air Quality**	$PM_{2.5}$, PM_{10}, SO_2 and NO_2	- One season for operation phase. - Twice a week for four consecutive weeks per season.	Upwind- 3 Downwind- 3 Near Project site- 2	As per RTDC LTD directions	RTDC Ltd.
4.	**Soil Quality**	N, P, K and Heavy metals	One season during operation phase	Construction site- 1 Labour Camp- 1	As per RTDC LTD directions	RTDC LTD
6.	**Avi fauna**	Assessment and presence of avi fauna	Once a year during operation phase	--	As per RTDC LTD directions	RTDC LTD

8.8 PROVISIONS FOR IMPLEMENTATION OF EMoP

Table-8.3: Cost for implementation of Environmental Monitoring Programme during Construction Phase

S. No.	Parameter	Cost (Rs. lakh)
1.	Avi fauna Study	36.63
2.	Water Quality	14.28
3.	Soil	0.73
4.	Ambient air quality	76.19
5.	Purchase of Noise Meter	1.50
	Total	**129.33**

Table-8.4: Cost for implementing Environmental Monitoring Programme during operation phase

S.No	Parameter	Cost (Rs. lakh)/year
1.	Avi fauna Study	3.00
2.	Water Quality	1.32
3.	Soil	0.06
4.	Ambient air quality	4.16
	Total	**8.54**

CHAPTER 9
ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

CHAPTER 9

ENVIRONMENTAL AND SOCIAL MANAGEMENTPLAN

9.1 INTRODUCTION

The primary objective of environmental and social management and monitoring is to record environmental and social impacts and risks as a result of proposed project activities and identify the mitigation measures.

The Environmental and Social Management Plan (ESMP) presents the anticipated impacts and risks, its mitigation measures, and responsibilities for the mitigation activities. Environmental management and monitoring activities for the subproject are divided into (a) pre-construction, (b) construction, and (c) operation phases.

ESMP is developed to ensure that the subproject is implemented in an environmentally and socially sustainable manner where all stakeholders understand the risks/ impacts of the subproject and take appropriate actions to manage the impacts adequately.

The construction and operation should be planned in full compliance with local building codes, local fire department regulations, local legal/insurance requirements, and in accordance with an internationally accepted Life and Fire Safety (L&FS) guidelines. ESMP will be incorporated in the bid documents while bidding out contracts so that the contractor allocates the required resources and mechanisms to implement these measures.

The contractor, through his Occupational Health and Safety (OHS) person who is also a suitably qualified L&FS professional, shall prepare and submit an L&FS Master Plan based on the proposed design, including preliminary drawings and specifications, and certify that the design meets the requirements of the New Development Bank (NDB)/World Bank (WB) and Environmental Health and Safety (EHS) guidelines, Building Byelaws of local Municipality/ Panchayat, and National Building Codes (Part IV Fire and Life Safety) of the Bureau of Indian Standards. This professional should conduct a review of L&FS systems as part of the commissioning tests for new and renovated buildings and certify that the construction of the L&FS systems has been carried out following the accepted design.

9.2 OBJECTIVES OF ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

The objective of the environmental management plan is to achieve the following objectives:

The objectives of the ESMP are as follows:

- Draws together the measures proposed to mitigate negative, and to maximize positive environmental and social impacts
- Define a proposed institutional structure to govern the implementation of the ESMP
- Defines the specific actions required, roles and responsibilities for these actions, timelines for implementation, and associated tentative costs; and
- Describes capacity building and training requirements for the implementation of the ESMP.

The ESMP for the construction phase and operation phase of the project is given in subsequent sections. Contractor will revise the ESMP based on Environmental and Social Impact Assessment (ESIA) studies post design finalization and get it approved from General Consultant (GC)/RTDC LTD. Contractor will implement ESMP during project implementation. The plan specifies measures for addressing the limited negative risks and impacts and for enhancing the beneficial impacts. In addition, proposed institutional capacity and capacity building requirements, to check and ensure the effectiveness of the plan throughout the lifecycle of the project have also been discussed.

9.3 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

Based on the environmental baseline conditions and project inputs, the adverse impacts will be identified and a set of measures will be suggested as a part of Environmental and Social Management Plan (ESMP) for their amelioration.

The major issues to be covered in ESMP are discussed in the following paragraphs:

9.3.1 Facilities in labour Camps

The aggregation of workers and their families in the project area during the construction phase, is likely to put lead to adverse environmental impacts. A community kitchen shall be provided where workers have their meals. The fuel used in the kitchen shall be LPG. The water for drinking purpose shall be collected from the streams flowing upstream of the labour camps. The water shall be stored in tanks, treated and supplied for use. The water quality in general is good and does not require any elaborate treatment. However, if some problems are anticipated as a result of bacteriological contamination, then suitable treatment units can be installed.

Housing

The aggregation of large number of workers in the project area during the construction phase is likely to put considerable stress on the prevailing biotic and abiotic environment of the area. The aim of the EMP is to minimize these stresses. The construction activities are likely to be concentrated at various locations along the ropeway alignment.

It has been observed during construction phase many times the workers generally live in slum type conditions, with inadequate facilities for potable water and sanitation. Such conditions, coupled with lack of hygiene make the labour population prone to increased incidence of various water-borne and vector-borne diseases. It is proposed that it should be made mandatory for the contractor involved in the construction activities to provide adequate facilities for water supply and sanitation. It is recommended that the contractor provides living units of 30-40 m^2 to each of the labour family involved in the construction activities. The unit should have proper ventilation.

Water Supply

Appropriate water supply sources along with potable water needs to be proposed to workers. Proper infrastructure for storage and if required treatment e.g. disinfection or other units or RO should also be provided.

Sewage Treatment

The labour population is proposed to be situated in labour camps. One community toilet needs to be provided for 20 persons. The sewage from the community toilets can be treated in a Sewage Treatment Plant (STP).

Solid Waste Management

The aggregation of workers and their families in the project area during the construction phase, is likely to generate municipal solid waste especially at the labour camps. If, proper treatment is not given then the accumulated solid waste may leads to many health hazards in the labour camps as well as in the surrounding areas.

9.3.3 Labour Management Plan

Infrastructure projects, engage large number of contract workers, are highly prone to hazards pertaining to site activities. The proposed project like any other construction project has significant impact on health and safety during project construction and its operation stage, which needs to be adequately addressed.

The Indian Standard applicable for handling Occupational health and Safety Management are listed in Table-9.1.

Table-9.1: International standards for occupational Health & Safety

S. No	IS: Code	Title
1.	15793:2007	Managing Environment, Occupation Health and Safety Legal Compliance – Requirement of good practices.
2.	15883 (part-I) :2009	Guidelines for construction project management.
3.	18001:2007	Occupational Health and Safety Management System
4.	IS 15883 (Part 5)	Guidelines for construction project Management-Health and Safety Management

It is recommended that the contractors involved in project construction activities prepare a Health and Safety Plan. These shall include the following aspects:

- Project specific health and safety objectives, targets and programmes in line with health and safety policy
- Hazard identification and risk assessment
- Resources, roles, responsibility and authority
- General health and safety rules
- Health and safety requirements to be followed by sub-contractors
- Activities requiring work permit system and its procedure
- Management of traffic safety during construction and operation phases
- Access control of employees

- Safety of passengers and visitors
- Management of critical activities such as work at a height, material handling and working with plant and machinery
- Emergency preparedness and response plan
- Traffic management plan
- Training matrix
- Provision of Personal Protective Equipment as per work requirement
- Health and safety performance monitoring measures such as Inspection, Audit Incident reporting and investigation procedure

Resource, Roles, Responsibility and Authority

Project manager shall define, document and communicate the roles, responsibilities and authorities of all personnel like health and safety officer and supervisor who manage, perform and verify activities influencing health and safety risks.

- Health and safety officers shall report to the project manager and functionally report to the senior Health and Safety Representative of the organization.
- Health and safety supervisors shall be engaged to assist the health and safety officers in performing their duties.
- Adequate resources to effectively manage the health and safety management system shall be possible.

Competence, Training and Awareness

It shall be ensured that all employees are competent to perform the assigned work safely based on appropriate education, training or experience. The objectives of health and safety training are to:

- Equip the employee with necessary knowledge and skill to perform the work assigned to him in a safe manner;
- Foster continual improvement; and
- Develop safety culture.

A training matrix shall be formulated based on capability and the job requirement. The workers shall be trained based on the requirements delineated in training matrix. The objective is to ensure that the work is performed in a time bound manner, monitoring for the highest level of safety.

Health and Safety Reporting

Procedures shall be established for timely recording and reporting of information required for continual improvement of health and safety performance. Reporting procedures shall cover:

- Incident reporting
- Non-conformance reporting
- Health and safety performance reporting
- Hazard Identification reporting
- Statutory reporting requirements
- Stakeholder reporting

The recording of reporting of health and safety performance shall be clearly documented in the project health and safety plan.

Certification of Plant and Machinery, Lifting

- Contractor will be mandatorily get various equipment tested and examined by a competent person once every year as per the provision of Building and other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 and other relevant central and state rules and regulations.
- Statutory testing and examination, project specific procedures shall be established to ensure the fitness of machinery and equipment being deployed at the project for the first time.
- Regular Inspections shall be carried out to ensure that machinery and equipment continue to be in safe condition.

9.3.4 Safety Issues

Activities associated with aerial ropeway construction and operations also give rise to associated hazards and accidents. It is therefore desirable that based on the categories of hazards prevailing at the project site, risk assessment may be carried out by specialists in the field and recommendations may be implemented.

Risk assessment covering seismicity, slope stability, soil erodibility, etc. shall be conducted.

A Disaster Management Plan shall be prepared. It shall cover:

- Emergency planning
- Emergency procedures
- Details on safety measures adopted for the ropeway.

Maintenance of the ropeway for all structural, mechanical, and electrical components shall be done regularly and kept in a state of good repair. A systematic maintenance plan shall be implemented. This shall cover:

- Procedures for maintenance and specific frequencies for periodic lubrication, inspection and adjustment.
- Ropeway designer, wire rope or strand manufacturer shall mention the frequency and methods for maintenance or inspections of wire rope or strand in the specification. These shall cover:

  - Conveyor belting
  - Drums and rollers
  - Conveyor belt tensioning system
  - Braking systems
  - Electrical control systems
  - Communications systems
  - Structures

9.3.5 Fire Safety

Fire Protection Equipment

It has been planned that all facilities to be constructed shall be fully equipped with the fire protection equipment as per IS standards. The analysis of fire hazard in the construction of

labour camps, colonies and other facilities along with management measures is summarized in Table-9.2.

Table-9.2: Analysis of fire hazard in the construction of labour camps, colonies and other facilities

S. No	Stage	Potential hazard	Remedial Measures
1.	Construction of Camp/colony	• Fire prevention and fire fighting not considered in design • Inadequate fire protection measures during construction	• The project proponent shall provide the fire protection system as per IS Standards for Fire code. • Proper housekeeping will be ensured • Proper maintenance of fire-fighting equipment. • It will be ensured that the fire fighting equipment are placed at common place also including work place preferably within 15 meters of work place. • Clear Term of Reference (ToR) will be given to contractor at tendering stage for incorporating fire safety provisions . • Fire fighting equipment will be placed at all common places (within 15 meters of work place)

Maintenance of fire protection equipment

During construction, it has been envisaged to set up full-fledged Environment Health & Safety (EHS) department reporting directly to Head of Project. This department shall also take care of the adequacy of Fire Safety measures set up in all facilities created either owned by RTDC Ltd. The analysis of responsibility for this EHS team in respect of Fire protection system is outlined in Table-9.3.

Table-9.3: Analysis of responsibility for this EHS team

S. No	Stage	Potential hazard	Remedial Measures
1.	During Occupation	• Fire incident due to electrical short circuit/LPG Leakage/ Improper handling of flammable liquids/lack of precaution • Improper access to and from the location • Inadequate fire fighting arrangements • Lack of communication • Lack of Knowledge on fighting fire and	• Residential complex will be constructed as per the approved design and will be checked for completeness on fire aspect before allotment to residents • Labour camp (5) will be provided with rated estimated trip off circuit breaker will be installed on each block. • All employees/labour shall be made aware of fire hazard by training, regular campaigns and by placing posters and signs • LPG Cylinders/Flammable liquids will stored at designated storage area. The storage will be well protected, ventilated with adequate provision of fire equipment.

S. No	Stage	Potential hazard	Remedial Measures
		handling fire equipment • Inadequate Emergency response	• Adequate number of fire safety extinguishers shall be provided. • Additionally fire point containing fire buckets, CO_2 extinguishers, DCP Extinguisher will be provided at the common place covering four residential blocks in labour Camp. • Placement of written posters of preventive measures in each accommodation block • Regular EHS inspection of the labour camp and site offices • Placement of placard of emergency numbers to be contacted in case of Emergency • Dedicated phone line will be provided in labour camp for effective communication. • Ensure proper access is maintained around and to the labour camp

9.3.6 Safety Use of Machine at Project Site

The major machinery to be deployed at site shall include excavators/JCB, Backhoe and loaders which can excavate earth mix with boulders / rock mass and load on to vehicles. The area where machinery shall be operated will be under supervision of trained operators and helpers besides technically qualified foreman to ensure that the machinery is operated as per specified design parameters of the manufacturer.

- Before the work is initiated every day, the routine check-up especially with regard to its hydraulic systems, mechanical conditions, and other operating systems shall be performed.
- Movement of trucks/trippers/tractors for loading /transportation of material within the project area and haul road area shall be regulated by a trained supervisor who shall be responsible for the safety of vehicle movement and prevention of accidents or incidents associated with the vehicular movement.
- All staff working with the construction machinery shall be trained in first-aid and other safety measures, accident or incident prevention and reporting and communication mechanisms.

9.3.7 Work Zone Safety and Community Safety Risks

The project construction works will have potential work zone safety for workforce as well as community safety risks, which can be summarized as hereunder:

- Safety issues for both workforce as well as community due to mud slips or land erosion during excavation operations for approach road widening and construction of protection works.

- Safety issues for both workforce as well as community due to movement of rotating construction equipment, vehicles deployed for hauling of materials and debris disposal etc.
- Community health concerns due to increased/ direct exposure to high noise levels of construction machineries.
- Increased levels of dust and vehicle emissions due to construction activities, movement of construction vehicles, induced traffic congestion and idling of vehicles due to ongoing construction works.
- Influx of migrant workers could potentially cause discomfort or potential conflicts with local community particularly at workplace and marketplaces.

9.3.8 Occupational Health & Safety (OHS)

The excavated material and construction material do not contain any toxic element. Therefore, the likelihood of any health hazard does not arise due to their handling per se.

