Department of Tourism and Civil Aviation (Government of Sikkim)

EIA Study for Passenger Ropeway between Dhapper and Bhaleydhunga in South Sikkim district of Sikkim

DRAFT REPORT

DECEMBER 2014

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NOMENCLATURE

AAQM	Ambient Air Quality Monitoring
BIS	Bureau of Indian Standards
BOD	Biochemical Oxygen Demand
DOT & CA	Department of Tourism and Civil Aviation
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CTE	Consent to Establish
dB	Decibel
DC	Direct Current
DG	Diesel Generator
DPR	Detailed Project Report
EAC	Expert Appraisal Committee
EC	Environmental Clearance
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPA	Environmental Protection Act
GIS	Geological Information System
GOI	Government of India
GSHAP	Global Seismic Hazard Assessment Program
HC	Hydro Carbons
HIRA	Hazard Identification and Risk Assessment
IRS	Indian Remote Sensing
IS	Indian Standard
ITP	Intermediate Terminal Point
KLD	Kilo Litre per Day
LTP	Lower Terminal Point
MoEF	Ministry of Environment and Forest
NEP	National Environment Policy
NO	Nitrogen Oxide
NOC	No Objection Certificate
O&M	Operation and Maintenance
PHE	Public Health Engineering
PM	Particulate Matter
PPH	Passenger Per Hour
ROU	Right of Use
ROW	Right of Way
SO_2	Sulphur Dioxide
SPCB	State Pollution Control Board
SWM	Solid Waste Management
TOR	Terms of Reference
UTP	Upper Terminal Point

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND

Sikkim is located in the Himalayan range of mountains, therefore it is an ancient belief and practice of the sikkimese to worship mountain for the safety and prosperity of the land occupants. In this region, people worship the apparently highest peak Bhaleydunga. Devotees from all the surrounding areas comprising of eleven blocks regularly go to the hilltop for worships and to visit millennium old Maenam Monastery. Other than this mobility, Trekkers and tourists from all parts of India and abroad also visit Bhaleydunga and Maenam peak through the popular trekker's route from Ravangla bazzar which is 13 kms in length. Therefore, it has been envisaged that Bhaleydunga peak has an importance to the local people from mythological point of view as well as an attraction to the trekkers for its natural beauty and landscape.

Since the Tourism industry holds a major share in the economy of Sikkim, department of Tourism, Govt. of Sikkim has given due importance to the tourism potentiality and weight age to the mythological believes of the local people and eco tourism, thus decided to provide certain infrastructure like Skywalk at Bhaleydunga and to connect the hilltop from its south-east part of the foothill, namely Dhapar so that socio-economic development spreads widely in the region. Ropeway system has been chosen as a most suitable and environment friendly mode of transport system in hilly region.

RITES Ltd. (A Government of India Enterprise) was appointed by Department of Tourism and Civil Aviation (DoT&CA), Government of Sikkim, as consultant, for the preparation of Detailed Project Report (DPR) and Environmental Impact Assessment (EIA) study for proposed Ropeway systems. An EIA study has been taken up as per the approved Terms of Reference (TOR) issued by Expert Appraisal Committee (EAC) of Ministry of Environment and Forest (MoEF) for Environmental Clearance of the project. The ToR issued by MoEF for the study is presented in **Annexure 1.1**.

1.2 CONCEPTUALIZATION OF THE PROJECT

In view of socio-economic development of Ravangla sub division of south district of Sikkim, department of Tourism, govt. of Sikkim has conceptualized certain development of infrastructure at Yangang, Dhapar as well as at Bhaleydunga hilltop at an altitude of 10500 ft. It has been outlined that the proposed development programme will ensure accessibility to the remote areas so that benefits of socio development programme could reach to the maximum numbers of common people of the state. The development programme will also ensure tourism attraction events so that a self sustained economical growth among the local people could be developed out of tourism.

1.3 OBJECTIVES OF THE STUDY AND TERMS OF REFERENCE

The objective of the study is to facilitate the DoT&CA to obtain prior environmental clearance from the Ministry of Environment and Forest (MoEF), Government of India for the proposed ropeway systems. In addition it also proposes to establish environmental baseline and safeguard measures for protection of environment for sustainable development during project cycles. The MoEF, Government of India, notification of 14th September 2006 and its amendment dated 1st December 2009 enlist Ropeway projects is category 'A' as per above notification schedule if located in ecological sensitive area. All projects or activities included as category 'A' in the schedule shall require prior environmental clearance from the Central Government in the MoEF on the recommendations of an Expert Appraisal Committee (EAC).

In order to follow the procedure of project appraisal the DoT&CA applied for the Terms of Reference for EIA study in MoEF in prescribed formats. The DoT&CA and RITES, the consultant made a presentation on the project before 127th EAC meeting at New Delhi. MoEF issued the Terms of Reference (ToR) for Ropeway project at Bhalaydhunga vide file no 10-51/2013-IA.III dated 14th November 2013.The ToR for EIA for the project is placed at **Annexure 1.1**.

1.4 LEGAL POLICY

The need for a well-developed legal mechanism to conserve resources, protect the environment and ensures the health and well being of the people in India was felt. Keeping the pace with international laws, the Ministry of Environment and Forest enacted Environmental Protection Act in 1986. Over the years, the Government of India has framed several policies and promulgated number of Acts, Rules and Notifications aimed at management and protection of the environment. During last three decades an extensive network of environmental legislation has grown and presently it has a fairly complex body of environmental legislation aimed at ensuring that the development process meets the overall objective of promoting sustainability in the long run. The available legal Acts and Legislation referred during the study are:

- The Water (Prevention and Control of Pollution) Act, 1974 (Amendment 1988).
- The Water (Prevention and Control of Pollution) Cess Act 1977, (Amendment), 2003.
- The Water (Prevention and Control of Pollution) Cess Rules, 1978, 1991.
- The Air (Prevention and Control of Pollution) Act 1981, amended 1987.
- Noise Pollution (Regulation and Control) Rules, 2000 amendment 2002, 2006.
- The Environment (Protection) Act, 1986, amended 1991.
- The Environment (Protection) Rules,1986.
- The Indian Forest Act, 1927.
- Forest (Conservation) Act, 1980, amended 1988.
- Forest (Conservation) Rules, 2003.
- The Wild Life (Protection) Act 1972, Amendment, 2002
- Municipal Solid Waste Rules, 2000
- EIA Notification 2006, Amendment,2009
- The Ancient Monuments and Archaeological sites and Remains (Amendment and Validation Act), 2010
- National Rehabilitation and Resettlement Policy, 2013
- EIA Guidance Manual for Aerial Ropeway

1.4.1 Environmental Clearance of Development Projects

The process for setting up of a development projects in India is through the Environmental Clearance (EC) Process. The EC process is mandated by the EIA notification 14th September 2006 (Amended in December 2009). The ropeway projects located in ecological sensitive area falls in category ‘A’. The proposed Ropeway project at is under Category ‘A’ as project is located within Maenam Wildlife Sanctuary, hence needs clearance from MoEF.

The project proponent has entrusted to prepare the Environmental Impact Assessment Report through RITES Ltd as per ToR issued by MoEF. In order to follow environmental appraisal procedures, the copy of draft EIA report requires to be submitted to Member Secretary of SPCB, Sikkim to conduct the public hearing. The final report of EIA shall be submitted along with a Feasibility/Detailed Project Report to the Expert Appraisal Committee (EAC) of the Ministry of Environment Forests (MoEF), New Delhi to get the environmental clearance.

1.4.2 Water and Water Pollution

The use of water resources and also the discharge of polluted water (sewerage) are primarily regulated by the Water (Prevention and Control of Pollution) Act, 1974 amended in 1988. The Water Cess Act, 1977 amended in 1992 and 2003, including Rules 1978 and 1991 provides for levy and collection of Cess on water consumed with a view to generate resources for prevention and control of water pollution. The Act assigns functions and powers to the Central Pollution Control Board (CPCB) and SPCBs for prevention and control of water pollution.

The Environment (Protection) Act 1986 amended in 1991 and Rules also lays down specific standards for quality of water effluents to be discharged into different type of water bodies (sewers, surface water bodies like lakes, rivers, marine discharge etc). Additionally, the water supplied to users for drinking shall also conform to the National Drinking Water Standard, IS-10500. **Annexure 1.2** summarizes the general standards for discharge of effluent in Inland Surface Water Bodies. To ascertain and categorize the existing water quality, the results of the analysis of water quality need to be compared with the water quality standards given in **Annexure 1.3.**

Off late, with rapid depletion of groundwater resources in several areas of the country, efforts have been initiated to regulate the use of groundwater resources. The focus of such acts and rules is to provide for mechanisms that would lead to replenishment of groundwater reserves through techniques like rain water harvesting. The Central Ground Water Board, the statutory authority set up by the Central government has also restricted the drilling of tube wells and bore wells in certain water scarce areas in the country.

1.4.3 Air Quality

The Air (Prevention and Control of Pollution) Act, 1981 and amended in 1987 including Rules 1982 and 1983 was enacted to prevent, control and reduce air pollution. According to Section 21 of the Act, no person shall establish or operate any activity, which can cause air pollution without obtaining Consent to Establish (CTE) as per the Air Act. The Act also lays down national ambient air quality standards for pollutants like PM_{10}, $PM_{2.5}$,Sulphur dioxide, Oxides of Nitrogen, Carbon monoxide, Lead, Ozone, Ammonia, Benzene and Benzo pyrene with the intent of managing air quality for different categories of areas (residential, industrial and sensitive).

Ambient Air Quality Standards have been notified by the CPCB vide Gazette Notification dated 16th November 2009, refer **Annexure 1.4.**

1.4.4 Noise Quality

With the objective of regulating ambient noise quality in the environment, the Central Government has notified the Noise Pollution (Regulation and Control) Rules, 2000 amended in 2002 and 2006 under the EPA. The noise standards for different category of areas are based on the weighted equivalent noise level (Leq). The EPR also lays down equipment noise standards for DG sets, Air conditioners and Construction Equipment, which would be in use for the project. Ambient Noise level standards have been notified by the MoEF vide Gazette Notification dated 4 February, 2000. It is based on the 'A' weighted equivalent noise level (L_{eq}). These are presented in **Annexure 1.5.**

1.4.5 Solid Waste Management

Project construction and operation generates solid waste at site. The DoT & CA would be responsible for collection and handling of solid waste as per the provisions of the Municipal Solid Waste Rules, 2000. The Hazardous Waste (Management and Handling) Rules, 2000

require facilities to classify wastes into categories, manage them as per the prescribed guidelines and obtain prior authorization from the SPCB for handling, treatment, storage and disposal of Hazardous Wastes.

1.5 INSTITUTIONAL FRAMEWORK

Ministry of Environment and Forests is the nodal agency in the administrative structure of the central government for planning, promotions, co-ordination and overseeing the implementation of India's environmental and forestry policies and programs. The major responsibilities of MoEF include:

- Environmental resource conservation and protection, including environmental impact assessment of developmental projects;
- Co-ordination with the other ministries and agencies, voluntary organizations and professional bodies on environmental action plans;
- Promotion of research and development, manpower planning and training and creation of environmental awareness;
- Liaison and coordination with international agencies involved in environmental matters.

Developmental project proponents are also required to submit Environmental Impact Statements/Assessments to establish that adequate measures are planned for pollution control and environmental protection, and that effluent discharged into the environment will not exceed permissible levels. The project developer appraises these statements/ assessments to EAC for approval of the project from the environmental angles.

1.5.1 Central and State Pollution Control Boards

The Central Pollution Control Board is responsible for pollution control throughout the country. In addition to the control of air, noise and water pollution they are also responsible for to ensure effective control on disposal of hazardous wastes and storage and handling of hazardous chemicals and substances. With the enactment of air and water pollution laws, states have set-up their own Pollution Control Boards (SPCBs) to monitor industrial emissions and effluents and to approve the operation of new industries after careful scrutiny. The functions of the SPCBs include:

- The planning of comprehensive state programs for the prevention and control of air and water pollution and to ensure the implementation thereof;
- Inspection of pollution control equipment/ plants for monitoring of their efficiency

The SPCB in consultation with the Central Pollution Control Board may establish norms for air quality, gaseous emission and noise etc.

1.6 APPROACH AND METHODOLOGY

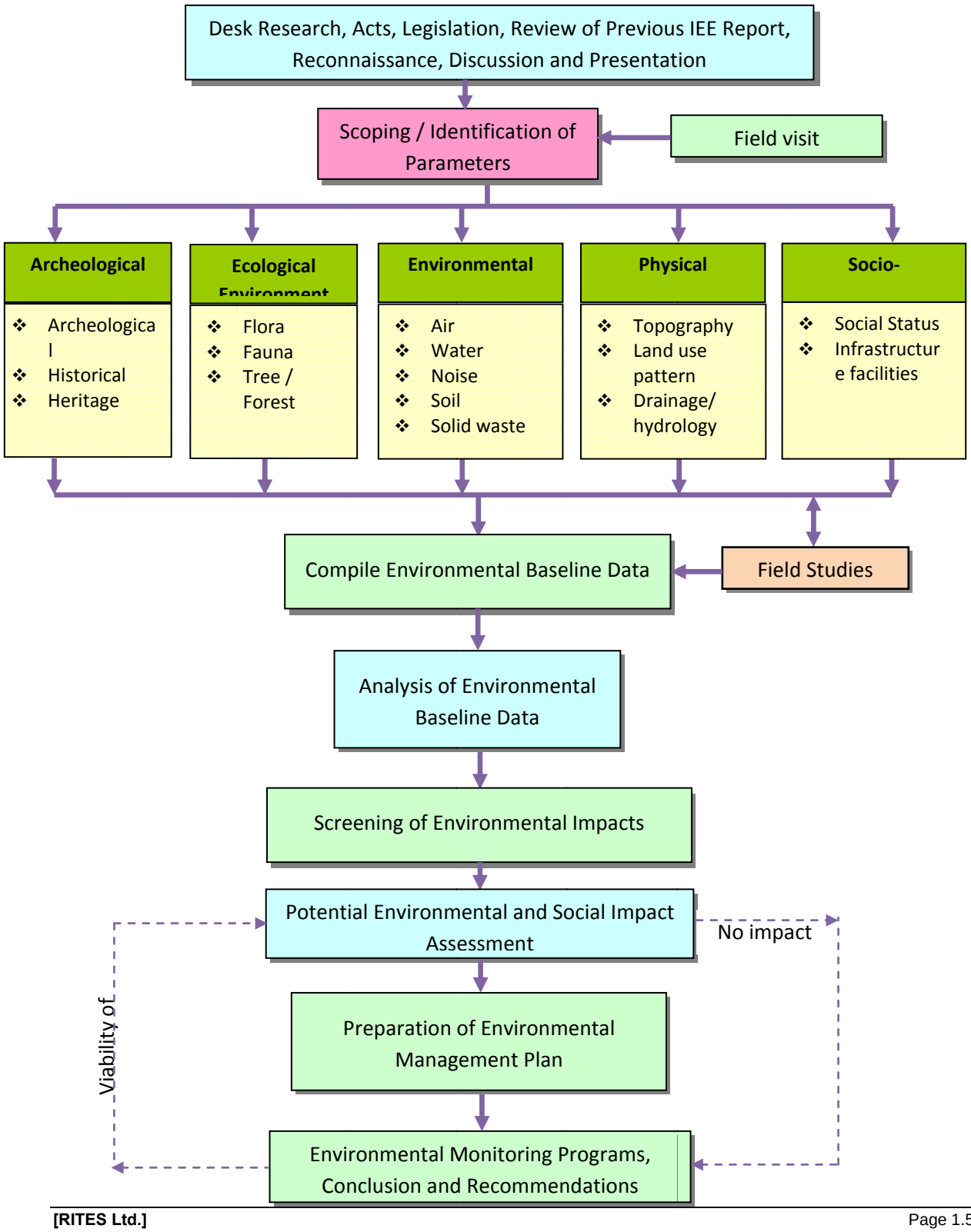
The Environmental Impact Assessment study is carried out following the sequence of steps for EIA study. The basic concept is to ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the project. The changes likely to occur in different components of the environment viz. physical, biological/ecological, environmental and socio-economic etc. have been studied, analyzed and quantified, wherever possible. The identification of parameters for data generation and impact assessment are important. The accurate analysis of assessment depends upon the reliable data generated/ available on environmental attributes. RITES has documented the baseline data for various parameters of physical (physiographic and soils), ecological (forestry, and wildlife), and ambient environment (air, water, noise, and solid waste). The impacts are assessed for various phases of project cycle namely:

- Impacts due to project location,

- Impacts due to project construction, and
- Impacts due to project operation.

The impacts are categorized as negative, positive or no impacts. The cost of management and monitoring programs are estimated on the basis of mitigation measures suggested for negative impacts and environmental monitoring programme during project construction and operation. The approach and methodology adopted for the study is presented in **Figure-1.1.**

FIGURE 1.1
METHODOLOGY FOR THE EIA STUDY



RITES has carried out Detailed Project Report (DPR) as well as the EIA study for the project. Hence, RITES Ltd. has integrated environmental concepts in the project preparation process in a better way. Such integration is advantageous both for DPR and EIA. To prepare this report, literature review, consultation with various departments, ground truth and sampling missions are undertaken and laboratory analysis were carried out.

The standard methodology for the data collection, impact assessment and formulation of management plans is adopted. The approved Terms of Reference are kept in mind during the study. The consultant collected and compiled the environmental baseline data for environmental attributes from primary and secondary sources. The primary sources include site visits, visual inspection, field studies, monitoring and analysis. The secondary sources include the books, reports, maps and documents from various government and non-government organizations where applicable, more detailed information on methods used is included in the concerned paragraph in the main body of the report.

1.6.1 Data Collection

The existing land-use pattern of the area has been identified mainly as settlements, roads and water body etc. The Soils parameters are studied from the field surveys and secondary data. Water Resources in the project area are considered in terms of precipitation, quantity and quality of water. Air and Noise quality is an important consideration during construction and operation phases. Ambient air quality and noise levels are monitored around project area to develop present baseline levels. Terrestrial Ecology is studied documenting the vegetation types through the visual inspection, past research and filed investigations.

1.6.2 Environmental Impact Assessment

The objective of the study is to assess the impacts as a result of construction and operation of the proposed ropeway project. The changes likely to occur in different components of the environment are studied and analyzed. The core area of study is 10 km from project site. Based on project particulars and the existing environmental conditions, potential impacts are identified that are expected to be occurring as a result of the proposed project and wherever possible, these impacts are quantified. Both positive and negative impacts are evaluated to have an idea about resultant impacts. These impacts are assessed for various phases of project cycle namely, location, construction and operation.

The standard methodology is adopted for impact prediction and assessment. Prediction is essentially a process to forecast the future environmental conditions in the project area that might be expected to occur. The predictions of impacts are made through mathematical modeling, overlays/ super imposition of activity, or comparison of impacts observed. The environmental impacts of the project include changes in land use, soil, erosion, water quality, air quality and noise levels etc. The impact on soils due to disposal of waste water and erosion during storms are predicted. The impact on water quality in the ground water is evaluated with the help of water quality analysis.

1.6.3 Environmental Management Plan

The management plans are essential to ensure that stress/ loads on the systems are within carrying capacity. The management plan aims at maintaining the environmental quality of project area at-least in pre-project stage. Environmental management strategy/ plans are developed to mitigate the adverse impacts. Efforts are made to enhance the quality of environmental attributes.

1.6.4 Environmental Monitoring

It is necessary to monitor environmental attributes during various phases of project cycles. Monitoring would indicate any environmental problem, which come up due to ongoing activities. This will facilitate to assess the effectiveness of management / mitigation measures. The consultant has also designed a post project environmental monitoring program for implementation. The cost estimates for environmental monitoring and management have been included in the project estimates.

1.7 FORMAT OF THE EIA REPORT

Chapter 1 provides a general introduction along with the objectives and Terms of Reference and an outline on the approach and methodology adopted for the EIA study. The legal/ policy frameworks along with environmental standards are also summarized in this chapter. In **Chapter-2,** a concise documentation is given on the proposed project activities and facilities including site selection, project features and cost estimates. Analysis of various alternatives for proposed ropeway has been discussed in **Chapter-3. Chapter-4** summarizes environmental baseline data on physical and ecological parameters as collected prior to the commencement of the project. **Chapter-5** highlights anticipated potential positive and adverse environmental impacts with mitigation measures of the project**.** Environmental Management Plan has been outlined in **Chapter-6**. Risk Assessment and Disaster Management Plan have been summarizes in **Chapter 7** and **Chapter 8** respectively. Environmental monitoring programme and cost are elucidated in **Chapter-9**. Summary and Conclusion of the EIA study conducted has been presented in **Chapter 10**.

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Annexure 1.1

TERMS OF REFERENCE

तार :
Telegram : PARYAVARAN,
NEW DELHI
दूरभाष :
Telephone : 2436 8526
टेलेक्स :
Telex : W-66185 DOE IN
FAX : 4360678
भारत सरकार
पर्यावरण एवं वन मंत्रालय
GOVERNMENT OF INDIA
MINISTRY OF ENVIRONMENT & FORESTS
पर्यावरण भवन, सी. जी. ओ. कॉम्प्लेक्स
PARYAVARAN BHAVAN, C.G.O. COMPLEX
लोदी रोड, नई दिल्ली-110003
LODHI ROAD, NEW DELHI-110003

Dated: 14th November, 2013

F.No.10-51/2013-IA.III

To
The Secretary,
M/s Tourism & Civil Aviation Dept.,
Govt. of Sikkim, M.G. Road,
Gangtok – 737 101, Sikkim

Subject: Finalization of ToR for construction of passenger Ropeway between Dhapper and Bhaleydhunga in South Sikkim District of Sikkim by M/s Tourism & Civil Aviation Dept., Govt of Sikkim, Gangtok - Reg.

Dear Sir,

Kindly refer to your above proposal submitted to this Ministry. The project involves construction of passenger Ropeway between Dhapper and Bhaleydhunga in South Sikkim district of Sikkim. The project is located at Dhapar in Ravangla sub-division of South Sikkim district. It is about 13 km from Ravangla sub division town. Ravangla is 125 kms away from Siliguri and 107 Kms from Gangtok. The proposed Ropeway project will provide facility to the tourist/devotees to reach the hilltop. The land requirement for the project is 2.9 ha. The project proposes Detachable grip 8 seat Monocable Gondola Ropeway System for a maximum design capacity of 400 PPH. The horizontal length and vertical rise of proposed ropeway is 2950 m and 1327m respectively. Line speed of the ropeway varies from 0-5 m/sec and travel time approximately 648 sec. Main Drive Motor is of capacity 800 KW and Diesel Engine for rescue is of capacity 160 KW. The total number of towers proposed is 22. Two diesel generators having capacity 635 KVA are proposed. The power requirement is 850 KW. The proposed ropeway is crossing one stream. About 50 nos. of trees falling in the project area. The hauling rope is of 58mm dia, having strength 1770N/mm^2. The total estimated project and annual operation & maintenance cost is Rs. 7333.44 lakhs and 149.37 lakhs respectively.

The project is located in Maenam Wildlife Sanctuary, hence, the project is in Category 'A' as EIA Notification. National Board for Wildlife (NBWL) has recommended the project for denotification of area required for the project in 27th meeting of NBWL. The estimated completion time of the proposed ropeway project is 36 months.

The above proposal was considered in the 127th EAC meeting held on 28th – 30th October, 2013. The details as presented by the project

1

proponents and after discussions, the following "Terms of Reference" were finalized to be suitably added to those furnished by the project proponent.

(i) Details of increment in human traffic as it is presumed that it will be in addition to the existing land route.

(ii) Submit the details of facilities viz. administration building, restaurant, toilets, waste collection and disposal etc at Lower terminal and upper terminal including parking area.

(iii) Examine and submit a brief description of the project-name, project site, geology, topography, nature, size, location of the project, project coverage, master plan, length of the proposed aerial rope way, details of ROW, height from MSL and its importance to the region/ State.

(iv) Submit the details of trees required to be cut for the project.

(v) Examine and submit the likely impact due to influx of people and associated developments

(vi) Any litigation pending against the proposed project and/or any direction/order passed by any court of law against the project, if so, details thereof should be provided.

(vii) Submit map of the project area and 10 km area from boundary of the proposed/existing project area, delineating project areas notified under the wild life (Protection) Act, 1972/critically polluted areas as identified by the CPCB from time to time/notified eco-sensitive areas/inter state boundaries and international boundaries.

(viii) Submit baseline data to be given on description of existing situation of the land at the proposed project area including description of terrain, hill slopes, inland topography, slope and elevation, rock types, regional tectonic setting (reported fractures/faulting/folding, warping), and history of any volcanic activity, seismicity and associated hazards.

(ix) Submit details of power requirement and source. Energy efficiency measures in the activity should be drawn up. Also submit details of D.G. Sets along with noise control measures.

(x) Submit details of anticipated impact during construction stage and operation stage on landslides, surface drainage etc., which can be predicted. The existing surrounding features up to 1 km and impact on them should be addressed separately.

(xi) Submit details on impact of vibrations on the surrounding environment including damage to materials/structures and due to present and future transportation activities by road.

(xii) Examine and submit activities associated with aerial ropeway construction and operations, as well as 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 should be carried out for seismicity, slope stability, soil erodibility, and flood hazard.

(xiii) Identify the competent authorities for safety of ropeway and its monitoring.

General Guidelines

(i) The EIA document shall be printed on both sides, as far as possible.

(ii) The status of accreditation of the EIA consultant with NABET/QCI shall be specifically mentioned. The consultant shall certify that his accreditation is for the sector for which this EIA is prepared.

(iii) On the front page of EIA/EMP reports, the name of the consultant/consultancy firm along with their complete details including their accreditation, if any shall be indicated. The consultant while submitting the EIA/EMP report shall give an undertaking to the effect that the model TORs have been complied with and the data submitted is factually correct (Refer MoEF Office Memorandum No. J-11013/41/2006-IA.II(I) dated 4th August, 2009).

(iv) While submitting the EIA/EMP reports, the name of the experts associated with/involved in the preparation of these reports and the laboratories through which the samples have been analysed should be stated in the report. It shall clearly be indicated whether these laboratories are approved under the Environment (Protection) Act, 1986 and the rules made there under (Please refer MoEF Office Memorandum No. J-11013/41/2006-IA.II(I) dated 4th August, 2009). The project leader of the EIA study shall also be mentioned.

(v) Environmental Management Plan presented before the EAC as a part of EIA report, shall be made part of Concessionaire Agreement/ other relevant documents. Proponent shall submit an undertaking in this regard.

(vi) Since most of the environmental issues are related to design parameters, following additional information should also be provided by PP apart from the information required as per

Chapter – 12 of the EIA Guideline manual for Highways (Disclosure of Consultant)

a) Name of the Design Consultant.

b) Name of the EIA consultant, EIA Coordinator, Functional Area Expert and details of accreditation.

(vii) The EIA report shall be prepared as per the EIA Notification, 2006, as amended from time to time.

Public Hearing should be conducted for the project in accordance with provisions of the Environmental Impact Assessment Notification, 2006 and the issues raised by the public should be addressed in the Environment Management Plan.

A detailed draft EIA/EMP report should be prepared as per the above additional TOR and should be submitted to the Ministry in accordance with the Notification.

The prescribed ToRs would be valid for a period of two years for submission of the EIA/EMP Reports, after public consultation.

Yours faithfully,

(Lalit Kapur)
Director (IA-III)

Copy to:
The Member Secretary, Sikkim Pollution Control Board, Dept. of Forest, Environment & Wildlife Management Government of Sikkim, Deorali – Gangtok, Sikkim.

Annexure 1.2

EFFLUENT DISCHARGE STANDARDS (INLAND SURFACE WATER)

S.No.	Parameter	Unit	Standards
1	Colour & Odor	--	All efforts should be made to remove colour and unpleasant odor as far as practicable.
2	Suspended Solids Max.	mg/l	100
3	Particle size of Suspended Solids	--	Shall pass 850 micron IS Sieve
4	pH value	--	5.5 to 9.0
5	Temperature, Max.	^{o}C	Shall not exceed 5°C above the receiving water temperature
6	Oil and grease, Max.	mg/l	10
7	Total residual Chlorine, Max.	mg/l	1.0
8	Ammonical Nitrogen (as N), Max.	mg/l	50
9	Total Kjeldah Nitrogen (as N), Max.	mg/l	100
10	Free Ammonia (as NH_3), Max.	mg/l	5
11	Biochemical Oxygen Demand (5 days at 20°C), Max.	mg/l	30
12	Chemical Oxygen Demand Max.	mg/l	250
13	Arsenic (as As), Max.	mg/l	0.2
14	Mercury (as Hg), Max.	mg/l	0.01
15	Lead (as Pb), Max.	mg/l	0.1
16	Cadmium (as Cd), Max.	mg/l	2.0
17	Hexavalent Chromium (as Cr^{+6}), Max.	mg/l	0.1
18	Total Chromium (as Cr) Max.	mg/l	2.0
19	Copper (as Cu), Max.	mg/l	3.0
20	Zinc (as Zn), Max.	mg/l	5.0
21	Selenium (as Se), Max.	mg/l	0.05
22	Nickel (as Ni), Max.	mg/l	3.0
23	Cyanide (as CN), Max.	mg/l	0.2
24	Fluorides (as F), Max.	mg/l	2.0
25	Dissolved phosphates (as P), Max.	mg/l	5.0
26	Sulphides (as S), Max.	mg/l	2.0
27	Phenolic compounds (as C_6H_5OH), Max.	mg/l	1.0
28	Radioactive Materials α Emitters, μcurie/ml, Max. β Emitters, μcurie/ml, Max.	mg/l	 10^{-7} 10^{-6}
29	Bio-assay test	mg/l	90% survival of fish after 96

S.No.	Parameter	Unit	Standards
			hours in 100% effluent
30	Manganese (as Mn)	mg/l	2.0
31	Iron (as Fe)	mg/l	3.0
32	Vanadium (as V)	mg/l	0.2
33	Nitrate Nitrogen	mg/l	10.0

Annexure 1.3

DRINKING WATER QUALITY STANDARDS (IS 10500:2012)

S. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable limit	Permissible limit in the absence of alternate source
Essential Characteristics				
1	Colour, Hazen units, Max	5	Above 5, consumer acceptance decreases	15
2	Odour	Agreeable	-	Agreeable
3	Taste	Agreeable	-	Agreeable
4	Turbidity NTU, max	1	Above 5, consumer acceptance decreases	5
5	pH Value	6.5 to 8.5	Beyond this range the water will affect the mucous membrane and/or water supply system	No relaxation
6	Total Hardness (as $CaCO_3$) mg/l, Max	200	Encrustation in water supply strucute and adverse effects on domestic use	600
7	Iron (as Fe) mg/l, max	0.3	Beyond this limit taste/appearance are affected, has adverse affect on domestic uses and water supply structures and promotes iron bacteria	No relaxation
8	Chloride (as Cl) mg/l, Max	250	Beyond this limit, test, corrosion and palatability are affected	1000
9	Free Residual free Chlorine, mg/l, Min	0.2	-	1.0
10	Fluoride (as F) mg/l, Max	1.0	Fluoride may be kept as low as possible. High fluoride may cause florosis	1.5
11	Dissolved solids mg/l, Max	500	Beyond this palatability decreases and may cause gastro intestinal irrigation	2000
12	Calcium (as Ca) mg/l, Max	75	Encrustation in water supply structure and adverse effects on domestic use	200
13	Magnesium (as Mg) mg/l, Max	30	Encrustation in water supply structure and	100

S. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable limit	Permissible limit in the absence of alternate source
Essential Characteristics				
			adverse effects on domestic use	
14	Copper (as Cu) mg/l, Max	0.05	Astringent taste, discoloration and corrosion of pipes fitting and utensils will be caused beyond this	1.5
15	Manganese (as Mn) mg/l, Max	0.1	Beyond this limit taste/appearance are affected, has adverse effect on domestic uses and water supply structures	0.3
16	Sulphate (as SO_4) mg/l, Max	200	Beyond this causes gastro intestinal irritation when magnesium or sodium are present	400
17	Nitrate (as NO_3) mg/l, Max	45	Beyond this methaemoglobinemia takes place	No relaxation
18	Phenolic compounds (as C_6H_5OH) mg/l, Max	0.001	Beyond this, it may cause objectionable taste and odour	0.002
19	Mercury (as Hg) mg/l, Max	0.001	Beyond this, the water become toxic	No relaxation
20	Cadmium (as Cd), mg/l, Max	0.003	Beyond this the water become toxic	No relaxation
21	Selenium (as Se), mg/l, Max	0.01	Beyond this the water become toxic	No relaxation
22	Arsenic (as As), mg/l, Max	0.01	Beyond this the water become toxic	0.05
23	Cyanide (as CN), mg/l, Max	0.05	Beyond this the water become toxic	No relaxation
24	Lead (as Pb), mg/l, Max	0.01	Beyond this the water become toxic	No relaxation
25	Zinc (as zn), mg/l, Max	5	Beyond this limit it can cause astringent taste and an opalescene in water	15
26	Anionic detergents (as MBAS), mg/l, Max	0.2	Beyond this limit it can cause a light froth in water	1.0
27	Total Chromium (as Cr) mg/l, Max	0.05	May be carcinogenic above this limit	No relaxation

S. No.	Substance or Characteristic	Requirement (Desirable Limit)	Undesirable Effect outside the Desirable limit	Permissible limit in the absence of alternate source
Essential Characteristics				
28	Polynuclear aromatic hydrocarbons (as PAH) mg/l, Max	0.0001	May be carcinogenic	No relaxation
29	Mineral oil mg/l Max	0.01	Beyond this undesirable and odour chlorination place	0.03
30	Pesticides mg/l Max	Absent	Toxic	0.001
31	Radioactive materials a) Alpha emitters Bq/l max b) Beta emitters pci/l, Max	 0.1 1.0	 - -	 No relaxation No relaxation
32	Total Alkalinity (as CaCo3)mg/l Max	200	Beyond this limit taste becomes unpleasant	600
33	Aluminium (as Al), mg/l Max	0.03	Cumulative effect is report to cause demntia	0.2
34	Boron (as B), mg/l, Max	0.5	-	1.0
35	Ammonia (as total ammonia-N) mg/l, Max	0.5		No relaxation

Annexure 1.4

NATIONAL AMBIENT AIR QUALITY STANDARDS

Pollutant	Time Weighted Average	Industrial, Residential, Rural & Other Area	Ecologically Sensitive Area (notified by Central Government
Sulphur Dioxide (SO_2), $\mu g/m^3$	Annual 24 Hours**	50 80	20 80
Nitrogen Dioxide as NO_2, $\mu g/m^3$	Annual 24 Hours**	40 80	30 80
Particulate Matter (size less than 10µm) or PM_{10} $\mu g/m^3$	Annual 24 Hours**	60 100	60 100
Particulate Matter (size less than 2.5µm) or PM2.5 $\mu g/m^3$	Annual * 24 Hours**	40 60	40 60
Ozone (O3 $\mu g/m^3$	8 hours** 24 Hours**	100 180	100 180
Lead (Pb) $\mu g/m^3$	Annual * 24 Hours**	0.50 1.0	0.50 1.0
Carbon Monoxide (CO) mg/m^3	8 Hours** 1 Hour**	02 04	02 04
Ammonia (NH_3) $\mu g/m^3$	Annual * 24 Hours**	100 400	100 400
Benzene (C_6H_6) $\mu g/m^3$	Annual *	05	05
Benzo (a) pyrene (BaP)particulate phase only nm^3	Annual *	01	01
Arsenic (AS) ng/m^3	Annual *	06	06
Nickle (Ni) ng/m^3	Annual *	20	20

: 18th November 2009

Annexure 1.5

NATIONAL AMBIENT NOISE STANDARDS

Category of Zones	Leq in dB (A)	
	Day *	Night
Industrial	75	70
Commercial	65	55
Residential	55	45
Silence Zone **	50	40

:

CHAPTER 2
PROJECT DISCRIPTION

2.1 PROJECT LOCATION

The proposed project site is located at the Dhappar. Dhappar is located in Ravangla sub-division under south district of Sikkim. It is about 13 km from Ravangla sub-division town, while Ravangla is 125 kms away from Siliguri and 107 Kms from Gangtok. The area is connected by the means of road transport from Railhead at suiliguri and airport at Bagdogra. The location of the project area is shown in **Figure 2.1.**

The project envisages construction of buildings at two ends namely LTP & UTP of Ropeway Systems for boarding/de-boarding of passengers. The required facilities for Ropeway systems are described in the subsequent paragraph.

2.2 ALTERNATIVES

Two possible alignments have been studied for the purpose of evaluation by comparison. Lower terminal area has been chosen within 2 kms of the rural road constructed under PMGSY. The upper terminal area has been selected close to the Bhaleydunga peak, adjacent to the last shelter shed of trekker's route that goes to the peak. Following observations are made:

a) Both the alignments are passing through hill slopes, over dense forest.
b) Contours have been changed rapidly for both the alignments.
c) Soil/ rocks conditions are identical in nature, for both the alignments.
d) Both the alignments pass over Yangang reserve forest at lower ridges of the hill slope, while the upper ridges (start from 1800 mtr. Altitude) of the alignments falls in Maenam Wildlife Sanctuary.

While both the terminals were frozen, RITES selected best-suited alignment with a view that gives maximum mechanical advantages in selection of prime movers. The shortest route alignment has been final.