- Process of excavation/ quarrying leads to some health hazards.
- Dust generated due to excavation loading and movement on Kutcha/riverbed haul road creates air borne dust which has silica content.
- Working in open during summer can expose workers to the direct sun rays causing heat strokes, cramps and burns besides leading to exhaustion.
- Medical examination of employees at the initial stage and periodically, shall be done by a team of qualified medical officers provided by the project proponent.
- Initial medical examination for all workers must be arranged during the first year of appointment and the periodical check-up during subsequent years as per the requirements.
- Regular medical check-up camps shall also be arranged for detection of occupational diseases and minor disease in the nearby rural population.
- Free check-up and medicine for treatment for their acute and chronic illness shall be provided.

9.3.9 Noise Induced Hearing Loss (NIHL)

Blasting causes intermittent high level of noises whereas the continuous running of construction machinery / compressors / wagon drills / rock breakers leads to high noise level in the immediate vicinity of the point of noise emission. Hearing conservation programmes exists at all operations. Baseline audiogram forms the basis for future assessment of employees in terms of hearing loss.

Using engineering initiatives to reduce noise at source is the priority management tool. The hearing conservation programme includes the provision of Hearing Protection Devises (HPDs) and annual audiometry examination of all employees. Apart from provision of HPDs emphasis is also laid on training the employees' responsibility to protect his / her hearing.

9.3.10 Occupational Lung Diseases (OLD)

There will be regular health camps for all the workers and nearby rural people. Lung function tests, chest X-rays etc. shall be carried out and any health disorders will be

evaluated. The budget shall be earmarked for the necessary protective devices and training needs.

9.4.11 Public Awareness Programme

The main objective is to slow down the spread of HIV/AIDS & COVID 19 infection through creation of awareness and aiming at behavioral change. The awareness programme has the following components:

- Ensuring Blood Safety
- Control of sexually transmitted diseases
- Public awareness and community support.

i. Ensuring blood safety

The training program for the doctors and the blood bank staff in consultation National or State AIDS Control Organization which includes the diagnosis of AIDS cases, mandatory licensing of blood banks and promotion of voluntary blood donation.

ii. Control of Sexually Transmitted Diseases

The main strategy for prevention and control of HIV/AIDS is to control of sexually transmitted diseases in the labour camp by the suggested measures of National or State AIDS Control Organization

iii. Public awareness and community support

A wide campaign using various media to spread awareness about the HIV/AIDS & COVID 19 in the project area shall be taken up as Environmental management programme. This includes the use of radio, print media and folk theatre by the contractor and project proponent.

The counseling centre shall be set up in near Government hospital, which will have the following objectives:

- To provide pre-test, post-test, follow-up, general and family counseling to general public, workers and technical staff coming to the hospital.
- To provide support services and after care services for HIV positive clients.
- To disseminate information regarding STD, HIV/AIDS and measures suggested by National or State AIDS Control Organization.

iv. Measures for AIDS Control

The following measures are recommended for AIDS control:

- Prevention
- Anti-retroviral treatment
- Primary health care

The above referred approaches for implementation in the project area are described briefly in the following paragraphs:

Prevention

- Awareness programme educating people to enable to make life saving need to be implemented.
- Intravenous drug users to be informed about the perils of sharing of needles.
- Use of various modes of media to educate people on AIDS, its nature, transmission and prevention.
- People in high risk groups to be refrained from donating blood, body organ, etc.
- All blood to be screened before transfusion.
- Strict sterilization practiced to be ensured in hospitals and dispensaries.
- Pre-sterlized or disposable syringes to be used as far as possible.

v. Anti-retroviral treatment

At present there is no vaccine or cure for treatment of HIV infection/AIDS. However, drugs that suppress the HIV infection rather than its complications can be used for prolonging the life of terminally ill patients.

vi. Primary health care

AIDS touches all aspects of primary health care, including mother and child, family planning and education. Thus, it is recommended that the AIDS control programme integrates various related issues into country's primary health care system. The AIDS control and awareness programs, developed by National Aids Control Society (NACO) need to be strictly implemented in the project area as well. In addition to primary health care, it is also recommended that the workers should be made aware not to hurt the traditional cultural and regions customs and practices.

9.4 MANAGEMENT MEASURES

The possible, associated risks, and monitoring indicators, mitigation measures due to proposed project activities are elaborated in this section. The mitigation measure for the different aspects their tentative costs for implementation is discussed in following paragraphs:

9.4.1 Avi-Faunal Management Plan

Forests are vital for the survival, foraging, breeding and nesting of avifauna. Natural forests provide a variety of food materials to the birds not only in the form of nectar of flowers, fruits, seeds etc. in the trees, shrubs, herbs and grasses but they also contain a large number of insects eaten by birds. In the forests, food is always available for the faunal component. Although most floral species flower during spring through summer but fruit maturation and seed ripening takes place in them throughout the year. Therefore, first strategy of improvement of habitat for birds is avoiding nest predation or brood parasitism through maintenance of large contiguous forest tract. These areas have the ability to support the

largest number of forest interior birds and will also be more likely to provide habitat for area sensitive species. It is more practicable to protect the existing forest area rather than creating new forest area.

Another measure for habitat improvement for avifauna is to be installation of artificial nest boxes in the influence zone of the project after consultation with the forest department as well as local NGOs. These nest boxes has been found to be quite beneficial for attracting hole nester birds. The size and capacity of boxes vary from one species to another.

The characteristic features of nest box are listed below and shown in Figure-9.1

- Untreated wood (Jamun, mango, pine, cedar or fir)
- Thick walls (at least ¾ inches)
- Extended, sloped roof
- Rough or grooved interior walls
- Recessed floor, coated with primer and paint
- Drainage holes
- Ventilation holes
- Easy access for monitoring and cleaning
- Sturdy construction
- No outside perches

The entrance hole should have a 2-inch diameter and 6 inch depth from entrance hole. Nest boxes are placed on trees at height from 10-12 ft. Such nest boxes designs have been used with success.

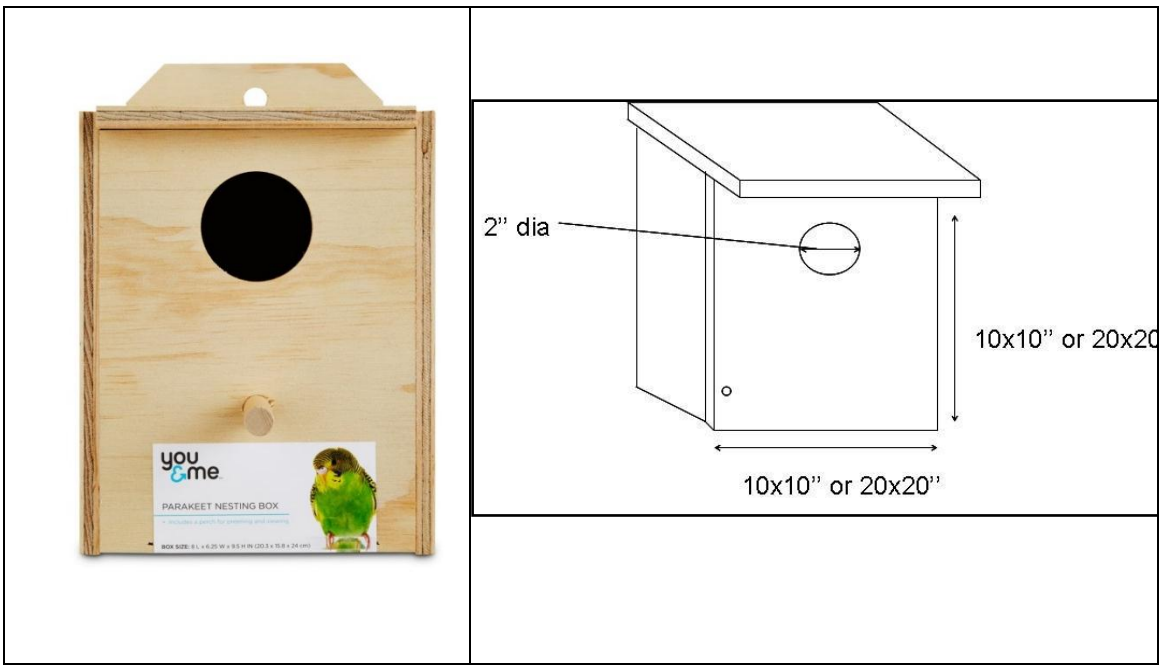


Figure 9.1: Nest Box

It is proposed that one qualified person be hired for a period of five years. An amount of Rs. 25.11 lakh can be earmarked for habitat improvement of Avi-fauna in the study area. The details are given in Table-9.4.

Table-9.4: Cost of habitat improvement for Avi-Fauna in the Study Area

S. No.	Particulars	Amount (Rs. lakh)
A	**Non-recurring Cost**	
1	Cost of nests of different sizes (10”x10” to 20”x20”; average cost Rs. 1000 per wooden box) and installation in the area along with the green belt (500)	5.00
2	Repair and maintenance of the nests	1.0
B	**Recurring Cost (for 5.5 years)**	
1	Salary for one skilled person @ Rs. 15,000 per month for implementation and data collection including 10% escalation	16.61
2	Contingencies (including avifaunal biodiversity awareness programme for the local inhabitants)	2.5
	Total Cost (A+B)	**25.11**

9.4.2 Landslide Control Measures

As part of EMP, landslide control measures have been formulated to protect and/or improve the embankments in the area where the proposal towards/station will be located to provide stability. The details are given in following sections.

Landslide Control Measures

The following control measures are proposed:

- Vulnerable areas which a likely to prone for landslides will be assessed.
- Drainage of surface water flowing into the landslide area or emerging in the head scarp area.
- Filling and compacting of the fill in all open cracks, which could be entered by, surface water.
- In the case of slow, creep-like slope movements, the packing of open cracks may also have an impeding effect, because it can hinder upslope propagation of slope deformation.

Mitigation Measures

The following mitigation measures have been suggested for controlling landslides in the project area:

- Rock anchoring, carving out of slopes, shot creting etc. should be planned.
- The impact of landslide on the project could be managed by arresting the potential landslides zones through suitable engineering treatments, afforestation etc.
- Landslide Control with Coir-Geotextile

For an area of about 20 m x 30 m along the slope, the slope length is divided by constructing two unbounded stone masonry walls of 22 m long and with a maximum height of 1.20 m at the bases of the steep slopes. This is to be carried out to arrest the debris movements and to provide sufficient drainage.

The soil on the surface of slope is first graded to remove the unevenness present, where possible. There may be still some patches of exposed rock/boulders. Wedge shaped trenches of 30 cm x 30 cm are to be dugged to anchor the coir nets at the top and the

bottom The area may be seeded with very limited quantity of *Pennisetum* sp*. / Vetiveria* sp*.,* grasses known for quick and easy growth and have root depth nearly equalling the existing soil cover, i.e. around 40 to 50 cm.

Rolls of the coir matting is first anchored in the top trench and then unrolled along the slope. Each slope is given an overlap of minimum 15 cm with the adjacent ones and anchored firmly into the ground by mild steel staple, spaced to form a grid of 2 m in either direction. Coir ropes of 20mm diameter were used to tying the coir matting, which is anchored in tension in a criss-cross pattern at around an angle of 90^o, making a grid of 1 m size. Steel staples are driven at each joint of the coir rope type. A matting is used on the upper half having a slope of 60^o and type B matting were used on bottom half with 40^o slope. Culms of locally growing bamboos species may also be used for anchoring the jute net/ geo-textile. Over a period of time the roots from the bamboo will develop and will further provide stability to the slope.

An amount of Rs.345.0 lakh has been earmarked for control of landslides. The details are given in Table-9.5.

Table-9.5: Budget for Landslide Control Measures

S. No.	Item	Cost (Rs. lakh)
1	Construction of retaining wall	200.0
2	Geo-textile measures	100.0
3	Turfing	10.0
4	Coir Matting	10.0
5	Contingencies	25.00
	Total	**345.0**

9.4.3 Restoration Plan for Quarries

The environment management plan for mining activity shall be prepared on the basis of impacts and shall be compatible with the eco-friendly management plan in case of the minor mineral. The plan shall have various ingredients like plantation in the area within 7.5-meter safety barrier, backfilling for mine restoration etc.

Measures to be adopted before quarrying

The top 6-12" of soil will be removed before starting the quarrying activity or any other surface disturbance. This top soil will be kept separate and stock piled so that it can be reused after quarrying is over for rehabilitation of sites.

Measures to be adopted after quarrying

Diversion of run off

Effective drainage system will be provided to avoid the infiltration of run-off and surface waters into the ground of quarry sites. Garland drains around quarry site shall be constructed to capture the runoff and divert the same to the nearest natural drain.

Filling of depressions

Removal of rocks from quarry sites for different construction works will result in the formation of depression and/or craters. These will be filled by the dumping materials consisting of boulders, rock, gravel and soil from nearby plant/working sites.

Construction of retaining walls

Retaining walls will be constructed at the filled up depressions of quarry sites to provide necessary support particularly where there are moderately steep slopes. In addition concrete guards, shall be constructed to check the soil erosion of the area.

Rocks for landscaping

After quarrying activities are over, these sites will be splattered with the leftovers of rocks and boulders. These boulders and rocks can support the growth of mosses and lichens, which will act as ecological pioneers and initiate the process of succession and colonization. The boulders of moderate size will be used to line the boundary of a path.

Laying of the top soil

The depressions/craters filled-up with rock aggregates will be covered with top soil. Fungal spores naturally present in top soil will aid plant growth and natural plant succession. The top soil will be further enriched by organic manure and Vesicular-Arbuscular Mycorrhizal (VAM) fungi. This will help in the process of soil reclamation and the early establishment of juvenile seedlings.

Barbed wire fencing

The periphery of the area of rock quarry site will be fenced to prevent entry of animals in the quarry area and to protect the plantation from grazing and to enhance natural regeneration.

Re-vegetation

The work plan formulated for re-vegetation of the dumping sites through 'Integrated Biological and Biotechnological Approach' would be based upon the following parameters:

- Evaluation of rock material for their physical and chemical properties to assess the nutrient status to support vegetation.
- Formulation of appropriate blends of organic waste and soil to enhance the nutrient status of rhizosphere.
- Isolation and screening of specialized strains of mycorrhizal fungi, rhizobium, azotobacter and phosphate solubilizers (bio-fertilizers inoculums) suitable for the mined out sites.
- Mass culture of plant specific biofertilizer and mycorrhizal fungi to be procured from different institutions/organizations which are engaged in the phyto-remediation activity of degraded areas.
- Plantation at quarry sites/areas using identified blend and biofertilizer inoculums.

An amount of Rs. 50 lakh has been earmarked for implementation of restoration plan for quarries.

9.4.4 Waste Water Management Plan

Sewage Treatment

The total construction time for the project is about 5 years. At peak construction phase, there will be an increase in population by 800. One community toilet shall be provided per 20 persons. The sewage from the community latrines shall be treated in mobile Sewage Treatment Plant (STP). For each 500 persons, one mobile sewage treatment plant shall be provided. The effluent from mobile sewage treatment plant shall be disposed off through absorption trenches. As mentioned earlier, the drinking water facilities and waste disposal sites will be located away from each other.

About 20 community latrines and two (2) mobile sewage treatment plants needs to be provided to mitigate the impacts of sewage generation from labour camps and latrines. The total cost earmarked is Rs.20.0 lakh. The details are given in Table-9.6

Table-9.6: Cost Estimate for Sanitary Facilities for Labour Camps

Unit	**Rate (Rs./unit)**	Number	**Cost (Rs. lakh)**
Community toilets	40,000	20	8.0
Sewage Treatment Plant			12.0
Total			**20.0**

Effluents from Workshops

As a part of infrastructural development for the project. Separate workshops would be set up during construction phase for:

- Earth moving machinery mounted on tracks like shovels, dozers, etc.,
- Earth moving machines mounted on tyres like dumpers, loaders, graders. etc.
- Pneumatic, concreting equipment like boomers, wet shotcrete machines, concrete pumps, etc.
- Transport equipment like buses, trucks, transit mixers, ambulances, light vehicles, etc.,

The effluent from workshops, will contain oil & grease and high suspended solids. The effluent if disposed without treatment can lead to unsightly conditions in the receiving water bodies on account of high oil & grease levels. The high suspended solids would lead to increase in turbidity levels. An Oil Separator Unit is proposed for which an amount of Rs.30.0 lakh has been earmarked.

9.4.5 Air Quality Management Plan

The air quality management plan shall comprise of following:

- Control of Emissions
- Air Pollution control due to DG sets
- Dust control Measures

Control of Emissions

Minor air quality impacts will be caused by emissions from construction vehicles, equipment and DG sets, and emissions from transportation traffic. Frequent truck trips will be required during the construction period for removal of excavated material and delivery of select concrete and other equipment and materials. The following measures are recommended to control air pollution:

- The contractor will be responsible for maintaining properly functioning construction equipment to minimize exhaust.
- Construction equipment and vehicles will be turned off when not used for extended periods of time.
- Unnecessary idling of construction vehicles to be prohibited.
- Effective traffic management to be undertaken to avoid significant delays in and around the project area.
- Road damage caused by sub-project activities will be promptly attended to with proper road repair and maintenance work.

Air Pollution control due to DG sets

The operation of DG sets may lead to increase in SO_2 levels beyond the permissible limits 60 µg/m^3. The DG sets be installed as per CPCB guidelines to avoid the atmospheric pollution.

Budget

An amount of Rs. 10.0 lakh is earmarked for implementation air pollution control measures.

9.4.6 Noise Control Measures

The contractors will be required to maintain properly functioning equipment and comply with occupational safety and health standards. The construction equipment will be required to use available noise suppression devices and properly maintained mufflers.

- Vehicles to be equipped with mufflers recommended by the vehicle manufacturer.
- Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible.
- Use of temporary sound fences or barriers to be evaluated.
- Notification will be given to residents within 300 feet (about 90 m) of major noise generating activities. The notification will describe the noise abatement measures that will be implemented.
- Monitoring of noise levels will be conducted during the construction phase of the project. In case of exceeding of pre-determined acceptable noise levels by the machinery will require the contractor(s) to stop work and remedy the situation prior to continuing construction.

- Provision with ear muffs or plugs for the workers, so as to attenuate the noise level near the crusher by atleast 15 dB(A).
- Working hours of the laborers will be decided considering the guidelines of Occupational Safety and Health Administration (OSHA)
- To prevent other psychological and physiological impacts the exposure period of affected persons be limited as recommended by OSHA.

B. Noise Control Measures for DG sets

The following Noise Standards for DG sets are recommended for the running of DG sets during the construction:

- The maximum permissible sound pressure level for new diesel generator sets with rated capacity upto 1000 kVA shall be 75 dB(A) at 1 m from the enclosure surface.
- Noise from the DG set should be controlled by providing an acoustic enclosure or by treating the enclosure acoustically.
- The Acoustic Enclosure should be made of CRCA sheets of appropriate thickness and structural/ sheet metal base. The walls of the enclosure should be insulated with fire retardant foam so as to comply with the 75 dB(A) at 1m sound levels specified by CPCB, Ministry of Environment & Forests. An amount of Rs. 6.0 lakh is earmarked for this purpose.
- The acoustic enclosure/acoustic treatment of the room should be designed for minimum 25 dB(A) Insertion Loss or for meeting the ambient noise standards, whichever is on the higher side.
- The DG set should also be provided with proper exhaust muffler with insertion loss of minimum 25 dB(A).
- Proper efforts to be made to bring down the noise levels due to the DG set, outside its premises, within the ambient noise requirements by proper siting and control measures. An amount of Rs. 9.0 lakh is earmarked for this purpose.
- A proper routine and preventive maintenance procedure for the DG set should be set and followed in consultation with the DG set manufacturer which would help prevent noise levels of the DG set from deteriorating with use. An amount of Rs.15 lakh is earmarked for this purpose.

C. Budget

An amount of Rs. 20.0 lakh has been earmarked for implementation of various measures. The details are given in **Table-9.7**.

Table-9.7: Cost estimate for implementation of various noise control measures

S. No.	Activity	Cost (Rs. lakh)
1.	Construction of acoustic enclosure for DG sets	6.0
2.	Maintenance of DG sets	9.0
3.	Distribution of PPE to labours	5.0
	Total	**20.0**

9.4.7 Solid Waste Management Plan

During construction phase of the project, there will be an influx of technical staff, laborers and other service providers into the project area. The total increase in population is of the order of 800, who shall proposed project labour camps and colonies. Solid waste will be generated from the colonies. It is very essential that from the planning stage, sewerage management and solid waste disposal facilities should be conceptualized to maintain the health of the people and the environment. The main sources of wastes shall be:

- Municipal waste from residential areas
- Solid wastes from labour camps near project sites
- Bio-medical wastes from Dispensary

Since most of the dam operations shall be automated or mechanized, very few people shall be staying in the project during the operation phase. The solid waste is primary problem during the construction phase of the project. Solid waste generated from temporary and permanent colonies

Municipal Solid Waste Management Plan

The labour colonies will generate substantial amount of municipal wastes. In view of the condition that might exist in the labour camps, most likely the solid wastes will contain majority of vegetable matter followed by paper cans and glasses. About 800 persons are likely to congregate during the construction phases resulting in generation of about 0.12 tonnes of solid waste/day. Adequate facilities for collection, conveyance and disposal of municipal waste generated from labour camps should be developed. For solid waste collection, masonry storage vats, each of 2 m^3 capacity at convenient dumping points in the labour camp will be constructed. Each vat will have a storage capacity of 150 kg (dry weight) of garbage, which will be emptied at regular intervals and will be transported to the landfill site. One covered truck to collect the solid waste from the common collection point and transfer it to the disposal site needs to be put to service.

Reuse/Recycling

In order to reduce quantum of waste generated, project will reuse significant quantity of Muck (generated due to excavations) for backfilling, form work (in civil work) wherever possible and will also reuse the packing materials received with packages etc.

Project proponent will explore opportunity to recycle the waste generated at the project site. In this context project will identify authorized vendors and send used batteries, used oil, and used oil filters for recycling.

Bio-degradable waste will be disposed by composting and the manure generated will be given to local community for cultivating vegetables and flowers.

The solid waste generated in construction and operation phases shall be handled as per the norms and guidelines for handling Municipal Solid Management Rules 2016. The key aspects are:

- House-to-house collection of solid waste on regular pre-informed timing and scheduling through any of the methods, like community bin collection (Central bin).
- Collection of wastes from office complexes, hotels and commercial areas.
- Avoid mixing of Bio-medical wastes with municipal solid wastes.
- Collected waste from residential areas shall be transferred to community bin by hand- driven containerized carts or another small vehicle. Horticulture and construction / demolition wastes or debris shall be separately collected and disposed of.

- Burning of wastes shall be prohibited.
- Collection of wastes from markets/shop and also dry leaves collected from avenues/ parks.

Various aspects of municipal solid waste management include:

- Segregation
- Storage
- Transportation
- Processing
- Disposal
- Refuse storage
- Collection and Transportation
- Disposal

Segregation of Municipal Solid Wastes

The project authority shall organize awareness programmes to encourage the generators of wastes and to ensure community participation in waste segregation. For this purpose, regular meeting at quarterly intervals shall be arranged with representatives of resident of colonies.

Storage of Municipal Solid Wastes

The project authority shall establish and maintain storage facilities in such a manner as they do not create unhygienic and insanitary conditions around it. The key factors shall be considered for establishing and maintaining storage facilities are:

- Storage facilities of bins shall have 'easy to operate 'design for handling, transfer and transportation of waste. Bins for storage of bio-degradable wastes shall be painted green, those for storage of recyclable wastes shall be painted white and those for storage of other wastes shall be painted black.
- Manual handling of waste shall be avoided, if required manual handling shall be carried out under proper precaution with due care for safety of workers.

Transportation of Municipal Solid Wastes

Vehicles used for transportation of wastes shall be covered and not exposed to open environment preventing their scattering.

Disposal

Degradable component

The degradable portion of the solid waste would be disposed off by composting. The degradable portion is taken as about 38.9%. Thus, (0.389*0.12) about 0.05 t/day of degradable portion of solid waste will be generated. In composting the process takes around 60 days to mature. Keeping, a margin of 30 days total capacity of pits have been provided as (0.05x90 = 4.5 m^3). Thus the total capacity of pits required would be 5 m^3.

A pit of 2m x 1.5m x 1.3m deep (0.3 m freeboard) size can take 3.0 cu m of compostable waste. Thus the no. of pits required shall be about 02. The total area will be almost three

times the pit area as some area in between pits will be required for transportation and stacking of waste. Hence, total area required will be 25 m^2. The pits will be covered with GI sheets. Additional 25 m^2 shall be kept for storage for compost plus screening and other activities.

The pits to be constructed will have around 25 cm of bottom lining consisting of about 5 cm thick stone grit over which 15 cm thick coarse sand followed by 15 cm thick earth lining will be done. The refuse along with animal dung will have to be laid in layers of 5 to 10 cm thickness. The pit will be then watered on alternate days. Thereafter waste is laid in 5 to 10 cm thick layers twice in a week till the whole pit is filled up. Every week, waste will need to be turned up and water will have to be sprinkled every day to keep adequate moisture. The process will take around 60 days where after the composted waste from the pit is taken out and after drying it is screened with screens having 2 mm dia holes. The screened compost would be filled in plastic bags and used as good manure especially for cultivation of vegetables and flowers.

Non-Degradable component

The non- degradable portion such as plastic bottles, cans, etc. shall be segregated and disposed off at separate sites identified by the district administration/ Shimla Municipal Corporation. Recycling opportunities would be explored in consultation with the local administration.

Awareness Programme

The awareness programmes shall be organized for waste segregation. Residents of labour camps shall be apprised of the benefits of waste segregation. Regular meeting shall be conducted with representative of residents of colonies where good upkeep shall be recognized and rewarded.

Budget

A total provision of Rs.80.72 lakh needs to be earmarked for this purpose. The details are given in Table-9.8.

Table-9.8: Details of Expenditure Required for Solid Waste Management

S. No.	Item	Cost (Rs.lakh)
1.	One covered truck for conveyance of solid waste up to landfill site	25.0
2	Manpower cost for 4 persons @ Rs.10,000/month for 5.5 years including 10% escalation/year	33.22
3	Waste collection hand carts 10 @ Rs.25,000/unit	2.50
	Total	**80.72**

Hazardous Waste Management

Hazardous waste *inter alia* include burnt mobile oil from vehicles and construction machinery and equipment, batteries and like items specified in column (3) of Schedule-I of Hazardous and other Wastes (Management & Transboundary Movement) Rules,2016. These will be disposed of by auctioning them to the recycling vendors approved by the CPCB or State Pollution Control Board in consonance with Hazardous and other Wastes (Management & Transboundary Movement) Rules,2016. The project proponent shall earmark a suitable site for storage of hazardous waste, prior to collection by an authorized vendor for handling the hazardous work.

Hazardous waste shall be sent or sold by the occupier to an authorized actual user or disposed in an authorized disposal facility only. Occupier shall transport wastes through an authorized or certified transporter to an authorized actual user or to an authorized disposal facility as per the provisions of these rules.

A sum of Rs 10.0 lakh has been earmarked for storage and handling of the waste.

E- Waste Management

E-Waste (Management) Rules, 2016, applies to consumer electrical and electronic equipment listed in Schedule I, including their components, consumables, parts and spares which make the product operational. Electrical equipment (LED/LCD TV sets, refrigerators, air conditioners, fluorescent and mercury lamps) and electronic equipment (Telex, Telephones, Computers, Printers, Cartridges) including their components, consumables, parts and spares mentioned under Schedule-I are covered under the rules.

Under clause 9 (1) of E-Waste (Management) Rules, 2016, consumers or bulk consumers of electrical and electronic equipment listed in Schedule I shall ensure that e-waste generated by them is channelized through collection center or dealer of authorized producer or dismantler or recycler or through the designated take back service provider of the producer to authorized dismantler or recycler. The collection, storage, transportation, segregation, refurbishment, dismantling, recycling and disposal of e-waste shall be in accordance with the procedures prescribed in the guidelines published by the Central Pollution Control Board from time to time. Implementation of e-waste (Management and Handling) Amendment Rules, 2016 shall be in accordance with the guidelines prescribed by the Central Pollution Control Board from time to time. For properly storage of e-waste before its disposal, as sum of Rs.10.0 lakh has been earmarked.

Total Budget for Waste Management

The total cost earmarked for management of various solid wastes is Rs. 100.72 and summarized in **Table-9.9**

Table-9.9: Cost Estimate for Waste Management Plan

S.N.	Particulars	Amount (Rs. lakh)
1	Solid Waste Management	80.72
2	Hazardous Waste Management	10.00
3	E-waste Management	10.00
	Total	**100.72**

9.4.8 Pubic Health Delivery System

General Measures

- Measures to be taken for provision of adequate drinking and sanitation facilities for the labour population and their families.
- Adequate measures for supply of potable water and sewage treatment have been recommended as a part of Environmental Management Plan.
- A proper surveillance, immunization schedule and medical facilities would be provided for the labour population migrating into the project area.

Development of Medical Facilities

A dispensary well-equipped to handle injuries, diseases likely to occur at a hydro-electric project site shall be constructed.

A first aid post is to be provided at major construction sites, so that workers are immediately attended to in case of an injury or accident.

This first-aid post will have at least the following facilities:

- First aid box with essential medicines including ORS packets
- First aid appliances-splints and dressing materials
- Stretcher, wheel chair, etc.