2.3 ROPEWAY SYSTEM

The ropeway system used in the alignment would be Detachable grip 8 seater Mono cable Gondola ropeway system. The salient features of Ropeway system is given in the **Table 2.1**. The alignment of proposed Ropeway system on Toposheet is given in **Figure 2.2** and longitudinal section of the alignment is given in **Figure 2.3.**

The land required for the development of Ropeway System is 2.9 ha in which 1.2 ha in Maenam Wildlife Sanctuary and 1.7 ha in Reserved Forest. All the facilities proposed for the operation of ropeway will be accommodated within the 2.9 ha area. The proposed project envisages development of the following facilities;

- Station building at ropeway ends,
- Construction/Fabrication of Structures (towers), and
- Control systems,

FIGURE 2.1
LOCATION MAP OF ROPEWAY SITE

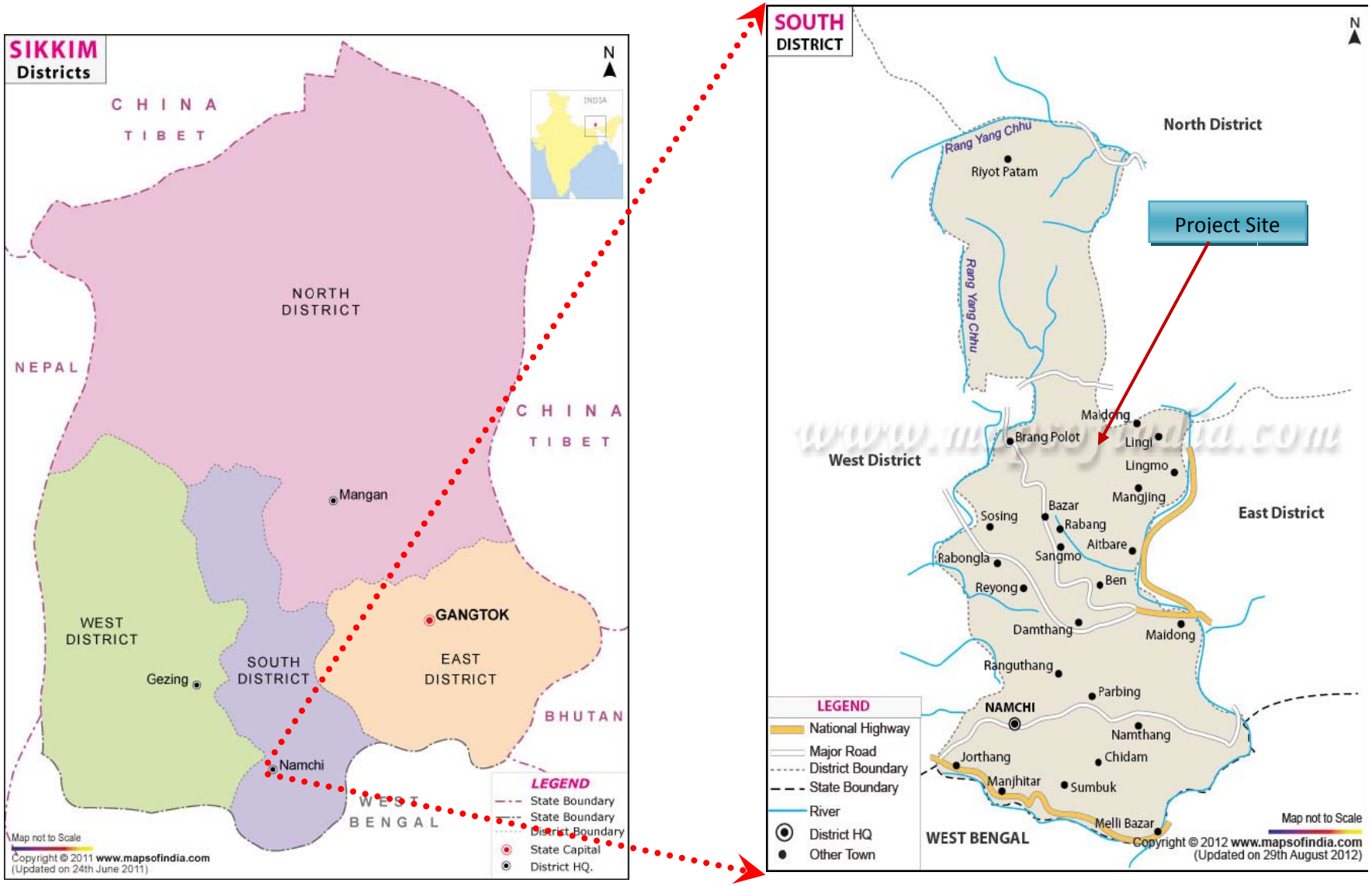
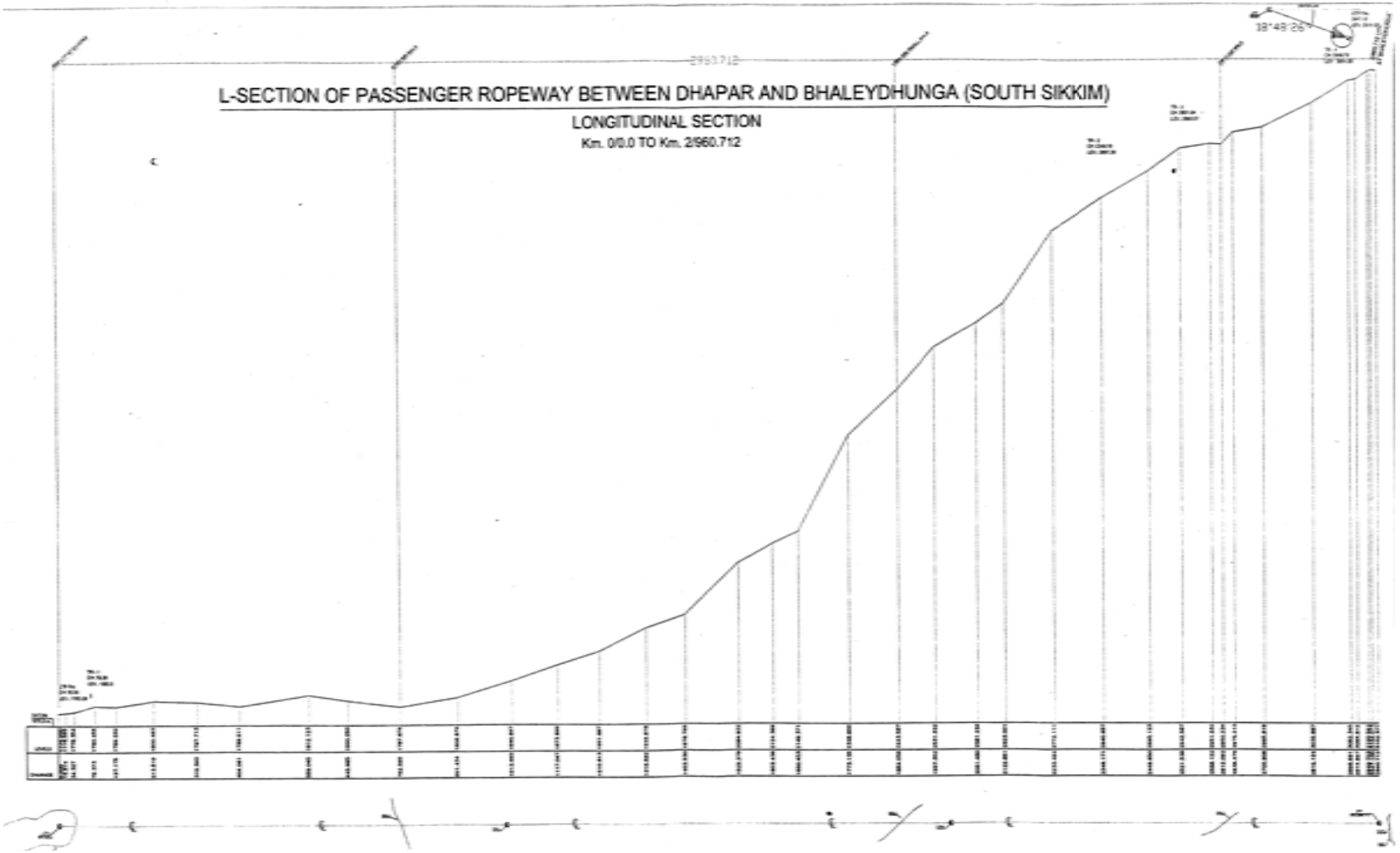


TABLE 2.1
SALIENT FEATURES OF ROPEWAY SYSTEM

Sr. No.	Particulars	Description
1	System	Monocable Detachable Gondola System
2	Capacity(Designed), PPH	400
3	Horizontal distance between stations, m	2960
4	Vertical rise, m	1327
5	Line speed, m/sec	0 to 5
6	Total Numbers of Tower	22
7	Working Hours	10
8	Capacity of cabin, persons	8
9	Land Requirement	2.9 ha
10	Travel time one way, min	10.8
11	Cabin, no	20
12	Type of cabin	Fully enclosed type with ventilation, automatic sliding door
13	Hauling rope	58 mm dia, 6 x 19 const; PPC tensile designation of wire 1770N/mm^2
14	Main drive motor, kw	800
15	Diesel Engine for rescue, kw	160
16	D.G. set, KVA	625 (2 nos)
17	Power Requirement, kw	850
18	Relevant standard	IS 5229

FIGURE 2.2
PROPOSED ROPEWAY SYSTEM ON TOPOSHEET

FIGURE 2.3
LONGITUDINAL SCTION OF ROPEWAY SYSTEM



2.3.1 Station Building at two ends

Upper Terminal Point (UTP)

The building would be two-storeyed RCC framed building and will have a concrete operating floor at first floor level, housed with truss and CGI sheet at the rooftop to house the Ropeway drive station, truss may be supported on structural steel column, Brick wall cladding with sufficient glazing to be provided at both the floors, so that, outside greenery could be seen. Ropeway mechanicals, waiting area and boarding/ de boarding arrangement except drive unit shall be placed at operating floor with an area of 330 sq. m, while equal area shall be utilized at ground floor to provide drive unit, panels, Solar panels, store, maintenance area, office etc. Ticket counters and covered queue area to be provided separately.

Lower Terminal Point (LTP)

A single –storeyed RCC framed, concrete roof annexed building with brick wall cladding and sufficient glazing, comprising of roughly 250 sq. m. For passenger handling would be located at lower terminal.

The operating floor would be of 450 sq.m area adjacent to annexed building at ground floor level. The operating floor would be Structural steel framed, housed with truss and CGI sheets at the rooftop.

2.3.2 Control System

There will be s 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 feed back element and annunciation will be provided.

There will be necessary safety devices and emergency stop push button stations to make the system complete safe. The safety will be ensured at Lower and Upper stations and Line. The main drive motors will be tripped automatically and safely in case of any safety fault occurred at Lower and Upper stations.

Controls Panels and Distribution Boards will be provided at drive and return stations for operation as well as maintenance purposes.

Control relays and interlocks will be provided for rescue engine, emergency motor and brake operation.

Operator’s control desk should capable to annunciate all faults, operating conditions etc.

A.C. drive will be provided with forward reverse operation, speed variation (auto and manual) and inching facilities.

2.3.3 Communication

One number Industrial type telephone system will be provided for communication with each station and line. The system basically consists of wall mounted sets (2 Nos. for each station), loudspeaker and amplifier. 2 Nos. portable sets will be provided for communication with line.

The wireless system (4 Nos. handsets) will be provided to communicate while maintenance/ rescue operation on line and for other reasons, when communication through telephone system will not be possible.

16-channel intercom system will be installed at each station for communication between operating and security personnel of that station.

2.3.4 Power Requirement and Supply

The total requirement for the motor and lighting load for the Ropeway and other infrastructure in Ropeway building is given below. It is envisaged that the power supply will be made available at 415V ± 5% with frequency of 50 cycles ± 1% by the SSPD.

Description	Upper Station	Lower Station	Total
Ropeway at Bhaleydunga Hill	Drive unit-650 KW Other-100 KW	100 KW	850 KW

The power availability position was discussed with the concerned officials of Power Department, Government of Sikkim it was noted that power availability at the drive terminals of the recommended alignment has to be arranged separately at both the terminals.

It is considerable that the ropeway system should be operational for a maximum period. Standby power supply arrangement using DG set has been proposed so that it can take care of the system in case of power failure. Two DG sets having capacity of 625 KVA is proposed to be installed at the Drive and 100 KVA at return stations respectively for running the system. DG set shall supply 415 V, 3 phases, 50 cycle electrical supply.

2.4 MANPOWER REQUIREMENT

Manpower will be required during construction and operation of the proposed project. During construction, requirement will be temporary in nature while during operation, it will be permanent. The basic requirement of manpower for operation of the Ropeway project will be categorized as Technical and Non-technical. Technical manpower should cover all the operation and maintenance functions. Non-Technical manpower should cover the functions of stores, House Keeping and accounts, etc. The manpower required for Ropeway systems are 26.

2.5 CONSTRUCTION PERIOD

Estimated completion time of the project has been worked to 36 months.

2.6 PROJECT COST

Estimated cost of the project inclusive of consultant and Infrastructural developmental cost is **Rs. 73.33 crores** only.

Estimated annual operation and maintenance cost at first year of operation is **Rs. 149.37 lacs.**

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CHAPTER 3
ANALYSIS OF ALTERNATIVES

RITES Ltd took up the work for finalization of alignments for ropeway considering various options of alignments and technology during analysis of alternatives for the preparation of Detailed Project Report (DPR).

The detailed reconnaissance survey has been carried out for the area while fixing an alignment and terminal points based on the requirement of project. Methodology to be adopted for selection of most favorable alignment were also discussed and following guidelines have been considered:

- Establishment of at least two alignments on the Bhaleydunga hill slope.
- Reconnaissance of each alternative alignment to ascertain actual condition of land and contours.
- Discussion on the proposed alternative alignments with the Tourism Department to record their views.
- Hold discussion on the proposed alternative alignments with SDM/Ravangla sub division, Power Department and PHE Deptt./ Yangang (Dhapar) to find out difficulties, if any, apprehended by them for providing various utility lines/ services, power etc.
- Comparison and evaluation of alternatives in the light of various considered views of the civil authorities, local administration and requirement/utility of proposed ropeway system.
- Freezing of best-suited alignment.
- Geo technical investigation of the finally chosen alignment.
- Environmental impact analysis of the vicinity due to installation of the Ropeway system.

The analysis of alternatives has been presented in the following sections.

3.1 SITE ALTERNATIVE

On completion of reconnaissance of alternative routes, two possible alignments have been marked on contour maps made available by the Tourism department for the purpose of evaluation by comparison. Following observations are made:

- Both the alignments are passing through hill slopes.
- Contours have been changed rapidly for both the alignments.
- Soil/ rocks conditions are identical in nature, for both the alignments.
- Both the alignments pass over Yangang reserve forest at lower ridges of the hill slope, while the upper ridges (start from 1800 mtr. Altitude) of the alignments falls in Maenam Wildlife Sanctuary.

In order to finalize the Ropeway alignment and terminal area following points have been kept in mind:

- Requirement for conducting regular maintenance and provision for passenger
- Evacuation system from line.
- Type of system i.e. Mono cable/Bi cable/Pulsated etc. suitable to the land profile.
- System suitable to fly over vegetations and other natural barriers in a long span that minimizes the environmental impact, if any.
- Over flying height restriction.
- Geographical features of the hill and availability of land.

- Available flat land to set up Ropeway stations and other infrastructure required for passenger handling.

The objective to set up ropeway system on this hill is to provide mechanized access to the Holy peak of Bhaleydunga for the local residents and sky walk visitors and to facilitate return journey of the trekkers to the Yangang side, so that benefit of tourism spread around Ravangla. With a view of that lower terminal area has been chosen within 2 kms. of the rural road constructed under PMGSY. The upper terminal area has been selected close to the Bhaleydunga peak, adjacent to the last shelter shed of trekker's route that goes to the peak.

While both the terminals were frozen, RITES selected best-suited alignment with a view that gives maximum mechanical advantages in selection of prime movers.

3.2 TECHNOLOGY ALTERNATIVES

The different types of ropeway system for transportation of passengers are primarily categorized as under:

- Monocable Ropeway Systems
- Bicable Ropeway Systems

3.2.1 Monocable Ropeway Systems

A monocable ropeway system comprises basically an endless rope which acts both as the carrying as well as the haulage rope to which a number of carriages are attached at regular intervals. The carriages circulate around the close system by continuous carrying-cum-haulage rope. The monocable ropeway system can be categorized as below:

- **Fixed grip type**, the carriages are fixed to the haulage/carrying rope and do not disengage during boarding/de-boarding operation.

- **Detachable grip type**, the carriages are automatically detached from the main haulage/carrying rope and are transported on the rails at the stations for boarding/de-boarding of passengers.

- **Jig back type** This system has a single carrying-cum-haulage rope to which one or a group of cabins are attached in either direction on diametrically opposite sides.

- **Pulsed type** When a cluster of gondolas are placed together and the system requires an intermediate stoppage a pulsated system is used which follows the same as fixed grip arrangement coupled with characteristics of a Jig Back system. Moreover intermittent stoppage allows having intermediate terminal/s as well more number of traffic can be handled.

3.2.2 Bicable Ropeway Systems

This ropeway system basically consists of single/two stationary carrying track ropes and an endless haulage rope. The track ropes are usually terminated at the terminals with one end provided with a tension unit and the other being anchored. In this ropeway, the carriage is moving on the track rope and the haulage rope does the hauling. Therefore track rope acts as a stationery member and the main load being rope instead of single rope acted as carrying and hauling like a Mono cable ropeways. Bicable ropeway consists of the following types:

- Detachable system
- Jig Back

3.2.3 System Selection

From the analysis of the terrain (ropeway length is 2960 m) and also the system capacities being recommended i.e. 400 Persons per Hour (PPH), the following considerations have been made:

A. Fixed Grip Gondola system is ruled out because of the following reasons:

a. Boarding/de-boarding needs to be carried out when the system is on. This would lead to serious problem particularly in the case of elderly persons and children

b. Being Fixed Grip system, the ropeway speed will be less. Therefore considering the length of the ropeway and the recommended capacity, a large number of cabins need to be installed.

B. **Jig Back system** is ruled out because of the following reasons:

a. Capacity is high for such a system considering the length of the ropeway.

C. Fixed Grip Pulsed Gondola system is ruled out because of the following reasons:

a. Pulsed Gondola system would invite multiple intermittent stoppages at line.
b. Does not match with capacity requirement

D. Detachable Grip Gondola system is felt in order because of the following reasons:

a. No problem during boarding/de-boarding, because this activities need to be carried out when the system speed comes down to almost nil at the station.
b. Capacity could be met with a reasonable system speed of 5 m/sec.
c. Cabin/Gondola capacity of 8 passengers would serve the purpose.
d. The system would be flexible. Depending on the requirement, its capacity could be increased or decreased by either changing the number of cabins or design speed
e. By providing special rescue arrangement, the system can be made monocable. This would lead to a less expensive system.

Based on the above alternative analysis for alignments and technology, it is proposed that Monocable Detachable Gondola system is feasible.

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CHAPTER 4
ENVIRONMENTAL BASELINE DATA

4.1 ENVIRONMENTAL SCOPING

This chapter deals with the description of existing environmental setting of the project area. The project study area is 10 km radius from centre point of proposed Ropeway. Environmental baseline data include the physical, biological and socio-economic data. The field data collection was carried out in the months of October-2014. A scoping matrix was formulated to identify the attributes likely to be affected due to the development of proposed project. The scoping matrix for the project is presented in **Table 4.1**. Based on environmental scoping matrix and project settings the attributes likely to be affected are identified under baseline data generation. Information presented in this chapter is collected from various primary as well as secondary sources. Land use data is compiled from Geological Information System (GIS); data on physiography and geology are collected from various reports/publications. RITES has carried out field studies to generate primary data on soil, water, air and noise quality at the project site. Field study is carried out for assessing the ecological status in the study area. Meteorological data is collected from Regional Meteorological Office Patna. Additional data, wherever necessary, is collected from various reports, literatures, books, and maps, and through discussions with various stakeholders. The environmental baseline data is compiled for:

- Land Environment (Physiography, Geology, Seismicity and Soils)
- Water Environment (Water Resources, Water Use, Water Quality)
- Air Environment (Meteorology and Air Quality)
- Noise Environment (Noise Levels)
- Ecological Environment (Flora and Fauna) and
- Socio-Economic Environment (Demography, Socio-Economics, etc)

TABLE 4.1
SCOPING MATRIX FOR THE PROJECT

Aspect of Environment	Likely Impacts	Baseline Data Collection
A. Land Environment		
Construction Phase	Increased soil erosion	-Present Landuse -Soil Characteristics -Physiography
	Pollution by construction spoils	
	Use of land for Labour colonies	
	Solid waste from Labour colonies, construction	
B. Water Resources & Water Quality		
Construction Phase	Water quality impacts due to disposal of wastewater from Labour colonies and construction sites.	-Meteorological data -Rainfall -Water Quality
Operation Phase	Disposal of waste water	
	Run off Drainage problems	
C. Air Pollution		
Construction Phase	Impacts due to emissions generated by construction machineries	Ambient Air Quality at different Locations
	Emissions from DG set	
Operation	Fugitive emission due to DG set	
D. Noise Pollution		
Construction Phase	Noise due to operation of various equipment	Noise levels at different locations in the area
Operation Phase	Noise due to DG Set	

Aspect of Environment	Likely Impacts	Baseline Data Collection
E. Terrestrial Ecology		
Construction Phase	loss of biomass	-Trees in the area -Type of tree species
Operation Phase	Plantation of trees	
F. Socio-Economics		
Construction Phase	Generate employment for unskilled and skilled local people	-Socio-economic survey
Operation Phase	Fast and easy communication to the people and goods	
	Increase in numbers of pilgrims	
	Increase revenue from business development	
	Increase overall growth of the region	

The methodology adopted for data collection is highlighted wherever necessary and the frequency adopted for data collection for environmental attributes is summarized in **Table 4.2.**

TABLE 4.2
ENVIRONMENTAL ATTRIBUTES AND FREQUENCY OF MONITORING

S No	Attribute	Parameter	Frequency	Source
Land Environment				
1	Land Use	Land use pattern	---	GIS studies & field observations
2	Geology	Geological history	---	Geological Survey of India, Literature
3	Soil	Soil Types	One season analysis	Field studies & secondary sources
4	Seismology	Seismic Hazard	---	Seismic zoning map of India
Water Environment				
5	Water Quality	Physical, Chemical and Biological parameters	One season analysis	Field studies and secondary sources.
Air Environment				
6	Ambient Air Quality	$PM_{2.5}$,PM_{10}, SO_2 , NO_X , O_3 , Pb, NH_3, HC & CO	One season analysis	Field Studies
7	Meteorology	Temperature, Humidity, Rainfall, Wind Speed & Direction	Data collection	Indian Meteorological Department and Field Study
Noise Environment				
8	Noise	Noise levels in dB (A)	One season monitoring	Field studies
Ecology Environment				
9	Ecology	Flora & Fauna	Data collection	Field observations and secondary sources
Socio-Economic				
10	Socio-economic aspects	Socio-economic characteristic of the affected area	Data Collection	Field studies, review of available Literature

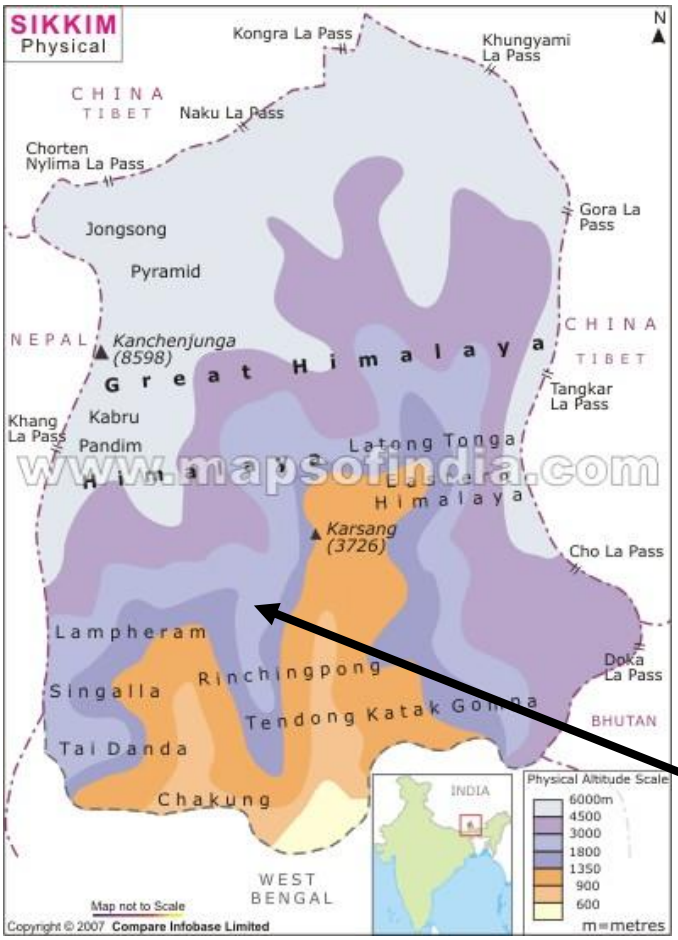
4.2 LAND ENVIRONMENT

Parameters involved in land environment are physiography, geology and soils, land use pattern and seismicity. These are discussed in following paragraphs.

4.2.1 Physiography

The South District (27 05N to 27 32N) is a very small district of the hill state of Sikkim. This district covers an area of 750 Sq km. The district with the headquarters at Namchi comprises of the two sub-division of Namchi and Ravongla. There are 45 Gram Panchayats units and 145 revenue blocks (including 10 special forest blocks). The district is a part of inner ranges of mountains of Western Himalayas consisting of higher hills, alpine zones and snow bound areas. The terrain is hilly with narrow incised river valleys with elevations ranging 300 to 5000 m. the slope varies from 80m, to more than 600m per kilometer. The district is almost encircled by the three rivers viz,Great Rangit in the South, Rangit in the West and Tista in the East. These rivers are the main channels of natural drainage. The Physical map of Sikkim is shown in **Figure 4.1**.

FIGURE 4.1
PHYSICAL MAP OF SIKKIM



4.2.2 Geology and Soil

Sikkim falls in the Easten Himalayas; the terrain in general, is underlain by geologically younger rocks. Similarly metamorphic high grade rocks occur at relatively higher elevations. The various rock types of the area represent pelitic and carbonate rocks of Tso Lhamo and Lacchi series, carbonate of Everest lime stone formation and alternate pelite-psammopelite and psammites of the Everest pelite group, sandstone, slate, coal and pebbly slate of Gondwana group rocks (Late Palaeozoic), Daling group (quartzite, phyllite, dolomite), Darjeeling gneisses, Kanchanjunga gneisses, Chunthang formation (quartzite, marbel, graphitic schist, mica schist, granite gneisses) and Lingtse granite, The contact between the

Dalings and Darjeeling gneiss marked by the presence of streaky gneiss and occasional mylonites is indicative of doubtful thrust. The soil pattern in the state varies from skeletal soils, Mountain meadow, brown red & yellow soils and lateritic soils.

The geological formation of South Sikkim district comprises Quaternary deposits of alluvium in river terrace are developed sporadically along the streams and rivers. The Gondwana rocks occur in the South Sikkim area around Namchi. The rock types are shale, sandstone, quartzite, coal. Among the Daling group Buxa formation is younger and consists of quartzites variegated sltates, black sltates and dolomite. Buxa formation is the oldest rock group represented by an 8 alternative sequence of metamorphosed politic-semi-pelitic to psamatic rocks comprising chloritic phyllite semicite phyllite, grey massive quartzite and variegated states.

The soils of the district in general have derived from parent rocks such as Sandstone, Phyllite, Schist, gneisses and colluvial materials. Soils are generally acidic to very acidic in reaction having soil pH between 5.00 and 6.0.

Two soil samples were collected in order to ascertain the quality and nature of soil within the vicinity of the project site after removing the top soil to the depth of about 30cm to 50cm to obtain soil free from roots, sods and organic matters. The soil samples were collected from location given in **Table 4.3**. The sample location has been shown on map in **Figure 4.2** and the samples were tested for physical and chemical properties. The results of the soil analysis are presented in **Table 4.4.**

TABLE 4.3
DESCRIPTION OF SOIL SAMPLING LOCATIONS

SAMPLE NO	LOCATION		AERIAL DISTANCE FROM PROPOSED ROPEWAY (KM)	DIRECTION
	LATITUDE	LONGITUDE		
1	N $27^0$18ô30ò	E $88^0$24ô20ò	1.75	S
2	N $27^0$16ô47ò	E $88^0$24ô10ò	5.60	SE

TABLE 4.4
SOIL SAMPLE ANALYSIS

Sr. No	Parameter	Sample – 1	Sample – 2
1	pH Value	6.33	4.80
2	Textures in % by mass, a) Sand b) Silt c) Clay	 58.20 24.2 17.6	 60.20 24.0 15.80
3	Total Organic matter (%)	1.80	1.35
4	Nitrogen (kg/hectare)	192.58	216.65
5	Phosphate (as P), kg/hectare	10.81	19.01
6	Sodium (as Na), ppm	31.89	44.15
7	Calcium (as Ca), ppm	66.05	41.28
8	Potassium (as K), kg/Hectare	144.55	195.75
9	Magnesium (as Mg), ppm	60.12	25.05
10	Chloride (as Cl), ppm	117.13	136.98
11	Electric Conductivity(millimohs/cm)	0.08	0.147
12	Moisture (% by mass)	14.80	12.60

FIGURE 4.2
LOCATION OF SOIL SAMPLES

4.2.3 Land use pattern

The land use/land cover data for the study area was derived using the latest cloud free satellite imagery. The satellite data were procured from National Remote Sensing Centre, Hyderabad. The satellite image used in the current study includes LISS-III data of Resourcesat-2 having Row 052 and Path 107 and date of pass as 20-01-2014. The entire data is in Universal Transverse Mercator projection system with spheroid and datum as WGS84 and zone as 45. The landuse classes that has been identified includes Very dense Forest, Moderately Dense Forest, Open Forest, Agriculture, Alpine Pasture, Barren, Landslide, River, River sand, Scrub, Settlement and Snow covering a total area of 732.48 sq km. 15 km Land use classification for the proposed ropeway alignment as centre is shown in the **Table 4.5**. The predominant land use of the area is very dense forest. A landuse map is prepared for study area of 15 km radius keeping proposed ropeway alignment as centre and is given in **Figure 4.3**.

The drainage pattern of the area for 10 km radius keeping proposed ropeway alignment as centre is given in **Figure 4.4**, which was prepared using topographical sheets of Survey of India, The entire study area is covered under the topographical sheet number 78A/07 and 78A/08.

4.2.4 Seismicity

Sikkim is located in the high risk seismic zone IV as per the seismic zoning map of India prepared by Bureau of Indian Standards (BIS code: IS 1893: Part-1:2002). The seismic zoning map of India is shown in **Figure 4.5**. The state is spread out on the Himalayan mountain range with two main thrust faults, the Main Boundary Thrust (MBT) and Main Central Thrust (MCT) crossing the state. Continuous thrusting of the Indo-Australian plate against the Eurasian plate has made most parts of the Himalayan collision zone seismically active. Sikkim is a part of this zone; therefore it had been a moderately active seismic region in historical times. Historically, parts of this state have experienced seismic activity in the M5.0-6.0 range. The project site is located in Zone IV.

TABLE 4.5
LAND USE CLASSIFICATION FOR STUDY AREA OF 15 KM RADIUS

Sl.	Land use/Land cover category	Area (KM^2)	Area (%)
1	Very Dense Forest	306.40	41.83049
2	Moderately Dense Forest	118.35	16.15744
3	Open Forest	120.83	16.49601
4	Agriculture	158.83	21.68387
5	Alpine Pasture (Grassland)	2.02	0.275775
6	Scrub Land	15.35	2.09562
7	Barren Land	0.95	0.129696
8	Landslide	0.17	0.023209
9	River /Waterbody	8.00	1.09218
10	River Sand	0.05	0.006826
11	Settlement	1.53	0.208879
	Total Area	**732.48**	**100**

According to Global Seismic Hazard Assessment Program (GSHAP) data, the state of Sikkim lies in a region of high seismic hazard. . The GSHAP map of the state of Sikkim is shown in **Figure 4.6**.

Considering its geographical location and its past seismic history, suitable provision of seismic factor may be made in the design of civil engineering structures to make them earthquake resistant. The structure in the region are designed and constructed as per guidelines laid down by Bureau of Indian Standards (BIS) to minimize the losses caused by earthquakes.

4.3 WATER ENVIRONMENT

Water environment consists of water resources and its quality. Its study is important from the point of view to assess the sufficiency of water resources for needs of the project in its various stages and the impact of the project on water environment.

4.3.1 Water Resources

The South District of Sikkim falls under Tista basin. The drainage of the district is controlled by the perennial Tista and Rangit rivers alongwith their tributaries. Tista the main river passes through the area which originates from the central crystalline zone defined by high mountain ranges which is covered by glaciers. The Tista and its tributaries drain different parts of the area. The rivers are perennial in nature which are fed by both snowmelt water and rain water. Rangit, another river originates from West Sikkim. During its southerly course it receives Melli Chhu, Namlong Khola, Rathang Chhu, Kalig Chhu, Rayong Khola, etc. The southerly flowing Tista is joined by Rangpchap Chhu at the extreme north of the South Sikkim. The type of drainage is trellis and dendritic. Most of the Kholas have originated from the higher altitudes and flow down by cutting deep gorges in lower altitude where they ultimately join with the main river Tista.

Hydrogelogically Sikkim is divided into two divisions viz, (i) Non permafrost area and (ii) Permafrost area. Ground water occurs largely in disconnected localized bodies under favourable geological conditions, such as jointed fractured zones in various lithological units, weathered zones in the phyllite, schist, gneisses and quartzite. The ground water is available from some perennial springs, from nalas present in all geological formations in the area and in the bored wells constructed by the Central Ground Water Board.