The first-aid post can be housed in temporarily erected structure and should be managed by one Health Assistant and assisted by one dresser/first aid attendant. Doctors from the dispensary can attend First Aid post regularly every day at a fixed time. Communication link between the dispensary and first-aid posts and the nearby hospitals shall be established, for urgent medical treatment in the event of an emergency. The first aid post shall have facilities such as fire-fighting equipment, telephone connection, one vehicle or ambulance van for effective functioning.

Health Extension Activities

The health extension activities will have to be carried out in the villages situated within the study area. It is important to inculcate hygienic habits of environmental sanitation especially with respect to water pollution by domestic wastes. There would be possibility of the

transmission of communicable diseases due to migration of labour population from other areas at the construction site.

The doctors from the dispensary will make regular visits to these villages and organize health promotional activities with the active participation of the local village leaders, NGOs and available local health functionaries. The health functionaries would undertake the following tasks as a part of health promotional activities:

- Collect water samples to ascertain the potability of water from different sources so as to monitor regular disinfection of drinking water sources.
- Maintain close surveillance on incidence of communicable diseases in these villages.
- Maintain close liaison with the community leaders and health functionaries of different departments, so that they can be mobilized in case of an emergency.
- Close interaction to be maintained with health department functionaries of the state government.

The costs estimates for salaries, materials and supplies are given in Tables-9.10 and 9.11 respectively.

Table-9.10: Expenditure on salaries

Post	Number	Monthly Emoluments (Rs.)	Annual Expenditure (Rs. lakh)
Recurring (Dispensary)			
Doctors	1	150,000	18.0
Nurse	1	40,000	4.8
Male Multi-purpose	1	20,000	2.4
Health Workers			**0**
Attendants	1	20,000	2.4
Drivers	1	20,000	2.4
Sub-Total (A)			**30.0**
First Aid Posts			
Health Assistants	1	20,000	2.4
Dressers	1	20,000	2.4
Sub-Total (B)			**4.8**
Grand Total			**34.8**

Table-9.11: Expenditure on Material and Supplies

Description	Expenditure (Rs. lakh)
Dispensary	
Non-recurring	
Mobile dispensary	25.0
Miscellaneous items	5.0
Total	**30.0**
Recurring	
Drugs and Medicine (per year)	3.0
Contingencies (per year)	1.0
2 First-Aid Posts at construction sites (per year)	2.4
Total	**6.4**

A. Infrastructure

Non-recurring

Mobile Dispensary: Considering the restriction of land a mobile dispensary has been proposed for this project

First-Aid Posts: These are of temporary nature and will be constructed with MS/GI sheets, bamboo, etc. It will cost @ Rs.150,000/First- Aid Post. The total cost for constructing two First-Aid Posts will be of the order of Rs.3.0 lakh.

Disposal of Bio-Medical Waste

The bio-medical waste need to be handle in a scientific manner. However, considering the type of facilities to be developed. For management, special type of collection container shall be placed near the dispensary and first-aid posts for proper collection and disposal of bio-medical waste.

Budget

The total expenditure for implementation of various public health measures shall be about Rs **353.95** lakh. The details are given in Table-9.12.

Table-9.12: Details of expenditure in Public Health Delivery System

	Description	**Expenditure (Rs. lakh)**
A.	**Recurring Expenditure**	
1.	Expenditure on salaries (per year)	38.8
2.	Expenditure on materials & supplies (per year)	6.4
	Sub-total (per year)	45.2
	Total expenditure for 5.5 years (considering 10% escalation per year) **(A)**	**275.95**
B.	**Non-Recurring Expenditure**	
1.	Infrastructure (Construction of 2 First aid posts)	3.0
2.	Expenditure on materials & supplies	30.0
3.	Free medicines for labourers @ Rs. 5.00 lakh each dispensary per year for 5 years	25.00
4.	Health awareness / vaccination camps @ Rs. 1.0 lakh/year for 5 years	5.00
5.	Cost of collection, transport, storage and treatment through CBWTF	10.00
6	Provision for chlorination of drinking water in project affected villages	5.00
	Total (B)	**78.0**
	Total A+B	**353.95**

9.4.9 Traffic and Logistics Management

Traffic management plan shall be prepared as a part of the project health and safety plan at the initial stage of the project to manage the traffic inside the project site. Traffic management plan shall include:

- Measures for segregating pedestrian and vehicle traffic
- Establish project specific traffic rules such as speed limit and one-way etc.

- Managing the flow of traffic such that blind zones and hazardous junctions are not present
- Managing the flow of traffic such that reversing can be avoided as far as possible
- Use of traffic control devices such as road humps, convex mirrors, delineators traffic signals and barriers. It shall be planned to deploy flag man, security personnel and traffic marshals at critical areas to regulate traffic.

9.4.10 Safety Practices During Construction Phase

Personal safety equipment

- All the personnel as well as the site representatives and visitors shall be equipped with appropriate personal safety equipment. The use of such equipments shall be compulsory.
- Every person entering the working area.
- Safety-loc footwear with steel caps shall be worn by all employees engaged in work having an inherent danger to the feet.
- Light footwear such as sandals, canvas or tennis shoes shall not be permitted for construction work.
- During drilling works and in the areas where the employees are exposed to harmful noise levels, ear protectors shall be made available and required to wear.
- Employees engaged in work having an inherent danger of eye or face injury shall be furnished and required to wear protection glasses, goggles or masks where irritant or toxic substances may come in contact with the skin or clothing, employees shall be wearing the protective clothing or shall be required to apply a protective ointment by a competent physician.
- Employees working on steep slopes or otherwise subject to possible falls from levels not protected by fixed guardrails or safety nets, shall be secured by safety construction belts and lifeline.

Maintenance of traffic and safety on public roads

- All necessary precautions for the protection of the work and the safety of the public on the roads affected by his activities shall be taken. Where the work will be carried out at the site of, or close to an existing road, the vehicular and pedestrian traffic shall be maintained safe at all times. If any operations can cause traffic hazards, the repair or fence or any such other measures shall be taken for ensuring safety.
- Roads subject to interference by the work shall be kept open or suitable detours shall be provided and maintained, and all necessary barricades, suitable and sufficient flashlights, flagmen, danger signals, and signs be provided.
- Roads, which will be closed to traffic, shall be protected by effective barricades on which acceptable warning and detour signs shall be placed. All barricades shall be kept illuminated and all lights shall be kept on from sunset to sunrise.

- The temporary passes and bridges shall be provided to give an access to the existing commuters and residents, houses, etc., to the satisfaction of the authorities concerned.

9.4.11 Traffic management during construction phase

Temporary diversions will be constructed with the approval of the Engineer. Detailed Traffic Control Plans will be prepared and submitted to the Engineer for approval, at least 5 days prior to commencement of works on any section of road. The traffic control plans shall contain details of temporary diversions, details of arrangements for construction under traffic, details of traffic arrangement after cessation of work each day, safety measures for transport of hazardous material and arrangement of flagmen.

The Contractor will ensure that the diversion/detour is always maintained in running condition, particularly during the monsoon to avoid disruption to traffic flow. He shall inform local community of changes to traffic routes, conditions and pedestrian access arrangements. The temporary traffic detours will be kept free of dust by frequent application of water.

9.4.12 Energy Conservation

a) Construction Phase

Provisions of Free Fuel

The project proponents, i.e. RTDC Ltd. in association with district administration shall make necessary arrangements for supply of fuel to the labour population and technical population migratory in the project area during construction phase. The contractor shall run community kitchens, using LPG as fuel. The provision of community kitchen shall from part of the Tender document to engage the contractor involved in construction activities.

Other Measures

The following energy conservation measures would be undertaken during construction works:

- Efficient work scheduling and methods that minimize equipment idle time and double handling of material
- Throttling down and switching off construction equipment when not in use
- Switching off truck engines while they are waiting to access the site and while they are waiting to be loaded and unloaded
- Switching off site office equipment and lights and using optimum lighting intensity for security and safety purposes
- Careful design of temporary roads to reduce transportation distance
- Regular maintenance of equipment to ensure optimum operations and fuel efficiency
- The specification of energy efficient construction equipment.

Provisions for Electricity

- Electricity supply shall be arranged for lighting purpose to the tune of two 100 W bulbs per family and provision of streetlight shall be made in the labour colony

- Electricity for heating purposes shall be provided at one (01) unit/day for each workers residing in project camp/colonies
- Provision of solar streetlight
- Provision of Solar water heater.

Budget for Energy Conservation Measures

The difference in cost of using fuel wood and other suggested substitutes which the contractors shall be loading in their tendered rates and which finally shall be included in the project cost.

b) Operation Phase

The following energy conservation measures would be implemented during operation phase:

- Use of CFL lights up to maximum possible extent.
- Awareness about the use of CFL lights by locals.
- Development of heating, cooling and lighting use in buildings through climate-responsive design and conservation practices.
- Employing renewable energy sources such as day lighting and passive solar heating.
- Optimizing building performance and system control strategies, such as controlling lights with occupancy sensors and controlling comfort.
- Maximizing the use of solar power for signage and pedestrian lighting.
- Designing roads on site to reduce transportation distances.

9.5 SUMMARY OF EMP

The proposed mitigation measures and institutional responsibilities etc. during construction and operation phase activities are given in Tables-9.13 to Table-9.14 respectively as a part of ESMP.

Table-9.13: ESMP during Construction Phase

Activities/ Concerns	Potential impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
Submission of C-ESMP	-		-	-	Contractor	Safeguard Team, of construction phase of RTDC LTD Supervision Consultant	
Labour management risk	Delayed and Unpaid wages to workers and suppliers Contractor's inability to provide adequate facilities for workers at worksite and work camp.	Medium	Include requirements for bidders in the bidding documents This will include a) labour management obligations with effective non-compliance remedies which will be applied where there is a breach; and b) E&S guarantee which can be applied against contractor in case of non-compliance with the labour management requirements	Feedback from workers and other Parties about receipt of their wages and payment on timely manner as per the requirements of relevant labour laws. Employee registers (attendance, wages, over time) maintained on site. Basic facilities (gender segregated toilets, canteen, crèche facilities, etc.) established at work-site as per relevant labour laws.	Contractor	PMU, Supervision Consultant	Contractor to include estimated cost for labour management and appropriate trainings in bidding document.
Safety hazards due to increased	Accident and incident risk	Medium	Traffic Management Plan (TMP) addressing general access Safety	Ensure the TMP is prepared and available at the	Contractor	Supervision Consultant	The cost to be is included by contractor

Activities/ Concerns	Potential impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
traffic			and security actions and procedures to protect the local community	project site			
Work place injury and hazard	Increased risk of workforce injury. Failure of contractor to abide by labour standard requirements pertaining to community & labour health and safety, including labour welfare	Medium	• Include requirement for ESMP and Occupation, Health and Safety Plan in specifications • Provide trainings on health, safety and labour welfare requirements to the employees as per existing laws and regulations.	• Acceptable ESMP and Occupation, Health and Safety Plan included in specifications • Labour awareness level, labour welfare rights including occupational health and safety requirements	Contractor	Safeguard team of construction phase of RTDC LTD Supervision Consultant.	Contractor to Include training for labour management and community safety.
Risks related to community health and safety including SEA / SH	Community safety issues. Risks related to labour influx Local community complaints and inconvenience from project activities. Local	Low	• Contractor to Comply with safety guidelines and ensure compliance of Code of Conduct by all workers. • Undertake community and stakeholders' consultation. • Disseminate information on Grievance Redressal Mechanism • Provision of toll-free	• Monitor contractor performance related to safety and health issues • Number of grievances received and redressed by multiple intake channels including GRC at the community	Contractor PMU	Supervision Consultant	Contractor to Include community safety and labour influx risk training to bidding document. PMU will conduct training for GRC members

Activities/ Concerns	Potential impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
	community to push for hiring residents instead of outsiders. Risks of transmission of communicable diseases including COVID-19, HIV/AIDS, etc.		project helpline no. to register and redress grievances in a timely manner. • A clause to be included in the contract to mandate the hiring of locals than outsider. Contractor to ensure compliance of guidelines on management of COVID-19 pandemic	and project level. • Number of local workers hired by the contractor during the construction period • Number of trainings and awareness camps on COVID-19, HIV/AIDS, GRM organised on site and with host community.			Regarding the Grievance redress Mechanism, and community disputes resolution
	SEA/SH risks	Low	Contractor to setup an Internal Complaints Committee (ICC) and provide trainings as per the requirements of the Sexual Harassment at the Workplace (Prevention, Prohibition and Redressal) Act, 2013 Mandatory training and dissemination of information related to SEA/SH risks, lawful conduct of workers and consequences for failure to comply with law. Contractor to ensure that	ICC setup by the contractor Number of complaints redressed by the ICC Number of trainings and awareness camps on SEA/SH organised on sites. Number of trainings and awareness camps on Worker's Code of Conduct organised on site.	Contractor	Supervision Consultant	Costs of trainings and awareness camps conducted on SEA/SH risks, COVID-19, HIV/AIDS to be included in the bidding document Dissemination activities on GRM, SEA/SH, COVID-19,

Activities/ Concerns	Potential impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
			each contractor's personnel is provided with a copy of the Code of Conduct and obtain that person's Signature on receipt.				HIV/AIDS undertaken by contractors to be included in the cost estimation.
Accidental leakage of oil, failure of unit	Risk to labours nearby residents	High	Contractor to ensure the up gradation of all equipment's and machinery	Record of frequency of accidents, strict monitoring	Contractor	Supervision consultant	-
Chance find	Loss of cultural, historical items	Medium	Strictly follow the cultural and heritage management rule	Strict monitoring reporting to PMU and construction activities	Contractor	Supervision consultant	-
Water logging	-	Low	-	Monitoring at site	Contractor	Supervision consultant	-
Excavated debris, soil disposal and management	-	Medium	After utilization for same during construction phase, balance materials, debris, discarded boxes, containers, drums etc; will be removed from the site. Solid waste, C&D waste will be segregated and disposed as per at designated sites in consultation with local authorities.	Monitoring at site	Contractor	Supervision consultant	-
Topsoil conservation		High		Monitoring at site	Contractor	Supervision consultant and RTDC	-

Activities/ Concerns	Potential impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
						LTD	
C&D waste	Impacts at working place and neighbouring people	Medium	• Disposal should be as per C&D waste as per C&D Rule 2016 • Segregation of C&D waste and deposit at collection centre or handover it to the authorized processing facilities. • To ensure that there is no littering or deposition so as to prevent obstruction to the traffic or the public or drains. • Removal of all C&D waste in consultation with concerned local authority on their own or through any agency	Monitoring at site	Contractor	Supervision consultant	-
Air Quality	Air pollution, fugitive dust emission due to dust, vehicle exhaust	High	Keep the Air Quality within the acceptable limits • At feeding points stone crusher air mist spray shall be carried out • The contractor will be responsible for maintaining properly functioning construction	Monitoring of air quality	Contractor	Supervision consultant and RTDC LTD	Monitoring programme and parameters are given in ESMP

Activities/ Concerns	Potential impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
			equipment to minimize exhaust. • Construction equipment and vehicles will be turned off when not used for extended periods of time. • Unnecessary idling of construction vehicles to be prohibited. • Effective traffic management to be undertaken to avoid significant delays in and around the project area. • Plantation of local species				
	Impact on biodiversity due to change in air quality	Medium	Implementation of conservation measures	Monitoring of air quality	Contractor	Supervision consultant and RTDC LTD	-
Noise and vibration	Noise pollution	Low to medium	• Vehicles to be equipped with mufflers recommended by the vehicle manufacturer. • The construction activities shall be limited to day time. Suitable barriers shall be provided around	Monitoring of Noise levels	Contractor	Supervision consultant and RTDC LTD	

Activities/ Concerns	Potential impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
			construction sites. • Staging of construction equipment and unnecessary idling of equipment within noise sensitive areas to be avoided whenever possible. • Notification will be given to residents within 100m.				
Water quality	Water pollution	Low	Keep the water quality within the acceptable limits • Provision of storm water and waste water management system • Provision of clean drinking & domestic water facility at labour camps and construction site • Provision of Mobile Toilets	Monitoring of water quality	Contractor	Supervision consultant and RTDC LTD	Monitoring programme and parameters are given in ESMP
Ecology	Impact on flora and fauna	Medium	Implementation of conservation measures	Monitoring of flora, fauna in the vicinity of construction sites	Contractor	Supervision consultant and RTDC LTD	
Solid waste	Water and Air pollution	High	Provision of solid waste management in construction phase Collection, segregation	Monitoring in the construction camps	Contractor	Supervision consultant and RTDC LTD	Monitoring programme and parameters

Activities/ Concerns	Potential impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
			and proper disposal of municipal waste, hazardous waste (used oil) and dredged soil				are given in ESMP

Table-9.14: ESMP during Operation Phase

Activities/ Concerns	Potential Impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
Operation of the Ropeway	Risk of injury and health issue.	Medium	Compliance with health and safety regulations applicable in the state and Ropeway sector.	• Ensure all newly hired staff receive training on safety and health issues. • Monitor contractor performance related to safety and health issue.	Official in charge of O&M RTDC LTD	-	Costs of Conducting safety and health training of all project staff, especially for newly hired. Part of project operation cost.
Gender & GRM	SEA/SH risks	Medium	Setup an Internal Complaints Committee (ICC) for the terminal staff and provide trainings as per the requirements of the Sexual Harassment at the Workplace (Prevention, Prohibition and Redressal) Act, 2013	ICC setup No. of complaints redressed by the ICC No. of trainings and awareness camps on SEA/SH organised at the terminal No. of trainings and	Official in charge of O&M RTDC LTD	Supervision Consultant/ PMU	Costs of trainings and awareness camps conducted on SEA/SH risks, COVID-19 of all project staff, especially for newly hired. Dissemination activities on

Activities/ Concerns	Potential Impacts	Assessed Risk level	Mitigation measures	Monitoring Indicators	Institutional Responsibilities		Remarks
					Implementation	Supervision	
			Security personnel deployed at the stations for safety and security of passengers, particularly women. Project helpline no. along with existing hotlines for women's safety to be advertised at the terminal. Training to staff on GRM including RTI, labour standard compliance including HR policies, safety and security of women users (including gender sensitization), and passenger services for differently abled, senior citizens, women and children.	awareness camps on employees' Code of Conduct organised No. of complaints redressed by Gender Based Violence (GBV) partner organisations.			GRM, SEA/SH, COVID-19, to all project staff especially for newly hired. These cost are part of project operation cost.
Employment opportunities	Limited employment opportunities for women	Medium	Comply with the requirements of policies of RTDC LTD and Government of H.P	Ensure reservation for women in vacancies at the	Officials in charge of O&M	PMU	Project operation cost

9.6 IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT PLAN DURING CONSTRUCTION PHASE

The EMP implementation by contractor can be achieved by following ways:

- Incorporation of Contractor's ESMP (C-ESMP) in bid document and should have full-fledged environment health and safety management cell (E&S Cell) to ensure the implementation of the EMP and the SHE policy
- The contractor E&S cell should have necessary experience in the field of Environment Health and Safety.
- Contractor should stipulate to the ECoPs designed for the project
- The contractor E&S cell should function in close coordination with PMU of RTDC LTD and GC to the project.
- The Contractor's E&S cell should submit the EMP compliance and applicable regulatory and RTDC Ltd E&S systems compliance on monthly basis.
- Mandatory deployment of environmental and social expert (by contractor) at site. The payments of the contractor to environmental performance be linked and penalties be imposed in case the environmental safeguard measures are not taken up adequately
- Appointing PMC to monitor the performance of contractor and compliance of the ESMP by contractor. PMC is responsible to communicate the status of compliance/non-compliance to project proponent and suggest the measures to be undertaken to contractor to meet the gaps/non-compliances.
- PMC can be appointed by RTDC Ltd through tendering process and the company's having experience of managing similar kind of projects should only be appointed for the work.

The roles and responsibilities of different units in implementation of ESMP are given in Table-9.15.

Table-9.15: Responsibility of different units in implementation of ESMP

Organizations	Responsibilities
PIU	• Overall monitoring and assisting RTDC management for smooth functioning of project. • Recruitment and supervision of external monitor and independent panel of experts
Environmental Expert and Social Development Expert within PIU	• Ensuring inclusion of ESMP in bidding documents • Closely coordinate with other concerned agencies, local governments and communities to support implementation • Preparation of progress reports on implementation of ESMP. • Ensure effective implementation of ESMP components not directly tasked to the contractor including components dealing with indirect, induced and cumulative effects, as well as operations and maintenance stage plans and measures. • Commissioning and oversight/review of consultant reports • Environmental Specialist will be overall responsible to provides direction, instructions and guidance to other experts under the E&S Cell working on this project

Organizations	Responsibilities
	• Responsibility to execute & implement ESMF, ESIA & ESMP etc. • To obtain mandatory statutory clearances. related to project • Consult with and advise individuals such as administrators, social workers, and legislators regarding social issues and policies. • Carry out site inspections, check and undertake periodic environmental monitoring and initiate necessary follow-up actions; • Document the good practices in the project on incorporation and integration of environmental issues into engineering design; • Facilitate and coordinate with the PMC • Assist in the preparation of periodic reports for dissemination to the PIU, and New Development Bank.
Contractor	• Submit and approve C-ESMP from PIU/RTDC LTD. • Responsible for implementation of mitigation and monitoring measures proposed in the ESMP • Each contractor will recruit an Environmental, Health, and Safety Manager, who will be responsible for implementing the contractors‟ environmental, health and safety responsibilities, and liaising with government agencies. The EHS manager will have adequate number of staff to support him/her for these tasks.

Management / Mitigation Measures

The Environmental and Social Risks due to such natural disasters can be managed/mitigated through an Emergency Response Plan (ERP) at terminal facility construction level, which shall further be in tandem with the Disaster Management and Relief Mechanism by the designated authorities/institutions at District/State level.

- In order to ensure the safety of work force at operational sites and safe evacuation of workforce in the event of natural disaster and/or any other natural calamities, the respective contractors of proposed construction shall have an Emergency Response Plan (ERP).
- As part of the ERP, the contractors shall establish and maintain regular coordination with the designated officers for Disaster Management at district/sub-division levels. Maintaining regular coordination will enable to seek quick response, in the event of natural disaster and/or any other natural calamity.
- Himanchal Pradesh State Disaster Management Authority is the constitutional authority looking after overall state for management of disasters. City Disaster Management Cell also established in Shimla Municipal Corporation. The project proponent/contractor has to work in close co-ordination with this cell.
- All project operations shall be planned and coordinated in tandem with the daily/weekly weather predictions/alerts issued by competent authorities as relevant for the district/ project location and all such alerts shall be duly considered and review the scheduled work programs on a daily basis.

- At project level, the respective contractors shall designate an Incident Controller (IC), Emergency Controller (EC), Assembly Coordinator (AC) and other required personnel for the emergency response mechanism in an event of natural disaster/ calamity in line with the ERP.
- The preparation and implementation of ERP shall form a part of ESMP of the respective contractors and checked and approved by the Supervision Consultant.
- All work force irrespective of levels are to be provided with training and periodic mock drills to ensure the preparedness for any emergency situations, always in short notice.
- The local community along project location shall also be engaged in mock drills for proactive participation in case of any natural hazards or disaster/ calamity.

9.7 CONTRACTOR'S ESMP

Management/ Mitigation measures

Prior to commencement of construction, the contractor will prepare and submit Contractor's ESMP (C-ESMP), which will include contractor's management plan to comply with the project's safeguard requirements and Management Strategies and Implementation Plans (MSIPs) for :

- Work Management;
- Traffic and work zone safety management plan for the prioritized encumbrance free stretches, in accordance with approved implementation schedule.
- Management Plan for to and fro of workers from labour camp to the site and site to labour camp will be prepared by the contractor and shall be approved by Supervision Consultant / RTDC LTD

In addition, the contractor will be contractually obligated to implement work zone safety arrangements which include provision of PPEs, fixed/ mobile barricades between work area and pedestrian/ traffic and required measures for ensuring community safety during construction activities. The requirements also include site specific traffic management plan for all types of works along with work zone safety check list.

The responsibility of contractor to manage these risks shall be clearly reflected in the contractual obligations of the Civil Works Contractor with appropriate mechanisms for addressing non-compliance. The bid documents for construction will incorporate requirements for Environment, Social, Health and Safety (ESHS) including list of applicable labour laws and community safety provisions for periodic reporting by contractors. Commencement of any activity by contractor without prior approval of these requirements will be treated as "fundamental breach of contract".

The C-ESMP will be approved by the PMC (Project Monitoring Consultant), prior to the commencement of construction activities, will be periodically reviewed by Supervision Consultant (but not later than every 3 months) and updated in a timely manner by the Contractor, to ensure that it contains appropriate measures for the work zone and community safety throughout construction phase.

Contractor's Code of Conduct

The contractor will carry out their work, including addressing risks of sexual exploitation and abuse, and sexual harassment as per this code of conduct. This Code of Conduct (CoC) applies to all staff, labourers, and other employees at the worksite or other places where the works are being carried out. It also applies to the personnel of each sub-contractor, suppliers and any other personnel assisting in the execution of the project. All such persons are referred to as "Contractor's Personnel" and or subject to this CoC. This code of conduct identifies the behaviour required from all contractor personnel.

The project work must be an environment where unsafe, offensive, abusive, or violent behaviour will not be tolerated and where all persons should feel comfortable raising issues or concerns without fear of retaliation.

The Contractor shall ensure that each Contractor's Personnel is provided a copy of this Code of Conduct, written in a language comprehensible to that person, and shall seek to obtain that person's a signature/fingerprint acknowledging receipt of the same. The Contractor shall also ensure that the Code of Conduct is visibly displayed in multiple locations on the site and any other place where the works will be carried out, as well as in areas outside the site accessible to the local community and project-affected people. The posted Code of Conduct shall be provided in languages comprehensible to Contractor's Personnel, Employer's Personnel and the local community and training will be conducted to ensure all the personnel including the laborers and staff do understand and abide by the contents of the Code.

9.8 CAPACITY BUILDING/ TRAINING AND ENVIRONMENTAL AWARENESS

Capacity building for effective implementation ESMP is highly essential. Capacity building on environmental and social safeguard is required for all levels of stakeholders, including RTDC LTD, E&S Cell of RTDC LTD, supervisor, and contractors.

At the construction site, supervisor will take the lead in capacity building plan. The contractors will also be responsible to conduct trainings for their own staff and workers. Table-9.16 provides a summary of various aspects of the environmental and social trainings to be conducted at the construction site. During the operation phase of the project, these trainings will continue to be conducted by RTDC LTD staff for all relevant personnel and community.

Table-9.16: Environmental and Social Trainings

Contents	Participants	Responsibility	Schedule
General environmental awareness; Environmental and social sensitivity of the project influence area; Key findings of the ESIA Mitigation measures; ESMP; Social and cultural values of the area.	Selected staff of RTDC LTD, supervisor, and contractors/ stakeholders	RTDC LTD and Contractor	Prior to the start of the project activities. (To be repeated as needed.)
General environmental and awareness; Environmental and social sensitivity of the project influence area; Mitigation measures; Community issues; Awareness of transmissible diseases; Social and cultural values.	PIU; supervisor; selected contractor's staff, /General public	RTDC LTD and Contractor	Prior to the start of the field activities. (To be repeated as needed.)
ESMP; Waste disposal;	Construction staff	Contractors	Prior to the start of The construction activities. (To be repeated as needed.)
Road/Ropeway Defensive driving, Waste disposal; Cultural values and social sensitivity,safety.	Drivers/Operators	Contractors	Before and during the field operations. (To be repeated as needed.)
Camp operation; Waste disposal; Natural resource conservation; Housekeeping.	Camp staff	Contractors	Before and during the field operations. (To be repeated as needed.)
Restoration requirements; Waste disposal.	Restoration teams	Contractors	Before the start of the restoration activities.
Conservation of important flora / fauna Cultural resources;	PIU; supervisor; selected contractor's staff	Contractors, Supervisor and E&S cell	Before the start of the restoration activities.

The capacity strengthening measures will cover the following staffing:

- PMU/PIU staff
- Project Monitoring Consultant (PMC)
- Grievance Redress Committees and nodal staff for GRM
- Contractor's staff

The training can be provided by the PMU and the Supervision Consultant's staff overseeing environmental, social, health and safety issues. If required, an external resource person can be

brought in for providing specific trainings to the staff. The contractor's Environmental, Social, Occupational, Health and Safety (ESOHS) officer will be responsible for capacity building and awareness raising of contractor's staffing and workers.

The key topics of capacity development and training are: E&S risk and impacts mitigations, contractor's code of conduct (CoC), GRM management; Occupational, Health and Safety (OHS) measures, labour risk management; World Bank and national requirements (laws and regulation, for instance labour laws); basic facilities for workers at worksite, labour influx and sexual exploitation and abuse (SEA) and sexual harassment (SH) risk prevention. Table-9.17 outlines the details of training participant, mode of training and social aspects to be covered.

Table-9.17: Details of training participant, mode of training and social aspects

S. No	Training Recipients	Mode of Training	Social Aspect to be covered	Training Conducting Agency	Training conducting Date
1	RTDC LTD Staff (PMU and Divisional level) and Supervision Consultant	Seminar Workshop Lecture	• Relevant Laws and Regulation/ standards and Acts • SMP and SMF/ RPF overview • EHS guidelines and pros and cons • Grievance redressal mechanism • Prevention of Sexual Exploitation and Abuse and Sexual Harassment (SEA/SH)	Env. and social specialists External resource person	Before and during the project implementation phase

9.9 PROVISIONS FOR IMPLEMENTATION OF ESMP FOR SHIMLA ROPEWAY

The provisions for implementing ESMP shall be Rs. 1193.11 lakhs . The details are given in Table-9.18. The cost estimate for provisions of SMP, Training and Awareness are given in Tables 9.19 and 9.20, The cost of environmental monitoring during the construction and operation period are given in Tables 9.21 and 9.22 respectively.