FIGURE 4.3
LANDUSE MAP OF PROJECT AREA (15 Km)

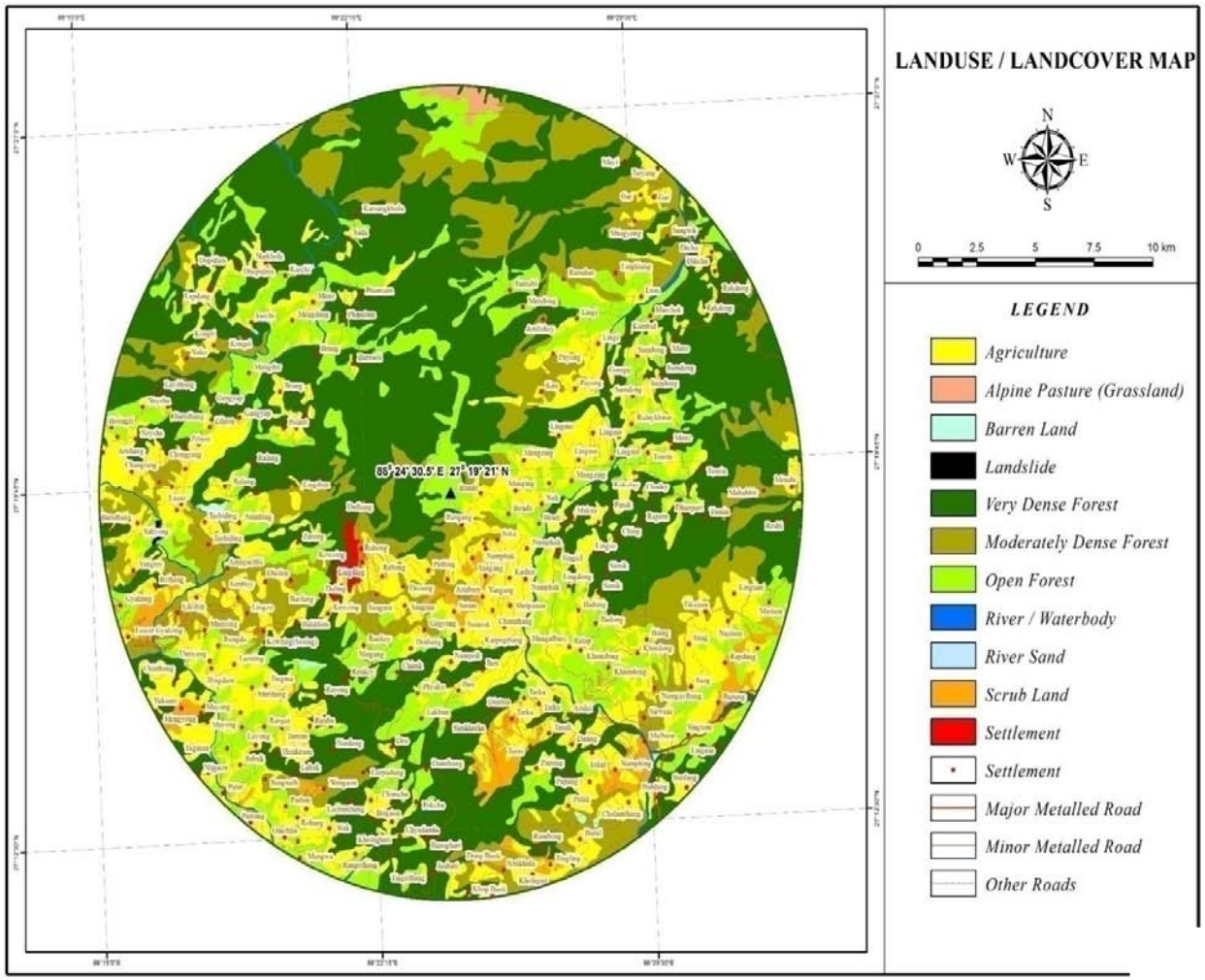


FIGURE 4.4
DRAINAGE MAP OF PROJECT AREA

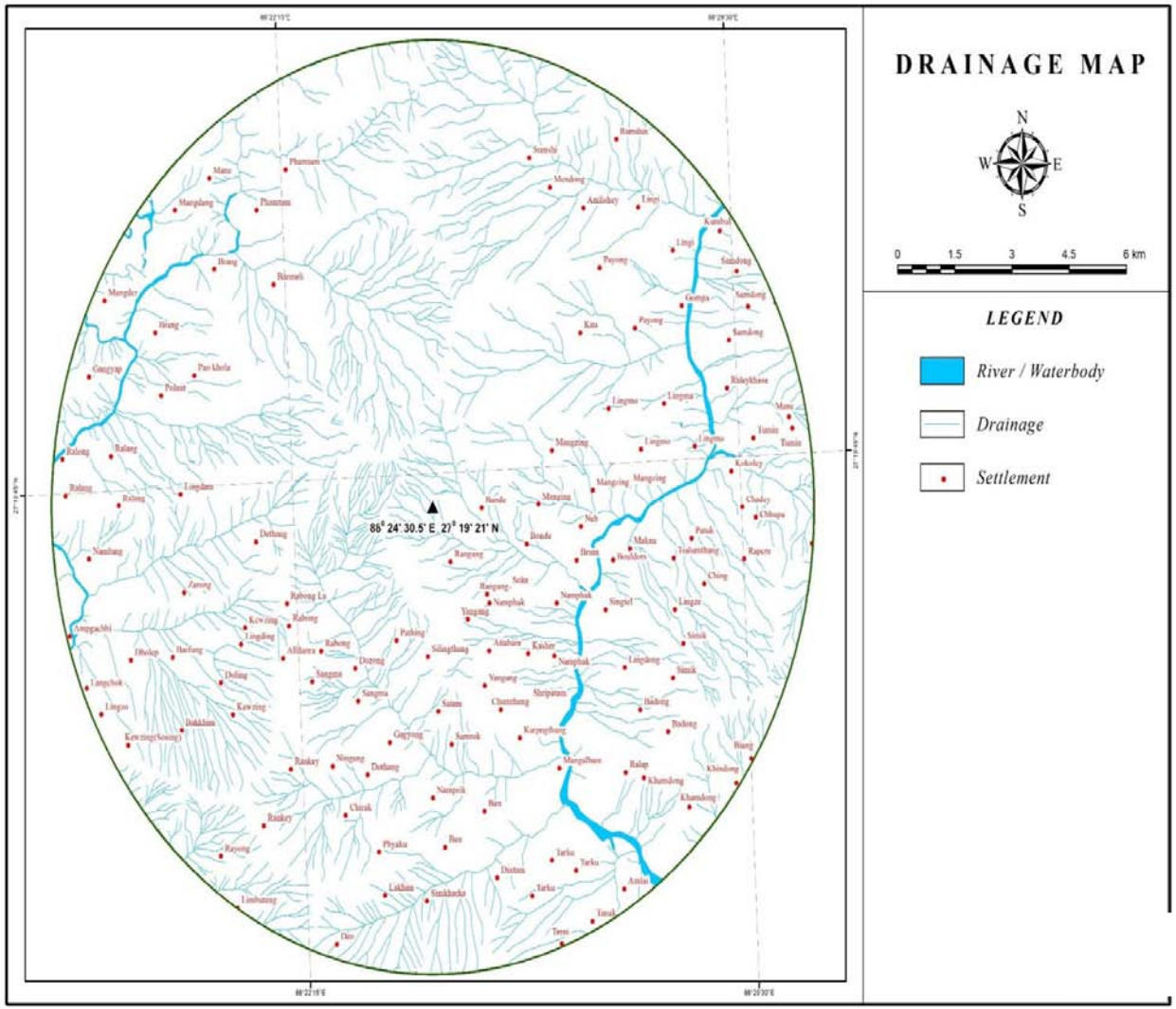


FIGURE 4.5
SEISMIC ZONING MAP OF INDIA

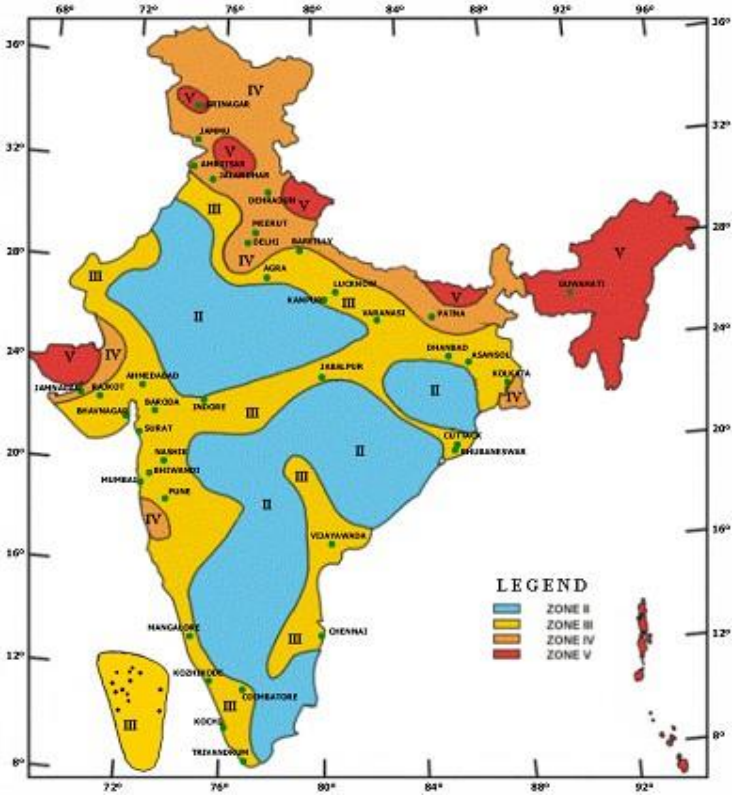
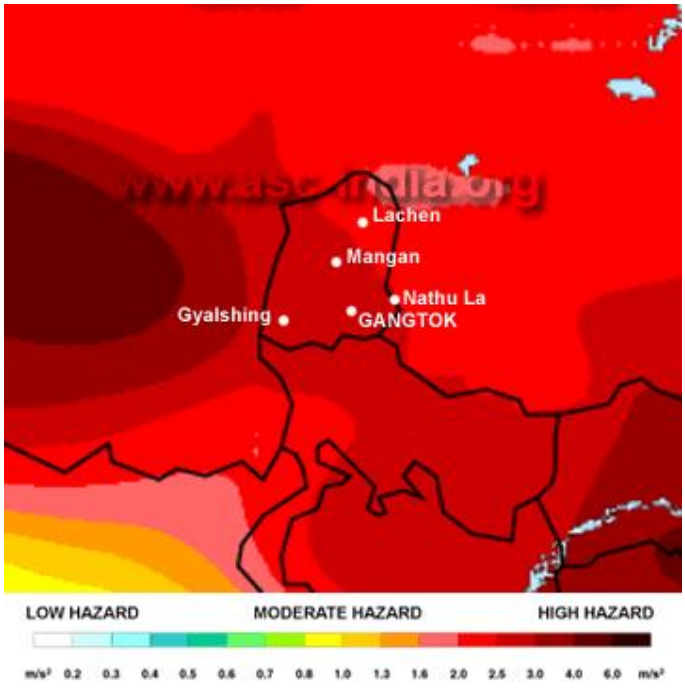


FIGURE 4.6
SEISMIC HAZADUS MAP OF SIKKIM



The South district of Sikkim water supply system solely depends upon ñSurface Water Sourcesò The basic water supply system consists of:

a) Tapping of water sources located at higher reaches.
b) Transporting the raw water through gravity from the sources to the lower reaches finally distributed to consumer points through zonal distribution system.
c) The people of the villages situated on the hill slopes, depend mainly on the springs and or nearly perennial kholas for their drinking water supply. The rural works department of the State Government has implemented schemes for water supply. The spring water collected in storage tank from where it is supplied to various villages situated at the same or lower altitudes by gravity.

4.3.2 Water Quality

The term water quality is defined as ñthose physical, chemical and biological characteristics of water by which the user evaluates the acceptability of waterò In order to assess the baseline water quality status of the study area, 2 water samples were collected. The sample locations are shown in **Figure 4.7**. Description of water sampling locations is given in the **Table 4.6**. The samples were analyzed for physical, chemical and biological constituents and the results of water analysis are compared with IS: 10500-2012 Drinking Water Standards. It is found that BOD and COD are present in both the samples and total coliform is present in sample no 2. Hence the water from both the sources should be treated before using it for drinking purpose. The results of analysis are presented in **Table 4.7**.

TABLE 4.6
WATER SAMPLING LOCATION

SAMPLE NO	LOCATION		SOURCE OF WATER	AERIAL DISTANCE FROM PROPOSED ROPEWAY (KM)	DIRECTION
	LATITUDE	LONGITUDE			
1	N $27^0$18ô30ò	E $88^0$24ô21ò	Spring	1.76	S
2	N $27^0$16ô19ò	E $88^0$25ô14ò	Spring	6.15	SE

FIGURE 4.7
LOCATION OF WATER SAMPLES

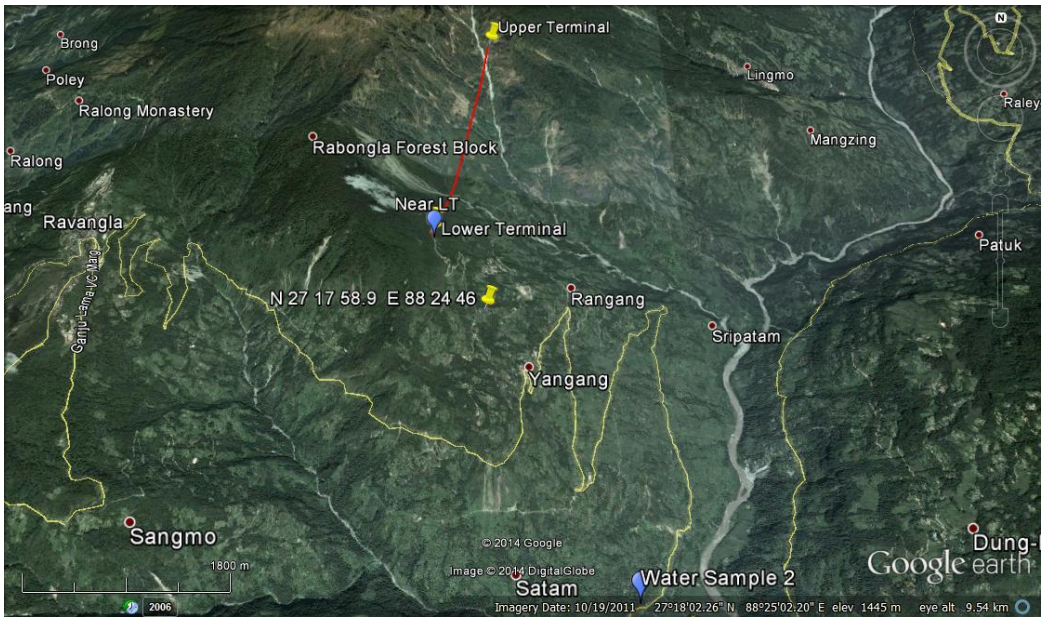


TABLE 4.7
WATER QUALITY AT PROJECT SITE

S.No	Parameters	Sample1	Sample2
1	pH Value	7.55	7.33
2	Total Hardness (as $CaCO_3$), mg/l	20.0	32.0
3	Fluoride (as F), mg/l	<1.0	<1.0
4	Sulphate (as SO_4), mg/l	BDL	BDL
5	Total Iron (as Fe), mg/l	BDL	BDL
6	Total Dissolved Solids (mg/l)	49.0	55.0
7	Total Suspended Solids (mg/l)	10.0	31.0
8	Total Alkalinity (as $CaCO_3$), mg/l	10.2	15.2
9	COD, mg/l	4.0	8.0
10	BOD for 3days at 27^oC (mg/l)	1.0	3.0
11	Sodium (as Na), mg/l	1.42	4.33
12	Potassium (as K), mg/l	0.40	0.54
13	Chloride (as Cl), mg/l	5.9	19.7
14	Manganese (as Mn), mg/l	BDL	BDL
15	Nitrate (as NO_3), mg/l	BDL	BDL
16	Arsenic (as As), mg/l	BDL	BDL
17	Lead (as As), mg/l	BDL	BDL
18	Phosphates as PO4 (mg/l)	BDL	BDL
19	Calcium (mg/l)	16.0	9.6
20	Copper, mg/l	BDL	BDL
21	Zinc, mg/l	0.049	BDL
22	Aluminium, mg/l	BDL	0.013
23	Cadmium, mg/l	BDL	BDL
24	Murcury, mg/l	BDL	0.0006
25	Nickel, mg/l	BDL	BDL
26	Total Coliform	Absent	Present
27	Dissolved Oxygen (mg/l)	5.1	4.8
28	Chromium (mg/l)	BDL	BDL
29	Magnesium (mg/l)	BDL	1.9
30	Phenolic Compounds (mg/l)	BDL	BDL

4.4 METEOROLOGY AND AIR ENVIRONMENT

Meteorology is an important parameter in Environmental Impact Assessment. All air pollutants emitted by point and non-point sources are transported, dispersed or concentrated. The dispersion and deposition is dependent on meteorological and topographical conditions of the area. The main parameters of meteorology are: Wind Speed, Wind Direction, Temperature, Relative Humidity, and Rainfall. In order to assess the impact on existing ambient environment due to the project, it is necessary to have baseline status of ambient environmental parameters.

The latest meteorological data of 10 years i.e., 2004 to 2013 have been collected for nearest observatory at Namtanng, South Sikkim & Gangtok, East Sikkim from Regional Meteorological Office. The Monthly Average Maximum and Minimum Temperature, Monthly Rainfall of Namtanng, South Sikkim and Monthly Average Relative Humidity at 0300 hrs &, at 1200 hrs of Gangtok, East Sikkim are tabulated in **Table 4.8, Table 4.9, Table 4.10, Table 4.11** and **Table 4.12** respectively.

TABLE 4.8
Monthly Average Maximum Temperature (in Degree Celsius) of Namthang, South Sikkim

Year / Month	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Jan	14.8	14.8	17.9	15.4	14.8	17.1	18.1	15.0	14.9	14.7
Feb	17.2	17.4	20.5	15.0	16.5	21.0	20.3	19.1	16.7	18.0
Mar	22.0	20.3	21.7	20.4	21.7	23.4	23.3	23.1	21.7	22.1
Apr	22.5	23.6	23.3	22.9	24.0	25.0	25.6	24.2	25.0	23.9
May	23.5	22.8	24.8	24.6	25.4	25.9	25.6	25.6	26.2	25.0
Jun	24.0	25.1	25.1	25.0	24.7	27.1	25.6	25.7	25.6	26.6
Jul	23.5	25.2	24.3	26.1	26.4	26.4	25.7	25.4	25.9	25.0
Aug	25.7	25.7	24.8	26.7	26.5	26.2	25.9	25.9	25.9	26.4
Sep	24.1	26.1	23.2	24.7	27.0	27.3	25.4	26.4	24.4	27.5
Oct	22.1	22.0	23.6	24.7	25.2	24.7	19.2	22.5	22.6	24.8
Nov	19.2	17.6	19.1	20.8	20.3	20.4	18.6	18.4	20.7	21.2
Dec	16.4	16.3	16.2	17.5	18.5	18.0	16.6	18.8	16.5	16.4

TABLE 4.9
Monthly Average Minimum Temperature (in Degree Celsius) of Namthang, South Sikkim

Year / Month	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Jan	06.7	05.6	06.9	05.7	06.7	07.6	09.2	05.5	05.2	04.5
Feb	08.2	04.3	11.8	06.2	07.8	09.9	08.4	08.2	07.0	06.9
Mar	13.2	08.7	12.5	09.5	15.1	11.5	12.6	11.5	10.9	10.6
Apr	13.8	13.5	11.8	11.9	17.9	13.9	13.0	12.4	13.1	12.6
May	15.8	15.0	16.4	10.1	16.1	14.8	14.1	15.8	14.5	16.1
Jun	17.5	17.7	17.3	10.7	18.4	19.4	18.4	17.8	17.7	20.4
Jul	18.8	19.0	17.8	11.4	19.1	19.1	19.0	17.0	18.2	20.4
Aug	19.0	18.4	17.9	11.5	19.3	18.7	21.5	17.5	18.3	19.8
Sep	17.7	19.3	18.0	10.9	18.1	19.5	18.9	17.5	18.7	19.5
Oct	13.2	14.2	12.5	09.1	13.8	13.5	17.2	15.5	14.3	16.0
Nov	10.1	10.2	09.9	07.9	10.8	09.9	16.1	09.2	09.5	10.4
Dec	07.9	07.3	08.4	07.9	10.0	10.0	07.8	08.9	06.5	08.0

TABLE 4.10
Monthly Total Rainfall (in milimetre) of Namthang, South Sikkim

Year / Month	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Jan	020.3	015.3	000.0	000.0	006.2	000.0	000.0	011.9	010.6	002.0
Feb	021.0	005.7	016.3	125.8	014.0	000.0	009.6	008.6	002.0	019.4
Mar	036.6	077.7	001.4	021.3	059.5	036.8	025.5	090.4	007.2	078.3
Apr	159.7	043.9	231.0	072.3	174.8	279.7	139.9	117.3	099.9	122.5
May	173.1	170.9	075.4	071.8	537.6	227.3	155.4	153.2	101.4	142.1
Jun	277.4	428.0	169.4	161.3	391.3	227.9	349.1	271.5	371.6	171.0
Jul	353.0	450.7	408.9	590.8	454.0	407.1	547.4	488.4	276.1	215.8
Aug	189.5	339.5	125.7	229.6	785.9	394.0	158.3	373.2	337.1	232.4
Sep	340.3	125.1	470.3	920.1	089.7	175.7	486.3	255.9	319.8	085.8
Oct	045.3	084.2	000.0	048.6	005.2	252.1	012.5	009.6	002.2	062.8
Nov	000.0	000.0	008.5	000.0	000.0	000.0	000.2	026.6	000.0	002.0
Dec	000.0	000.0	000.0	000.0	011.7	000.0	000.0	000.0	000.0	006
Annual Total	1616.2	1741	1506.9	2241.6	2529.9	2000.6	1884.2	1806.6	1527.9	1140.1

TABLE 4.11
Monthly Average Relative Humidity (in %) at 0300 UTC of Gangtok, East Sikkim

Year / Month	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Jan	85	84	80	85	84	84	74	85	83	76
Feb	83	83	83	89	83	82	83	84	83	71
Mar	80	83	76	82	80	68	81	75	76	76
Apr	86	77	74	87	82	81	79	75	80	80
May	90	90	89	85	85	85	87	88	80	90
Jun	93	93	96	94	96	93	93	93	94	93
Jul	96	96	96	96	96	95	94	96	95	95
Aug	96	96	93	94	95	95	95	94	93	94
Sep	96	92	94	92	92	91	93	93	93	94
Oct	87	89	83	92	77	82	86	83	84	87
Nov	80	84	85	81	76	80	87	82	78	75
Dec	80	75	83	82	83	87	76	81	80	85

TABLE 4.12
Monthly Average Relative Humidity (in %) at 1200 UTC of Gangtok, East Sikkim

Year / Month	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Jan	80	80	74	77	81	78	66	76	81	63
Feb	78	80	77	88	76	74	72	76	76	66
Mar	78	83	70	77	80	65	78	73	68	74
Apr	86	77	79	86	81	79	84	77	83	81
May	87	89	86	83	84	81	84	84	78	88
Jun	90	89	93	91	93	88	89	88	93	90
Jul	93	94	94	95	93	92	92	93	94	93
Aug	93	94	93	93	93	92	93	92	91	92
Sep	93	89	91	91	90	88	91	91	91	91
Oct	83	86	81	88	79	79	85	82	80	86
Nov	79	78	83	81	73	78	84	81	73	73
Dec	78	70	81	77	83	81	71	75	74	82

4.4.1 Climatology

Temperature: In winter minimum temperature is 4.5°C and maximum temperature is 14.7°C.In summer minimum temperature is 20.5°C and maximum temperature is 27.5°C.

Rainfall: Most of the rainfall is received between April to September. During the remaining period, rainfall is sporadic and scanty.

Humidity: Months mean maximum and minimum relative humidity at 0300 hrs is 96 % to 71 % respectively, while Months mean maximum and minimum relative humidity at 1200 hrs is 95 % to 71 % respectively.

Wind Speed and Wind Direction: Generally, light to moderate winds prevail throughout the year. Minimum and Maximum Wind speed during last 30 years (Year1971-2000) is varies from 0 to 50.4 km/hr. The Wind Rose Diagram of 0300hrs and 1200hrs for the Year 1971 to 2000 are shown in **Annexure 4.1**.

4.4.2 Air Quality

The prime objective of baseline air quality survey is to assess the air quality of the area; it would also be useful in assessing the conformity to standards of the ambient air quality The ambient air quality within the project study area of 10 km radius forms the baseline information.

The atmospheric concentrations of air pollutants are monitored at 5 locations as shown in **Figure 4.8** for parameters $PM_{2.5}$, PM_{10}, SO_2 , NO_X , O_3 , Pb, NH_3 , HC & CO under ambient air quality monitoring (AAQM). The monitoring is carried out for one season from 19th October 2014 to 21st October 2014. The monitoring frequency for parameters has been kept 48 hourly. The description of Ambient Air Quality Monitoring stations are given in the **Table 4.13**. The results obtained are reported in **Table 4.14**. The results obtained are analysed and compared with ambient air quality standards of Central Pollution Control Board (CPCB). When air quality is compared to the prescribed standards, it is observed that all parameters are within the standards.

FIGURE 4.8
LOCATION OF AIR and NOISE SAMPLES

TABLE 4.13
DESCRIPTION OF AMBIENT AIR and NOISE QUALITY MONITORING STATIONS

STATION NAME	LOCATION		AERIAL DISTANCE FROM PROPOSED ROPEWAY (KM)	DIRECTION
	LATITUDE	LONGITUDE		
Ranggang Village	$27^0$18'54.7" N	$88^0$24'40.1" E	1.02	SE
Mangzing Village	$27^0$17'52.9" N	$88^0$24'40.0" E	2.9	S
Rabangla	$27^0$18'20.5" N	$88^0$21'55.5" E	4.76	NW
Namphak Village	$27^0$18'53.5" N	$88^0$24'42.2" E	1.07	SE
Yanggang Village	$27^0$17'58.9" N	$88^0$24'46.0" E	2.74	S

TABLE 4.14
AIR QUALITY IN AND AROUND PROJECT SITE

Station Name	Date	Parameters								
		Particulate Matter (PM_{10})	Particulate Matter ($PM_{2.5}$)	Sulphur Dioxide (as SO_2)	Oxides of Nitrogen (as NO_2)	Ozone (O_3)	Ammonia (NH_3)	Lead (Pb)	Hydrocarbon as Methane	Carbon Monoxide (CO)
		Unit : $\mu g/m^3$								mg/m^3
Ranggang Village	19/20.10.2014	42	22	4.0	18.6	<19.62	13.8	<0.02	0.54	0.27
	20/21.10.2014	44	23	4.2	21.3	<19.62	18.5	<0.02	0.59	0.31
Mangzing Village	19/20.10.2014	91	46	5.4	24.6	<19.62	20.6	0.02	0.68	0.58
	20/21.10.2014	97	50	6.8	27.4	<19.62	25.8	0.02	0.74	0.67
Rabangla	19/20.10.2014	93	48	6.3	28.6	<19.62	26.3	0.02	0.66	0.62
	20/21.10.2014	86	44	5.9	27.4	<19.62	24.8	0.02	0.61	0.59
Namphak Village	19/20.10.2014	67	34	4.6	26.8	<19.62	22.4	<0.02	0.54	0.43
	20/21.10.2014	71	37	4.8	25.7	<19.62	21.6	<0.02	0.72	0.46
Yanggang Village	19/20.10.2014	62	33	5.0	26.4	<19.62	23.2	<0.02	0.82	0.49
	20/21.10.2014	45	24	4.3	20.6	<19.62	16.3	<0.02	0.68	0.35

4.4.3 Critically polluted area

The proposed ropeway site is not coming under critically polluted areas identified by Central Pollution Control Board.

4.5 NOISE ENVIRONMENT

The impact of noise can lead to effects such as noise induced hearing loss and annoyance depending upon the loudness of noise level. The assessment of impacts of noise sources on surrounding depends on;

- Characteristics of noise sources (instantaneous, intermittent or continuous in nature).
- Time of day at which noise occurs, for example high noise levels at night in residential areas are not acceptable because of sleep disturbance.

- Location of noise source, with respect to noise sensitive land use, which determines the loudness and period of exposure.

Noise level survey is conducted at the project area with an objective to establish the baseline noise levels and assess the impacts of the noise expected due to the proposed development. Noise level survey is conducted at 5 locations. The description of noise sampling locations are same as air sampling locations and given in **Table 4.13**. Noise levels are recorded on hourly equivalent noise level for 48 hourly in order to have an assessment of the Day and Night time noise levels. At all the location noise ambient noise quality is within prescribed limit given by Central Pollution Control Board except Rabangla Town location. The monitoring result of Rabangla Town is exceed the permissible limit because the heavy Traffic. The noise levels so obtained are summarized in **Table 4.15.**

TABLE 4.15
NOISE LEVELS OF THE PROJECT SITE

STATION NAME	Date	L_{10}	L_{50}	L_{90}	L_{max}	L_{min}	L_{day}	L_{night}	L_{dn}
Ranggang Village	19/20.10.2014	48.2	53.3	63.0	63.9	47.3	59.6	50.4	49.2
	20/21.10.2014	47.9	50.3	54.3	56.0	47.0	51.8	50.9	47.6
Mangzing Village	19/20.10.2014	49.6	55.5	62.2	63.7	46.5	59.8	52.0	50.2
	20/21.10.2014	50.4	51.8	54.1	55.4	49.9	52.6	52.1	48.8
Rabangla	19/20.10.2014	48.3	65.1	73.4	74.7	45.1	70.9	52.8	57.7
	20/21.10.2014	49.2	64.0	75.3	76.2	47.1	71.9	53.6	58.7
Namphak Village	19/20.10.2014	49.2	55.9	62.1	63.9	48.0	60.0	52.9	50.9
	20/21.10.2014	49.1	53.6	63.4	66.1	47.8	60.4	50.8	49.8
Yangang Village	19/20.10.2014	48.7	51.4	55.6	58.2	48.1	53.5	51.0	47.9
	20/21.10.2014	52.8	54.5	57.1	57.9	51.9	55.1	54.6	51.3

The major source of noise pollution during construction phase will be construction machineries, while DG sets will create noise during power failure. The noise generated during the construction phase is temporary in nature and precautionary measures are taken in the Environmental Management Plan (EMP). However, during operation of Ropeway, the only concern is the emission from DG set during power failure.

4.6 ECOLOGICAL ENVIRONMENT

The ecological studies are required to understand the impact of activities due to the project on the environment. The main aim of this section is to document the flora and fauna at project site and in its surroundings within 10 km radius. Information is documented through field visits, surveys and visual inspection. The project area falls in the Maenam Wildlife Sanctuary and Reserved Forest.

Sikkim is situated in an ecological hotspot of the lower Himalayas, one of only three among the Ecoregions of Sikkim is situated in an ecological hotspot of the lower Himalayas, one of only three among the Ecoregions of India. The forested regions of the state exhibit a diverse range of fauna andflora. Owing to its altitudinal gradation, the state has a wide variety of plants, from tropical to temperate to alpine and tundra, and is perhaps one of the few regions to exhibit such a diversity within such a small area. Nearly 81% of the area of Sikkim comes under the administration of its forest department.

The flora of Sikkim include the rhododendron, the state tree, with a wide range of species occurring from subtropical to alpine regions. Orchids, figs, laurel, bananas, sal trees and bamboo grow in the lower altitudes of Sikkim, which enjoy a subtropical-type climate. In the temperate elevations above 1,500 metres, oaks, chestnuts, maples, birches, alders, and magnolias grow in large numbers. Thealpine-type vegetation includes juniper, pine, firs,

cypresses and rhododendrons, and is typically found between an altitude of 3,500 to 5 000 m. Sikkim has around 5,000 flowering plants, 515 rare orchids, 60 primula species, 36 rhododendron species, 11 oak varieties, 23 bamboo varieties, 16 conifer species, 362 types of ferns and ferns allies, 8 tree ferns, and over 424 medicinal plants. A variant of the Poinsettia, locally known as "Christmas Flower", can be found in abundance in the mountainous state. The orchid Dendrobium nobile is the official flower of Sikkim.

The fauna include the snow leopard, the musk deer, the Himalayan Tahr, the red panda, the Himalayan marmot, the serow, the goral, the barking deer, the common langur, the Himalayan Black Bear, the clouded leopard, the Marbled Cat, the leopard cat, the wild dog, the Tibetan wolf, the hog badger, the binturong, the jungle cat and the civet cat.

The avifauna of Sikkim consist of the Impeyan pheasant, the crimson horned pheasant, the snow partridge, the snow cock, the lammergeyer and griffon vultures, as well as golden eagles, quail,plovers, woodcock, sandpipers, pigeons, Old World flycatchers, babblers and robins. Sikkim has more than 550 species of birds, some of which have been declared endangered.

4.6.1 Maenam Wildlife Sanctuary

The Maenam Wildlife Sanctuary was declared vide notification No. 63/WL/F/86 dated 09/03/1987 covering an extent of 35.34 sq. km. The word Maenam has ethnically derived from the original local word ñMaenam-laò meaning the ñTreasure-house of Medicinesò Maenam Wildlife Sanctuary is located on the Maenam-Tendong ridge which runs north-south bisecting Sikkim longitudinally and is rained by the Tista river to the East and Rangit river in the West. The altitudinal gradient of 2,300 m - 3,300 m provides for a range of microclimates and floral diversity from subtropical forests to stabilized scree slopes. These diverse forest types in turn shelter a wide range of faunal elements. The Sanctuary has tremendous watershed value, being the only source of perennial water on this ridge.

4.6.1.1 Flora

The sanctuary with its geographical location, wide variety of vegetation structure, topography and conducive climate have all contributed to its hosting almost all possible major groups of plants. The list of flora found in the Sanctuary is given in **Table 4.16**

TABLE 4.16
LIST OF FLORA FOUND IN WILDLIFE SANTUARY

S.NO.	BOTANICAL NAME	LOCAL NAME
1	Castanoipsis hysterix	Katus
2	Machilus spp.	Kawla
3	Rhododendron spp.	Chimal
4	Symplocos spicata	Kholme
5	Symplocos theifolia	Kharane
6	Michelia excelsa	Rani Champ
7	Quercus Drboretum	Buk
8	Quercus lineate	phalant
9	Leocosceptrum canum	Ghurpis
10	Lithocarpus pachyphylla	Sungure Katus
11	Betula alnoides	Saur
12	Nyssa javanicit	Lekh Chilaune
13	Symingtoria populnea	Pipli
14	Acer campbelli	Kapasi
15	Magnolia campbelli	Ghoge Champ
16	Engelhardtia spicata	Mahuwa
17	Eurya japonica	Jhingni

18	Rhododendron Drboretum	Guransh
19	Vibemum spp.	Asare
20	Abies densa	Gobre Salla
21	Rhododendron spp.	Chimal
22	Betula utilis	Bhujpat
23	Cinnamomum spp.	Sissi
24	Quercus lancaefolia	Patle Katus
25	Echinocarpus dasycarpus	Gobre
26	Elaeocarpus lancaefolius	Bhadrase
27	Litsea spp.	Pahenle

4.6.1.2 Fauna

The sanctuary is very rich in wildlife and contains 6 .species included in Schedule-I of the Wildlife (protection) Act, 1972. (Reference in Chapter-I, Part-I.S) including presence of the Red Panda which is the flagship species. The list of major fauna found in the Sanctuary is given in **Table 4.17**.

TABLE 4.17
LIST OF FAUNA EXISTING IN SANTUARY

Sr. No.	Family	Common Name
1	Felidae	Leopard
2	Mustelidae	Himalayan Yellow Throated Marten, Common Otter
3	Viverridae	Himalayan Palm Civet
4	Cannidae	Wild dog, Indian Fox, Jackal
5	Ursidae	Himalayan Black Bear
6	Suidae	Wild Boar
7	Ailuridae	Red Panda
8	Cervidae	Musk Deer, Barking Deer
9	Goat - Antelope	Goral, Serow
10	Primates	Assamese Macaque
11	Pheasants	Crimson Homed Pheasant and Kaleej Pheasant & Blood Pheasant
12	Others	Crestless Porcupine, Rufous Tailed Hare, Chinese Pangolin, Parti-coloured Flying Squirrel, Hoary-bellied Squirrel, Orange Bellied Squirrel, Shrew, Himalayan Mouse Hare

4.7 Historical/Archeological Monuments

There is no ancient archeologically important monument in the project area.

4.8 SOCIO-ECONOMIC ENVIRONMENT

The state of Sikkim enveloped by the Himalayas, is home to one of the world's highest peaks, Kanchenjunga, and as with most of the Himalayan region, Sikkim is rich in bio-diversity and natural beauty, making it a sought after tourist destination. Sikkim draws its culture from its neighbors which are Nepal, Bhutan, and Tibet, and many dialects are spoken here. The cuisine, music and other recreational activities like festivals are also influenced by Sikkim's border-mates. The Sikkim census of 2011 says population of Sikkim is the least in all of India. This thinly populated state has a population of mere 6 lakh, and has grown by approximately one lakh since the last census. The decadal population growth of Sikkim for 2001-2011 is 12.36% against the national average of 17.64%. The adverse land-man ratio is reflected in the low density of population, which is 86 per sq. km against the national average of 382 per sq.km. According to 2011 census, the literacy rate in the state is 87.29% which is also greater than the country. The some of the Socio-Demographic details given in **Table 4.18**.

TABLE 4.18
SOCIO-DEMOGRAPHIC INDICATORS OF SIKKIM AND INDIA

Indicators	Sikkim		India	
	2001	2011	2001	2011
Population Males Females	5,40,851 2,88,484 2,52,367	6,07,688 3,21,661 2,86,027	1,027,015,247 53,12,77,078 49,57,38,169	1,210,569,573 623,121,843 587,447,730
Percentage decadal growth	12.36		17.64	
Sex ratio	875	889	933	943
Population Density (Population per sq.km.)	76	86	325	382
Literacy (%)				
Male Female Total	77.38 59.63 68.81	87.29 76.43 82.20	75.26 53.67 64.83	82.14 65.46 74.04
Area (sq.km.)	7,096		32,87,263	

Source: Census of India-2001 and 2011

The South District is a very small district of the hill state of Sikkim. This district covers an area of 750 Sq km with a population of 1,25,651. The literacy rate of 66.41 percent, which is below the state average. The district with the headquarters at Namchi comprises of the two sub-division of Namchi and Ravongla. There area 45 Gram Panchayats units and 145 revenue blocks (including 10 special forest blocks). The district is a part of inner ranges of mountains of Western Himalayas consisting of higher hills, alpine zones and snow bound areas. The terrain is hilly with narrow incised river valleys with elevations ranging 300 to 5000 m. the slope varies from 80m, to more than 600m per kilometer.

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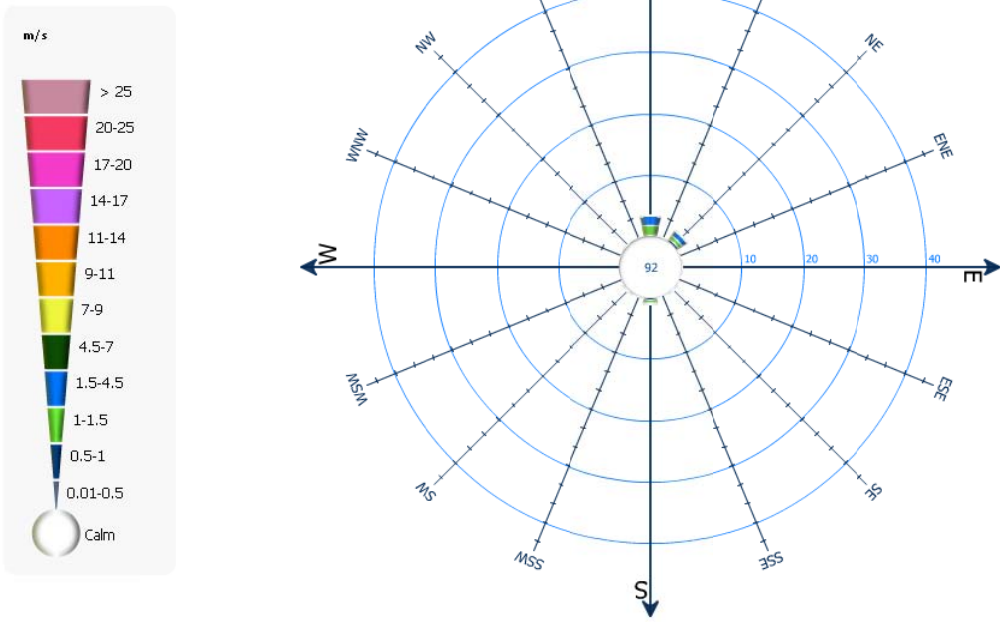
Annexure 4.1

Wind Rose Diagram of 0300hrs and 1200hrs for the Year 1971 to 2000

GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

Month(s) : 01
Hour(s) : 03
Period : 1971/01/01 00:00 - 2000/12/31 23:00



GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

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Hour(s) : 03
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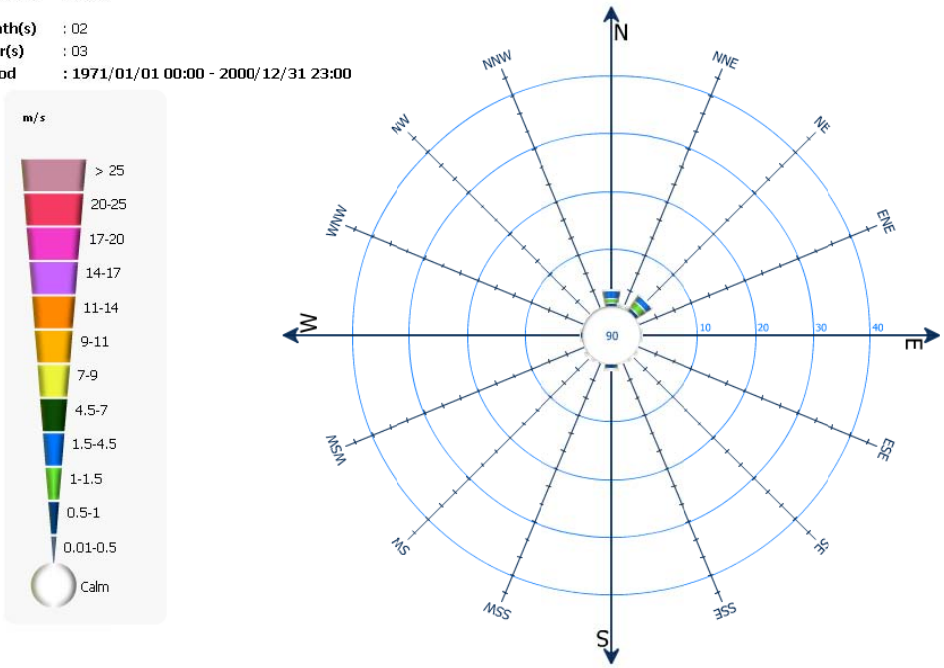
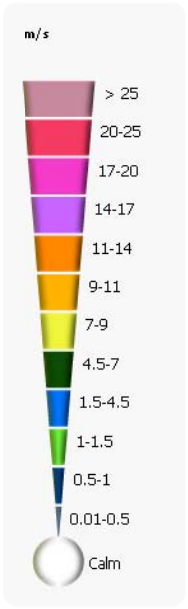
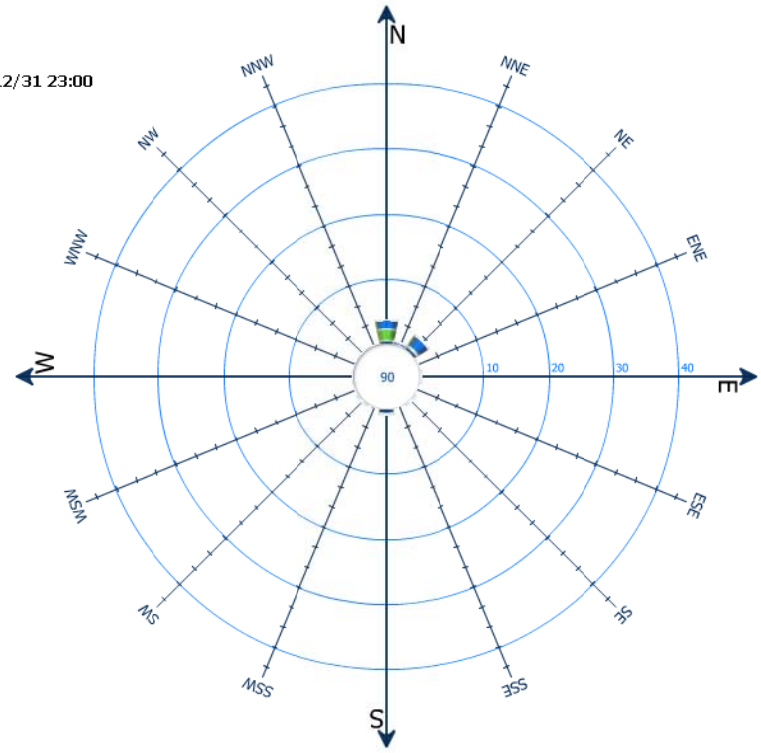


GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

Month(s) : 03
Hour(s) : 03
Period : 1971/01/01 00:00 - 2000/12/31 23:00





GANGTOK

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Longitude : 88 5'19"E
Elevation : 1756.0 m

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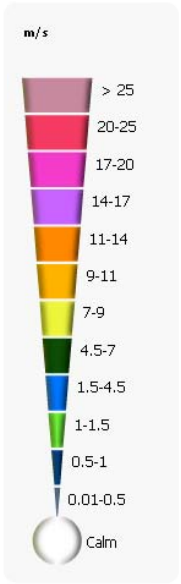

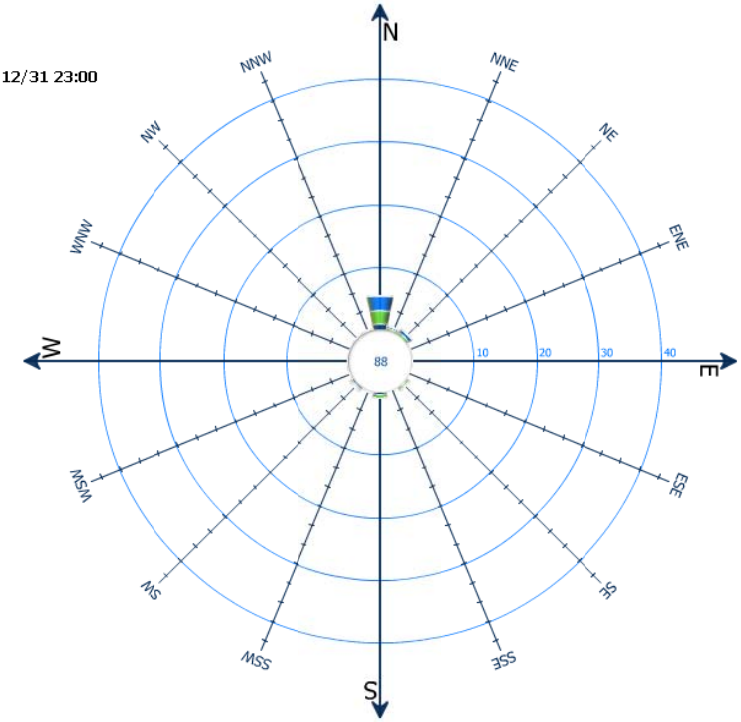

GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

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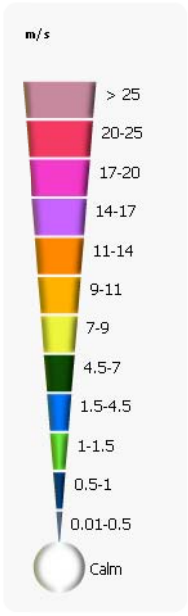
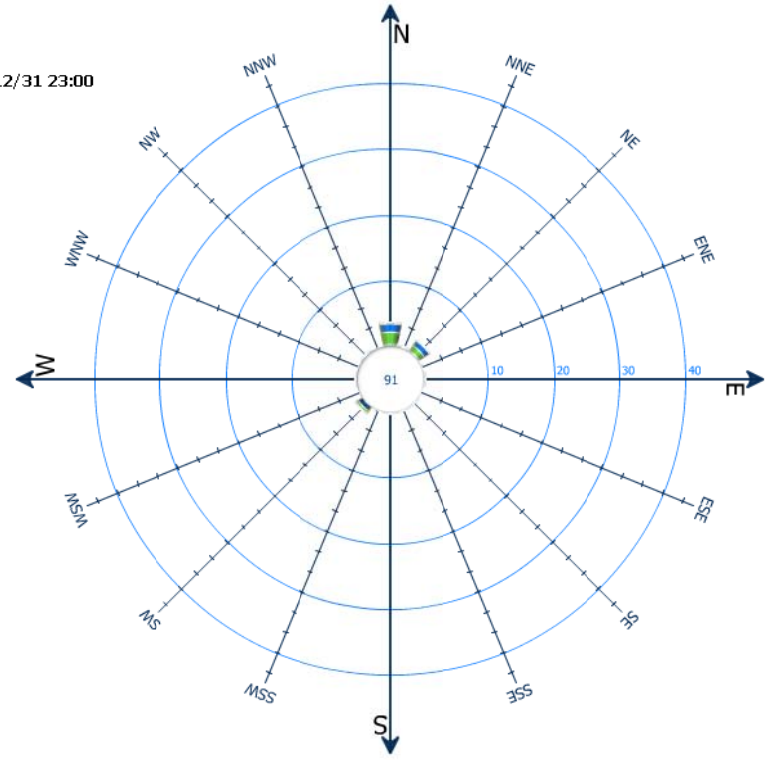
Hour(s) : 03
Period : 1971/01/01 00:00 - 2000/12/31 23:00





GANGTOK

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Longitude : 88 5'19"E
Elevation : 1756.0 m

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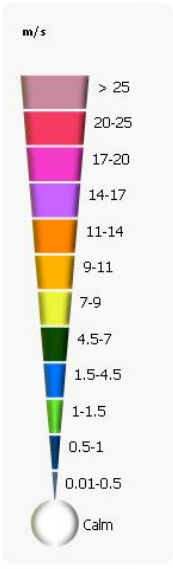
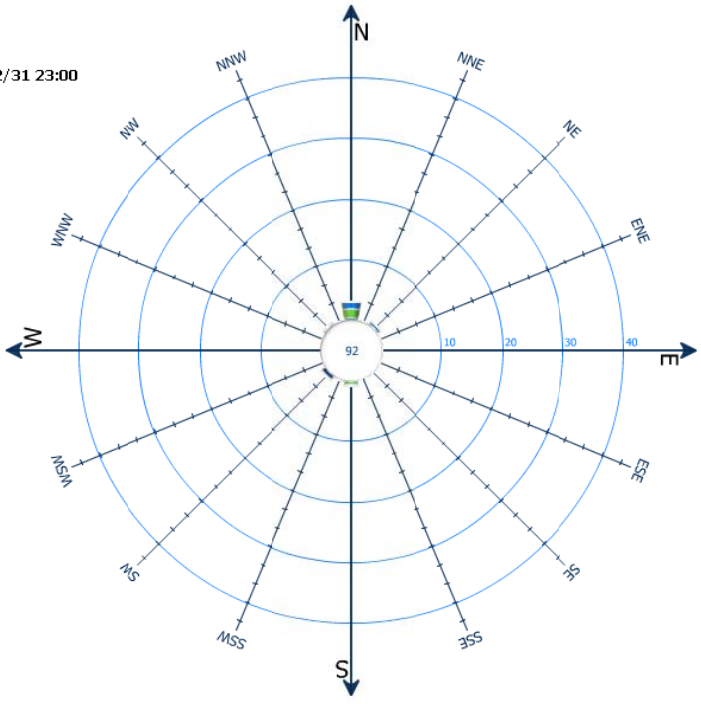
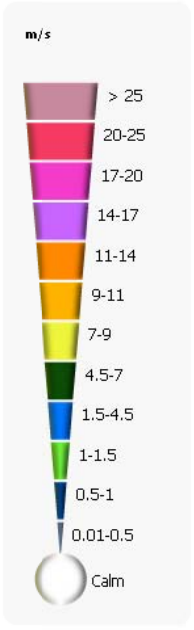


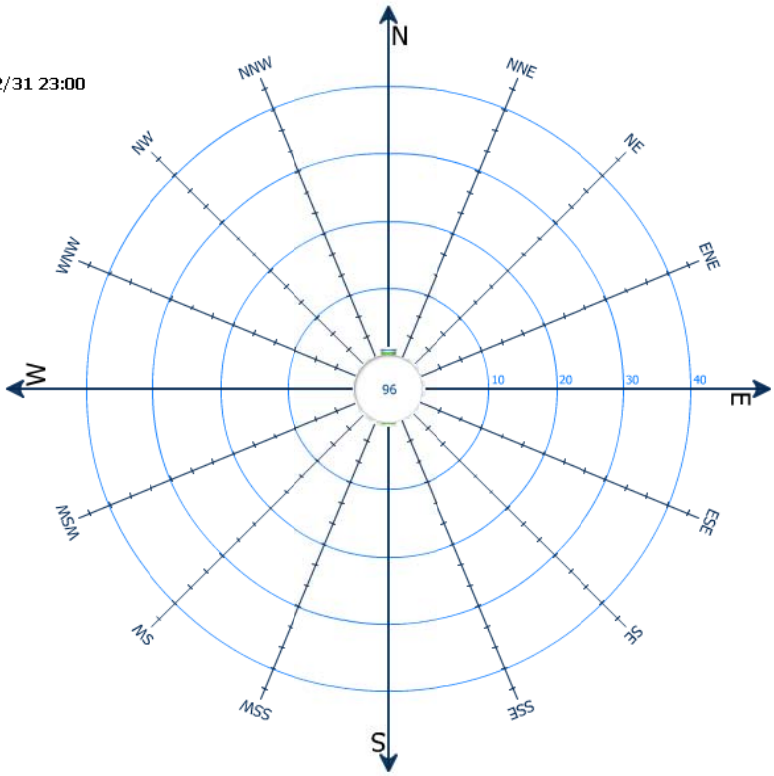


GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

Month(s) : 07
Hour(s) : 03
Period : 1971/01/01 00:00 - 2000/12/31 23:00





GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

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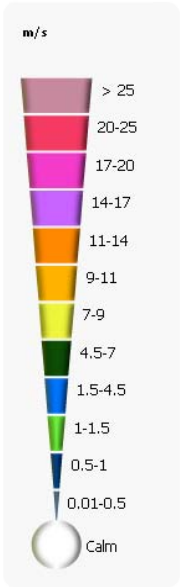

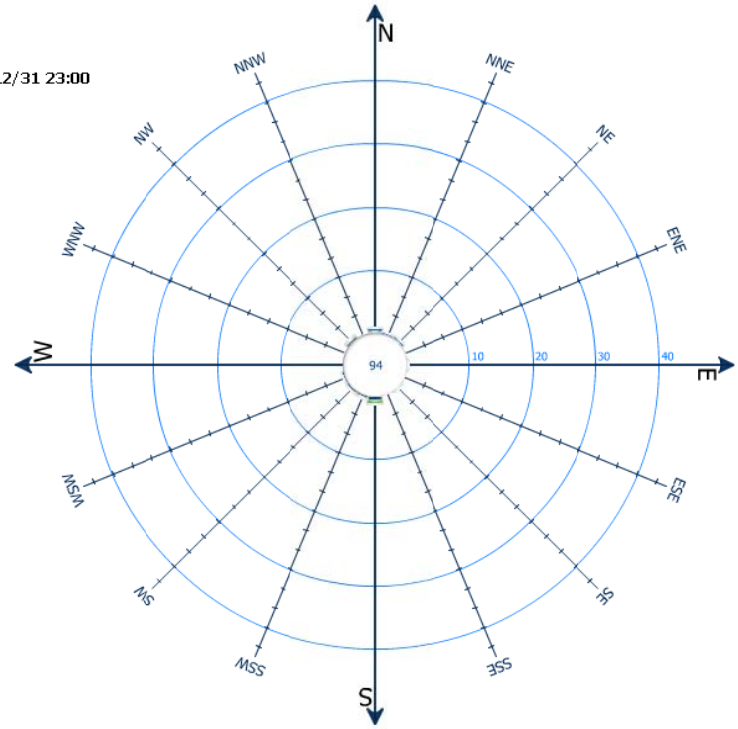

GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

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Hour(s) : 03
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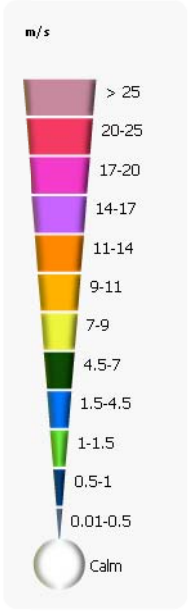

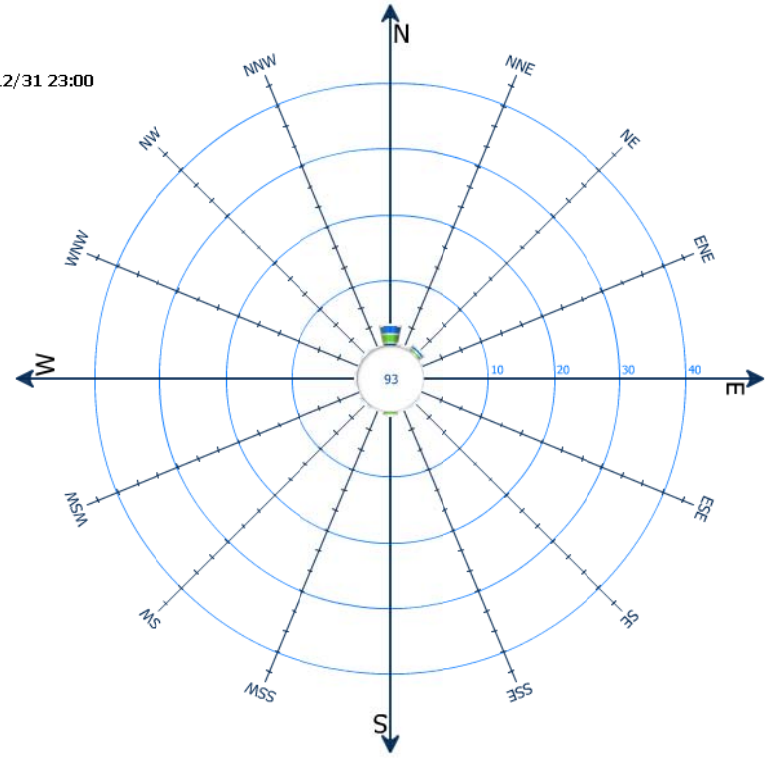

GANGTOK

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Longitude : 88 5'19"E
Elevation : 1756.0 m

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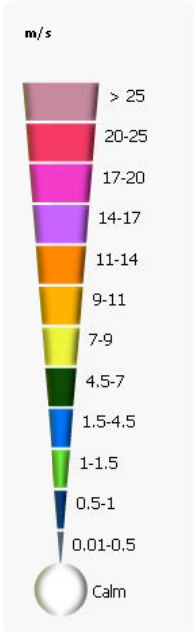

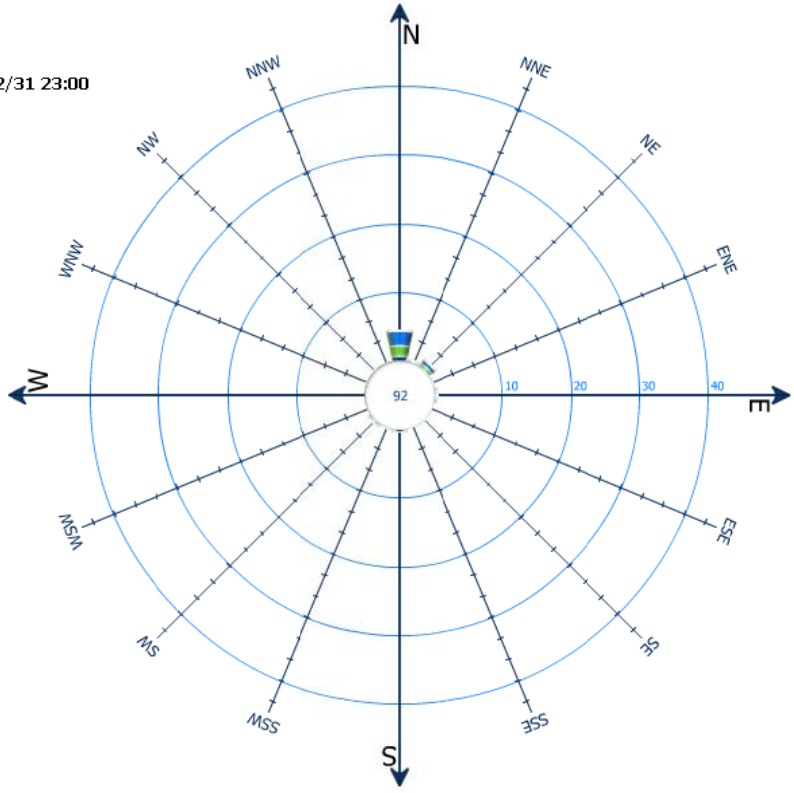

GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

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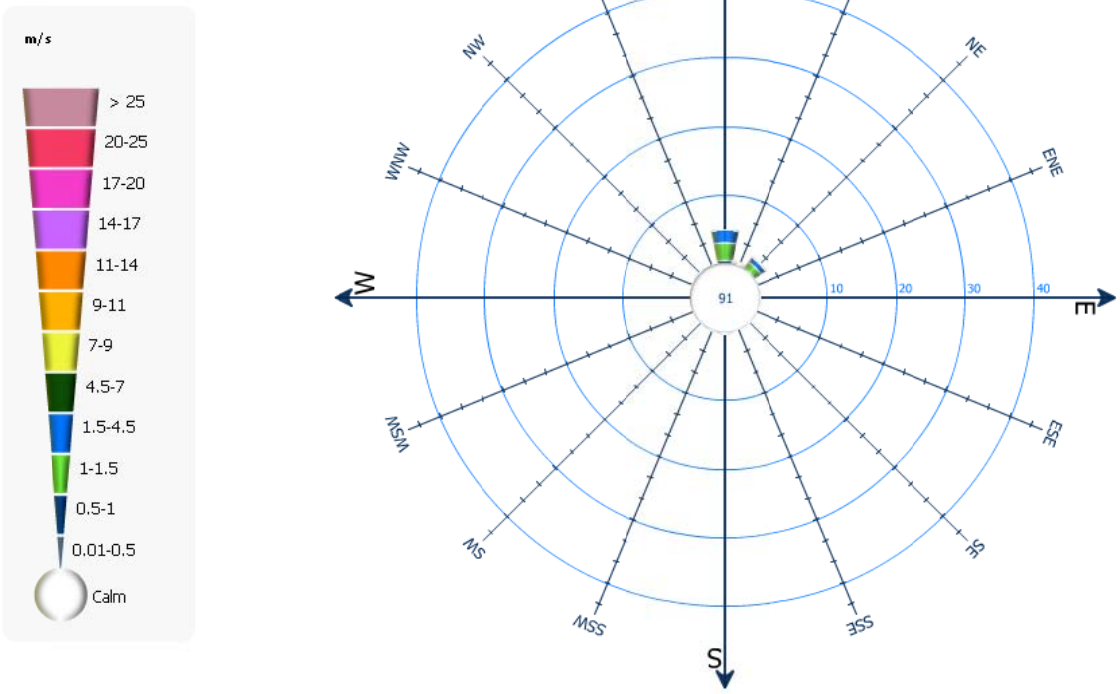

GANGTOK

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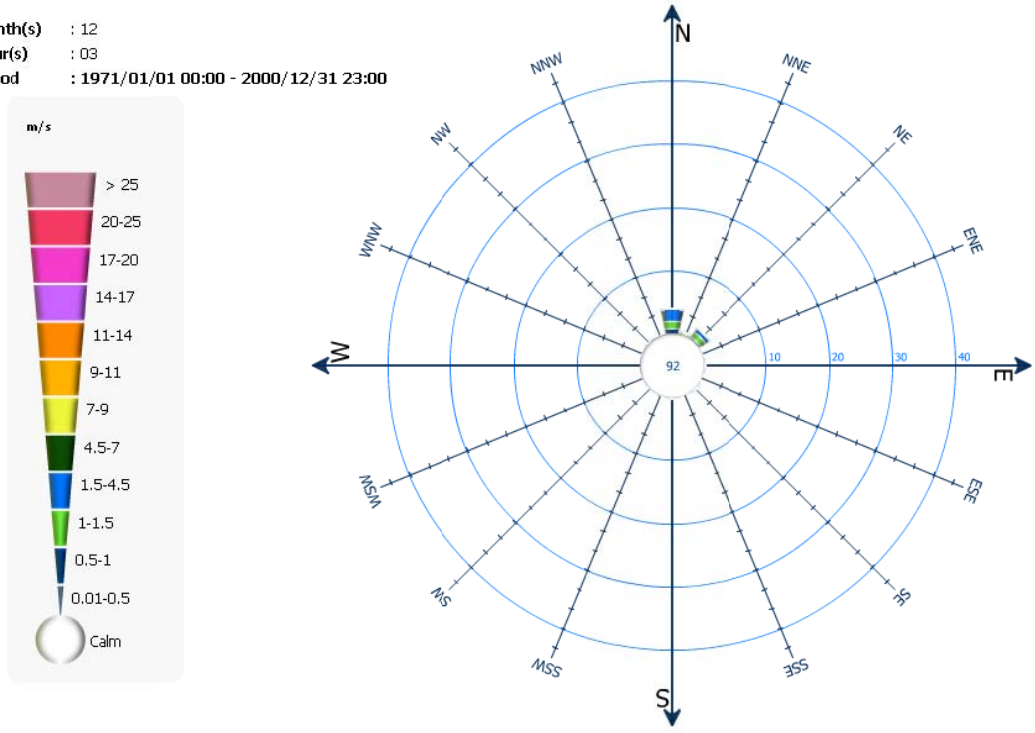

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

Month(s) : 01
Hour(s) : 12
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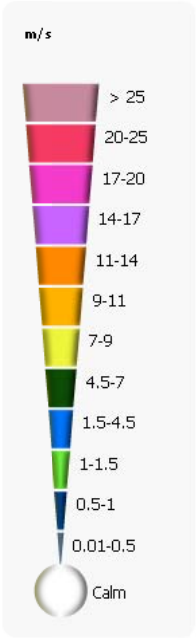

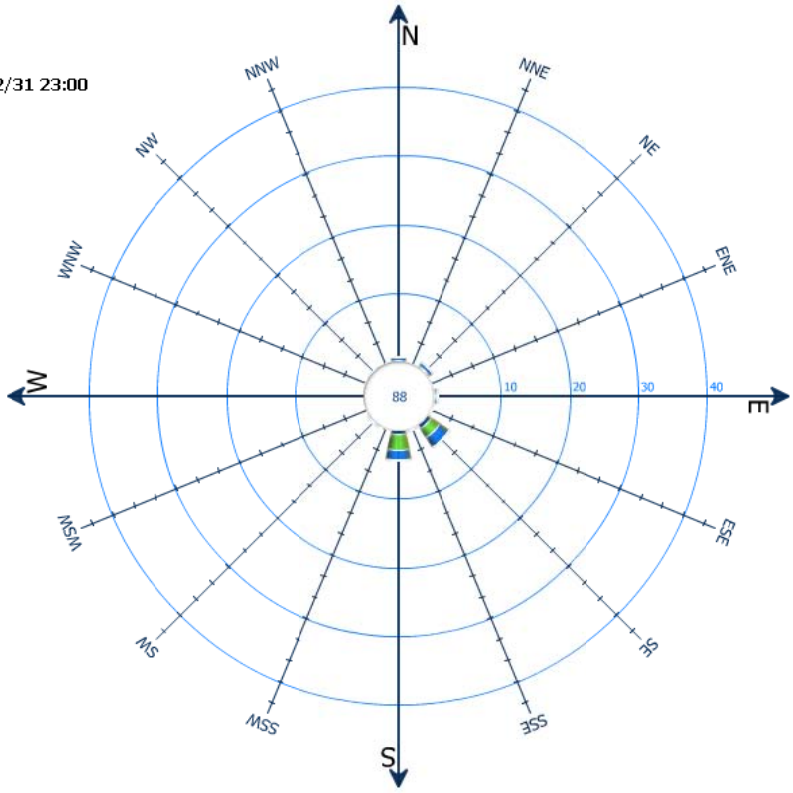

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Hour(s) : 12
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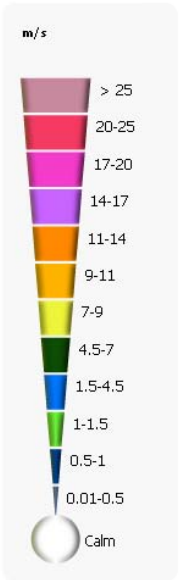

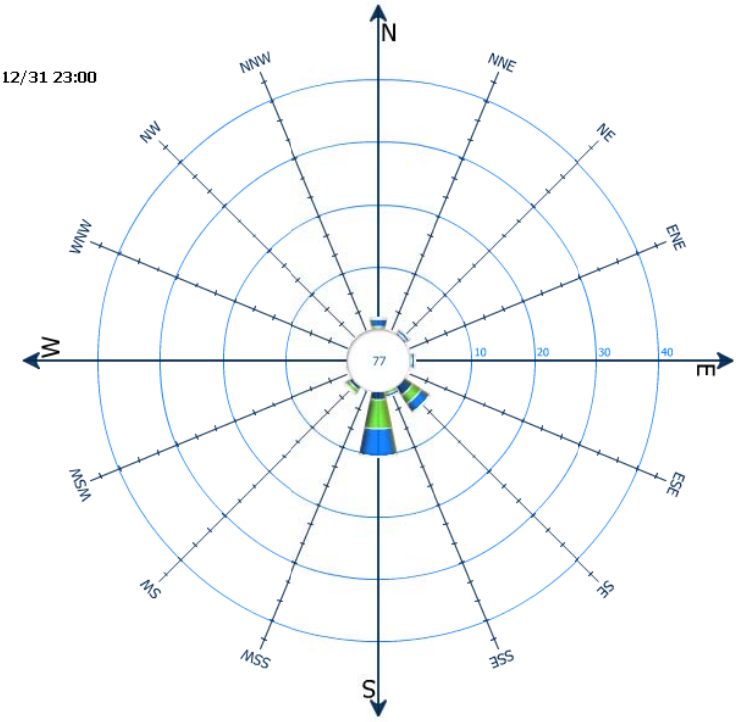

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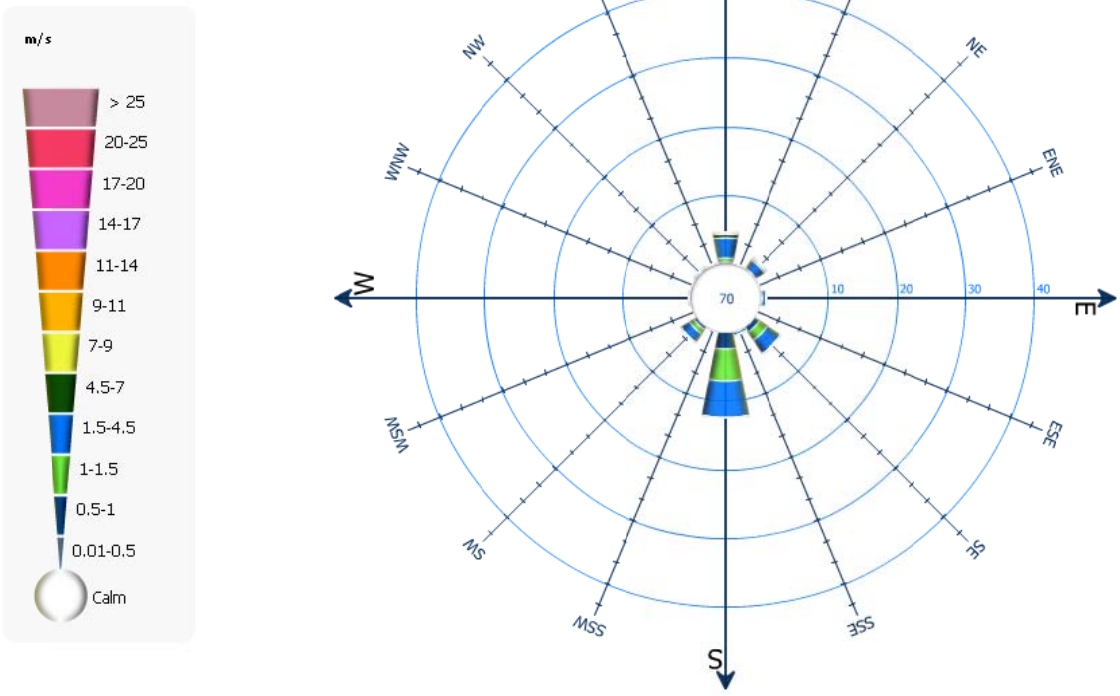

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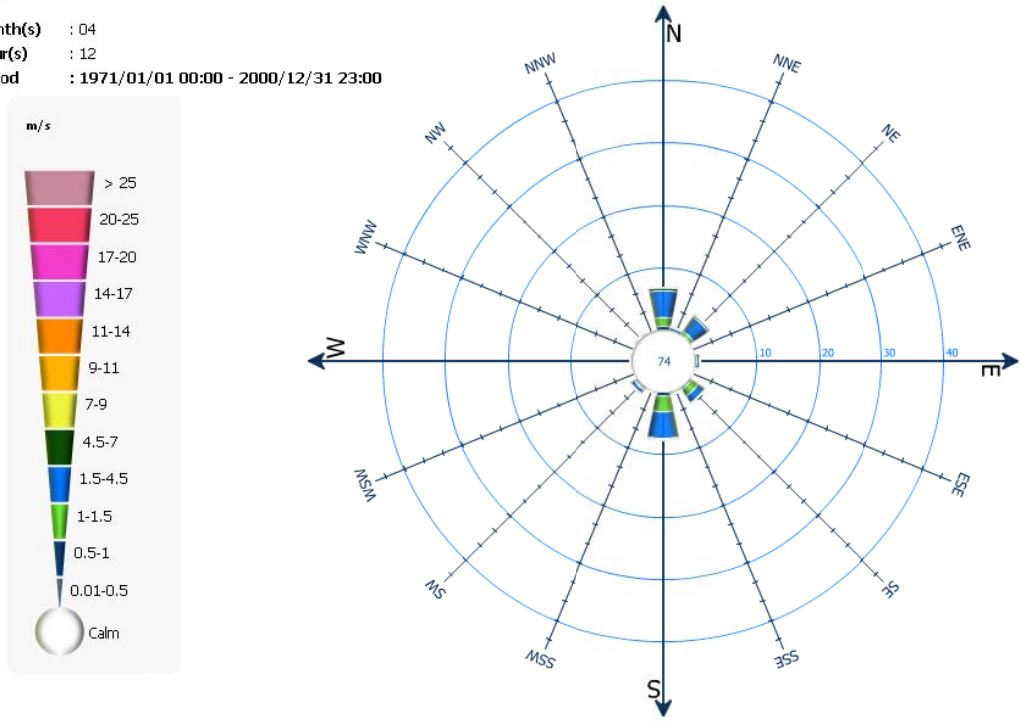

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Elevation : 1756.0 m

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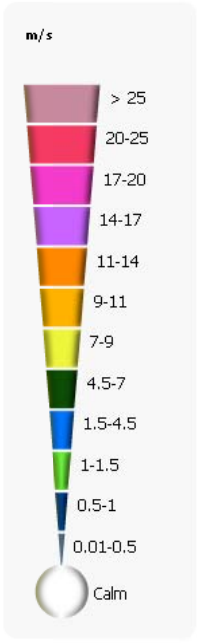

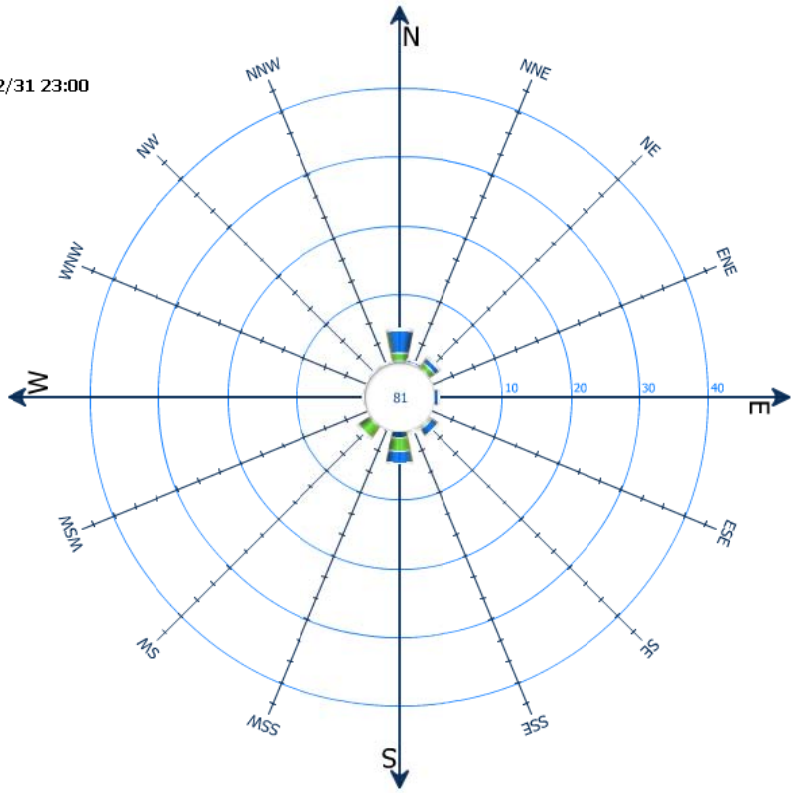

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Elevation : 1756.0 m

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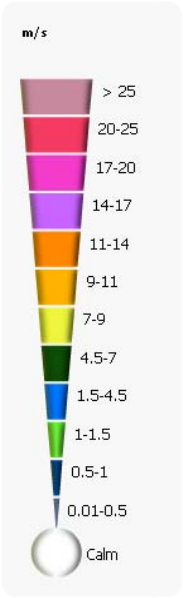