Table-9.18: Summary of cost estimate for implementing ESMP for Construction Phase

S. No.	*Item*	Cost (Rs. lakh)
1.	Avi Fauna Conservation Plan	24.11
2.	Landslide Control Measures	345.00
3.	Restoration of Quarries	50.00
6.	Control of Water Pollution (Construction Phase)	20.00
7.	Treatment of effluent for Workshop	30.00
8.	Control of Air Pollution	10.00
9.	Control of Noise Pollution	20.00
10.	Solid Waste Management	100.72
11.	Public Health Delivery System	353.95
12	Disaster Management Plan	50.00
13.	Training for SMP (Refer Table-9.23)	45.00
14.	Environmental awareness programme (Refer Table-9.24)	15.00
15.	Implementation of Environmental Monitoring Programme during construction stage (Refer Table-9.25)	129.33
	Total	**1193.11**

Table-9.19: Provisions for SMP

Item of SMP	Duration	Estimated costs (Rs. lakh)
Training for contractor staff on contractor's code of conduct, SEA/SH, labour management, grievance management, etc.	Actual, before and during the project implementation time	15.00
Social safeguards training including training of staff on GRM. GBV training (SEA, SH and HT)	Actual, before and during the project implementation time	20.00
Environmental, and Health and Safety Officer and Social Development Specialist hired by contractor, for on-site supervision	Actual, during the project implementation	20.00
	Total	**45.00**

Table-9.20: Cost estimate for training and environmental awareness

Training Items	Target group	Budget (Rs. lakh)
General environmental awareness; environmental and social sensitivity of the project influence area; Key findings of the ESIA; Mitigation measures; ESMP; Social and cultural values of the area.	Training for Selected staff of RTDC LTD, supervisor, and contractors,	4.0
Community issues; Awareness of transmissible diseases; Social and cultural values.	PIU; supervisor; selected staff and contractors	3.0
EMP; Waste disposal, Cultural values and social sensitivity.	Construction staff	1.0
Road and Ropeway safety	RTDC Staff, Contractors staff	2.0
Camp operation; Waste disposal; Natural resource conservation; Housekeeping.	Camp staff	1.5

Training Items	Target group	Budget (Rs. lakh)
Construction Implementation requirements; handling situations for important flora / fauna; Physical Cultural resources;	PIU; supervisor selected crew members and contractors	3.0
Management, Information and tracking system	RTDC Ltd.	0.5
	Total	**15.0**

Table-9.21: Cost for implementation of Environmental Monitoring Programme during Construction Phase

S. No.	Parameter	Cost (Rs. lakh)
1.	Avi - fauna Study	36.63
2.	Water Quality	14.28
3.	Soil	0.73
4.	Ambient air quality	76.19
5.	Purchase of Noise Meter	1.50
	Total	**129.33**

Table-9.22: Cost for implementing Environmental Monitoring Programme during operation phase

S.No	Parameter	Cost (Rs. lakh)/year
1.	Avi fauna Study	3.00
2.	Water Quality	1.32
3.	Soil	0.06
4.	Ambient air quality	4.16
	Total	**8.54**

CHAPTER-10
CONCLUSION

CHAPTER-10
CONCLUSION

Himachal Pradesh Government has constituted the Ropeways & Rapid transport System Development Corporation HP Ltd. (RTDC), with a long-term objective for development of Rapid transport system. The main aim is to provide suitable alternatives which would aid in controlling the spiking growth of vehicular traffic resulting congestion in populous cities of Himachal Pradesh.

As part of this vision, RTDC has decided to undertake development and operation/ maintenance of alternative mobility options for the cities of Shimla, Manali and Dharamshala.

The concept plan has been approved by the Government of Himachal Pradesh, and it recommended the development of ropeway system for a length to be implemented in 3 Phases as Ph-I (30.8 km), Ph-II (19.14 km) and Ph-III 33.16 km . RTDC Ltd. has currently planned to develop ropeway for a stretch of 14.69 km with 15 (fifteen) stations as a part of Phase 1 of Ropeway system.

WAPCOS Ltd. (A Government of India Enterprise) under the Ministry of Jal Shakti has been selected by the RTDC Ltd. as a consultant for the project for the preparation of DPR. The ESIA study is also part of DPR preparation. This ESIA Report has been prepared for this planned route of 13.82 km.

Detail Project Report has covered the 13.82 km part of Phase 1 network. It constitutes 15 (fifteen) stations and a total network has been divided in 7 routes. Most of the stations will be located on government land especially forest land, and private land acquisition is not envisaged. The total Project Cost for Shimla Phase 1 Ropeway Network is about Rs. 1546.4 crore.

The commissioning of any development project can lead to significant impacts on environmental resources of the project area and its surroundings. An aerial ropeway project too can result in wide range of impacts on the environment through construction and operation activities.

The preparation of ESIA report and implementation of ESMP is an essential tool for effectively managing these adverse effects. The objective of ESIA is to ascertain the baseline environmental conditions and then assess the impacts as a result of the proposed project during various phases of the project cycle.

The ESIA studies has been conducted, in accordance with the applicable World Bank/NDB requirements on environmental, social, health and safety management.

The stages involved in the ESIA study includes:

- Screening and Scoping
- Baseline Study
- Impact Prediction

- Environmental and Social Management Plan
- Environmental Monitoring Programme

The Study Area considered for ESIA includes area within 500 m radius from the project alignment, area to be acquired for various project appurtenances, area within ROW of 20 meter along the alignment, area within 10 km periphery of proposed alignment of ropeway and terminal stations for secondary data.

The baseline status with in the study areas has been collected through primary and secondary data sources for physico-chemical aspects, ecological aspects and socio economic aspects.

As a part of primary data collection field studies were conducted and primary data pertaining to water, soil, air, noise, terrestrial ecology and socio economic aspects have been collected.

A Stakeholder Consultation has been carried out in the project area through formal consultations, stakeholders meeting and Focus Group Discussions (FGDs) etc. For the stakeholder consultation a meeting was conducted in the month of March 2023. The different Government departments, NGOs etc. have participated in the meeting and expressed their views/concerns etc. regarding the proposed project.

The impacts have been assessed considering the project details and the baseline environmental and social status. Suitable mitigation measures have been suggested to mitigate the adverse impact to the extent possible. The environmental components like land, water, air, noise, biological and socio-economic environment have been considered for the assessment of impacts due to proposed project.

Based on the environmental and social risk and as per the categorization criteria of NDB, the proposed project comes under Category ‘B’ (moderate risks).

The positive and negative impacts due to the proposed projects are summarized as below:

Positive Impacts

- Provide Eco-friendly overhead transport solution for decongestion of existing roads
- Ease of travel for local inhabitants and as well as tourists thereby improving the ease of living.
- Considerably reduce the accidents and thus fatalities as this is the safest mode of transport after Air travel.
- Earn carbon credit, enhance tourism potential and generate employment opportunities thereby leading to overall socio-economic development of area.
- Improved connectivity between various places by providing direct aerial and congestion free connectivity.
- Reduce the traffic burden of the roads as an alternative mode of transportation.
- Work as a feeder for other modes of transportation system.
- Private land is not required hence, least rehabilitation & resettlement costs

Negative Impacts

- Pollution of air and noise quality during the construction phase
- Disposal of untreated effluents from labour colonies/camps and construction activities

may lead to pollution of nearby water resources.
- Traffic congestion, hindrance to movement of pedestrian during the construction activities.
- Loss of trees which needs to be cut for the proposed towers/stations.
- Loss of Biodiversity.
- Spillage of construction material near the construction and on the approach roads if, the vehicle carrying construction materials are not properly covered during transportation.
- Disposal of Municipal Solid Waste as well as Construction and Demolition Waste (C&D) near the labour camps, and construction sites.
- Social conflicts due to influx of labour from outside area.
- Temporary reduction in revenue of Government Road Transport Departments due to reduction in passengers. However, transport department needs to arrange the frequency and number of their fleets in co-ordination with Ropeway Authorities so that in long term the State transport department will also get more revenue due to increase in tourist passengers.

The Environmental and Social Management Plan (ESMP) has been prepared which includes mitigation measures and responsibilities for the mitigation activities. Environmental management and monitoring activities for the construction, and operation phases. The Environmental Monitoring Programme (EMoP) has been prepared to ensure that the intended environmental protection goals are achieved and results in desired benefits of the project. The ESMP also includes the tentative cost for implementation of ESMP and EMoP during construction and operation phases.

The proposed projects will have immense benefits like, employment opportunities, benefits to economy, reduction in traffic congestion, quick service and safety, traffic noise reduction, less fuel consumption and reduced air pollution etc.

The environmental and social mitigation measures needs to be implemented in construction and operation phases properly as suggested in the ESIA study. This will be helpful in minimizing the adverse impacts.

ANNEXURES

Ropeway Mobility for Urban Decongestion of Shimla
RTDC, Himachal Pradesh

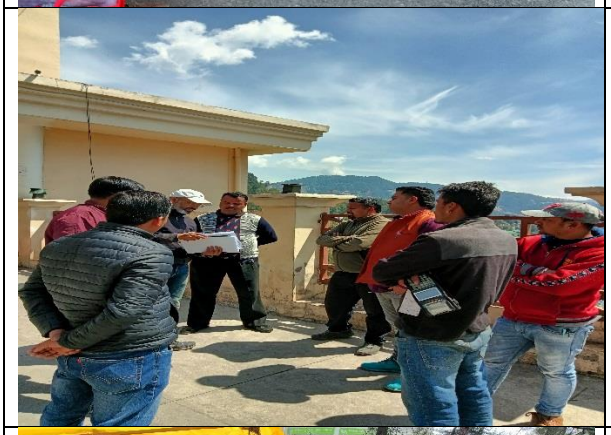
1	Location	
2	Date of FGDs	
3	Number of participants	
S No.	**Points Discussed**	
1.	Present system of public transport	
2.	Time of services	
3.	Daily Passengers Number	
4.	Main category of commuters (Workers, Traders, Students etc.)	
5.	Major routes / area where people travel from this place	
6.	Fares and time required for road transport	
7.	Public Demand in terms of □ Infrastructure Facilities □ Better service □ No of services and timing □ Safety conditions and precautions □ List other ,if any	
8.	General trend in peak hours and its impacts on public transport	
9.	Problems faced by passengers during tourist season	
10.	Major issues and any accidents reported and reasons thereof	
11.	Overall observations	
12.	Existing facilities and limitations	
	Project information	
12.	Are you aware of this transport project?	
13.	Impacts of the proposed project	
14.	What are your suggestions for this project?	

ANNEXURE-II

Glimpses of Focus Group Discussions (FGDs)









Coaching Academy
CHHOTA SHIMLA
9816-4-24100
BANK
PO
CLERK

ANNEXURE-III

Ropeways and Rapid Transport System
Development Corporation HP Limited
(A State Government Undertaking)
US Club, Shimla -1
Phone No. *0177-2811001, 2811003, 2811004*

RTDC
Ropeways and Rapid Transport System Development Corporation HP Ltd.

RTDC/Shimla Ropeway/2022 / 122-153 **Dated** 13 **/04/2023**

To,

1. The Director General of Police, Nigam Vihar, Chotta Shimla, Shimla, Himachal Pradesh 171002
2. The Principal Chief Conservator of Forest-cum-Hoff, Tolland Shimla Himachal Pradesh 171001.
3. Distt. and Sessions Judge, Shimla Division, Court Chakkar, Court Complex Chakkar, Shimla Himachal Pradesh.
4. The Deputy Commissioner, Shimla District, Shimla.
5. The Chief Fire officer, Fire Service Department Mall Road Shimla Himachal Pradesh 171001.
6. The Chief Executive Officer Himachal Waqf Board Lower Chakkar, Chakkar, Shimla, Himachal Pradesh 171004
7. The Managing Director, Shimla Smart City Ltd. 2nd Floor Community Center Building Lane-1 Sector-2 New Shimla Himachal Pradesh
8. The Managing Director, Himachal Pradesh State Electricity Board Ltd, Vidyut Bhawan Kumar House Shimla Himachal Pradesh 171004.
9. The Managing Director, Shimla Jal Prabandhan Nigam Ltd. US Club Shimla Himachal Pradesh.
10. The Director, Town & Country Planning Department Govt. of HP SDA Complex Kasumpti Shimla Himachal Pradesh 171009.
11. The Directorate of Energy, GoHP, Shanti Bhawan, Phase-3, Sector-6, New Shimla, Shimla-171009.
12. The Director, Tourism & Civil Aviation Department, Block no. 28 SDA Complex Kasumpti Shimla Himachal Pradesh.
13. The Director, Department of Environment Science and Technology, Paryavaran Bhawan near US club, Shimla Himachal Pradesh.
14. The Commissioner, Municipal Corporation Shimla, Old Judicial Complex, Near DC Office, The Mall Shimla, Himachal Pradesh – 171001
15. The Engineer- in Chief, Himachal Pradesh Public Works Department Nigam Vihar Shimla Himachal Pradesh 171001
16. The Engineer- in Chief, Jal Shakti Vibhag, Jal Shakti Bhawan, Shimla 171005.
17. The Member Secretary, HP Pollution Control Board, Him Parivesh Phase-3 New Shimla Himachal Pradesh.
18. The Divisional Forest officer, Cart Rd, Khalini Shimla Himachal Pradesh 171001.
19. The Senior Divisional Engineer III, Ambala Division, Northern Railway, Ambala, Haryana.
20. The Divisional Manager, Himachal Road Transport Corporation Shimla Himachal Pradesh 171004.

Ropeways and Rapid Transport System
Development Corporation HP Limited
(A State Government Undertaking)
US Club, Shimla -1
Phone No. *0177-2811001, 2811003, 2811004*

21. The Chief General Manager, BSNL, SDAComplex Kasumpti Shimla-171009 Himachal Pradesh.
22. Sh. Devender Singh Rawat Nav Chetna NGO Attri Niwas near R.K. Traders, Khalini, Shimla Himachal Pradesh.
23. The Principal, St. Bede's College, Navbhar Shimla 171002.
24. The Principal, IGMC, Shimla Ridge Sanjuli Rd. Lakkar Bazar, Shimla HP 171001
25. The Medical Superintendent, Kamla Nehru Hospital, Milsington Estate, Chotta Shimla, Shimla, Himachal Pradesh 171001.
26. The Superintending Engineer, CPWD, Shankli, Longwood, Shimla, Himachal Pradesh 171001
27. The Manager Punjab University Teachers Holiday Home / Guest House Shimla, Near hotel land mark, and Prakash Aara Machine, Shimla, Himachal Pradesh 171003
28. Taxi associations/Tour and Travels Operators Shimla, Holiday Himachal tour and travels, Uday niwas Lower Tutikandi Shimla Himachal Pradesh.
29. The President Hotel and Restaurant Association, Shimla Himachal Pradesh.
30. The Traders/Market associations Amrik Fruit Traders (AFT), Shop no. 62 MRF Building RMC Dhalli-2Shimla.
31. The Traders/Market associations Sharekhan Lakkar Bazar, Shandil building lower chaps lee estate, Lakkar bazar Shimla.
32. The President Home Stay Association Oakview Patarkar Vihar Kachighatti Shimla 171010.