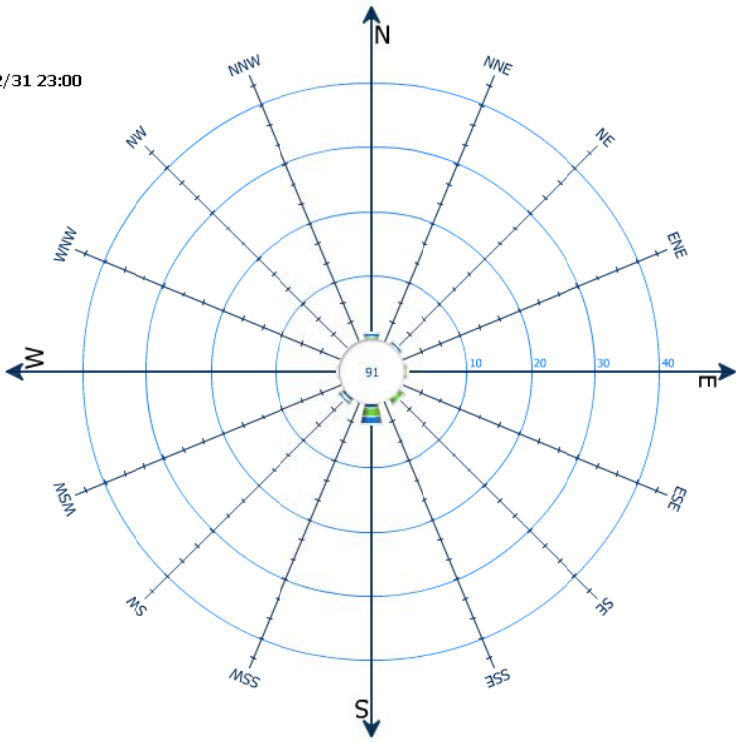

GANGTOK

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Elevation : 1756.0 m

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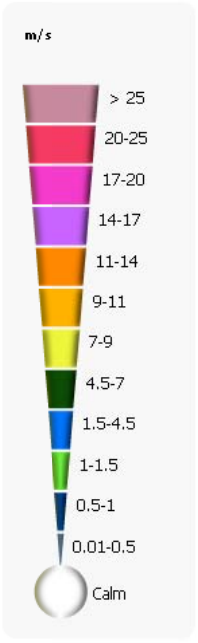
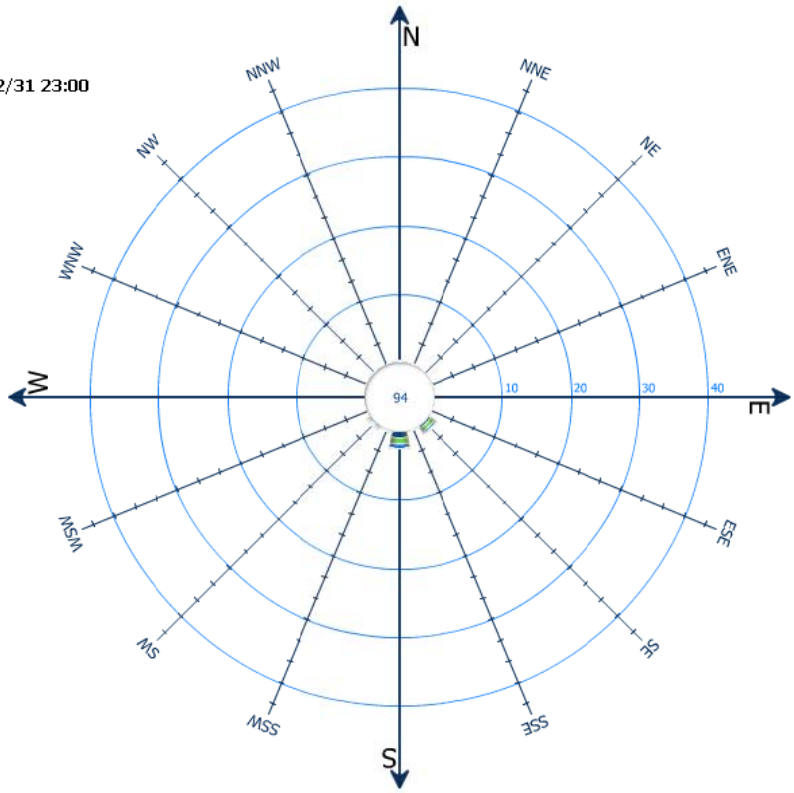
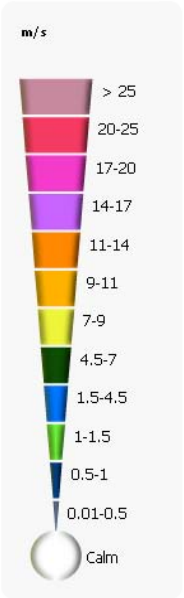


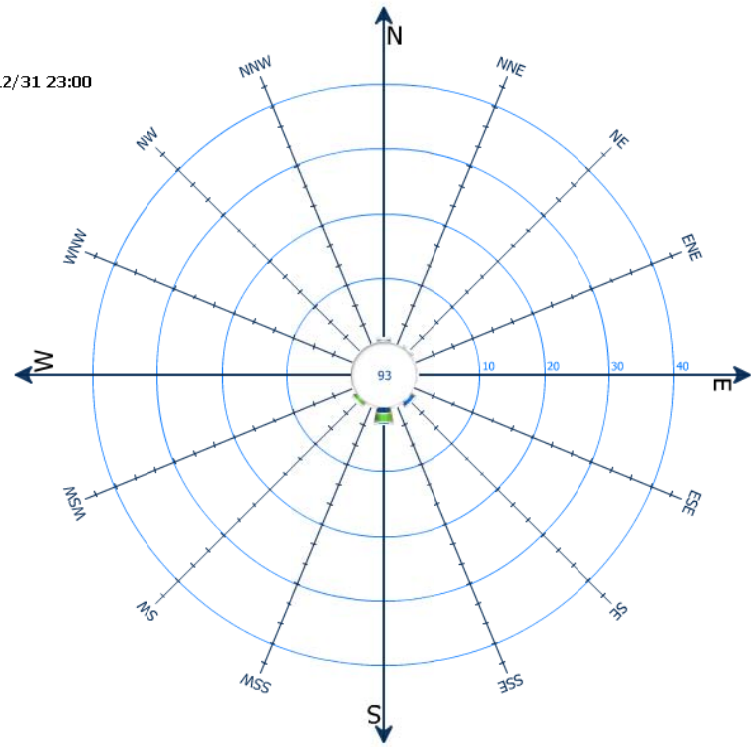


GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

Month(s) : 08
Hour(s) : 12
Period : **1971/01/01 00:00 - 2000/12/31 23:00**





GANGTOK

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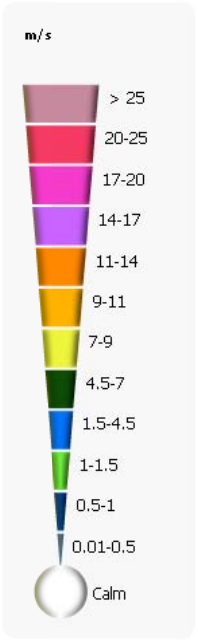
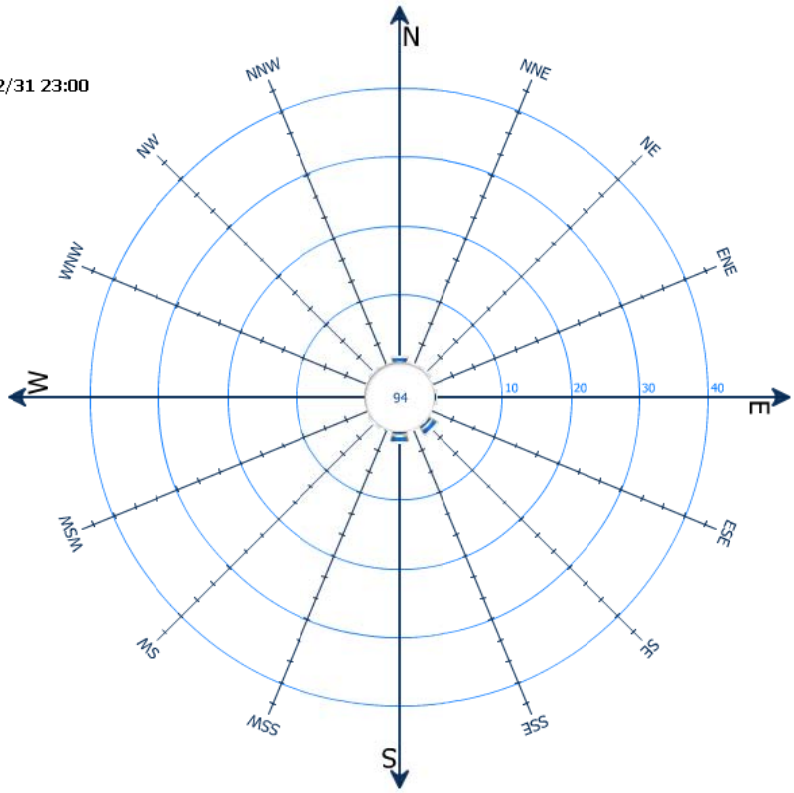
Longitude : 88 5'19"E
Elevation : 1756.0 m

Month(s) : 09
Hour(s) : 12
Period : 1971/01/01 00:00 - 2000/12/31 23:00





GANGTOK

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Longitude : 88 5'19"E
Elevation : 1756.0 m

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Hour(s) : 12
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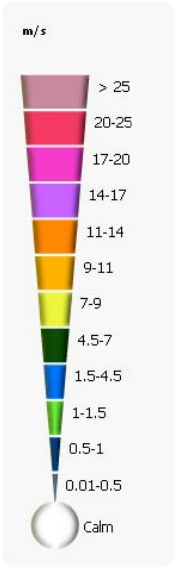

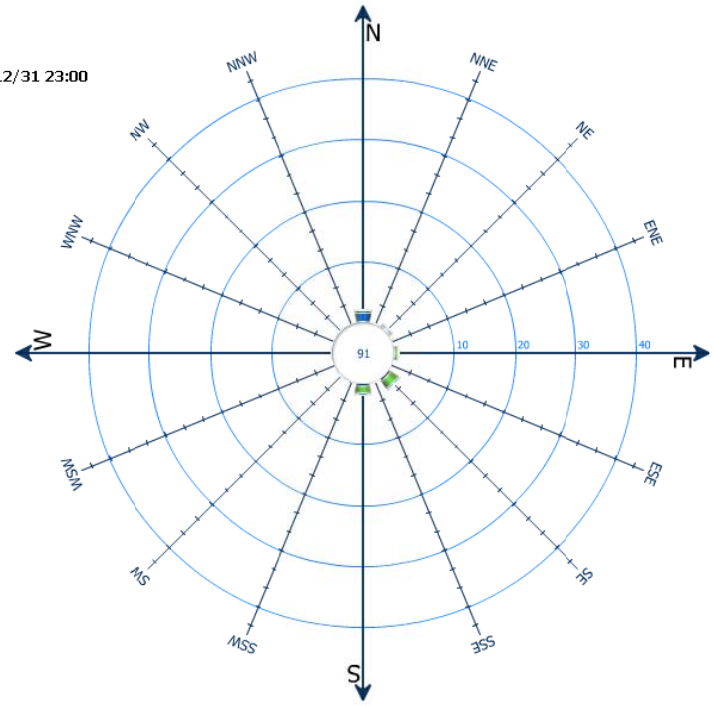

GANGTOK

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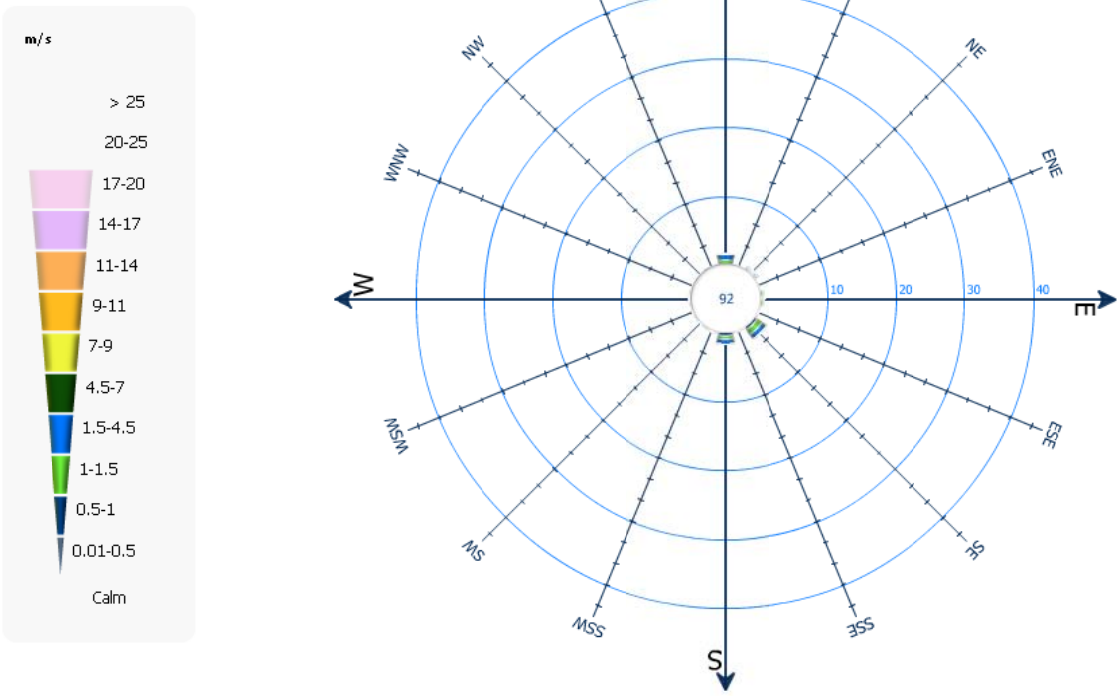
Longitude : 88 5'19"E
Elevation : 1756.0 m

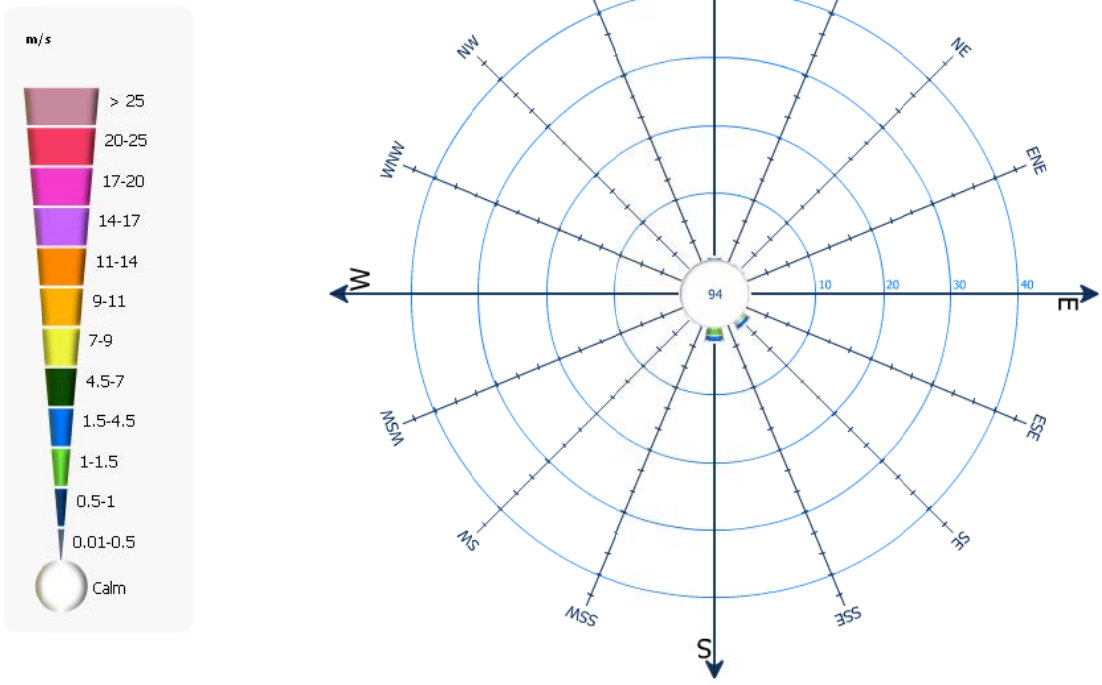
Month(s) : 11
Hour(s) : 12
Period : **1971/01/01 00:00 - 2000/12/31 23:00**



GANGTOK

Latitude : 27 1'38"N
Longitude : 88 5'19"E
Elevation : 1756.0 m

Month(s) : 12
Hour(s) : 12
Period : **1971/01/01 00:00 - 2000/12/31 23:00**



CHAPTER 5
IMPACT ASSESSMENT & MITIGATION MEASURE

5.1 ENVIRONMENTAL IMPACT

The primary function of an environmental impact assessment study is to predict and quantify the magnitude of impacts, evaluate and assess the importance of the identified changes and formulate plans to monitor and mitigate the actual changes. Environmental impacts could be positive or negative, direct or indirect, local, regional or global, reversible or irreversible. The process begins by identifying the development and operational activities resulting from the proposed project as contained in **Chapter-2** and **Chapter-4** is dedicated for providing information on the baseline environmental conditions for various parameters. This chapter discusses the potential impacts on environment. Attempts have been made to predict the impacts due to proposed project. The pollutants generated at the proposed project premises during construction and operation phases are solid, liquid and gaseous in nature. Pollutants may be generated continuously, periodically or accidentally. Sources of pollutants and their characteristics during the construction and operation phase are given in **Table 5.1**. This section identifies and appraises the negative as well as positive impacts on various aspects of the environment likely to result from the proposed development.

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

The impacts on the above environmental components have been assessed during various phases of project cycle namely project design, construction and operation.

5.2 IMPACT ON LAND ENVIRONMENT

The impacts likely to take place due to the project location could be mainly due to land acquisition and its diversion for project purpose. The land required for the proposed project is about 2.9 ha in which 1.2 ha in Maenam Wildlife Sanctuary and 1.7 ha in Reserved Forest. Hence, an application was submitted for denotification of proposed land. The Honorable Supreme Court of India permits the use of 2.1 ha land of Maenam Wildlife Sanctuary land for the construction of Skywalk and Ropeway. The copy of order is enclosed as **Annexure 5.1**. During construction, increased soil erosion due to site clearance and earthwork is anticipated. The land use of 2.9 ha is changed from forest to non forest.

5.2.1 Displacement of People

The proposed Ropeway systems will not have any displacement of people since the land belongs to the Maenam Wildlife Sanctuary and Reserved Forest. Hence no social issues related to land acquisition, encroachers and squatters is anticipated.

5.2.2 Impacts on Topography, Drainage and Soil Quality

The area required for terminal stations are almost flat. The ropeway alignment crosses one nallah. The sites for the terminal stations will be leveled in accordance with the topography of the region and thus there will be no significant impact on the topography and drainage of the area. The ropeway Impact on soil owing to the construction of terminals includes soil erosion, compaction and pollution of soil in case of waste discharge on land. The impact will be however short term in duration and will have no significant impacts.

TABLE 5.1
POLLUTION SOURCES AND CHARACTERISTICS

S.No.	Activity/Area	Pollutant	Pollutant Characteristic	Frequency
CONSTRUCTION PHASE				
1	Construction activities on and off the construction site.	Air Emissions- $PM_{2.5}$, PM_{10}, CO, NO_x, SO_2	Dust from excavation, concrete mixing, material handling and other construction activities. Emissions from vehicles and machinery.	Temporary during construction phase only.
		Debris/Solid waste	Debris/leftover waste from construction activities. Garbage of construction workers /office	Commensurate with the construction activities
		Noise	Noise generated from construction equipment and machinery	Commensurate with the construction activities
		Waste water	Construction office/workers	Temporary during construction phase only
OPERATION PHASE				
2	Vehicular movement	Air Emission and Noise	Vehicular emissions	Continuous/ Periodic
3	Diesel Generators	Air emission	SO_2, NO_X, SPM, CO from fuel burning	Intermittent/ Periodic
		Noise	Noise due to running of equipment	Intermittent/ Periodic
4	Office, restaurant, etc.	Sewage	Domestic wastewater-BOD, Suspended solids, pathogens	Continuous
5	Open area	Wastewater, solid waste	Wash water and road sweepings	Intermittent/ Periodic
6	Storm water drains	Suspended Solid	Contaminated discharge from site – mainly suspended solids	During rainy season

5.2.3 Impact on Slope Erosion/Landslides

Slope Erosion: Erosion aspect of a hill slope is an important factor in determining its stability condition. The deep gully, toe erosion by nallahs destabilizes slopes. It has been observed that the toe erosion by nallah is affecting the slope stability at number of places but nowhere affecting the proposed ropeway.

Landslide: The status of slope stability is an important aspect that can affect the landslide hazard in the area. This is reflected by the landslide incidences in the past. The landslide affected slopes reflect the instability condition of slope and add to the hazard vulnerability in the area. There is no landslide incidences occurred at project site.

5.2.4 Risk due to Earthquakes

The project area falls under seismic zone IV as per the Seismic Zoning Map of India. Necessary seismic factors (horizontal and vertical ground acceleration), as per relevant Indian Standard Code (IS: 1893 – Part – 1: 2002) shall be adopted. All components of structures shall be designed for seismic zone IV to ensure the safeguard against earthquake risks.

5.2.5 Impact due to Solid Waste

During Construction: Building construction leads to generation of sand, gravel, concrete, stone, bricks, wood, metal, glass, polythene sheets, plastic, paper etc. as waste. Inorganic solid waste generated during the construction phase like waste concrete and mortar, left over aggregate and debris etc. shall be recycled for use in the base layers of paved area. About 100 numbers of labours will be required for construction of Ropeway. Considering an average contribution of 100 gm/person/day, 10.0 Kg/day of solid waste shall be generated from construction site. Most of the waste generated will be Municipal solid waste as major construction activities at site are assembling the structural steel components for towers and terminal stations.

During operation: About 26 persons per day are recommended in DPR for operation of Ropeway systems. The design capacity of the proposed ropeway is 4000 passenger per day. It is estimated that about 402.6 kg per day of municipal solid waste @ 100gm/day/person will be generated during the operation phase, which needs to be disposed off.

The recommended waste management plan is based upon the principle to reduce the amount of waste for disposal through the development of outline plans for waste avoidance, material re-use and recycling and is discussed in the Environment Management Plan.

5.2.6 Impact on Existing Features within 1 km

The existing features at project site within 1 km radius are Maenam Wildlife Sanctuary, Reserved Forest, Helipad, Approach Road/Footpath and Water storage tanks.

Impact on Maenam Wildlife Sanctuary has been assessed as depicted in **Section 5.7**. Impacts on the other features are insignificant due to limited construction activities. No environmental impacts are anticipated during operation of ropeway systems.

5.3 IMPACT ON WATER ENVIRONMENT

The impacts on water environment will be during its use in construction and operation period, on water resources and on drainage system of the area.

5.3.1 Water Use

The project implementation would involve various construction activities. Development of site for the proposed project involves excavation, levelling of the ground surface and tower foundation. However as the project site where terminal stations have been placed is almost flat with sparse vegetation. The levelling activities would result in less use of water.

During Construction: The construction of station at lower and upper terminal would require water. Water demand during construction phase would be for Construction activities and Man Power involved in construction.

Construction phase will last for a period of approximately 36 months. About 100 workers will be working at site during peak construction. Water demand during construction for labours is estimated about 4.50 KLD which will be supplied from existing water supply source line of the Public Health Engineering Department. The Waste water generated will be 3.6 KLD. The breakup of water consumption and waste water generation during construction of the Ropeway is shown in **Table 5.2**.

TABLE 5.2
CONSTRUCTION STAGE WATER REQUIREMENT

S. No	Description	Total water requirement KLD	Waste water generation KLD	Remarks
	Construction Site			
1	Domestic use	4.5	3.6	Manpower
2	Construction works	15.5	--	Based on the Construction Activity
Total		**20.0**	**3.6**	

During Operation: There will be 26 persons including staff and security during operation of the Ropeway project. The design capacity of the proposed ropeway is 4000 passenger per day. The total water requirement will be 181.82 KLD. Daily sewage flow considering 80 % of the domestic water consumption works out to be 145.46 KLD.

5.4 IMPACT ON AIR ENVIRONMENT

Emissions to the atmosphere from construction sites include particulates (that is dust, construction equipment/machineries emissions). Such emissions can have adverse off-site impacts if they are not properly managed or controlled. Emissions can occur from any of the following activities:

- Clearing of land and related excavation and compaction activities.
- Operation of heavy machinery and related equipment for earthmoving and construction purposes (excavators, cranes, etc.) and the engines associated with such machines.
- Erection of structures using steel, concrete, brick, glass, timber, and other materials.
- Metal joining and finishing including welding, brazing, soldering and other techniques.
- Generation of solid wastes and debris, their stockpiling and transfer during loading onto trolleys.
- Transport of building materials and supplies onto the site.
- Movement of vehicles.

Air pollution occurs mainly due to fugitive emissions/dust generation from various construction activities during construction period and use of DG set during operation period.

5.4.1 Impact during Construction

The construction activities for the proposed terminal stations will be of small scale and thus the particulate emissions will be minimal and short term in nature. For the construction of line towers the generation of the dust will be low as compared to the construction of terminal stations. The impact of other pollutants such as SO_2, NOx and CO will be caused due to diesel-operated mechanical equipment and their impact is expected to be negligible and of short term duration.

An emission due to use of construction machineries like mobile crane, concrete vibrator and dewatering pump has been estimated and given in the **Table 5.3**. Use of these machineries is limited and considered working for 2-3 hours per day during construction. Operation of these machineries will release insignificant quantity of pollutant into air.

TABLE 5.3
TOTAL POLLUTION LOAD DURING CONSTRUCTION PERIOD

POLLUTANT	EMISSION FACTOR (kg/lit)	POLLUTANT LOAD IN Kg/hr DUE TO CONSTRUCTION EQUIPMENT
PM10	0.0035	0.02
NOx	0.039	0.25
SO_2	0.0037	0.02
CO	0.015	0.10

5.4.2 Impact during Operation

The operation of the proposed ropeway will not involve major air emissions. Ropeway operation is an environmentally efficient non-polluting transport system. Two DG sets of capacity 625 KVA proposed at the lower and upper terminal stations for backup power supply. The DG set and vehicular movement will be the source of emission.

5.5 IMPACT ON NOISE ENVIRONMENT

Noise is one of the most common occupational health hazards. Annoyance, stress and interference with speech communication are the main concern in noisy environment. Like air environment, impact of noise is also anticipated during construction and operation phase of the project cycle. These are discussed in subsequent sections.

5.5.1 Impact during Construction

Noise at a construction site varies and depends on the construction activities in progress. The prime sources of noise levels during the construction phase are the construction machinery and the vehicular noise due to material movement at the site. The noise levels created by construction equipment will vary greatly depending on factors such as the type of equipments, the specific model, the operation being performed and the condition of the equipment. The equivalent sound level (L_{eq}) of the construction activity also depends on the fraction of time that the equipment is operated over the time period of construction. The dominant source of noise from most construction equipment is the engine. Typical noise levels of construction equipments which will be used at the site are given in **Table 5.4.**

TABLE 5.4
CONSTRUCTION EQUIPMENT NOISE EMISSION LEVELS

S.No	Equipment	Typical Noise level (dBA) 50 ft from source
1.	Concrete mixer	85
2.	Concrete Vibrator	76
3.	Mobile Crane	83
4.	Generator	81

U.S. Environmental Protection Agency."Noise from Construction Equipment and Operations, Building Equipment and Home Appliances," NTID300.1, December 31, 1971

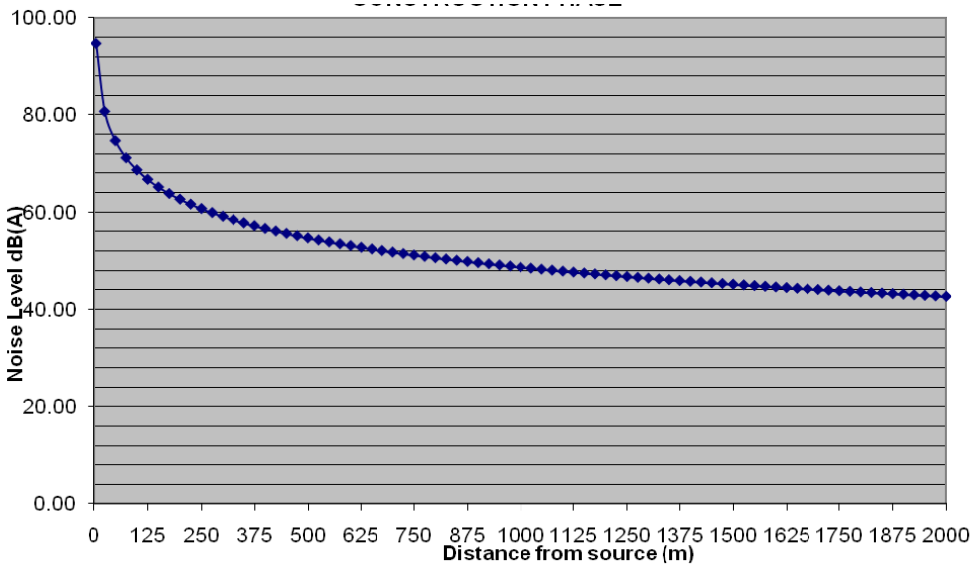
For an approximate estimation of dispersion of noise in the surroundings from the source point a standard mathematical model for sound wave propagation is used. The equation for sound wave propagation used is as follows:

$$\text{Noise}_{(\text{receptor})} \quad \text{Noise}_{(\text{source})} - 20\text{Log}\,[\text{distance}_{(\text{receptor})} \text{ or distance}_{(\text{source})}]$$

The noise levels predicted by logarithmic equation up to a receptor location of 2 km are presented in **Figure 5.1**. During construction of Ropeway the major construction activity will be the construction of foundation work and welding work for erection of towers. The main noise generating equipment that will be used at site will be concreter mixer and concrete

vibrator. As per **Table 5.4**, concrete mixer generates noise level of 85 dB (A) at 50 feet distance.

FIGURE 5.1
IMPACT ON RECEPTOR OF NOISE GENERATED DURING CONSTRUCTION PHASE



Since the proposed project does not involve extensive construction works, the noise levels during this phase are not expected to be significant. Due to the high noise levels of construction machinery at source, the personnel operating the machines and the workers stationed close to the machines will be prone to exposure of high levels of noise. To prevent adverse outcomes of noise exposure, noise levels should be reduced to acceptable levels. The best method of noise reduction is to use engineering modifications to the noise source itself, or to the workplace environment. Where technology cannot adequately control the problem, personal hearing protection (such as ear muffs or plugs) can be used. The following measures shall be considered and implemented.

- Construction contract will clearly specify the use of equipment emitting noise of not greater than 65 dB (A) for the eight hour operation shift.
- Project construction activities that generate noise in excess of 65 dB (A) at the project site boundary shall be limited to the hours of 7 a.m. to 6 p.m.
- Special acoustic enclosures should be provided for individual noise generating construction equipment like DG sets. The Special acoustic enclosures may be provided by way of noise shields.
- For protection of construction workers, earplugs should be provided to those workers who will be working very close to noise generation source.

5.5.2 Impact during Operation

During operation of ropeway, only generator set would generate noise during power failure. Two DG set having capacity of 625 KVA is proposed to be installed at the Lower Terminal and Upper Terminal.

All the D.G. Sets shall be placed in recommended acoustic enclosure or with silencers and Periodic maintenance.

5.6 IMPACT DUE TO VIBRATION

Construction activities have the potential to produce vibration that may be annoying or disturbing to humans and may cause damage to the structures. Architectural and even structural damage to existing structures surrounding a site could occur if appropriate

precautions are not taken. Vibration generated by construction activities is categoried into ground borne and sound generated vibration. Vibration produced during construction activities are transmitted through the ground to nearby structures.

5.6.1 Impact due to construction

The construction activities will be carried out for foundation of Towers at LTP, UTP and intermediate towers. Trucks/vehicle movement will be only at Lower Terminal. Rock drilling will be used at all the locations for foundation of towers. These stations and intermediate towers are away from the existing structures. Hence there is no anticipated impact during construction due to vibration. Additional protection to mitigate the construction vibration is, frequent checking of construction equipments and machineries and by avoiding night time activities.

5.6.2 Impact during Operation

There is no impact of vibration during operation as no vibration producing equipment or machineries will be utilized in the ropeway system.

5.6.3 Impact due to Wind Pressure

As per Indian standard, the wind speed should not be more than 150 km/hr during operation of aerial ropeway.

5.7 IMPACT ON BIOLOGICAL ENVIRONMENT

The Total numbers of trees within ropeway corridor are 45 numbers, out of which 17 have girth 30 cm or more. The numbers of trees likely to be cut/ trimmed are 45. The number of trees with their size and species is given in the **Table 5.5**.

The proposed project may result in air, noise and water pollution, which may have an impact on the terrestrial ecology. However, the impact will last for small duration and will be minor in nature.

TABLE 5.5
DETAILS OF TREES WITHIN THE ROPEWAY CORRIDORS

Sr. No.	Species	GIRTH (In cm)					Total
		30	31-60	61-90	91-120	121-150	
1	Asharey	2	-	-	-	-	2
2	Ghurips	1	-	-	-	-	1
3	Kharaney	5	-	-	-	-	5
4	Mauwa	3	-	-	-	-	3
5	Malata	3	-	-	-	-	3
6	Buk	-	-	-	-	2	2
7	Guras	1	-	-	-	-	1
8	Rani Chanp	-	1	-	-	-	1
9	Bhlayo	-	2	1	-	-	3
10	Phusrey Chanp	-	3	-	-	-	3
11	Phaledo	-	-	1	-	-	1
12	Phirpirey	2	-	-	-	-	2
13	Kholmay	-	1	-	-	-	1
14	Lekh Chilowney	2	-	-	-	-	2
15	Bilowney	1	-	-	-	-	1
16	Mozitto	3	-	-	-	-	3
17	Buro Okhatey	2	-	-	-	-	2
18	Chimal	2	-	-	-	-	2
19	Gobrey	-	3	-	-	-	3
20	Angherey	1	-	-	-	-	1
21	Siler Fir	-	-	-	-	3	3
Total		28	10	02	-	5	45

Source: Maenam Wildlife Sanctuary, Forest Department

5.8 SOCIO- ECONOMIC IMPACTS

The required land for construction of the project is Maenam Wildlife Sanctuary. Hence the proposed project shall not displace and resettle any people/family. In addition, it shall create direct and indirect business and employment opportunities during construction and operation.

Impact of Ropeway during Construction and Operation: During construction of ropeway, employment opportunity will increase due to deployment of people in various activities of project. Activities include civil, mechanical and electrical works. Total deployment of people during construction and operation is anticipated as 100 and 26 respectively.

5.9 IMPACTS ON HUMAN USE VALUES

5.9.1 Loss of Historical and Cultural Monuments

No Historical or Cultural Monuments will be affected/ lost due to the construction of the proposed project.

5.10 POSITIVE IMPACTS

Based on project particulars **(Chapter–2)** and the existing environmental conditions **(Chapter–4)** potential positive impacts likely to result from the proposed project have been identified. These have been listed under the following headings:

- Increase in Tourism Potential
- Employment Opportunities
- Improvement in Aesthetics
- Better connectivity
- Revenue Generation

5.10.1 Increased Tourism Potential

This ropeway provides the link with a hilltop. Provision of ropeway would attract more tourists, which will work as a catalyst for economic development and employment opportunities.

5.10.2 Employment Opportunities

The construction phase of the project is spread over a period of 36 months. During this period various categories of skilled, semiskilled and unskilled manpower would be deployed for the project. About 100 persons would be working on the project during peak construction period. This would create good opportunities of direct employment for the local people. In addition, indirect employment opportunities would be created in the support service sector. The post construction phase would also create similar job opportunities.

5.10.3 Improvement in Aesthetics

The project will lead to improved aesthetics of the surrounding by way of providing a pleasing architectural design of ropeway. Grass Turfing on open space within ropeway station premises would be done to increase the beauty of the area.

5.10.4 Better connectivity

Ropeway project will provide easy accessibility of tourists to Hill top.

5.10.5 Revenue Generation

Earnings would be generated by way of charges from tourist using the proposed ropeway. Tariff for ropeway will be fixed in such a way that would be enough for operation and maintenance expenses of ropeway along with generation of funds for future development.

5.11 CHECKLIST OF IMPACTS

Checklist is the list of environmental parameters or impact indicators, which the environmentalist is encouraged to consider when summarizing the potential impacts. A typical checklist identifying the anticipated environmental impacts due to the project activities are shown in **Table 5.6.**

TABLE 5.6
CHECKLIST OF IMPACTS

S. No.	Parameter	Negative Impact	No Impact	Positive Impact	Short Term	Long Term	Remark
A	**IMPACT ON LAND ENVIRONMENT**						
i)	Displacement of people		*				
ii)	Change of land use pattern	*				*	Insignificant
iii)	Impact on Soil quality/ Erosion	*			*		
iv)	Risk due to earthquake	*				*	Zone IV factors will be taken in design
v)	Impact due to solid waste	*				*	Insignificant
B	**IMPACT ON WATER ENVIRONMENT**						
i)	Impact on Water resources	*			*		
ii)	Impact on Water Quality during construction	*			*		
iii)	Impact on Water Quality during operation	*				*	Insignificant
C	**IMPACT ON AIR ENVIRONMENT**						
i)	During Construction	*			*		
ii)	During Operation	*				*	Insignificant
D	**IMPACT ON NOISE ENVIRONMENT**						
i)	During Construction	*			*		
ii)	During Operation	*				*	Insignificant
E	**IMPACT ON BIOLOGICAL ENVIRONMENT**						
i)	Loss of trees	*			*		
G	**SOCIO ECONOMIC IMPACT**			*		*	
H	**IMPACT ON HUMAN USE VALUES**						
i)	Loss of Historical and Cultural Monuments		*				
ii)	Impact on Aesthetics			*		*	
I	**POSITIVE IMPACTS**						
i)	Tourism Potential			*		*	
ii)	Employment Opportunities			*		*	
iv)	Improvement in Aesthetics			*		*	
v)	Better connectivity			*		*	
vi)	Revenue Generation			*		*	

5.12 EPILOGUE

As discussed above, insignificant negative impacts on land, water, air and noise environment, basically related to the construction stage, are anticipated from the project, which could be mitigated through simple/ good construction and project management practices. There will be no major impact anticipated during operation stage of the project. On the other hand the project would lead to long term socio-economic benefits. Incorporation of the environmental management plan would certainly enhance the sustainability of the project.

Annexure 5.1

ORDER OF HONORABLE SUPREME COURT OF INDIA

WP(C) NO. 337 of 1995

1

ITEM NO.307 & 324 COURT NO. 5 SECTION PIL

S U P R E M E C O U R T O F I N D I A
RECORD OF PROCEEDINGS

980654

IA No. 160 in WP(C) NO. 337/1995

CENTRE FOR ENVIR. LAW, WWF-I Petitioner(s)

VERSUS

U O I & ORS Respondent(s)

Certified to be true copy
Assistant Registrar (Judl.)
17/12/13 2013
Supreme Court of India

(For directions)
WITh
IA Nos. 162-163 in WP(C) NO.337/1995
(For permission to file application for directions and directions)

Date: 09/12/2013 These Applications were called on for hearing today.

CORAM :
HON'BLE MR. JUSTICE A.K. PATNAIK
HON'BLE MR. JUSTICE SURINDER SINGH NIJJAR
HON'BLE MR. JUSTICE FAKKIR MOHAMED IBRAHIM KALIFULLA

Mr. Harish N. Salve, Sr. Adv.(A.C.)
Mr. P.S. Narasimha, Sr. Adv. (A.C.)(NP)

Mr. A.D.N. Rao, Adv.

Mr. Siddhartha Chowdhury, Adv. (A.C.)

For Petitioner(s) Mr. Raj Panjwani, Sr. Adv.
Mr. Vijay Panjwani, Adv.

For Applicant(s) In IA 160 Mr. A. Mariarputham, Sr. Adv.
Ms. Aruna Mathur,Adv.
For M/s. Arputham Aruna & Co., Advs.

In IA 162 & 163 Ms. Neelam Rathore, Adv.
Mr. Pankaj Yadav, Adv.
Mr. Nikhilesh Ramachandran, Adv.

For Respondent(s) Mr. Milind Kumar, Adv.
Mr. Ravindra Kumar, Adv.
Mr. Syed Tabinda Suman, Adv.

(C) NO.337 of 1995

2

or UT of Anaman & Nicobar Islands — Col. R Balasubramanian, Adv.
Mr. K.V. Jagdishvaran, Adv.
Ms. G. Indira, Adv.

UPON hearing counsel the Court made the following

O R D E R

IA NO.160

We have heard learned counsel for the parties.

This application is regarding use of 2.1 hectares of land of Maenam Wildlife Sanctuary for the construction of the Skywalk and Aerial Ropeway for promotion of Wildlife Tourism at Bhaleydunga in South Sikkim. The Chief Wildlife Warden, Sikkim has recommended the use of the aforesaid forest land subject to the following conditions:

(i) Labour camps will not be permitted to be set up inside the sanctuary.
(ii) All workers need to obtain permits for working in the project site inside the sanctuary.
(iii) Construction materials should be stored in the identified area.
(iv) No additional felling of tree or destruction of wildlife habitat, exploitation or removal of any wildlife including forest produce from the sanctuary should take place.
(v) Authorized sanctuary personnel will check the construction sites as and when required.
(vi) The project implementing authorities and workers will obey dos and dont's of the Sanctuary.

The Central Empowered Committee has recommended the use of the forest land subject to the following conditions:

C) NO. 337 of 1995

(i) for use of the forest land the approval under the Forest (Conservation) Act, 1980 will be obtained and the NPV payable as per the rates prescribed by this Hon'ble Court for the forest land falling within the Sanctuary (five times the normal rate of the NPV) will be deposited in the Compensatory Afforestation Fund;

(ii) the conditions as stipulated by the Chief Wildlife Warden, State of Sikkim and recommended by the Standing Committee of the National Board for Wildlife will be strictly complied with;

(iii) no plastics will be brought into the Sanctuary area; and

(iv) 5% of the estimated project cost for the portion of the project falling within the Sanctuary will be deposited in the Compensatory Afforestation Fund for conservation and protection of the Sanctuary."

We allow this application and permit the use of 2.1 hectares of forest land for the aforesaid construction of the Skywalk and Ropeway subject to the aforesaid conditions recommended by the Chief Wildlife Warden and the Central Empowered Committee in their respective recommendations.

IA Nos. 162-163

These applications be listed on 16th December, 2013.

[KALYANI GUPTA]
COURT MASTER

[SHARDA KAPOOR]
COURT MASTER

CHAPTER 6
ENVIRONMENTAL MANAGEMENT PLAN

6.1 GENERAL

The Environmental Management Plan (EMP) describes the proposed remedial measures and monitoring plan for the impact during construction and operational period of the project. The EMP often contains a construction/management guideline that specifically addresses how the project proponent/contractors are to incorporate environmental considerations into their work. EMP considers compensatory measures if mitigation measures are not feasible or cost-effective. This chapter spells out the set of measures to be undertaken during project construction and operation to mitigate or reduce the adverse environmental impacts and bring them to acceptable levels based on the proposed Environmental Management Plans.

The most reliable way to ensure the implementation of EMP is that these plans are integrated into the overall project planning and implementation to make them as an integral component of the project. This ensures that it will receive funding and supervision along with other investment components. For optimal integration of EMP into the project, there should be links for:

- Funding,
- Management, training and
- Monitoring.

The purpose of the first link is to ensure that proposed actions are adequately financed. The second link helps in embedding training, technical assistance, staffing and other institutional strengthening in the mitigation measures to implement the overall management plan. The third link provides a critical path for implementation and enables sponsors and the funding agency to evaluate the success of mitigation measures, as part of project supervision, and as a means to improve future projects. For every impact discussed in **Chapter - 5**, the mitigation measures, implementing agency and budget have been presented as far as possible. All required funds would be channeled through the project authority. The Environmental Management Plans have been prepared and discussed in subsequent sections.

6.2 ENVIRONMENTAL MANAGEMENT PLAN

EMP contains a set of mitigation measures for negative environmental impacts through: a) changes in the design, construction practices, maintenance, and operation; and b) additional actions taken to protect the biophysical and social environment, as well as individuals who have been impacted adversely by a project. The extent and timing of mitigate actions are based on the significance of the predicted impacts. In the proposed project some aspects of impact mitigation are incorporated into project design which has largely resolved the threat of impacts before construction commences. However, many mitigation measures require implementation during construction and operation phase to ensure that proposed actions are carried out at the correct times. Based on Project Description **(Chapter - 2)**, Environmental Baseline Data **(Chapter - 4)** and Environmental Impacts **(Chapter - 5)**, the environmental management plans to be adopted at stages like pre construction, construction and operation phases are presented below.

6.3 PRE-CONSTRUCTION STAGE

The pre-construction measures need to be incorporated in the planning process. Some of these shall be included in design and budgeted for.

6.3.1 Forest Management

The objective of the Forest management should be to develop natural areas in which ecological functions could be maintained on sustainable basis. The Department of Forests is responsible for the conservation and management of trees/forests/wildlife in the project area.

MAENAM WILDLIFE SANCTUARY MANAGEMENT

The Compensatory Forestation (CA) shall be taken up over 4.2 ha of degraded forest identified at Barkhey, Maenam Wildlife Sanctuary under Ranvangla Range in South (T) Division. The cost estimated by Forest Department for raising and maintaining the compensatory afforestation is about **Rs 18,04,879/- (Rupees Eighteen Lakhs Four Thousand Eight Hundred and Seventy-Nine only).**

The department of Tourism shall transfer **Rs 73,39,500/- (Rupees Seventy-Three Lakhs Thirty-Nine Thousand and Five Hundred only)** for the Net Present Value (NPV) of the Forest

The department of Tourism shall payment **Rs 15.00 Crore (Rupees Fifteen Crore only)** for the Biodiversity Conservation & Wildlife Protection Plan of Maenam Wildlife Sanctuary.

The department of Tourism shall payment **Rs 19,897/- (Rupees Nineteen Thousand Eight Hundred and Ninety-Seven only)** towards cutting, felling, logging and transportation of project affect trees.

RESERVE FOREST MANAGEMENT

The Compensatory Forestation (CA) shall be taken up over 9.4 ha of degraded forest land identified at Rangan R.F. under Rabong Range in South (T) Division. The cost estimated by Forest Department for raising and maintaining the compensatory afforestation is about **Rs 20,13,958/- (Rupees Twenty Lakhs Thirteen Thousand Nine Hundred and FiftyEight only).**

The department of Tourism shall transfer **Rs 30,87,900/- (Rupees Thirty Lakhs Eighty Seven Thousand and Nine Hundred only)** for the Net Present Value (NPV) of the Forest

The department of Tourism shall payment **Rs 3,38,502/- (Rupees Three Lakhs Thirty - Eight Thousand Five Hundred and Two only)** towards cutting, felling, logging and transportation of project affect trees.

6.3.2 Energy Conservation Measures

Energy conservation measures are often the easiest, quickest and cheapest way to reduce costs and implement environmentally pro-active Energy conservation program both on energy demand and supply. The amount of energy used for lighting varies from industry to industry, but typically, lighting accounts for approximately 50% of the electrical load in office building. By having an understanding of the lamps, ballasts, luminaries and control options available today as well as the techniques used to develop efficient lighting, lighting can be produced that is energy efficient, cost effective and yields a high quality of light.

An improvement in lighting efficiency would be adopted in the building/ terminal stations with measures as:

- The most efficient lamp for the purpose, taking into account size, shape, colour and output of the lamp.

- The high-efficiency spectacular reflectors or high-efficiency luminaries.
- Automatic control systems - installation of (a) timer circuits that switch lamps off during room vacancy times, (b) photoelectric sensors that sense the amount of daylight in the room and either switch lamps on or off or adjust the lamp brightness accordingly and (c) occupancy sensors that switch lamps off when work stations are unoccupied.
- Localized switching - installing localized switches near work stations to control local lighting.
- Lighting design - (a) design lighting systems that maximize the use of daylight and (b) introducing local task lights (e.g. desks lights), allowing a reduction in general overhead lighting.
- Maintenance schedule - setting up a maintenance schedule to clean and replace lamps on a regular basis.
- Promoting employees awareness on energy conservation
- Training staff on methods of energy conservation and to be vigilant to such opportunities

6.3.3 Construction Material Management

The construction material to be used for construction of Ropeway are coarse aggregates, cement, coarse sand, reinforcement steel, structural steel, etc. The duties of the contractor will include monitoring the all aspects of construction activities like storing, loading & unloading of construction materials and equipment in order to maintain the quality of environment. During the construction period, the construction material storage site is to be regularly inspected for the presence of uncontrolled construction waste. Close liaison with the Tourism Officer and the head of the construction crew will be required to address any environmental issues and to set up procedures for mitigating the impacts. The scheduling of material procurement and transport shall be linked with construction schedule of the project. The Contractor shall be responsible for management of construction material during entire construction period of the project. Sufficient quantity of materials should be available before starting of an activity. The contractor should test all the materials in the Government laboratories or Government approved laboratories in order to ensure the quality of materials before construction.

6.3.4 Borrow area Management

No borrow land will be required for the project site development. The cut and fill activities will fulfill the purpose while preparing the site. Hence no extra borrow area will be required. Following measures should be taken during cutting and filling:

- The borrowed earth should be utilized only within the project area.
- After filling, the loose soil will be well compacted to avoid the soil erosion.
- Horticulture or natural grass turfing will be done at the borrowed patches wherever necessary.

6.4 CONSTRUCTION STAGE

6.4.1 Air Pollution & Dust Control measures

During construction period the impacts on air quality are mainly due to the material movement and the construction activities. Due to loading/unloading and stocking of construction material, the air quality in the immediate influence area will be affected and the pollution levels in ambient air would be increased, though, not in significant levels. The emissions from DG sets, construction equipment and vehicles may deteriorate the air quality

in the area. In order to reduce the dust emissions due to material transport and construction activities following measures need to be taken:

- Provisions will be made for sprinkling of water where earth filling and excavation is being carried out. It will be ensured that the construction debris is removed daily.
- Idling of delivery trucks or other equipment wherever useful will not be permitted during periods of unloading or when they are not in active use.
- Vehicles carrying construction material shall be covered to avoid spilling
- Low emission construction equipments will be used wherever possible and all the machineries/equipments used will adhere to the standard emission norms.
- Water sprinkling at the construction site as per requirement
- The work schedule and the operation time for construction machinery shall be suitably modified and have limited construction activity to exercise a control on ambient air quality standards.
- All stationary machines / DG sets emitting the pollutants shall be inspected frequently for maintenance and should be fitted with exhaust pollution control devices.
- In no case, loose earth will be allowed to pile up along the approach roads.
- As soon as the construction activity is over the surplus earth should be utilized to fill up the low-lying areas, if any.

6.4.2 Water Supply and Sanitation

About 100 workers will be working at site during peak construction. Water demand during construction for labours is estimated about 4.5 KLD which will be supplied from existing water supply source line of the Public Health Engineering Department. Adequate provision has been kept in the project DPR for the potable drinking water facility of the project. The Waste water generated will be 3.6 KLD. This waste water will managed by providing sanitation facility which is integral part of the project, adequate provisions has been kept in the project.

6.4.3 Oil Spill control/Management

During construction and operation of project, vehicles and equipments generate oil waste, which are likely to spoil the natural environment. These oil spills may enter in the runoff, which ultimately contaminate the soil and natural drains. To control the oil spill during construction stage of the project following measures should be taken:

- Good housekeeping
- Routine checkup of construction machineries and equipments
- Temporary cement/metal platform will be provided below the construction machineries and at maintenance site to capture the spill.
- These platforms should be at sufficient height to avoid the littering
- Conducting routine inspections to ensure proper functioning of machineries/ equipments.

6.4.4 Solid Waste Management

Solid Waste / Refuse include many different substances such as garbage, rubbish, sweepings and food waste. Health problem may arise since some of the refuse is attractive to insects and rodents. Refuse disposal program should include storage, collection and disposal. Solid waste generated during construction will be 10.0 Kg/day. The solid waste generated shall have adequate collection, conveyance and disposal facilities and will be disposed along with existing collection and disposal system. Collection containers of about 20 liters capacity fitted with side handles to facilitate handling shall be provided. The location of placing the containers shall be such that it is convenient for labor to use them. To avoid

odour and accumulation of fly-supporting materials, waste containers should be washed at frequent intervals.

Following measures shall be adopted for management of solid waste:

- Inorganic waste shall be segregated and kept in different heaps as far as possible so that their further gradation and reuse is facilitated.
- Material which can be recycled and reused for the purpose of construction shall be kept in separate heaps from those, which are to be sold or disposed off.
- Clearly label all such waste containers with the waste being stored and the date of generation.
- Educate employees and sub-contractors on waste storage and disposal procedures.

6.4.5 First Aid Health System

Health problems of the workers should be taken care of by providing basic health care facilities. All necessary first aid and medical facilities will be provided to the workers. The provision and maintenance of suitably equipped first aid facility throughout the extent of the works has to be borne by the contractor who shall be responsible for welfare arrangements and requirements to the satisfaction of the Supervision Consultant and Site Engineer.

6.4.6 Training

The training programmes need to be conducted for officers of project developer and contractors. These programmes should also be extended for the workers for their active participation in the project implementation. Apart from training, such programmes should include guidelines for safety, measures of disaster prevention, action required in case of emergency, fire protection, environmental risk etc. The cost involved for such a programme is presented in **Table 6.1**.

TABLE 6.1
COST OF ENVIRONMENTAL TRAINING PROGRAMMES

Sr. No.	ITEM	COST (Rs)
1	15 days training during construction period	1,50,000
2	Demonstration/presentation aids	25,000
3	Transportation and Miscellaneous	25,000
	TOTAL	**2,00,000**

6.4.7 Soil Erosion Control

The cutting and filling operations may lead to erosion due to loosening of topsoil. The excavation of construction materials may alter the topography and may also lead to soil erosion. Temporary erosion/sedimentation and pollution control measures will be used to control the phenomenon of erosion, sedimentation and pollution that may develop during normal construction practices. The soil erosion at construction site can be minimized by following measures:

- Construction will not be carried out during monsoon.
- Erosion control measures such as ramming of topsoil immediately after the excavation and provision of silt control measures to minimize soil erosion.
- Ensure that no soil is left unconsolidated before completion of work at the site.
- Construction material shall be procured from the licensed material supplier.
- The excavated earth debris will be transported immediately to the disposal site and no accumulation shall be allowed at construction site.
- Soil erosion can also be controlled by efficient storm water management.

6.5 OPERATION STAGE

6.5.1 Air Pollution Control

During Operation Phase, the major sources of air pollution are from DG sets and vehicular movement at Lower Terminal. Control measures to reduce the pollutant emissions from vehicular movement and DG sets are as follows.

- Greenbelt is one of the preferred methods to mitigate air pollution. Plants serve as a sink for pollutants, act as a barrier to break the wind speed as well as allow the dust and other particulates to settle out there. It also helps to reduce the noise level to some extent. The project site and nearby area are within Maenam Wildlife Sanctuary and Reserved Forest which is having good plantations/vegetations.
- Good quality fuel with low sulphur content should be used in DG sets.
- Periodic maintenance of DG sets as per defined schedule of manufacturer.
- These DG Sets shall be provided with stack having recommended height.

6.5.2 Water Supply and Sanitation

During operation of the Ropeway project the water requirement for staff, security and passenger would be 181.82 KLD. The wastewater generation from all the activities during operation phase shall be 145.46 KLD.

Adequate provision has been kept in the project DPR for the potable drinking water facility of the project. The waste water will managed by providing sanitation facility which is integral part of the project, adequate provisions has been kept in the project.

6.5.3 Solid waste disposal

The solid waste generated will be 402.6 kg per day. The solid waste within the wildlife zone and other peripheral areas will be managed systematically and scientifically through Solid Waste Management plant outside the Wildlife Sanctuary for which adequate provisions has been kept in the project DPR.

6.5.4 First Aid Health System

All necessary first aid and medical facilities will be provided at Lower and Upper terminals. The provision and maintenance of suitably equipped first aid facility has to be borne by the Tourism Department.

6.6 EPILOGUE

After incorporation of environmental management plans, the environmental sustainability will be further improved. In a nutshell, it could be concluded that the project is environmentally sustainable and eco-friendly. The most of the mitigation measures for the construction phase impacts will form the part of tender documents. The responsibility for their compliance thus would be binding for the prospective contractor as per the contract condition. The overall responsibility for implementation and monitoring of mitigation measures will, however, rest with the Project Implementation Unit (PIU). Risk Analysis and Disaster Management Plan for safe operation of Ropeway will be suggested in the subsequent chapter.

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CHAPTER 7
RISK ASSESMENT AND MITIGATION MEASURE

7.1 GENERAL

A methodology is developed to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, livelihoods and the environment on which they depend. Risk assessments include detailed Quantitative and Qualitative understanding of risk, its physical, social, economic and environmental factors and consequences. It is a necessary first step for any serious consideration of disaster reduction strategies.

Risk assessment encompasses the systematic use of available information to determine the likelihood of certain events occurring and the magnitude of their possible consequences. As a process, it is generally agreed that it includes:

- Identifying the nature, location, intensity and probability of a threat;
- Determining the existence and degree of vulnerabilities and exposure to those threats;
- Identifying the capacities and resources available to address or manage threats; and
- Determining acceptable levels of risk.

7.2 RISK

Risk is the probability that a substance or situation will produce harm under specified condition. Risk may be defined as:

- The probability of an event to occur
- The probability of a toxic substance to be released by an event.
- The probability of the adverse effects due to exposure of individual population, eco system or other factors to the harmful substance or material.

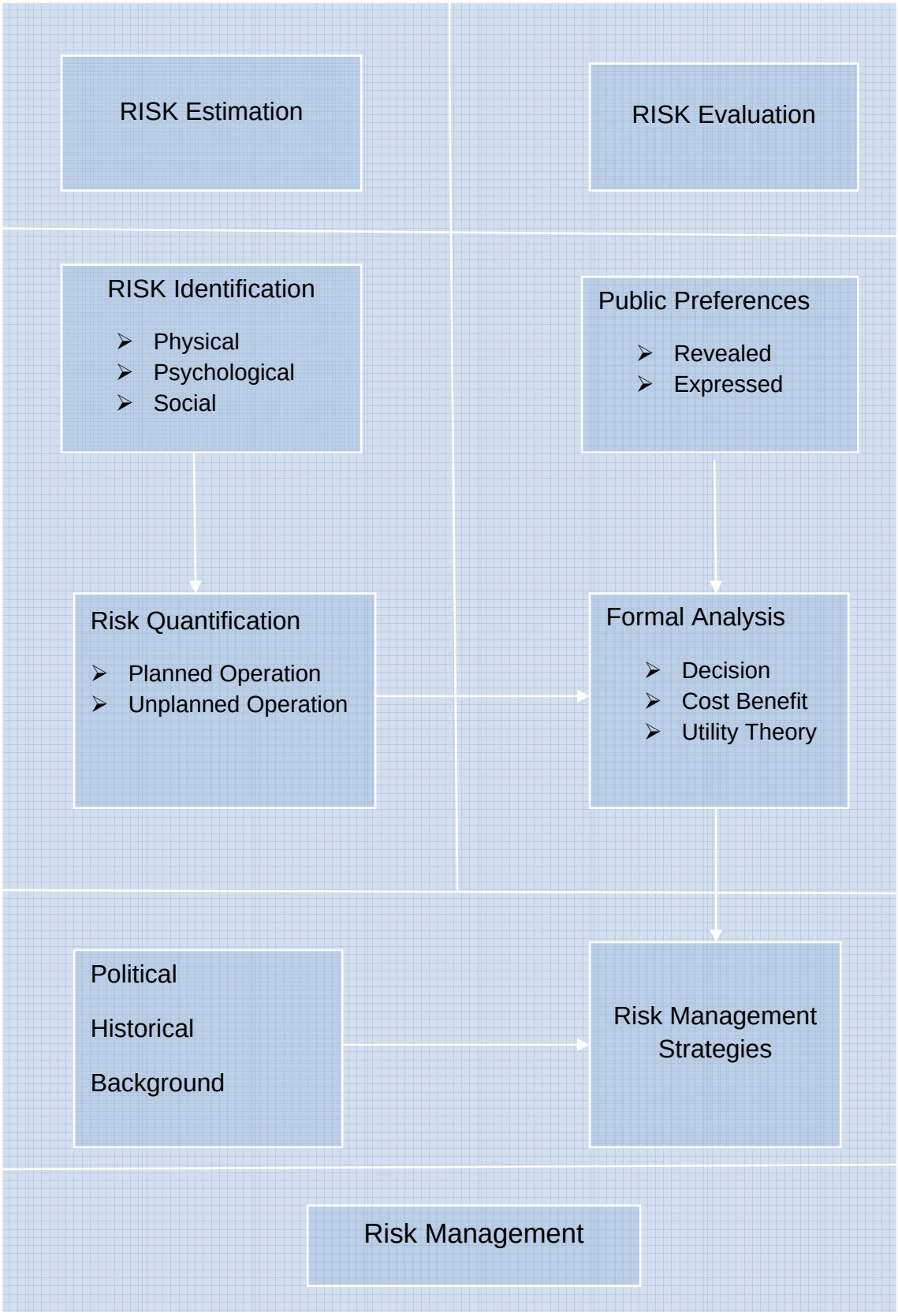
7.2.1 Risk Assessment

It is Quantitative or Qualitative analysis of the hazard and risk. It estimates the severity and likelihood of harm to any human life and the environment.

Risk assessment is the use of the factual base to define health effects of exposure of individual or population to hazard material and situations. It is the identification of main hazard and unsafe practices in Ropeway and required preventive or remedial action. Risk Assessment framework are given in the **Figure 7.1**

- Assessment of Structure (geographical/functional/process/flow)
- Identify Hazards and Risk based on information collected
- To monitor and audit management policies, procedures and performance to secure safety in work place
- Requirement of safety legislation and guidance
- Preparation of safety policies
- To identify potential problems
- To investigate accidents
- Record the assessment
- Measurement the effectiveness of action
- To prevent undesired accidents
- To prepare reports
- Monitor and Review the program of Risk assessment

FIGURE 7.1
RISK ASSESSMENT FRAMEWORK



7.2.2 Risk Characteristics

It includes the estimation of health risk associated with the process under investigation. The result of this characteristic is a number that represents the probability of adverse health effects from that accident or operation of Ropeway.

7.2.3 Risk Management

Risk management uses information from risk identification and risk assessment along with the information of technical resources, social economic value and information to reduce and control any identified hazard. It also involves design and implementation of policies and strategies resulting from decision process making.

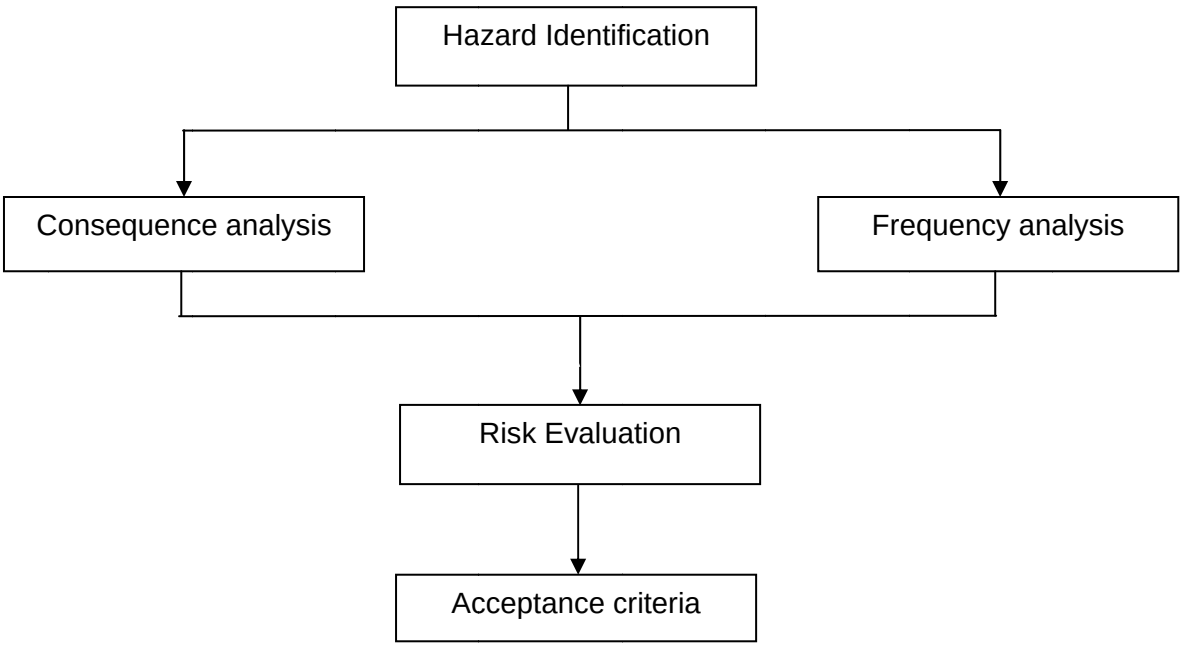
7.2.4 Risk Communication

Risk communication is the exchange of information between the general public and the concerned authority about the risk perceived and to reduce, control, and prevent accident. Risk communication can be done with the detailed information detail information of the assessed risk which is documented and forwarded to staff and responsible person. Signs and symbols can be put up to prevent illegal entry into unsafe areas.

7.2.5 Risk Assessment Methodology

Risk assessment is an appraisal of both the kinds and degree of threat posed by an environmental hazard. Such appraisal includes the recognition of hazard, the measurement of threat and understanding of the social meaning of such measurements. There is a need for preliminary practice of hazard identification before more and detailed appraisal takes place. There is also a need to broaden the concept to estimate and evaluate. The estimates of the likelihood of risk may relate to an event, to its consequences or both. Risk estimation may include quantified estimates of probability or non qualified probabilistic estimates and these may reveal intuited or exploited from experience. Social evaluation of risk may seek to avoid some risk at all cost, balance (benefit-risk) and with other cost (Cost - Benefit). The five stages of Risk Assessment are given in the **Figure 7.2**.

FIGURE 7.2
THE FIVE STAGES OF RISK ASSESSMENT



- **Hazard**

A hazard is defined as a "Condition, event, or circumstance that could lead to or contribute to an unplanned or undesirable event." Seldom does a single hazard cause an accident. More often, an accident occurs as the result of a sequence of causes. A hazard analysis will consider system state for its failures or malfunctions.

Nature has gifted human beings with power and means to negotiate distances and heights. Machines made their task easy and fast. Aerial ropeway is one such exclusive and simple mechanical system, which facilitates transport of man and material over difficult and abnormal terrain bringing about comparative ease and economy vis-à-vis other means of transport

- **Hazard Identification**

Hazard identification and risk assessment is a continual process. It is performed to identify whatever could cause injury, damage, ill-health, financial loss and loss of reputation to the organization. Hazard identification is an analysis to determine whether a risk agent under plausible conditions would cause harm to population or the environment. Hazard identification is an analysis which is in many ways a detailed study of operations and process, epidemiology, ergonomics. Hazard identification and risk assessment (HIRA) Objectives are to,

- ✓ Identify any thing that may cause injury, damage, ill-health]
- ✓ Prioritize the risks in terms of urgency of required attentions
- ✓ Discover preventive or mitigating actions that can be taken in each case
- ✓ Create awareness in all concerned in each and every factor and activity that may cause injury damage or ill health
- ✓ Enhance decision making by brining all concerned and effected parties into the HIRA process
- ✓ Encourage employees to take ownership of their own safety in terms of recognizing and reporting hazards and participating in the discovery and implementations of the solutions that will prevent incidents or mitigate the consequence
- ✓ Build a team approach to Safety Health and Environment Management

- **Risk Assessment**

Determine which hazards are more serious than others, so you can start dealing with those ones first. To assess the risk associated with hazards you have identified, ask the following questions:

- ✓ How likely is the hazard to cause harm to someone?
- ✓ What is the worst possible damage the hazard could cause in terms of human suffering and cost if you don't resolve the problem?
- ✓ How many people are exposed to the risk? Sometimes it may be the amount of time workers spend on an activity that creates the safety risk, rather than the nature of the work task itself. Everyone is different. A hazard may also pose

more risk to some people more than others because of differences in physical strength, experience, training etc.

- **Risk Control**

  - Identify the underlying cause of hazards and put measures in place to prevent a recurrence of the risk

  - Focus attention on the most urgent hazards, priorities the hazards using the risk management matrix, understanding that some methods are more effective than others. Use the highest-ranked control that is practicable for controlling risk, and only use the lower-ranked controls as a last resort or until a more effective way of controlling risk can be used. More than one control measure can be used to reduce the exposure to hazards, which are follows

    - ✓ Eliminate the hazard
    - ✓ Substitute the hazard with a safer alternative
    - ✓ Isolate the hazard
    - ✓ Use engineering controls
    - ✓ Use administrative controls
    - ✓ Use personal protective clothing and equipment (PPCE)

- **Review/Monitor-Evaluate the Results**

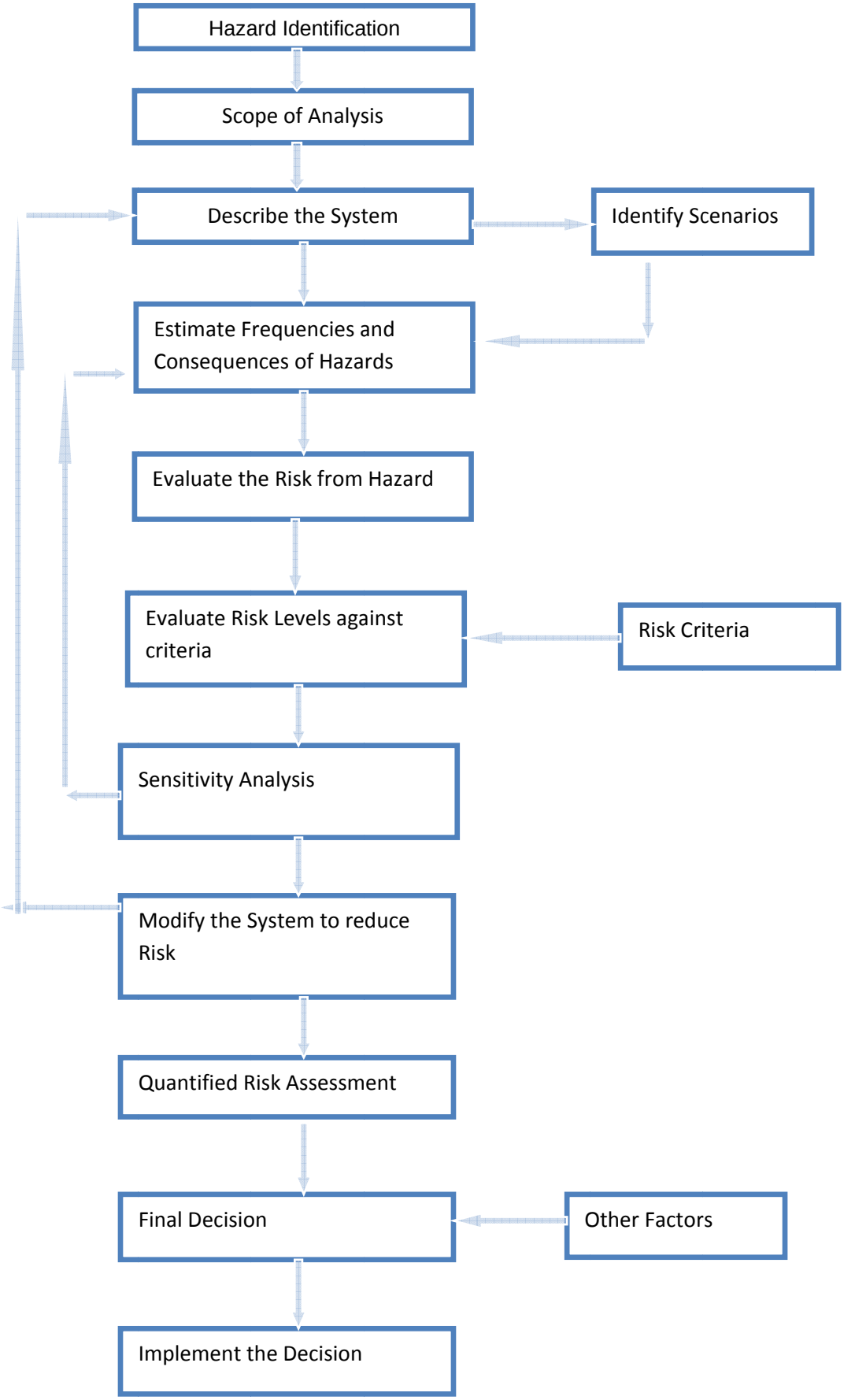
Review your safety solutions regularly to make sure they are effective, and making sure your controls do not introduce new hazards. To assess the success of your risk control methods:

- ✓ Talk to the people involved and look at your centre injury/accident records.
- ✓ Seek advice from those affected by the changes and consult with them Regarding any modifications
- ✓ Consider staff training needs, communicate with employers, managers, contractors and workers work together as all parties in the workplace have a legal responsibility for workplace health and safety

Risk assessment involves comparing likely exposure with likely effects. Both distributions are represented hypothetically as symmetrical BUT THEY NEED NOT BE SO. Precise probability effects could in principle, be computed from the extent of overlap of distribution. The main reason to specify risk is that they can be managed. From the prospective of environment risk assessment, decisions have to be taken about what to protect prior to an assessment being carried out. Decisions have to be taken about to what level protection will be exercised so that appropriate threshold levels can be defined. Management often involves balancing the advantages to the environment and human health by different options and with their consequences for other social benefits. The significant point is that risk is a function of two parameters; the likelihood of an occurrence of undesired event and its consequences. The procedure for Risk Assessment is given in the **Figure 7.3**.