Subject: Stakeholders Consultation Meeting for proposed Shimla Ropeway Network Phase-I.

Sir,

The State Government of Himachal Pradesh has constituted the Ropeways and Rapid Transport System Development Corporation Ltd. (RTDC), Himachal Pradesh, with a long-term view for development of Rapid transport system. The main objective of the project is to provide suitable alternatives which would aid in controlling the spiking growth of vehicular traffic resulting congestion in populous cities of Himachal Pradesh.

RTDC is currently engaged in preparation of DPR for the proposed Shimla Urban Ropeway project with proposed network tram constituting 15 of stations with a total length of 14.69 km. This project has been posed by DEA to the NDB for consideration of funding. This will start from Taradevi and will cover entire core Shimla; a map of the proposed network and proposed stations is enclosed as **Annexure** for your kind reference.

Ropeways and Rapid Transport System
Development Corporation HP Limited
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US Club, Shimla -1
Phone No. *0177-2811001, 2811003, 2811004*

M/s WAPCOS Limited, A Govt. of India enterprise under Ministry of Jal Shakti, has been approved by the RTDC, as a consultant for the project for the preparation of DPR, ESIA study etc. As a part of DPR/ESIA study a Stakeholder. Consultation has been planned by RTDC on 24/04/2023 at 11AM in Hotel Holiday Home Shimla in order to get the feedback from various Line Departments at the DPR stage. The project proponent i.e., RTDC and WAPCOS officials will brief about the proposed project and ongoing as well as planned activities during stakeholder consultation meeting.

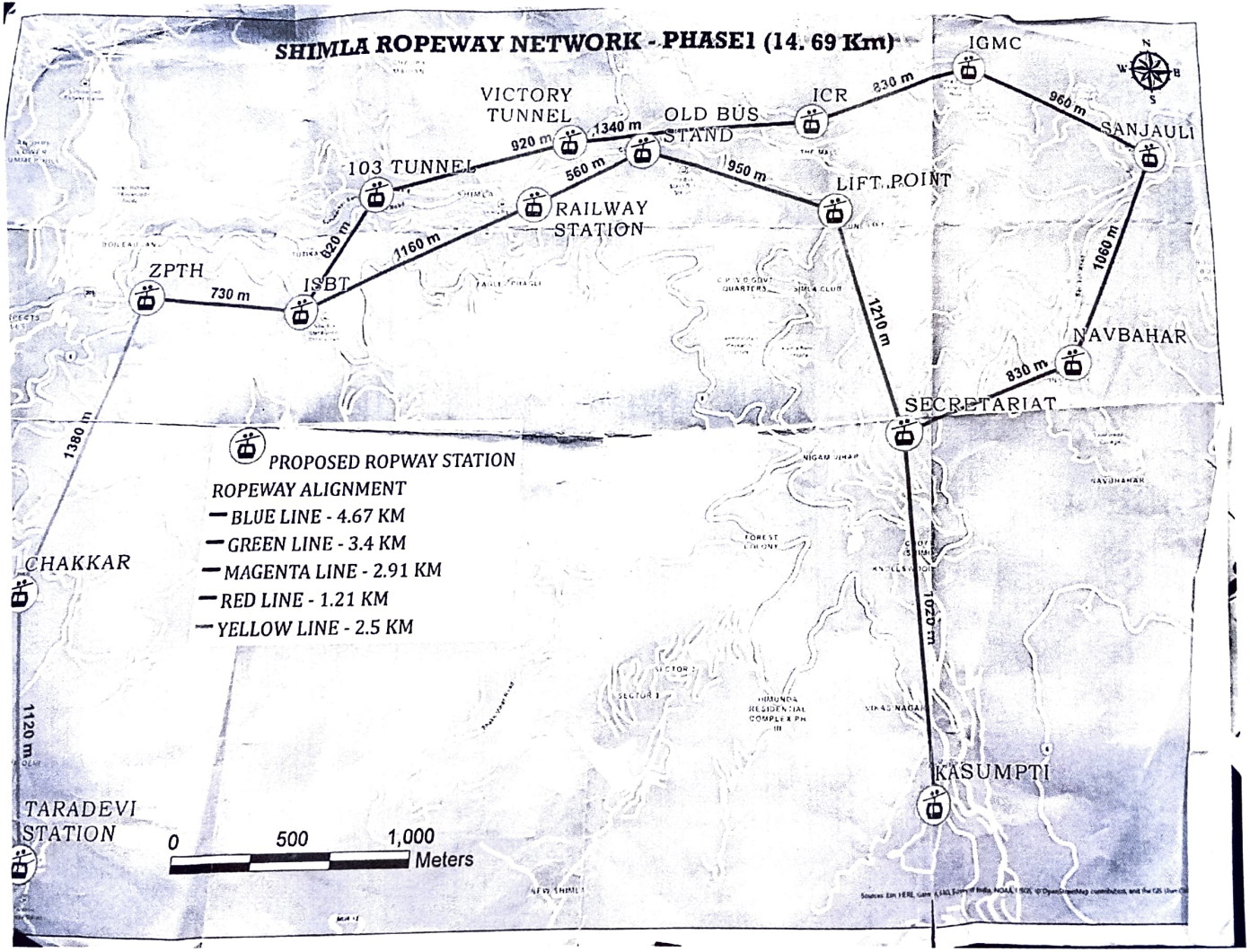
You are requested to kindly depute a Senior Officer from your department to attend the said stakeholder consultation on 24/04/2023 at 11AM in Hotel Holiday Home Shimla for discussions and give valuable inputs at the project formulation stage. The feedback from your department will be useful in preparing a project encompassing inputs and views from a broad range of stakeholder covering the major aspects of the project.

You are requested to send your queries/observations in advance on our email id: - cgmrtdchp@gmail.com

Yours faithfully,

19/4/23

Chief General Manager,
Ropeway & Rapid Transport System
Development Corporation, H.P. Ltd.
US, Club, Shimla-1.
Email: cgmrtdchp@gmail.com


SHIMLA ROPEWAY NETWORK - PHASE1 (14. 69 Km)
IGMC
ICR
830 m
960 m
SANJAULI
VICTORY TUNNEL
920 m
1340 m
OLD BUS STAND
103 TUNNEL
560 m
950 m
LIFT POINT
RAILWAY STATION
820 m
1160 m
ZPTH
730 m
ISBT
1060 m
NAVBAHAR
830 m
1210 m
SECRETARIAT
1380 m
PROPOSED ROPWAY STATION
ROPEWAY ALIGNMENT
BLUE LINE - 4.67 KM
GREEN LINE - 3.4 KM
MAGENTA LINE - 2.91 KM
RED LINE - 1.21 KM
YELLOW LINE - 2.5 KM
CHAKKAR
1020 m
1120 m
KASUMPTI
TARADEVI STATION
0
500
1,000
Meters

ANNEXURE-IV

Ropeway Mobility for Urban Decongestion of Shimla
RTDC, Himachal Pradesh

Stakeholder:

Name and Designation of the person answering:

Email & Contact No.:

Municipality/District:

Date:

Consent:

Do you provide consent to document, use, store and share the information provide for reporting and communication purposes?

Yes ( ) **No** ( )

QUESTION	RESPONSE	REMARKS
KNOWLEDGE		
Have you heard about this Project?		
Where and from whom did you first hear about this Project?		
In your opinion how can a person get involved and benefitted from this Project?		
What are the positive and negative impact of this Project?		

PARTICIPATION		
Community activities do you think are most effective for the better outcome of this Project?		
Strengths and capacities of different groups what has worked well in the past for other or similar projects.		
Queries/ questions regarding this project		
Is there any project/ activities going on or proposed from your organization/ Department in the proposed sites or in the vicinity of the project		
Past experience of similar kind of development projects and suggestions if any, for better outcome of the project		

Stakeholders Consultation Meeting, Shimla, Himachal Pradesh

Consultation Meeting No.	**Date**	**No. of Stakeholders Attended**
1	24.04.2023	17
Venue	Conference Hall, Hotel Holiday Home, Shimla	
Details of the Discussion		
Brief Introduction of the Discussion: Sri Rohit Thakur, Chief General Manager, Ropeway and Rapid Transport System Development Corporation (RTDC) inaugurated the meeting and greeted all the dignitaries and participants present. Subsequently Sri Munish Sahni, DGM, RTDC delivered the welcome address and explained about the background and importance of the Ropeway Mobility especially for the Urban Decongestion and also briefed about the objectives of the meeting to stakeholders. The meeting was started with brief introduction about RTDC, ESIA study and objectives of stakeholder's consultation meeting. On behalf of project proponent WAPCOS Limited, Consultant for the study lead the consultation meeting. Mr. P. P. Mitra and Dr Deepak Chandra made a detailed presentation on the works awarded to WAPCOS, activities performed till date by WAPCOS and importance of stakeholder's consultation meeting under this project. Mr. Rohit Thakur, CGM, RTDC presented vote of thanks to all stakeholders who spared time from their busy schedule to attend the meeting and shared their experiences for better outcome of the activities to WAPCOS for preparation of ESIA report as well as to project proponent for implementation of overall project.		
Name & Designation of the Stakeholder	**Issue raised during interaction**	**Response from Project Proponent**
Sri Harsh Vardhan Kathuria (IFS) APCCF, FCA, Himachal Pradesh Forest Department, Shimla	• Provision for parking facilities on ropeway stations also needs to be planned	The stations with parking facilities are planned as per availability of space.
Dr. Manam Sharma (Environment Officer), Department of Environment, Shimla	• Concern on compliances which are required before starting the project • All statutory compliances under water/ air act from H P pollution control board, Shimla • Disaster Management Plan from authority • Plantation as per state/ forest department • Appropriate air pollution control system (both	It was clarified that all statutory compliances/ consents will be obtained from the concern departments before the start of the work. The feasible mitigation measures will also be followed and monitored to control any kind of pollution during construction and operational stages of the project.

	during construction/ operational phase. • Necessary permission to install DG sets. • Baseline noise level data before construction of project • Appropriate water pollution control system • Energy conservation measures, use of solar energy • Adequate parking arrangements • Environment management plan • Self-environment audit by authority	
Mr. Subhash Chand Kaundal, Additional SE, Directorate of Energy	• Is this project totally based on computer based system • How much time will be taken to cover these three distances • Apart from this project is there any other project being planned by RTDC	The proposed project is based on latest technology with International standards.
Mr. Shivam Pratap Singh, ADC, Shimla	• Parking facilities • Safety of the commuters • Frequency of cable cars	Officials from RTDC clarified all the concerns and issues regarding the project will be adequately addressed.
Mr. Surjeet Kumar, Publicity Officer, Tourism Department	• Provision for parking facilities near boarding/ junction points may be considered during planning	Well planned station with parking facilities.
Er. Shubham Sharma, Shimla Jal Prabandan Nigam Ltd	• Raised and showed his concern for forest, wildlife and scenic beauty of Shimla. • Suggestion to take every care during planning and construction phase to avoid any harm to beauty of Shimla as tourists come to feel and enjoy the nature	It was assured by RTDC that it's a duty and concern of every citizen to save environment, the same is the motto of RTDC and every possible measures will be taken during planning and construction of the project.

Dr. Sita Thakur, Principal, IGMC, Shimla	• inquired about the timeline of the project and facilities for patients on wheel chairs • Facilities for patients travelling by proposed ropeway system	Feasibility study have been done for the project and works on DPR is going on. The suggestions will be considered during designing, planning and operational phase.
Mr. Narvir Singh Rathour, ASP (TTR), PHQ, Shimla	• Raised the issue on provision for parking and fare of proposed ropeway facilities to the locals	Parking facilities near the stations will be developed and are also considered in design. The fare of proposed ropeway facilities will be competitive and at par with the existing public transport system.
Ar. Inder Gulati and **Er. R. K. Rai** Panjab University	• The officials asked RTDC to share the detailed design plan as a proposed ropeway station near 103 tunnel is near to St. Burnard Building in Dingle Estate which is a property of Panjab University.	RTDC assured to share the details and take Panjab University in confidence for better planning and avoid any conflicts during construction.
Prof Sr. Molly and **Dr. Neeta Khanna** St. Bede's College	• Concessional passes and cards for students and senior citizens	Suggestions are noted and will be considered.
Mr. Diwakar Senior Section Engineer Shimla Northern Railway	• The proposed station near old bus stand (Parking area the land belongs to Railway department) • It was suggested that any development works on Railway land are sanctioned from Head Quarters of Northern railway.	Proper channel will be followed to acquire/ transfer the land for proposed ropeway project. The project details will be shared with respective departments before starting of any construction work.