Risk = f (Frequency x consequences)

FIGURE 7.3
PROCEDURE FOR A RISK ASSESSMENT



7.2.6 Safeguarding of passengers and personnel – risk assessment methodology

For new installations or relocations, a risk assessment shall be performed. The risk assessment shall take into account 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. A number of methodologies are available to do a risk assessment. Any method is acceptable which prescribes safeguarding equivalent to or more stringent than the requirements of this annex. The risk assessment process shall be instituted during the system planning/design phase and continue throughout the system construction, operation, and decommissioning. The risk assessment process shall emphasize the prevention of accidents by resolving hazards in a systematic manner as described below.

The hazard resolution process shall be initiated by defining the physical and functional characteristics of the Passenger Ropeway system to be analyzed. These characteristics shall be presented in terms of the people, procedures, facilities and equipment which are integrated to perform a specific operational task or function within a specific environment.

The hazards shall be identified. The techniques and methods used to identify the hazards shall include:

(1) Data from previous accidents or operating experience
(2) Expert opinion and hazard scenarios
(3) Checklists of potential hazards
(4) Previous hazard analyses
(5) Other analysis techniques as appropriate

All identified hazards shall be assessed in terms of the severity or consequence of the hazard and the probability of occurrence. This shall be accomplished in general accordance with the criteria outlined herein or equivalent.

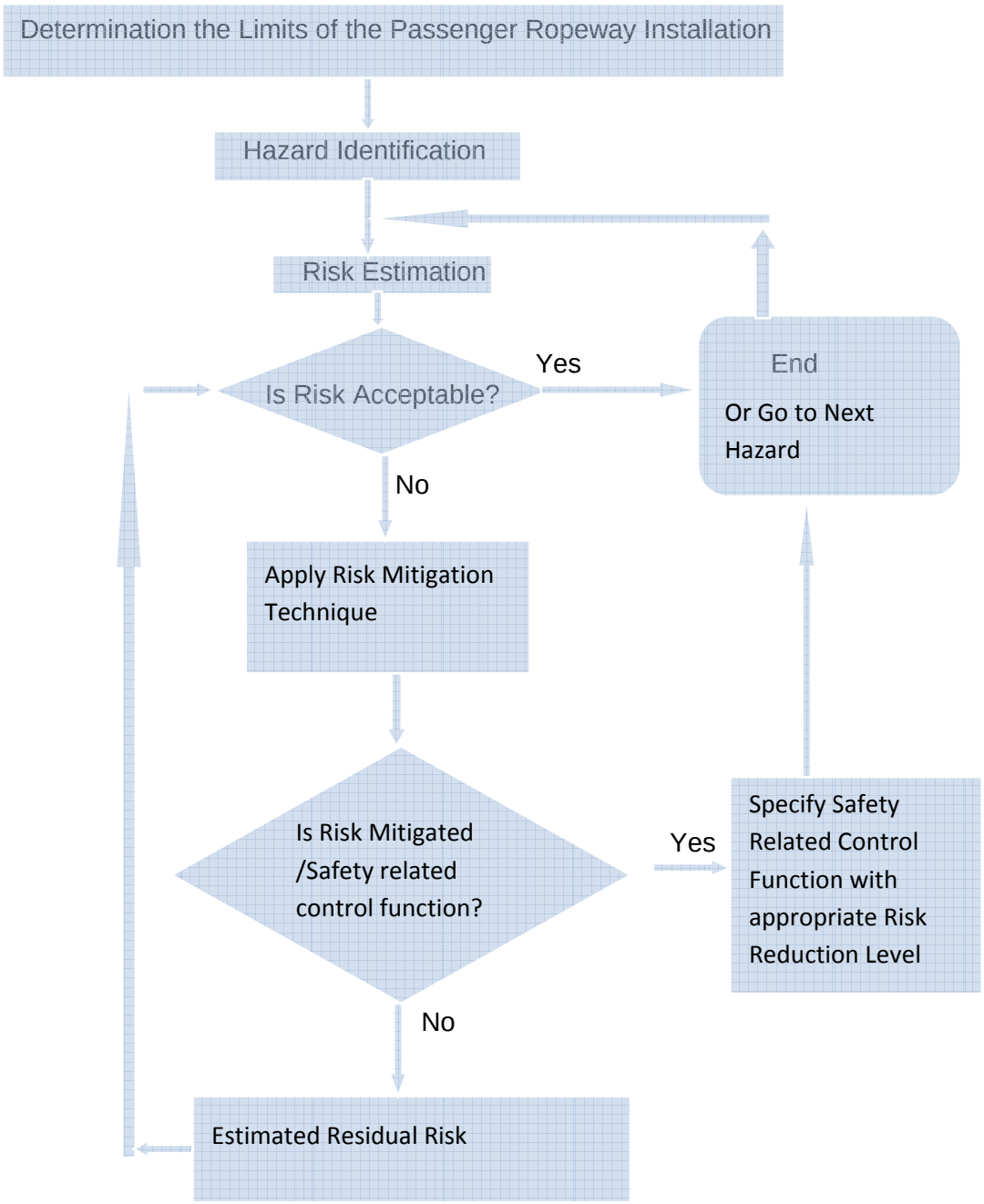
Risk assessment estimates shall be used as the basis in the decision-making process to determine whether individual system or subsystem hazards shall be eliminated, mitigated, or accepted. Hazards shall be resolved through a design process that emphasizes the elimination of the hazard. For all other hazard resolution strategies, or safeguards, the following hierarchy of controls shall be employed, in order of effectiveness (most to least);

(1) Design by hazard elimination or substitution
(2) Engineered Safeguards
(3) Awareness means
(4) Administrative controls (Training and Procedures)
(5) Personal Protective Equipment
(6) Acceptance of the residual risk / Information for use concerning the residual risk

This process shall include full documentation of the hazard resolution activities. The effectiveness of the safeguards shall be monitored to determine that no new hazards are introduced. In addition, whenever substantive changes are made to the system, analyses shall be conducted to identify and resolve any new hazards introduced.

Where risk mitigation techniques and safeguarding methods are previously prescribed by various sections in this standard, the risk assessment shall serve as a method for determining suitable application according to the “hierarchy of controls” as well as functional safety circuit performance requirements as applicable. This method may be utilized to assess the applicability of a safeguard according to variable conditions or characteristics for a particular application which is shown in **Figure 7.4**.

FIGURE 7.4
RISK ASSESSMENT FLOW CHART FOR LIMITS OF PASSENGER ROPEWAY INSTALLATION



7.3 ROPEWAY ACCIDENTS HISTORY

7.3.1 Wire Rope Failure Accidents in Cableway/ropeway industry

- March 1999, Italy, Cavalese ropeway, wire rope snapped and caused 20 persons died.
- July 1st 1999, west France, The Alps ropeway, wire rope snapped and caused 21 astronomers died.
- Oct 3, 1999, P. R. China, Gui Zhou Ma Ling ropeway, wire rope snapped and caused 14 persons died, 22 people injured.
- Jan 19, 2003, Indian, Pavagadh Ropeway, wire rope snapped and caused 7 person died, 42 person injured.

- On 19 October 2003. Darjeeling Rungeet Valley Ropeway Four tourists were killed and 11 others injured. The carriages, with the passengers, crashed and rolled into the steep tea garden slopes nearly 100 ft below.

One of the reasons for the accident was a change in alignment of the ropeway following a shift in the mountains

- Oct 16, 2006, P. R. China, Guang Xi Wu Zhou ropeway, wire rope snapped and caused 5 persons died.
- Aug 27, 2007 India Palani hill shrine Four persons, including three of a family, were killed and two boys seriously injured when a cabin of a ropeway car hit another on the way.
- Feb 21, 2009, India Chadayamangalam Jadayu Rock ropeway, wire rope snapped and caused 1 person died.

7.3.2 Wire Rope Failure Accidents in Hoisting industry

- May 24, 2002, the steel rope carrying the helicopter's load had snapped and caught in the rotor blades, bringing the helicopter came down off Orkney, UK, a pilot killed in this accident.
- Feb 20, 2006, the wire rope snapped at a well-intervention vessel operated by the oilfield services company, UK, 1 worker died.
- July 12, 2007, the crane wire rope snapped at New Delhi's metro caused the entire structure tumbled down in a V-shaped pile, crushing workers underneath. Six people were killed and 13 injured. 3 cranes crashed.
- Aug 2, 2007, A Sydney judge has proposed awarding damages of $1.4 million to a Navy reservist in Western Australia who fell from a high ropes course when a safety cable broke.
- July 23, 2008, James Dawes of Topeka, Illinois, was killed after being struck by the boom of a Link-Belt crane, operated by Area Erectors. The accident was caused by the boom hoist wire rope breaking, dropping the boom onto the aerial lift in which Dawes was working.
- Dec 15, 2008, Shen Yang coal group Hong Ling coal mine, wire rope snapped and caused 1 person died.
- Jan 1, 2009, New Brighton Pier, a steel cable snapped and 1 person seriously injured.
- May 20, 2009, a crane wire rope snapped at Chang Zheng coal mine, Gan Su, 1 person died and 26 people seriously injured.
- Apr 22, 2009, a wire rope snapped at Yu Tan gold mine, De Xing and 2 people died.

7.3.3 Wire Rope Failure Accidents in Elevator industry

- May 29, 2006, the elevator cable snapped and caused the elevator plunked in Ukraine transport ministry building, 11 people seriously injured.
- May 30, 2007, the elevator cable snapped and caused the elevator plunked in a company at Nei Jing, Si Chan, P. R. China, 3 people died.
- Aug 5, 2008, the elevator cable snapped and caused the elevator plunked in a building of Salt Lake city, Utah, USA. One person injured.
- Oct 30, 2008, the elevator cable snapped and caused the elevator plunked in the building site of Yang Guang Cheng, Xia Pu, Fu Jian, P. R. China, 12 people died in this accident.

- Jun 23, 2008, the elevator cable snapped and caused the elevator plunked in Las Vegas hotel, Nevada, USA, A 60 years old man injured.
- Dec 27, 2008, the elevator cable snapped and caused the elevator plunked in a construction site at Shang Hai Cheng, Chang Sha, Hu Nan, P. R. China, 17 people died, 1person seriously injured.
- Feb 19 2009, the elevator cable snapped and caused the elevator plunked in a construction site at He Fei, P. R. China, 2 people died and 2 people injured.
- May 11, 2009, Six people were injured in an incident caused by a snapped cable in a lift inside London's Tower Bridge.

7.4 FIVE MAJOR PROBLEMS IN USE OF WIRE ROPES

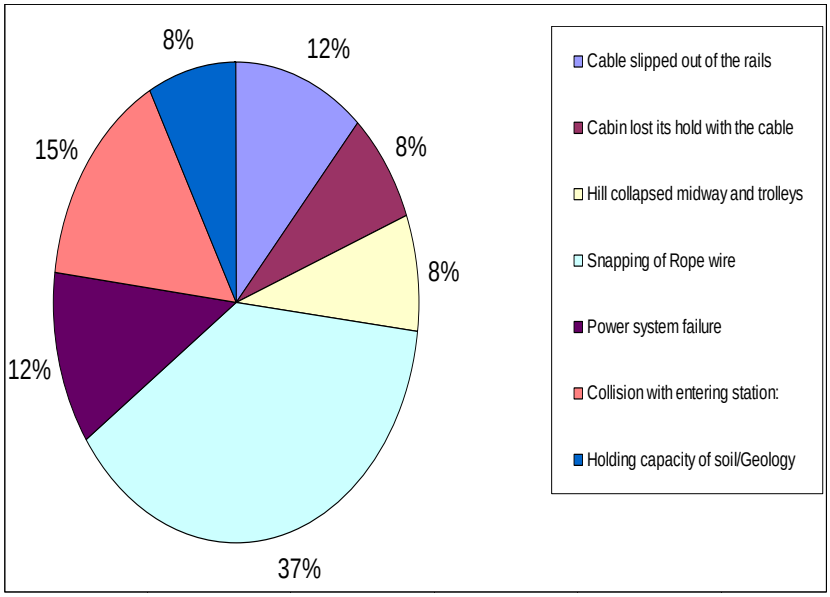
- Unsafe: Wire breakage accidents caused by strength loss always exist in the use of wire ropes. According to survey conducted by USA authority organization, 12% in-service wire ropes in 8,000 wire rope users are in "extremely dangerous" situation.
- Diseconomy: Regular replacement of wire ropes causes huge waste. The statistics from USA indicates that 70% of those compulsively replaced wire ropes have just little strength loss.
- Inefficiency: Traditional visual inspection method costs more time and labor, and low efficiency.
- Unreliable: Manual inspection is not reliable and many hidden dangers cannot be detected.
- Serious danger: Serious wire breakage accident inevitably caused serious damage. According to statistics of State Administration Bureau of Safety Production Supervision China, there were 1065 accidents related to wire rope breakage in Chinese coal mine industry in year 2004 and 2005, causing 1142 persons dead. The most serious accident caused 14 persons dead and 5 seriously wounded.

7.5 IDENTIFIED HAZARD

1. Cable slips out of the rails at the tower from the upper station can cause the carriages to be knocked off. The accidents take place due to negligence.
2. Cabin loses its hold with the cable and collided with the another one cabin of ropeway car and hit another on the way,
3. Hill collapses midway and trolleys are dangling in the air.
4. Power system failure
5. Collision with entering station: operator failes to slow the vehicle down upon entering the station which causes collision of the ropeway car at the entering station
6. Holding capacity of Soil/Geology
7. Flood
8. Soil Erosion
9. Earthquake
10. Landslide

Figure 7.5, Pie chart showing probable percentage causes of accident in Ropeway.

FIGURE 7.5
PROBABLE PERCENTAGE CAUSES OF ACCIDENT IN ROPEWAY



7.6 CONSEQUENCES AND FREQUENCY ANALYSIS

Cause of Hazard	Consequences	Frequency (Probable Percentage)
Cable slipped	Passenger death and material fall down	**12**
Cabin lost its hold with the cable	Passenger death and material fall down	**8**
Hill collapsed	Entire system fail and higher percentage of death	**8**
Snapping of Rope wire	Passenger death, and material fall down	**37**
Power system failure	Delay in operation	**12**
Collision with entering station	Small injury	**15**
Holding capacity of soil/Geology	Tower collapse & passenger death/Material fall	**8**
		100

7.7 ACCEPTANCE CRITERIA

In a regulatory context requirements for acceptance criteria are usually kept very general. Basically, there are only qualitative definitions of the risk acceptability limit such as:

- The industrial activity should not impose any risks which can be reasonably avoided,
- The costs of avoiding risks should not be disproportionate to the benefits,
- The risks of catastrophic accidents should be a small in proportion of the total.

Risk contains, by definition, both the Probability of Failure (PoF) and Consequence of Failure (CoF) aspects. For the regulatory perspective the introduction of the consequence element enables a risk-based inspection or maintenance procedure to get acceptance by the authorities.

Cause of Hazard	Acceptance Criteria
Cable slipped	High Risk
Cabin lost its hold with the cable	High Risk
Hill collapsed	High Risk
Snapping of Rope wire	High Risk
Power system failure	Low Risk
Collision with entering station	Low Risk
Holding capacity of soil/Geology	High Risk

A. Individual Risk

A formal definition of Individual Risk is expressed as the frequency at which an individual may be expected to sustain a given level of harm from the realization of specific hazards. It is usually taken to be the risk of death, and normally expressed as risk per year.

Individual Risk is the risk experienced by a single individual in a given time period. It reflects the severity of hazards and the amount of time the individual is in proximity to them. There are typically three different types of Individual Risks:

- **Location-Specific Individual Risk (LSIR):** Risk for an individual who is present at a particular location 24 hours a day, and 365 days a year. LSIR is not a realistic risk as the individual does not usually remain at the same location all the time and is not exposed to the same risk all the time.
- **Individual-Specific Individual Risk (ISIR):** Risk for an individual who is present at different locations during different periods. ISIR is more realistic than LSIR.
- **Average Individual Risk (AIR):** AIR is calculated from historical data a number of fatalities per year divided by the number of people at risk.

Individual Risks are also commonly expressed by means of the Fatal Accident Rate (FAR), which is the number of fatalities per 108 hours of exposure. FARs are typically in the range from 1 to 30, and are more convenient and more readily understandable than Individual Risks per year.

B. Societal Risk

A formal definition of the Societal Risk is given in as the frequency and the number of people suffering a given level of harm from the realisation of specified hazards. It usually refers to the risk of death, and expressed as risk per year.

This expression of risk is useful to limit the risks of catastrophes affecting many people at one time. Societal risks may be expressed as risk per year.

C. Area Risk

A third often-used measure of risk is the Area Risk. This measure is very useful when more than one source contribute to the overall risk of certain geographical area.

D. Environmental Risk

Environmental Risk includes short term and long-term effects to the biosphere. Here the affected area in m² (soil, ground and surface water) or the amount of released dangerous substances to the environment per year can be an adequate measure. Due to the fact that there are also financial aspects linked to the environmental risk, which can be measured in money (like cleanup costs, penalties, negative media publicity, etc.), these are best covered when evaluating the Economic Risk.

7.8 MITIGATION MEASURES

7.8.1 Design Verification

Aerial ropeways drawings are to be submitted to a recognized design verifier, before fabrication, construction, inspection, testing and certification. Design verifier may be an accredited inspection body, or, in-house recognized ISO 9001 designer's quality management system. These inspected drawings will include:

- Profiles of installation, specification particulars sheet, and rope specification details;
- Dimensioned drawings of main structural towers to show construction of top and bottom terminals, bull wheels, sheave batteries and tensioning arrangements;
- Calculations for stress analysis of critical parts of the structure, showing magnitude and direction of rope forces on all towers at the top and bottom terminal structures supporting the ropeway. The various individual loading conditions and factors from which, the rope forces are derived and identified; and
- Design checks are carried out by recognized design verifiers are of structures and equipment supporting the loads imposed by the ropeway system, e.g. terminal station sheaves and support structures, towers, sheave batteries, and are in terms of factors of safety.

7.8.2 Acceptance

While starting operation of a passenger ropeway is placed in, it shall be subjected to commissioning inspection and testing. Thorough tests shall be made under loadings which provide the most unfavorable conditions, where practicable. This shall include an operational check of motive power, acceleration, deceleration, all brakes, all push-button stops, and all automatic stops and limit switches, and all communication devices. Prior to acceptance tests the passenger ropeway shall be run for a full day, and checked for overheating of moving parts, excessive vibration or deflection, free movement of counterweights, etc.

7.8.3 Materials

Choice, quality testing, and use of materials for aerial ropeways shall be in accordance with the appropriate Bureau of Indian Standard, noting that for load-bearing parts, including towers, and drive and return terminal structures, the materials are to comply with the low temperature impact properties for the minimum operating ambient site temperature. The design, details, materials and construction features shall provide safety factors at least equivalent to those specified of Indian Standard. The ropes used shall conform to the relevant Indian Standards. (IS 7649)

As far as possible, all wire ropes shall be in single piece and of non-rotating construction. Welded joints in the rope shall be spaced at least 6 times the pitch of the wire and their number in 500 m length shall not exceed the number of wires in the wire rope.

7.8.4 Foundation of Towers

The foundations of either tensioning devices or those of the anchorage shall be either a shallow foundation or deep foundation or founded on rock anchors. These foundations shall be in accordance with IS 4091. For the structural safety against sliding, overturning and for the footings at different levels provisions lay down in IS: 1904 shall apply. The depth of footings and other provisions shall conform to the provisions laid down in the relevant Indian Standards depending on the type of foundation. [Refer IS 1904, IS 1080, IS 2950, IS 11089, IS 9456, IS 2911 (Part 1/Sec 1), IS 2911 (Part 1/Sec 2), IS 2911 (Part 1/Sec 3), IS 2911 (Part 1/Sec 4), IS 2911 (Part 3)] These foundations shall be in accordance with Code of Practice for Design and Construction of Foundations for Transmission lines Towers and Poles IS 4091. For the structural safety against sliding, overturning and for the footings at different levels provisions lay down in IS 1904 shall apply.
Construction of structures be avoided on the steep and dip slopes. Light structures are preferable where the structure will be founded on cohesion less material or in highly weathered foundation rock. Weathered/shear portion be removed and treated by use of a thick mat of reinforced concrete or by providing thick cement base on fresh surface. Construction of civil structures be avoided where water zones are available in the bed rock within foundation level. In loose soil, exposed on steep slopes, structures be avoided and if un-avoidable, deep foundation with protective works and drainage network is suggested. Easing of slopes, with proper grading and buttress walls are also recommended. Constructions of big buildings are preferable where topographic slopes would not exceed 25^0 Plate load tests are suggested to ascertain the amount and type of settlement where heavy structures are to be constructed.

7.8.5 Maximum Speed and Minimum Spacing between Cabin

The maximum speed of the Cabin at the station shall not be more than 1.5 m/s. The maximum speed of the Cabins along the line may reach 3 m/s provided that the variation of speed on account of the requirements of route alignment of the ropeways between two terminals. This will not give rise to dangerous oscillations of Cabins.

In order to ensure the free movement of passengers and personnel in the station, the side clearance between the spaces occupied by a Cabin and fixed obstacles belonging to the installation shall not be less than 0.40 m measured towards the interior of the line.

Such clearance shall be 0.5 m measured towards the outside of the line. In case there are no guides for Cabin, such clearance shall be maintained even when the vehicle is inclined transversally at 12°.

Along the line the distance between the two paths of travel of the carrying-hauling rope shall be such as to ensure a clearance of at least 0.5 m between Cabins swung by 12° towards one another. Such clearance shall be required for spans having a length of not more than 200 m. For longer spans; the clearance shall be increased by 0.20 m for each additional 100 m or fraction thereof.

A minimum clearance of 0.30 m between the space occupied by a loaded vehicle swung longitudinally by 15° and obstacles lying on the vertical longitudinal plane shall be ensured either along the line or in the stations.

7.8.6 Wind Effects

The wind forces and their effects (static and dynamic) should be taken into account when designing ropeways. The provisions mentioned in IS 875 (part 3), IS 802 (Part 1) - shall be followed. The ropeway design shall also consider seismic loads in accordance with IS 1893. In addition, other special loads in accordance with IS 875 (part 5) shall also be considered

while designing ropeway. The trestle shall be analyzed and designed for various load combinations as per IS: 802

In areas subjected to storms and where the wind velocity exceeds frequently 150 km/h, it is necessary to assume the pressure of the wind as the maximum value ascertained in the area taken into consideration.

The tubes used in the hangers shall have no longitudinal welds and preferably seamless. Their interior shall be protected against corrosion. If welded tubes are used, welding should be checked by Non-Destructive Testing (NDT).

Aerial ropeways shall be closed down when the wind velocity reaches the design limit values, as agreed by the design verifier, the lift manufacturer and the lift controller, for the particular operating conditions and particular lift installation. For this purpose, suitable wind gauges like anemometer shall be installed at appropriate locations to ascertain wind velocity.

7.8.7 Inspection and Testing of Aerial Ropeways

The inspection and testing of an aerial ropeway shall include the following:

- Visual examination of towers and machinery, for workmanship and correct installation in accordance with plans and specifications;
- The operation of the ropeway for a full day continuously to check for overheating of moving parts, excessive vibration or deflection of mechanical or structural components, free movement of tensioning system, etc.;
- Checking of operational controls for correct functioning, including manually operated stop switches, automatic stop switches, limit switches, deropement switches, brakes, antiroll back devices, over speed governor, under main and auxiliary power;
- Thorough operating tests under full load and any partial loading which may provide the most adverse operating system.

7.9 RULES OF PRACTICE FOR PASSENGER ROPEWAYS

Conditions In Terms of Load

- Overload tests on service brake, emergency brake and drive equipment simulating 10% overload conditions;
- Tests to establish the ability of the prime mover to start the ropeway under the most unfavorable loading conditions in main and auxiliary power;
- Check of all communication and alarm devices;
- Unless previous tests are documented, chairs and cabins, together with hangers, shall be tested as a unit with weight equal to twice their passenger-carrying capacity. While the weights are in place, all attachments to the chairs or cabins under tension shall be proven safe. The mass of a passenger shall be taken 80Kg.
- Any other tests which the inspection body may consider necessary, or the manufacturer recommends; and
- Record of all tests and inspections shall be maintained.

The manufacturer or the designer shall submit a complete schedule of all proposed acceptance tests to the design verifier before such tests are performed. This schedule shall then be forwarded to the equipment inspector attending the commissioning.

In the event of disputes over testing requirements, reference shall be made to Occupational Safety and Health. Inspections of a passenger ropeway will take place during its construction and periodically throughout its lifecycle regardless of when the inspection occurs.

Safety Officers may use the following tools:

- Helmet,
- Hand tachometer,
- Level,
- Digital camera,
- Dynamometer,
- Stop watch,
- Inclinometer (to measure angles of slopes), and
- Ski boots and skis are other pieces of equipment

The Safety Officers use above tools during the operational inspection and testing of passenger ropeways. Approved fall arrest equipment (Zula) is mandatory when Safety Officers are climbing towers and onto the passenger ropeway station.

Suggested test: The following parts should undergo test

Loading test, Main drive, Rollback, Brake performance, Service brake, Emergency brake, Auxiliary drive, Emergency drive, Unload carriers: Demonstration of evacuation system.

7.10 OPERATION AND MAINTENANCE OF ROPEWAY

All equipment covered by BIS Code of Practice shall be maintained in a safe condition. A systematic routine maintenance and inspection schedule, based on a 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. For any passenger ropeway, records of the rates of deterioration (such as corrosion, erosion, etc.) shall be maintained. During a periodic inspection (Monthly), a Safety Officer appointed by operators of ropeway may inspect towers, sheave assemblies, brakes and braking functions, and the operation of main drives, auxiliary drives, and evacuation drives. Periodic inspections will take place at any time of the year. Although these will occur during the ski season while the ropeway is in operation, inspections can also take place before the winter months. Safety Officers can conduct more inspections when the ropeway are not in operation or open to the public. This would include riding the maintenance-work carrier to check the towers on the line. The fuel supply for IC engines shall be checked regularly as appropriate for the fuel tank size and the usage. For primary power units, there shall be sufficient fuel to conduct the anticipated period of operation and to deal with all emergencies without refueling. Power units shall be shut down during the refueling.

Starting of ropeways

Only competent persons authorized by the ropeway management shall start a passenger ropeway.

Inspections

Prior to transporting passengers, a daily inspection shall be conducted by a competent person under the supervision of manager of operators of ropeway. As a minimum, the inspection shall consist of the following:

i. Inspect visually each terminal, station, and the entire length of the ropeway, lift or tow, including grips, hangers and carriers;

ii. Note the position of tension carriages and counterweights and ensure that the tensioning system is free to move in both directions;

iii. Test the operation of all manual and automatic switches in terminals, stations, and loading and unloading areas as per the manufacturer's specifications;

iv. Test the operation of main drive and all braking systems;

v. Test the operation of communication systems;

vi. Ropeways and lifts having emergency power units shall have the emergency engine checked during this inspection and operated at least once weekly;

vii. Note the general condition of the hauling rope including splices;

viii. Commissioning inspection including load test runs;

ix. Formal pre-season inspection;

x. Fairly and periodic maintenance inspections;

xi. Annual inspection (or at change of ownership);

xii. Periodic major inspection of critical components; and

xiii. Designer and manufacturer stipulated inspections and ancillary equipment inspections.

Ropeway Operator

The position of ropeway operator shall be such that he shall have the best possible view of the route and the controls and communicating devices shall be within his reach. The control panel must have following indicator:

- Speed indicator,
- Indicator for the vehicle position along the line, and
- Fault indicator.

The driving gear shall be provided with an emergency motor fed by auxiliary power or Internal Combustion engine which can ensure a rescue operation as needed even when there is something wrong with the main motor or even in case of power failure.

However, installations having length less than 200m winching device may be provided. Working of the main motor shall be stopped automatically when any brake is on or if any safety device operates. Two different friction brakes called 'service brake' and the other 'emergency brake' shall be used in case of electric motor drive to cause both the normal stopping and

emergency one. Each of such brakes shall be able to ensure the safe stopping of the installation's motion under most unfavourable conditions of loading. In any case, the nominal average deceleration shall not exceed 0.5 m/s^2 A suitable automatic device which prevents the reverse motion of the system in normal service shall be installed.

Communications

All stations shall be connected to each other by mobile telephone. Minimum one station shall be linked up with the public network. Communication facilities (telephone or wireless) shall be provided in the vehicle for communication with the driving station or with the second vehicle.

The entire ropeways system shall be provided with suitable earthing and protection against lightning.

The following testing must be carried out:

Load testing at 5 yearly intervals or at change of critical load bearing components; non-destructive testing; and destructive testing (ropes).

All non-destructive testing must be carried out by a suitably experienced person and in accordance with relevant Indian Standards.

Procedures must be developed (and regularly audited) for

- Daily start-up, running and shut-down;
- Daily and periodic maintenance; and environmental conditions

Maintenance program for aerial ropeway towers

Particular attention must be given to towers. In these circumstances, the employer must make sure the maintenance program includes regular tests (e.g. torque tests or visual inspection) to check for fatigue or corrosion of the anchor bolts on tower.

Consideration must also be given to whether the towers and anchorage system have been subject to any random vibration due to movement of the haul rope and carrier grips over sheave assemblies and other factors that may have an impact on the effectiveness of anchor bolts such as:

- Whether a continuous uphill load imposed by the subtended angle of the haul rope on any vertical tower might lead to excessive fluctuating loads on the anchor bolts; or

- Whether tower base plates that are not fitted directly to the concrete footing have incorporated expanding grout between the tower base plate and the upper surface of the concrete footing to allow a continuous tension load on the anchor bolts to be maintained.

As well, towers that have bracing tubes around anchor bolts connected to the main tower tube by a gusset should be subject to detailed investigation for water retention and resultant corrosion.

In addition to the tower maintenance procedures must address the major components and systems. The following is a brief overview:

- Chair, Hanger and Rope Grip assembly,

- Ropes,
- Haul Rope,
- Counterweight Tension Rope,
- Guy Ropes or Stays,
- Rope Tensioning Equipment,
- Communication and safety systems including emergency stop,
- Drives,
- Main Drive,
- Standby Drive,
- Rescue Drive,
- Integrity of power source for all drives,
- Sheave assemblies and rope guiding equipment,
- Line sheave assemblies, sheave bearings and liners,
- Alignment,
- Bull wheels,
- Drive and return sheaves, bearings and liners,
- Rope guiding equipment,
- Alignment,
- Brakes,
- Service Brake,
- Emergency Brake,
- Anti-rollback systems,
- Backstops and anti-rollback brakes,
- Loading and unloading stations and equipment,
- Safety Gates,
- Firefighting equipment,
- Inspection and testing requirements in accordance with Australian Standards,
- Electrical systems and equipment,
- Earthing systems,
- Control and monitoring devices,
- Emergency evacuation – procedures and equipment, and
- Corrosion protection

Termination of daily operations

Procedures shall be established for terminating daily operations to ensure that passengers shall not be left on the ropeway after it has been shut down.

7.11 CONTROL AND SAFETY OF PASSENGERS

The operating agency shall have specific plan for marshalling passengers for safe loading and unloading. The ropeway manager shall draw up special instructions necessary to be observed by staff to ensure the safety of children riding the ropeway, and shall ensure that such instructions are implemented and enforced by the staff. Loading attendants are to ensure that passengers do not embark on chairs, or in cars or cabins, with equipment which will in any way be a hazard to the safety of themselves or other passengers.

Appropriate signs shall be posted where they may be easily read by all persons using the ropeway. Some commonly used wording, suggested for use in connection with passenger ropeways signage is as follows:

- If not familiar with use of lift, ask attendant for instructions
- Prepare to unload Keep ski tips up

- Unload here

- Do not swing or bounce chairs
- Stay in track
- No loose clothing or long hair exposed (At loading area)
- Remove pole straps from wrists (At loading area)

The ropeway management should ensure that adequate provisions, such as pictograms, are made for passengers, who do not read or speak Hindi or English, to be able to use the ropeway correctly and safely. Any additional signs which may be required to ensure the safe operation of the ropeway shall be posted to the satisfaction of a competent person.

Markers

Where guyed towers are used and guys meet the ground within ski-runs, the guys shall be marked for visibility, preferably with boards painted with black and yellow stripes.

First aid at Ropeway

There shall be ready access to first-aid supplies and equipment, and provision shall be made to render first aid in the event of persons being injured on the ropeway.

7.12 SAFETY MANAGEMENT PLANS

Under a safety management plan, the licensed contractor will be required, as per terms and condition 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.

Safety Manager

The operator of ropeway will have Safety Authenticity. Safety Authority appoints the local safety manager, who is given the authority to perform the following duties:

- Provide technical support and expertise to Safety Officers;
- Evaluate industry training programs and the qualifications of those who train attendants and operators;
- Provide correct interpretation of the and regulations;
- Issue, suspend, or revoke a contractor's license as necessary;
- Review safety management plans;
- Issue directives, discipline orders, monetary penalties, and safety orders; and
- Review a Safety Officer's decision upon a client's request.

Other responsibilities of the Safety Manager include recommending regulatory changes, providing input on the operational functions of the program, advising on risk management systems, and undertaking incident investigations.

Safety Officers

Safety Officers are at the forefront when dealing with owners and licensed contractors. They are an integral part of the program and report on wherever safety is compromised. Some of their responsibilities are as follows:

- Issue permits;
- Answer inquiries;
- Conduct safety inspections;

- Investigate, document, and follow up on incidents;
- Promote public and worker safety awareness;
- Educate and provide technical information to industry owners and contractors on changing technology, codes, and standards;

- Develop and deliver training, seminars and briefings;
- Grant variances;
- Provide recommendations to the Safety Manager;
- Conduct compliance monitoring and audits; and
- Assess the need for changes to the regulations.

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.

Procedures for Strange Occurrences

The management shall prepare, and put in the control booth for which the procedures to be followed in case of unusual occurrences, such as:

- Roll back;
- Over speed;
- Counterweight limits reached;
- Tower development switch tripped;
- Communication system failure;
- Fire; and
- Earthquake.

7.13 ELECTRICAL PROTECTION

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

Investigating Incidents

A Safety Officer investigates serious incidents as soon as they are brought to the attention of the Safety Authority. Under the Industrial Safety Act an incident is the occurrence of a death, personal injury, or damage to property, or the risk of personal injury or damage to property. An incident is the result of regulated work or the testing, use or operation of a passenger ropeway. The levels of an incident, personal injury and damage to property can range from serious to minor.

Incidents may be caused by mechanical failure, passenger error, abnormal weather or operational error. Whatever the case may be, the Safety Manager will consider what measures may be taken to prevent similar incidents from occurring and what will be necessary to get the equipment back into operation.

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CHAPTER 8
DISASTER MANAGEMENT PLAN

8.1 DISASTER MANAGEMENT

Disaster is an unexpected event due to sudden failure of the system, external threats, internal disturbances, earthquakes, fire and accidents. The first step is to identify the causes which develop/ pose unexpected danger to the structural integrity of Ropeway. The potential risks are given in **Chapter 7**. The main aim of the disaster management plan is

1. Safety of the passenger
2. Quick response at the time accident and treatment to casualties
3. Evacuation of passengers to safe area
4. Bring the disaster under control within short time
5. Investigation of accident and prepare prevention plan

8.1.1 Preventive Action

Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Manager responsible for preventive action should identify sources of repair equipments, materials, labour and expertise for use during emergency.

8.1.2 Reporting Procedures

The level at which a situation will be termed a disaster shall be specified. This shall include the stage at which the surveillance requirements should be increased both in frequency and details. The Manager should notify the officer for the following information:

- Exit points for the public,
- Nearest medical facilities.

8.1.3 Communication System

An efficient communication system is absolutely essential for the success of any disaster management plan. This has to be worked out in consultation with local authorities. More often, the entire communication system gets disrupted when a disaster occurs. The damage areas need to be clearly identified and provided with temporary and full proof communication system.

8.1.4 Emergency Action Committee

To ensure co-ordination action, an Emergency Action Committee should be constituted. The civic administrator may be the Chairman of this Committee. The committee may comprise of

- Police Officer of the area,
- Health Department representative,
- Department of Information and Publicity, and
- Non-Governmental Organization of the area.

Emergency Action Committee will prepare the evacuation plan and procedures for implementation based on local needs and facilities available. The plan should include:

- Demarcation of the areas to be evacuated with priorities,
- Safe route to be used, adequacy of transport for evacuation, and traffic control,

- Safe area and shelters,
- Security of property left behind in the evacuated areas,
- Functions and responsibilities of various members of evacuation teams, and
- Setting up of joint control room.

All personnel involved in the Emergency Action Plan should be thoroughly familiar with all the elements of the plan and their responsibilities. They should be trained through drills for the Emergency Action Plan. The staff at the site should be trained for problem detection, evaluation and emergency remedial measures. Individual responsibility to handle the segments in emergency plan must be allotted.

Success of an emergency plan depends on public participation, their response to warning notifications and timely action. Public has to be educated on the hazards and key role in disaster mitigation by helping in the planned evacuation and rescue operations.

It is essential to communicate by whom and how a declared emergency will be terminated. There should be proper notification to the public on de-alert signals regarding termination of the emergency. The notification should be clear so that the evacuees know precisely what to do when re-entering or approaching the affected areas.

8.2 EMERGENCY MEASURES

The emergency measures are adopted to avoid any failure in the system. The aim of Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of accident. The action plan should also include preventive action, notification, warning procedures and co-ordination among various relief authorities.

8.2.1 Safety Measures

- Grip pressure-monitoring devices at both stations after attachment with the rope.

- The Gondolas are provided with door lock, which cannot be opened by the passengers.

- Carriage of each cabin is provided with 2 numbers detachable rope grips.

- Two separate brakes are provided in the drive of ropeway system. One number weight operated and thrustor/pneumatically released brake is provided on brake ring fitted on drive sheave. This will act as **emergency brake**. A second thrustor released brake is provided on high-speed brake drum coupling, which will act as **service brake**.

- In the event of main supply power failure, full capacity D.G. sets will be provided to supply power to run drive motors.

- Standby Diesel Engine is provided for to run ropeway at slow speed to rescue passengers from line in case of failure of main A.C. motor.

- Line safety devices are installed on each trestle, hold-downs and pressure frames which immediately stop the ropeway in the unlikely event of rope derailment. This comprises of electrical trip limit switch with attachment mounted on line sheave mount. In an accidental case, if the hauling rope comes out of line sheave it automatically trips the ropeway by the actuation of limit switch through the attachment.

- 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 de-ropement.

- Emergency push buttons are provided at all stations to stop the ropeway, if required.

- The Ropeway Main Drive Motors will be tripped if :

    - Set rope speed exceeds by 5%, and
    - Wind speed exceeds the set limit

- Cabin Guide arrangement shall be provided in both the station.

- Cabin door locking should be properly secured all the time during traveling period. If required one additional latch from outside shall have to be provided.

- Installation of Anti-roll Back device at Drive unit.

- Adequate arrangement of rat mesh at the opening below the panel at LTP and UTP, DG sets, etc.

- Cable trench shall be covered with 6mm chequered plate wherever exists.

- All the safety devices should be in operative condition even the main power supply goes off.

SAFETY DEVICES AT STATIONS

Two safety devices are fitted on outgoing side and one on the incoming side of lower and upper stations .The purpose of the devices is to ensure that the following conditions are met during the passage of each cabin at the stations.

Safety Device No. 1 (Cabin Jaw)

This safety device is placed on the exit side of the station just after the transfer point of cabins from rail to rope. This safety device comes into operation when:

- The rope is not correctly placed in the jaws.
- The jaws remain open.

Safety Device No. 2 (Cabin Lock

This safety device is located on the exit side of the station after the rope is gripped in the jaws, the toggle arm is vertical and the safety lock of cabin is in position. This safety device comes in operation when:

- The safety clutch is unlocked
- The rope and jaws wear and require adjustment.
- The jaws remain open.

Safety Device No. 3

This safety device is located on the entrance side, after the carriage jaws have unlocked and the rope has left the jaws as the cabin moves on the station shunt rail. This safety device

comes into operation when the jaws have not unlocked the rope after the movement of the cabin on the Scroll.

If the above conditions for devices No. 1 and 2 are not fulfilled then the limit switches fitted to these devices will trip and stop the ropeway. In this event, it is necessary to correct the fault and then reset the limit switch before further running of the ropeway. In the case of device No. 3, not only the ropeway will be tripped but also the Cat Whisker of limit switch will be broken and this should be replaced before further running of the ropeway.

In addition to the above, emergency stop buttons are provided at convenient points to stop the cabin lift in the event of any emergency.

LINE SECURITY DEVICES

A safety device would be installed on both sides of battery of sheaves on Trestles, P.F. and Hold-downs. In the unlikely event of the hauling rope coming off the line sheaves, a limit switch wired into the line security circuit is operated which stops the ropeway main drive motor. It will be necessary to set the rope in position and reset the control panel before the ropeway can be re-started.

8.2.2 RESCUE AND OTHER ARRANGEMENT

The ropeway system would be provided with suitable means for rescue which shall be provided to facilitate the rescue of passengers who might remain trapped along the line on account of unforeseen stopping of the installation, in a reasonable short time and in the easiest and safest manner. The use of such equipment shall not require the help of the passengers.

The chosen rescue equipment shall be such that the rescue operation can be carried out in a perfect manner even at the most critical points of the route.

Rescue apparatus like Poly Propylene rope, safety belt, chair, pullies etc. should be made available at each cabin in a sufficient quantity for four passengers. The rescuer should fit rescue carriage easily that might be self-driven and self-controlled type. Rescue carriage should be able to travel over the rope grip smoothly. An adequate number of rescuer carriages need to be supplied, so that all the stranded passengers could be brought back to a safe location on ground at a reasonably short time.

Besides above, for the larger span to be supported with rescue carrier driven separately by a rescue rope, which will stop beside each cabin at line and facilitate transshipment of passenger from one cabin at line to rescue cabin, both the cabins to be designed with due consideration for passage/opening in emergency.

8.2.2.1 COMMUNICATION

O.H. Control and Communication Wires

- One multi core cable suspended from catenary wire will run from Lower to Upper station to carry trip and annunciation signals. This will be supported on ropeway steel structures.

- The catenary wire will be supported on insulators on Power line poles from Lower to Upper station.

Communication System

- One number Industrial type telephone system will be provided for communication with each station and line. The system basically consists of wall mounted sets (2 Nos. for each station), loudspeaker and amplifier. 2 Nos. portable sets will be provided for communication with line.

- The wireless system (4 Nos. handsets) will be provided to communicate while maintenance/ rescue operation on line and for other reasons, when communication through telephone system will not be possible.

- 16-channel intercom system will be installed at each station for communication between operating and security personnel of that station.

8.2.2.2 CCTV AT BOTH THE STATION

Arrangement of one number color CCTV shall be provided at the control room of both the station to look at the movement of passengers. This will also serve as security purpose.

8.2.2.3 PUBLIC ADDRESS SYSTEM

All the two stations shall be provided with a Public Address System.

8.2.2.4 PROTECTIONS

Other standard protections, such as, electrical protection for LT, lightening protection, earthing etc. shall be provided.

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CHAPTER 9
ENVIRONMENTAL MONITORING PLAN AND COST

9.1 GENERAL

The environmental monitoring programme is a vital process for the Environmental Management of infrastructure project. This helps in signaling the potential problems that would result from the construction and operation of proposed project and will allow for prompt implementation of corrective measures. The environmental monitoring is proposed during construction and operational phases. The following parameters need to be monitored:

- Water Quality,
- Air and Noise Quality, and
- Soil.

9.2 WATER QUALITY MONITORING

Water contamination leads to various water related diseases, the project authorities shall establish a procedure for water quality surveillance and ensure safe water for the consumers. Minimum 3 samples shall be tested around the project site for drinking water quality parameters as per BIS: 10500. Water monitoring should be carried out at least three times a year to cover seasonal variations by any Government or recognized private agency. Water quality should be analyzed by applying the standard methods.

Water quality shall be monitored before starting the construction, during the construction phase, and for at least one year after the completion of the project. There is no major construction activity for proposed ropeway.

9.3 AIR AND NOISE QUALITY MONITORING

To assess the effectiveness of air and noise pollution control, ambient air quality and noise levels shall be monitored during the construction and for at least one year after the completion of the project. The proposed monitoring program for field monitoring and laboratory analysis of air and noise is given in **Table 9.1**.

TABLE 9.1
PROPOSED MONITORING PROGRAMME FOR AIR AND NOISE QUALITY

Particular	Description
Ambient Air Quality	
Parameters to be monitored	PM_{10}, $PM_{2.5}$, SO_2,CO, and NO_x,
Number of Location during construction and operation	At least three locations, The locations shall be decided by the Environmental Engineer/Officer incharge.
Monitoring period	During construction and 1 year after construction.
Frequency	Once in Month for Three Season in a Year i.e. Pre-Monsoon, Post-Monsoon and Winter
Ambient Noise Quality	
Parameters to be monitored	Noise level in dB(A)
Proposed Locations during construction and operation	At least three locations, The locations shall be decided by the Environmental Engineer/Officer incharge.
Monitoring period	Same as above for air
Frequency	Same as above for air

9.4 SOIL QUALITY MONITORING

Soil near to the construction area shall be monitored to ascertain presence of soil pollution due to construction activities. The soil monitoring schedule is given in **Table 9.2**.

TABLE 9.2
PROPOSED MONITORING PROGRAMME FOR SOIL QUALITY

PARAMETER	LOCATION	DURATION	FREQUENCY
pH, Texture, Total Organic Matter, Nitrogen, Phosphate, Moisture Content, Sodium, Potassium, Calcium, Chloride, Magnesium, and Electric Conductivity	During Construction and Operation: Three sample	During construction and 1 year after construction	Seasonal

9.5 ESTABLISHMENT OF ENVIRONMENTAL CELL

The project authority shall establish an Environmental cell in the initial stage of the project. The division shall have one Environmental Engineer/Officer. The task of the environmental Engineer/Officer shall be to supervise and co-ordinate environmental concerns, monitoring and implementation of mitigation measures. The officer will monitor the environmental works in coordination with the Project Director. Cost of such a division has been estimated as **Rs. 25.96 lakh** as per the details given in **Table 9.3** below.

TABLE 9.3
COST OF ENVIRONMENTAL CELL

S No	ITEM	COST (Rs)
A	**Capital Cost**	
	Office Furnishings (Computer, Audio visual aid and furniture)	2,00,000
B	**Recurring Cost**	
	Man Power Cost (For 36 months)	
	Environmental Engineer/Officer @ Rs. 45,000/month	16,20,000
	Office Maintenance and consumables @ Rs. 15,000/month	5,40,000
C	**Sub Total (A B)**	**23,60,000**
	Miscellaneous and unforeseen expenses, LS (10 % of C)	2,36,000
	Total cost for establishment of cell	**25,96,000**

9.6 ENVIRONMENTAL COST

Most of the items described in the environmental management plan form part of the project cost which will be included in the project civil cost. Certain items like health care and medical facility to workers make part of the contractual obligations of the construction contractor. The environmental costs towards implementation of environmental management plan and mitigation measures during pre-construction, construction and operation of the proposed project are estimated of **Rs. 1684.10 lakh** and described in **Table 9.4**.

TABLE 9.4
ENVIRONMENTAL COST

S No	ITEM	QUANTITY	ESTIMATED UNIT RATE (Rs.)	TOTAL COST (Rs. In Lakh)
A. ENVIRONMENTAL MONITORING COST				
I	**Water Quality Monitoring**			
	Monitoring during Construction Stage and after Construction	3 location x 3 times a year x (3 Constr. year + 1 years after Construction) = 36 samples	8000	2.88
II	**Air and Noise Quality Monitoring**			
	Monitoring during construction and after Construction	36 samples	15000	5.40
III	**Soil Quality Monitoring**			
	Monitoring during construction and after Construction	3 location x 3 times a year x (3 Constr. year + 1 years after Construction) = 36 samples	5000	1.80
IV	**Environmental Cell Cost**			
	Establishment of Environmental Cell	Refer Section 9.5	Refer Table 9.3	25.96
Environmental Monitoring Cost (A) Sub Total (I) (II) (III) (IV)				**36.04**
B. MANAGEMENT/MITIGATION COST				
1	**Forest Management (Refer Section 6.3.1)**			
A	**Maenam Wildlife Sanctuary Management**			
	Compensatory Forestation (CA)			18.05
	Net Present Value (NPV)			73.40
	Biodiversity Conservation & Wildlife Protection Plan			1500.00
	Cutting, felling, logging and transportation of project affect trees			0.20
B	**Reserve Forest Management**			
	Compensatory Forestation (CA)			20.14
	Net Present Value (NPV)			30.88
	Cutting, felling, logging and transportation of project affect trees			3.39
2	Environmental Training	Environmental Awareness and Management	Refer section 6.4.6	2.00
Management /Mitigation Cost (B)				**1648.06**
TOTAL COST (A) (B)				**1684.10**
ENVIRONMENTAL COST				**1684.10**

CHAPTER 10
SUMMARY AND CONCLUSION

10.1 INTRODUCTION

Sikkim is located in the Himalayan range of mountains, therefore it is an ancient belief and practice of the sikkimese to worship mountain for the safety and prosperity of the land occupants. In this region, people worship the apparently highest peak Bhaleydunga. Devotees from all the surrounding areas comprising of eleven blocks regularly go to the hilltop for worships and to visit millennium old Maenam Monastery. Other than this mobility, Trekkers and tourists from all parts of India and abroad also visit Bhaleydunga and Maenam peak through the popular trekkerôs route from Ravangla bazzar which is 13 kms in length. Therefore, it has been envisaged that Bhaleydunga peak has an importance to the local people from mythological point of view as well as an attraction to the trekkers for its natural beauty and landscape.

Since the Tourism industry holds a major share in the economy of Sikkim, department of Tourism, Govt. of Sikkim has given due importance to the tourism potentiality and weight age to the mythological believes of the local people and eco tourism, thus decided to provide certain infrastructure like Skywalk at Bhaleydunga and to connect the hilltop from its south-east part of the foothill, namely Dhapar so that socio-economic development spreads widely in the region. Ropeway system has been chosen as a most suitable and environment friendly mode of transport system in hilly region.

RITES Ltd. (A Government of India Enterprise) was appointed by Department of Tourism and Civil Aviation (DoT&CA), Government of Sikkim, as consultant, for the preparation of Detailed Project Report (DPR) and Environmental Impact Assessment (EIA) study for proposed Ropeway systems. An EIA study has been taken up as per the approved Terms of Reference (TOR) issued by Expert Appraisal Committee (EAC) of Ministry of Environment and Forest (MoEF) for Environmental Clearance of the project.

Conceptualization of the project: In view of socio-economic development of Ravangla sub division of south district of Sikkim, department of Tourism, govt. of Sikkim has conceptualized certain development of infrastructure at Yangang, Dhapar as well as at Bhaleydunga hilltop at an altitude of 10500 ft. It has been outlined that the proposed development programme will ensure accessibility to the remote areas so that benefits of socio development programme could reach to the maximum numbers of common people of the state. The development programme will also ensure tourism attraction events so that a self sustained economical growth among the local people could be developed out of tourism.

Objectives of the Study and Terms of Reference: The objective of the study is to facilitate the DoT&CA to obtain prior environmental clearance from the Ministry of Environment and Forest (MoEF), Government of India for the proposed ropeway systems. In addition it also proposes to establish environmental baseline and safeguard measures for protection of environment for sustainable development during project cycles. The MoEF, Government of India, notification of 14th September 2006 and its amendment dated 1st December 2009 enlist Ropeway projects is category ôAô as per above notification schedule if located in ecological sensitive area. All projects or activities included as category ôAôin the schedule shall require prior environmental clearance from the Central Government in the MoEF on the recommendations of an Expert Appraisal Committee (EAC).

In order to follow the procedure of project appraisal the DoT&CA applied for the Terms of Reference for EIA study in MoEF in prescribed formats. The DoT&CA and RITES, the consultant made a presentation on the project before 127th EAC meeting at New Delhi.

MoEF issued the Terms of Reference (ToR) for Ropeway project at Bhalaydhunga vide file no 10-51/2013-IA.III dated 14th November 2013.

Approach and methodology: The approach of the study is to conduct EIA as per Notification, Acts, Guidelines and Standards. The basic concept is to ascertain the existing baseline conditions and assess the impacts as a result of construction and operation of the activities of the project. The impacts are assessed for various phases of project cycle namely: Impacts due to project location, Impacts due to project construction, and Impacts due to project operation.

The standard methodology for the data collection, impact assessment and formulation of management plans is adopted while carrying out the field study and preparing the report. The approved Terms of Reference are kept in mind during the field study.

10.2 PROJECT DESCRIPTION

Project and its location: The proposed project site is located at the Dhappar. Dhappar is located in Ravangla sub-division under south district of Sikkim. It is about 13 km from Ravangla sub-division town, while Ravangla is 125 kms away from Siliguri and 107 Kms from Gangtok. The area is connected by the means of road transport from Railhead at suiliguri and airport at Bagdogra. The project envisages construction of buildings at two ends namely LTP & UTP of Ropeway Systems for boarding/de-boarding of passengers.

Salient features of proposed ropeway system: The ropeway system used in the alignment would be Detachable grip 8 seater Mono cable Gondola ropeway system, 400 Persons Per Hour capacity, length 2.96 km. The speed of the ropeway system will be 0-5 m/sec and drive location will be at lower terminal. The facilities include, Lower Terminal Station, Upper Terminal Station and Passengerôs amenities at stations. The completion of the project is expected in 36 months from the date of award of work. The capital cost and operation & maintenance cost of ropeway systems is worked out as **Rs. 73.33 crores crores** and **Rs. 149.37 lacs** respectively.

Alternatives Analysis: The finalization of alignments for ropeway considering various options of alignments and technology during analysis of alternatives.

10.3 BASELINE ENVIRONMENTAL DATA

The collection of environmental baseline data is required to assess the impacts of project activities on the environment. The project study area is 10 km radius from centre point of proposed Ropeway. The data have been compiled for: Land Environment (Physiography, Geology, Seismicity and Soils), Water Environment (Water Resources, Water Use, Water Quality), Air Environment (Meteorology and Air Quality), Noise Environment (Noise Levels), Ecological Environment (Flora and Fauna) and Socio-Economic Environment (Demography, Socio-Economics, etc).

Physiography: The South District (27 05ô N to 27 32ô N) is a very small district of the hill state of Sikkim. This district covers an area of 750 Sq km. The district with the headquarters at Namchi comprises of the two sub-division of Namchi and Ravongla. The district is a part of inner ranges of mountains of Western Himalayas consisting of higher hills, alpine zones and snow bound areas. The terrain is hilly with narrow incised river valleys with elevations ranging 300 to 5000 m. the slope varies from 80m, to more than 600m per kilometer.

Geology and Soil: The geological formation of South Sikkim district comprises Quaternary deposits of alluvium in river terrace are developed sporadically along the streams and rivers.

The soils of the district in general have derived from parent rocks such as Sandstone, Phyllite, Schist, gneisses and colluvial materials

Land use pattern: The land use/land cover data for the study area was derived using the latest cloud free satellite imagery. The landuse classes that has been identified includes Very dense Forest, Moderately Dense Forest, Open Forest, Agriculture, Alpine Pasture, Barren, Landslide, River, River sand, Scrub, Settlement and Snow covering a total area of 732.48 sq km. Land use of the 15 km radius shows that the predominant land use of the area is very dense forest.

Seismicity: Sikkim is located in the high risk seismic zone IV as per the seismic zoning map of India prepared by Bureau of Indian Standards (BIS code: IS 1893: Part-1:2002). Considering its geographical location and its past seismic history, suitable provision of seismic factor may be made in the design of civil engineering structures to make them earthquake resistant.

Water: The South District of Sikkim falls under Tista basin. The drainage of the district is controlled by the perennial Tista and Rangit rivers alongwith their tributaries. The Tista and its tributaries drain different parts of the Area.The Rivers are perennial in nature which is fed by both snowmelt water and rain water. Rangit, another river originates from West Sikkim. In order to assess the baseline water quality status of the study area, 2 water samples were collected. It is found that BOD and COD are present in both the samples and total coliform is present in sample no 2. Hence the water from both the sources should be treated before using it for drinking purpose.

Temperature: In winter minimum temperature is 4.5°C and maximum temperature is 14.7°C.In summer minimum temperature is 20.5°C and maximum temperature is 27.5°C.

Rainfall: Most of the rainfall is received between April to September. During the remaining period, rainfall is sporadic and scanty.

Humidity: Months mean maximum and minimum relative humidity at 0300 hrs is 96 % to 71 % respectively, while Months mean maximum and minimum relative humidity at 1200 hrs is 95 % to 71 % respectively.

Wind Speed and Wind Direction: Generally, light to moderate winds prevail throughout the year. Minimum and Maximum Wind speed during last 30 years (Year1971-2000) is varies from 0 to 50.4 km/hr.

Air Quality: The atmospheric concentrations of air pollutants are monitored at 5 locations for parameters $PM_{2.5}$, PM_{10}, SO_2, NO_X, O_3, Pb, NH_3, HC & CO under ambient air quality monitoring (AAQM). It is observed that all parameters are within the standards. The proposed ropeway site is not coming under critically polluted areas identified by Central Pollution Control Board.

Noise Quality: Noise level survey is conducted at five locations. At all the location noise ambient noise quality is within prescribed limit given by Central Pollution Control Board except Rabangla Town location. The monitoring result of Rabangla Town location is exceed the permissible limit because the heavy traffic.

Ecological Environment: The project area falls in the Maenam Wildlife Sanctuary.

Historical/Archeological Monuments: There is no ancient archeologically important monument in the project area.

Socio-Economic Profile of the Project Area: The South District is a very small district of the hill state of Sikkim. This district covers an area of 750 Sq km with a population of 1,25,651. The literacy rate of 66.41 percent, which is below the state average. The district with the headquarters at Namchi comprises of the two sub-division of Namchi and Ravongla. There area 45 Gram Panchayats units and 145 revenue blocks (including 10 special forest blocks).

10.4 ENVIRONMENTAL IMPACTS ASSESSMENT

NEGATIVE ENVIRONMENTAL INPACTS

There are negative as well as positive impacts on various aspects of the environment likely to result from the proposed development.

Land: The impacts likely to take place due to the project location could be mainly due to land acquisition and its diversion for project purpose. The land required for the proposed project is about 2.9 ha in which 1.2 ha in Maenam Wildlife Sanctuary and 1.7 ha in Reserved Forest. Hence, an application was submitted for denotification of proposed land. The Honorable Supreme Court of India permits the use of 2.1 ha land of Maenam Wildlife Sanctuary land for the construction of Skywalk and Ropeway.During construction, increased soil erosion due to site clearance and earthwork is anticipated. The land use of 2.9 ha is changed from forest to non forest.

Displacement of People: The proposed Ropeway systems will not have any displacement of people since the land belongs to the Maenam Wildlife Sanctuary and Reserved Forest. Hence no social issues related to land acquisition, encroachers and squatters is anticipated.

Topography, Drainage and Soil Quality: The area required for terminal stations are almost flat. The ropeway alignment crosses one nallah. The sites for the terminal stations will be leveled in accordance with the topography of the region and thus there will be no significant impact on the topography and drainage of the area. The ropeway Impact on soil owing to the construction of terminals includes soil erosion, compaction and pollution of soil in case of waste discharge on land. The impact will be however short term in duration and will have no significant impacts.

Slope Erosion: Erosion aspect of a hill slope is an important factor in determining its stability condition. The deep gully, toe erosion by nallahs destabilizes slopes. It has been observed that the toe erosion by nallah is affecting the slope stability at number of places but nowhere affecting the proposed ropeway.

Landslide: The status of slope stability is an important aspect that can affect the landslide hazard in the area. This is reflected by the landslide incidences in the past. The landslide affected slopes reflect the instability condition of slope and add to the hazard vulnerability in the area. There is no landslide incidences occurred at project site.

Earthquakes: The project area falls under seismic zone IV as per the Seismic Zoning Map of India. Necessary seismic factors (horizontal and vertical ground acceleration), as per relevant Indian Standard Code (IS: 1893 ï Part ï 1: 2002) shall be adopted. All components of structures shall be designed for seismic zone IV to ensure the safeguard against earthquake risks.

Solid Waste: About 100 and 26 numbers of labours/Person will be required for construction and operation of Ropeway respectively. The design capacity of the proposed ropeway is 4000 passenger per day. 10.0 Kg/day and 402.6 Kg/day of solid waste shall be generated during construction and operation.

Existing Features within 1 km: The existing features at project site within 1 km radius are Maenam Wildlife Sanctuary, Reserved Forest, Helipad, Approach Road/Footpath and Water storage tanks.

Water Supply and Sanitation*:* Construction phase will last for a period of approximately 36 months. About 100 workers will be working at site during peak construction. Water demand during construction is estimated about 20 KLD which will be supplied from existing water supply source line of the Public Health Engineering Department. The Waste water generated will be 3.6 KLD during construction.

About 26 persons including staff and security during operation of the Ropeway project. The design capacity of the proposed ropeway is 4000 passenger per day. The total water requirement will be 181.82 KLD. The Waste water generated will be 145.46 KLD .

Air Environment: The construction activities for the proposed terminal stations will be of small scale and thus the particulate emissions will be minimal and short term in nature. For the construction of line towers the generation of the dust will be low as compared to the construction of terminal stations. The impact of other pollutants such as SO_2, NOx and CO will be caused due to diesel-operated mechanical equipment and their impact is expected to be negligible and of short term duration. Use of these machineries is limited to and considered working for few hours in a construction period. No air pollution is anticipated during operation.

Noise Environment: During Construction the prime sources of noise are the construction machinery and the vehicular noise due to material movement at the site. The main noise generating equipment that will be used at site will be concrete mixer (for small concrete work) and concrete vibrator. Concrete mixer generates noise level of 85 dB (A) at 50 feet distance. It could therefore be concluded that the construction activities would not have a significant impact on existing environment during construction phase. During Operation of ropeway, All the D.G. Sets shall be placed in recommended acoustic enclosure or with silencers and Periodic maintenance. Hence no significant change in noise levels is anticipated.

Wind Pressure: As per Indian standard, the wind speed should not be more than 150 km/hr during operation of aerial ropeway.

Biological Environment: The Total numbers of trees within ropeway corridor are 45 numbers, out of which 17 have girth 30 cm or more.

Socio-Economic: The required land for construction of the project is Maenam Wildlife Sanctuary. Hence the proposed project shall not displace and resettle any people/family. In addition, it shall create direct and indirect business and employment opportunities during construction and operation. No Historical or Cultural Monuments will be affected/ lost due to the construction of the project.

POSITIVE ENVIRONMENTAL IMPACTS

Employment Opportunities: The construction phase of the project is spread over a period of 36 months. During this period various categories of skilled, semiskilled and unskilled manpower would be deployed for the project. About 100 persons would be working on the project during peak construction period. This would create good opportunities of direct employment for the local people. In addition, indirect employment opportunities would be created in the support service sector. The post construction phase would also create similar job opportunities.

Improvement in Aesthetics: The project will lead to improved aesthetics of the surrounding by way of providing a pleasing architectural design of ropeway. Grass Turfing on open space within ropeway station premises would be done to increase the beauty of the area.

Better Connectivity: Ropeway project will provide easy accessibility of tourists to Hill top.

Revenue Generation: Earnings would be generated by way of charges from tourist using the proposed ropeway. Tariff for ropeway will be fixed in such a way that would be enough for operation and maintenance expenses of ropeway along with generation of funds for future development.

10.5 ENVIRONMENTAL MANAGEMENT PLAN

The Environmental Management Plan (EMP) describes the proposed remedial measures and monitoring plan for the impact during construction and operational period of the project. The EMP often contains a construction/management guideline that specifically addresses how the project proponent/contractors are to incorporate environmental considerations into their work. EMP considers compensatory measures if mitigation measures are not feasible or cost-effective. This chapter spells out the set of measures to be undertaken during project construction and operation to mitigate or reduce the adverse environmental impacts and bring them to acceptable levels based on the proposed Environmental Management Plans.

PRE-CONSTRUCTION STAGE

FOREST MANAGEMENT

The Department of Forests is responsible for the conservation and management of trees/forests/wildlife in the project area.

Maenam Wildlife Sanctuary Management: The Compensatory Forestation (CA) shall be taken up over 4.2 ha of degraded forest identified at Barkhey, Maenam Wildlife Sanctuary under Ranvangla Range in South (T) Division. The cost estimated by Forest Department for raising and maintaining the compensatory afforestation is about Rs 18,04,879/- (Rupees Eighteen Lakhs Four Thousand Eight Hundred and Seventy-Nine only). The department of Tourism shall transfer Rs 73,39,500/- (Rupees Seventy-Three Lakhs Thirty-Nine Thousand and Five Hundred only) for the Net Present Value (NPV) of the Forest. The department of Tourism shall payment Rs 15.00 Crore (Rupees Fifteen Crore only) for the Biodiversity Conservation & Wildlife Protection Plan of Maenam Wildlife Sanctuary. The department of Tourism shall payment Rs 19,897/- (Rupees Nineteen Thousand Eight Hundred and Ninety-Seven only) towards cutting, felling, logging and transportation of project affect trees.

Reserve Forest Management: The Compensatory Forestation (CA) shall be taken up over 9.4 ha of degraded forest land identified at Rangan R.F. under Rabong Range in South (T) Division. The cost estimated by Forest Department for raising and maintaining the compensatory afforestation is about Rs 20,13,958/- (Rupees Twenty Lakhs Thirteen Thousand Nine Hundred and FiftyEight only). The department of Tourism shall transfer Rs 30,87,900/- (Rupees Thirty Lakhs Eighty Seven Thousand and Nine Hundred only) for the Net Present Value (NPV) of the Forest. The department of Tourism shall payment Rs 3,38,502/- (Rupees Three Lakhs Thirty -Eight Thousand Five Hundred and Two only) towards cutting, felling, logging and transportation of project affect trees.

Energy Conservation Measures: Energy conservation measures are often the easiest, quickest and cheapest way to reduce costs and implement environmentally pro-active Energy conservation program both on energy demand and supply. The amount of energy used for lighting varies from industry to industry, but typically, lighting accounts for

approximately 50% of the electrical load in office building. By having an understanding of the lamps, ballasts, luminaries and control options available today as well as the techniques used to develop efficient lighting, lighting can be produced that is energy efficient, cost effective and yields a high quality of light.

CONSTRUCTION STAGE

Air Pollution & Dust Control measures: In order to reduce the emissions due to material transport and construction activities following measures are proposed

- Provisions for sprinkling of water on open surface,
- Use of low emission construction equipments,
- All stationary machines / DG sets emitting the pollutants shall be inspected frequently
- In no case, loose earth will be allowed to pile up along the approach roads.
- As soon as the construction activity is over the surplus earth should be utilized to fill up the low-lying areas, if any.
- Limiting the time period of construction.

Water Supply and Sanitation: About 100 workers will be working at site during peak construction. Water demand during construction for labours is estimated about 4.5 KLD which will be supplied from existing water supply source line of the Public Health Engineering Department. Adequate provision has been kept in the project DPR for the potable drinking water facility of the project. The Waste water generated will be 3.6 KLD. This waste water will managed by providing sanitation facility which is integral part of the project, adequate provisions has been kept in the project.

Oil Spill control/Management: To control the oil spill during construction stage of the project following measures should be taken:

- Good housekeeping
- Routine checkup of construction machineries and equipments
- Temporary cement/metal platform

Solid Waste Management: Refuse disposal program should include storage, collection and disposal. Solid waste generated during construction will be 10.0 Kg/day. The solid waste generated shall have adequate collection, conveyance and disposal facilities and will be disposed along with existing collection and disposal system. Collection containers of about 20 liters capacity fitted with side handles to facilitate handling shall be provided.

First Aid Health System: Health problems of the workers should be taken care of by providing basic health care facilities. All necessary first aid and medical facilities will be provided to the workers. The provision and maintenance of suitably equipped first aid facility throughout the extent of the works has to be borne by the contractor who shall be responsible for welfare arrangements and requirements to the satisfaction of the Supervision Consultant and Site Engineer.

Training and Extension: These programmes should be extended for the workers for their active participation in the project implementation and to get awareness for safety, disaster prevention, action required in case of emergency, fire protection, environmental risk analysis etc. The cost involved for such a programme is estimated as **Rs. 2.00 Lakh**.

Soil Erosion Control: The soil erosion at construction site can be minimized by preventing work in monsoon season, ramming of soil immediately after excavation, no accumulation of earth debris at site and efficient management of storm water collection system.

OPERATION STAGE

Air Pollution Control: During Operation Phase, the major sources of air pollution are from DG sets only. Control measures to reduce the pollutant emissions from DG sets are:

- Periodic maintenance of DG sets as per defined schedule of manufacturer.
- These D. G. Sets shall meet CPCB guidelines.

Water Supply and Sanitation: During operation of the Ropeway project the water requirement for staff, security and passenger would be 181.82 KLD. The wastewater generation from all the activities during operation phase shall be 145.46 KLD.

Adequate provision has been kept in the project DPR for the potable drinking water facility of the project. The waste water will managed by providing sanitation facility which is integral part of the project, adequate provisions has been kept in the project.

Solid Waste Disposal: The solid waste generated will be 402.6 kg per day. The solid waste within the wildlife zone and other peripheral areas will be managed systematically and scientifically through Solid Waste Management plant outside the Wildlife Sanctuary for which adequate provisions has been kept in the project DPR.

First Aid Health System: All necessary first aid and medical facilities will be provided at Lower and Upper terminals. The provision and maintenance of suitably equipped first aid facility has to be borne by the Tourism Department.

10.6 RISK ANALYSIS

Risk assessments include detailed quantitative and qualitative understanding of risk, its physical, social, economic and environmental factors and consequences. Risk assessment encompasses the systematic use of available information to determine the likelihood of certain events occurring and the magnitude of their possible consequences. The causes of risk may be:

- Cable slipped out of the rails at the tower from the upper station can cause the carriages to be knocked off. The accident took place due to negligence.
- Cabin lost its hold with the cable and collided with the another one cabin of ropeway car and hit another on the way,
- Hill collapsed midway and trolleys were dangling in the air.
- Snapping of Rope wire,
- Power system failure,
- Collision with entering station: operator failed to slow the vehicle down upon entering the station it causes collision of the ropeway car at the entering station, and
- Holding capacity of soil/Geology

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.

SAFETY MANAGEMENT PLANS: Under a safety management plan, the licensed contractor will be required, as per terms and condition 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.

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

10.7 DISASTER MANAGEMENT PLAN

The main aim of the disaster management plan is safety of the passenger, quick response to accident and treatment to casualties, evacuation of passengers to safe area, bring the disaster under control within short time and investigation of accident and prepare prevention plan.

Preventive Action: Once the likelihood of a disaster is suspected, action has to be initiated to prevent a failure. Manager responsible for preventive action should identify sources of repair equipments, materials, labour and expertise for use during emergency.

Emergency Action Committee: To ensure co-ordination action, an Emergency Action Committee should be constituted. The civic administrator may be the Chairman of this Committee.

Emergency Measure: The emergency measures are adopted to avoid any failure in the system. The aim of Emergency Action Plan is to identify areas, population and structures likely to be affected due to a catastrophic event of accident. The action plan should also include preventive action, notification, warning procedures and co-ordination among various relief authorities.

Rescue Operation: Aerial ropeways shall be equipped with adequate and sufficient facilities which shall be readily available to clear the line of passengers and return them within a reasonable time to a terminal, or location, where access for emergency services is available. Sufficient numbers of trained persons for carrying out the rescue operation (the rescue crew) shall be on duty when the aerial ropeway is in operation.

10.8 ENVIRONMENTAL MONITORING PLAN

Water Quality: The project authorities shall establish a procedure for water quality surveillance and ensure safe water for the consumers. Minimum 3 samples shall be tested around the project site for drinking water quality parameters as per BIS: 10500. Water monitoring should be carried out at least three times a year to cover seasonal variations by any Government or recognized private agency. Water quality should be analyzed by applying the standard methods. Water quality shall be monitored before starting the construction, during the construction phase, and for at least one year after the completion of the project. The cost for water quality monitoring is estimated of **Rs. 2.88 lakh.**

Air and Noise Quality: To assess the effectiveness of air and noise pollution control, ambient air quality and noise levels shall be monitored during the construction and for at least one year after the completion of the project. The Parameters to be monitored for air quality are PM_{10}, $PM_{2.5}$, SO_2, CO, and NO_x at least three locations. The frequency of air quality monitoring will be Once in Month for Three Season in a Year. Ambient Noise Quality will be monitored at least three locations. The frequency and duration for noise quality monitoring is same as air. The cost for air and noise quality monitoring is estimated of **Rs. 5.4 lakh.**

Soils Quality: Soil near to the construction area shall be monitored to ascertain presence of soil pollution due to construction activities. The parameters to be monitored are pH, Texture, Total Organic Matter, Nitrogen, Phosphate, Moisture Content, Sodium, Potassium, Calcium, Chloride, Magnesium, and Electric Conductivity. The frequency of soil quality monitoring will be once in Season for at least three locations. The cost for soil quality monitoring is estimated of **Rs. 1.8 lakh.**

Establishment of Environmental Cell: The project authority shall establish an Environmental cell in the initial stage of the project. The division shall have one Environmental Engineer/Officer. The task of the environmental Engineer/Officer shall be to supervise and co-ordinate environmental concerns, monitoring and implementation of mitigation measures. The officer will monitor the environmental works in coordination with the Project Director. Cost of such a division has been estimated as **Rs. 25.96 lakh.**

10.9 ENVIRONMENTAL COST

The environmental costs towards implementation of environmental management plan and mitigation measures during pre-construction, construction and operation of the proposed project is estimated of **Rs. 1684.10 lakh**.

10.10 CONCLUSION

The proposed project is aimed to develop the eco tourism at Maenam Wildlife Sanctuary. The project will provide a safer means of transportation to devotees/tourist. All possible environment aspects have been adequately assessed and necessary control measures have been formulated to meet with statutory requirements, during the preparation of the EIA report. Thus implementing this project will not have any appreciable negative impacts. In view of Environmental Impact Assessment study conducted, the proposed project is environment friendly and would enhance the development in the region.

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