Ropeway Mobility for Urban Decongestion of Shimla,
RTDC, Himachal Pradesh

Participants List

DATE: 24th April 2023 **PLACE:** Hotel Holiday Home, Shimla

S. No.	Name of the Participants	Designation / Occupation/ Department	Mobile No	Email ID	Signature
1.	Prof. Sr. Molly	Principal St. Bede's College.	9818645774	bedescollege@gmail.com	molly
2.	Dr Neeta Khanna	Associate Prof. St. Bede's College	9418090549	neetakhanna.9@gmail.com	Khanna
3.	NARVIR SINGH RATHOUR	Addl- SP TTR PHQ. Shimla	9418078578	rathournarvir6@mail.com	
4.	RK Rai	Executive Engineer Panjab University Chandigarh	9815612115	xeni@pu.ac.in	
5.	AR. INDER GULATI	ARCHITECT PANJAB UNIVERSITY CHANDIGARH.	7529837979	architectpu14@gmail.com	

ANNEXURE_VI

Ropeway Mobility for Urban Decongestion of Shimla, RTDC, Himachal Pradesh

Participants List

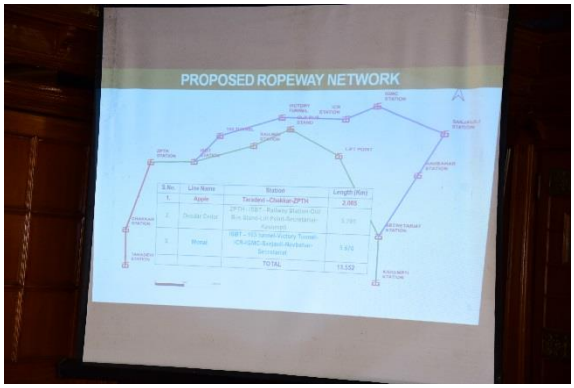
DATE: 24th April 2023 **PLACE:** Hotel Holiday Home, Shimla

S. No.	Name of the Participants	Designation / Occupation/ Department	Mobile No	Email ID	Signature
1.	Prof. Sr. Molly	Principal St. Bede's College.	9818645774	bedescollege@gmail.com	molly
2.	Dr Neeta Khanna	Associate Prof. St. Bede's College	9418090549	neetakhanna.9@gmail.com	Khanna
3.	NARVIR SINGH RATHOUR	Addl- SP TTR PHQ. Shimla	9418078578	rathournarvir6@gmail.com	
4.	R K Rai	Executive Engineer Panjab University Chandigarh	9815612115	xeni@pu.ac.in	
5.	AR. INDER GULATI	ARCHITECT PANJAB UNIVERSITY CHANDIGARH.	7529837979	architectpu14@gmail.com	

S. No.	Name of the Participants	Designation / Occupation/ Department	Mobile No	Email ID	Signature
6.	Surjeet Kumar	Publicity Officer Tourism Deptt. H.P. Shimla-9.	94181 05752	tourismmin-hp@nic.in	24/4/23
7	Dr. Manum Sharma	Deptt. of Env. S&T Shimla, Himachal Pradesh	8.910 1107	emeofficer.dest@gmail.com	
8.	HARSH VARDHAN KATHURIA IFS	NODAL OFFICER cum APCCF FCA H.P. FOREST DEPTT	9418450010	Harshoney@gmail.com	
9.	Gopesh Behl	AE, MC Shimla	7018074689	behlgopeshmcs@gmail.com	
10.	Subhash chand	ASE, Directorate of Energy	9816889857	Subhash.kaundal66@gmail.com	
11	Shriram Pratap Singh	ADC Shimla	9149197887	shriram.pratap444@gmail.com	
12	Bansher Thakur	Dy. Ranger Shimla (U)	7018913677	Rallanifalsara@gmail.com	

S. No.	Name of the Participants	Designation / Occupation Department	Mobile No	Email ID	Signature
13.	Mangaram.	Fire Service.	9418392631	rammangse2@gov.in.	
14.	Diwakar	Senior Section Engineer Shimla Northern Railway	9805039232	ssewsml@gmail.com	Diwakar
15.	Shubham Sharma	J.E. SJPNL	7018 228585	jesjpnl jecentralzone.sjpnl@gmail.com	24/4/25
16	ISHA	AD, Urne	—		
17	Dr Sitalhakim	Principal cum Dms Ilrmc	9418091572	Sitalhakim 09@gmail.com	

ANNEXURE-VII










ANNEXURE-VIII

DRINKING WATER QUALITY STANDARD

Drinking water quality standards

Characteristics	***Acceptable**	****Cause for Rejection**
Turbidity (units on JTU scale)	2.5	10
Colour (Units on platinum cobalt scale)	5.0	25
Taste and Odour	Unobjectionable	Unobjectionable
PH	7.0 to 8.5	<6.5 or >9.2
Total Dissolved Solids (mg/l)	500	1500
Total hardness (mg/l) (as $CaCO_3$)	200	600
Chlorides as CD (mg/l)	200	1000
Sulphates (as SO_4)	200	400
Fluorides (as F) (mg/l)	1.0	1.5
Nitrates (as NO_3) (mg/l)	45	45
Calcium (as Ca) (mg/l)	75	200
Magnesium (as Mg) (mg/l) If there are 250 mg/l of sulphates, Mg content can be increased to a maximum of 125 mg/l with the reduction of sulphates at the rate of 1 unit per every 2.5 units of sulphates	30	150
Iron (as Fe) (mg/l)	0.1	1.0
Manganese (as Mn) (mg/l)	0.05	0.5
Copper (as Cu) (mg/l)	0.05	1.5
Zinc (as Zn) (mg/l)	5.0	15.0
Phenolic compounds (as phenol) (mg/l)	0.001	0.002
Anionic detergents (as MBAS) (mg/l)	0.2	1.0
Mineral Oil (mg/l)	0.01	0.3
Toxic materials		
Arsenic (as As) (mg/l)	0.05	0.05
Cadmium (as Cd) (mg/l)	0.01	0.01
Chromium (as hexaalent Cr) (mg/l)	0.05	0.05
Cyanides (as CN) (mg/l)	0.05	0.05
Lead (as Pb) (mg/l)	0.1	0.1
Selenium (as Se) (mg/l)	0.01	0.01
Mercury (total as Hg) (mg/l)	0.001	0.001
Polynuclear aromatic hydrocarbons (PAH)	0.2 μg/l	0.2 μg/l

Notes:-

*1.The figures indicated under the column `Acceptable' are the limits upto which water is generally acceptable to the consumers

**2. Figures in excess of those mentioned under `Acceptable render the water not acceptable, but still may be tolerated in the absence of alternative and better source but upto the limits indicated under column "Cause for Rejection" above which are supply will have to be rejected.

ANNEXURES-IX

NATIONAL AMBIENT AIR QUALITY MONITORING STANDARDS

National Ambient Air Quality Monitoring Standards

Parameter	**Industrial, Residential, Rural & other areas**	**Ecologically Sensitive Area Central Government**
Particulate Matter PM 2.5 (µg/m3)	60	60
Particulate Matter PM 10 (µg/m3)	100	100
Sulphur Dioxide (as SO2) (µg/m3)	80	80
Oxides of Nitrogen (as NO2) (µg/m3)	80	80
Carbon Monoxide (as CO), (mg/m3)	02	02
Ozone (as O3) (µg/m3)	100	100
Lead (as Pb) (µg/m3)	1.0	1.0
Ammonia (as NH3) (µg/m3)	400	400
Benzene (as C6H6) (µg/m3)	05	05
Benzo (O) Pyrene (as BaP) (ng/m3)	01	01
Arsenic (as As) (ng/m3)	06	06
Nickel (as Ni) (ng/m3)	20	20

ANNEXURE-X

AMBIENT NOISE STANDARDS

Ambient Noise Standards

Area Code	Category of Area	Limits in dB(A)Leq	
		Day time	Night time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

Note : 1. Day time 6 A.M. and 9 P.M.

2. Night time is 9 P.M. and 6 A.M.

3. Silence zone is defined as areas upto 100 meters around such premises as hospitals, educational institutions and courts. The silence zones are to be declared by competent authority. Use of vehicular horns, loudspeakers and bursting of crackers shall be banned in these zones.

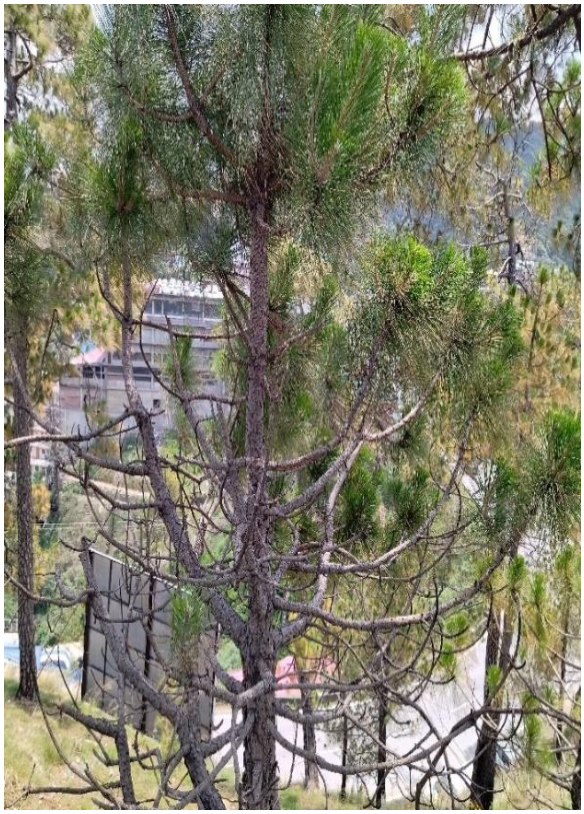
4. Environment (Protection) Third Amendment Rules, 2000 Gazette notification, Government of India, date 14.2.2000.

ANNEXURE-XI

Floral Diversity in the Study Areas

Artemisia annua

Fagopyrum acutatum



Pinus roxburghii

vicia pannonica

Spartium junceum

Verbascum thapsus

Sonchus arvensis

Rumex nepalensis

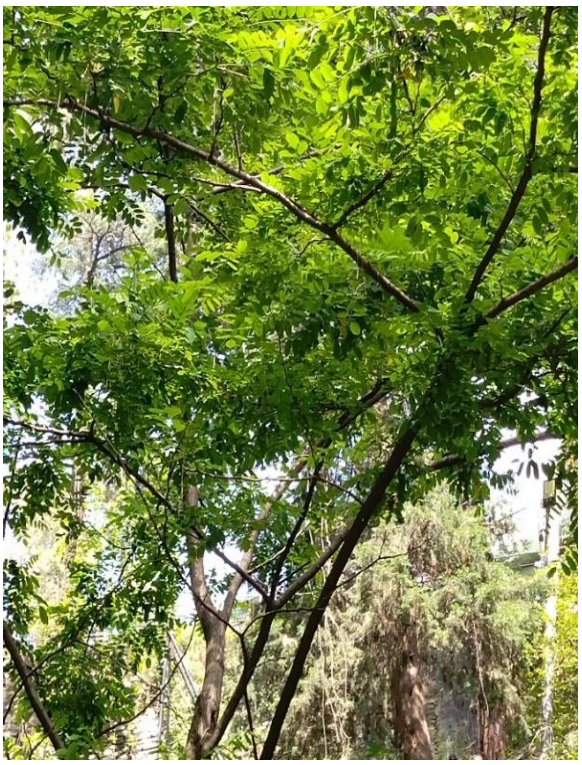
Rumex hastatus

Cupressus torulosa

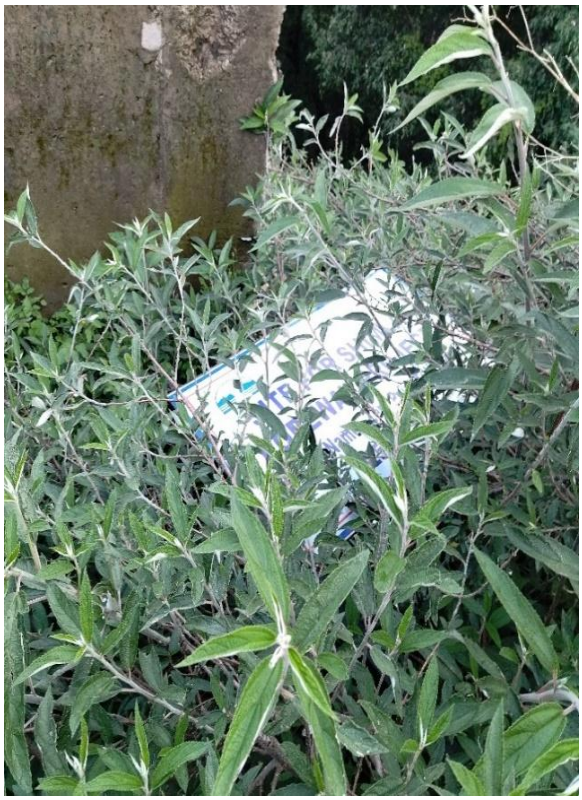
Aesculus indica

Hedera helix

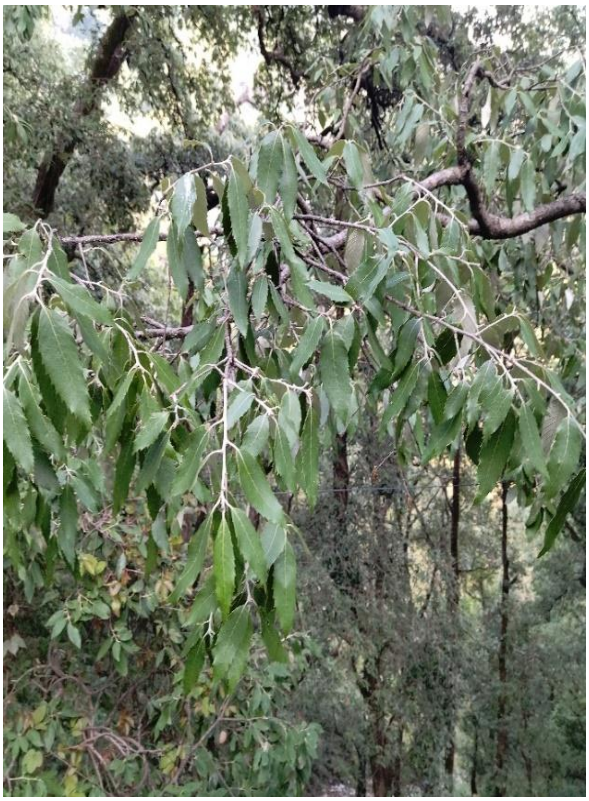
Girardinia diversifolia



Robinia pseudoacacia



Debregeasia saeneb



Quercus oblongata

Rubus ellipticus

Oxalis latifolia

Ageratina adenophora

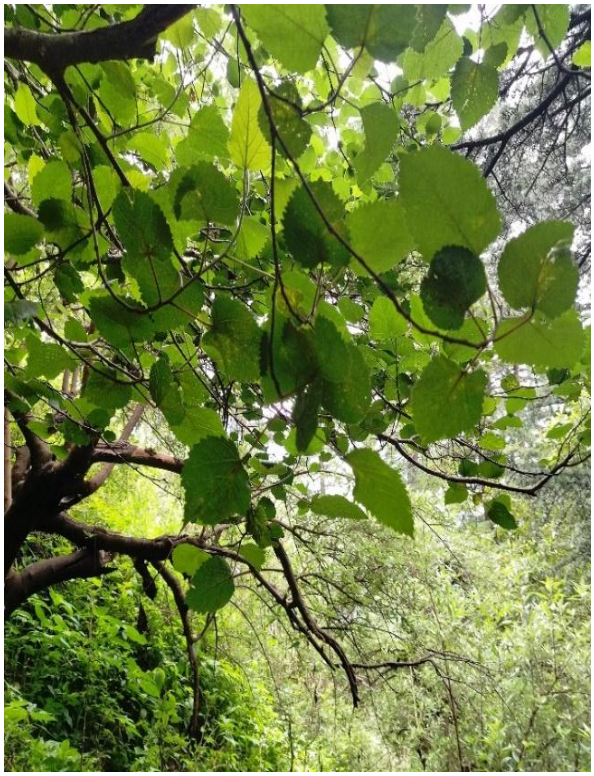
Urtica dioica

Chenopodium album

Fragaria nubicola

Fern species

Solanum americanum



Morus species

Spilanthes acmella

Trachycarpus fortune

Cedrus deodara

Floral diversity in the study area

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Email: environment@wapcos.co.in