

ENVIRONMENTAL IMPACT ASSESSMENT FOR THE PROPOSED GREENFIELD INTERNATIONAL AIRPORT AT MOPA, GOA



GOVERNMENT OF GOA



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इंडिया लिमिटेड
(भारत सरकार का उपक्रम)



ENGINEERS
INDIA LIMITED
(A Govt. of India Undertaking)

(QCI-NABET Accredited EIA Consultancy Organization)

**REPORT ON
ENVIRONMENTAL IMPACT ASSESSMENT
FOR THE PROPOSED GREEN FIELD
INTERNATIONAL AIRPORT AT
MOPA, GOA**

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Declaration by Experts contributing to the EIA Study Report for the proposed Greenfield International Airport at Mopa, Goa

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA.

EIA Coordinator:

Name: Mr. R S Prasad

Signature & Date:

Period of involvement: 27/09/2013 – 08/10/2014

Contact information: 9818689849.

Handwritten signature and date: R S Prasad 25/11/14

Functional Area Experts:

Sr. No.	Functional Areas	Name of the experts/s	Involvement (Period & Task**)	Signature & Date
1.	AP*, WP*, SHW*	Jayant Kumar Joshi	Oct 2013- Oct 2014 Estimation of emissions of air pollutants from aircrafts and suggesting prevention and control measures. Review of proposed water requirements for the project, verification and analysis of baseline data, impact assessment, Preparation of environmental management plan for water environment. Review of storage and disposal of solid and hazardous waste	<i>Handwritten signature and date: Jayant Kumar Joshi 27/11/14</i>
2.	AQ*, HG*, LU*	Raja Subbaratna Prasad	Oct 2013 - Oct 2014 Verification of meteorological data, air quality assessment, impact assessment, Preparation of environmental management plan. Study of Drainage pattern and land use in the study area.	<i>Handwritten signature and date: Raja Subbaratna Prasad 25/11/14</i>
3.	SE*	Sudhir Saksena	Oct 2013 - Oct 2014 Review of Demographic Characteristics, baseline data. Impact Assessment and preparation of Environmental Management Plan	<i>Handwritten signature and date: Sudhir Saksena 22/11/14</i>
4.	EB*	Dr. Chiranjibi Pattanaik	Oct 2013 - Oct 2014 Collection and analysis of baseline data on flora and fauna, impact assessment of the study area, preparation of greenbelt development plan and environmental management plan for biological environment.	<i>Handwritten signature and date: Dr. Chiranjibi Pattanaik 25/11/14</i>

5.	NV*	S.V.R. Subramanyam	Oct 2013 - Oct 2014 Verification of noise and traffic baseline data, noise modelling and impact assessment, Preparation of environmental management plan for noise environment.	<i>R. Subramanyam</i> 28/11
6.	RH*	P Jayakumar	Oct 2013 - Oct 2014 The Disaster Management Plan is prepared for the Proposed Green field International Airport at Mopa.	<i>P Jayakumar</i> 25/11/14

Declaration by the head of the Accredited Consultant Organization/authorized person

I, J. K. Joshi, hereby, confirm that the above mentioned experts prepared the EIA Study Report for the Proposed Greenfield International Airport at Mopa, Goa. I also confirm that the consultant organization shall be fully accountable for any misleading information mentioned in the statement.

Signature:

Name: Mr. J. K. Joshi

Designation: Head- Environment Division

Name of the EIA Consultant Organization: Engineers India Limited

EXECUTIVE SUMMARY

1.0 INTRODUCTION

The Government of Goa has undertaken the development of a new Greenfield Airport for Goa, near the Village of Mopa. The Village of Mopa is located in North Goa near the Maharashtra border, approximately 35 kilometers north of the Panaji, the Goa State Capital. The new Greenfield Airport at Mopa will be an International Airport serving both the tourism and business markets and keeping pace with the growing air travel segment in India.

The project will be implemented in four phases as given in the table 1.0. The estimated cost of the entire project is Rs. 3000 Crore.

Table 1.0 Phase wise implementation

Phase	Design Year	Annual Passengers
I	2020	4.4 million
II	2025	5.8 million
III	2035	9.4 million
IV	2045	13.1 million

The components in Phase I of proposed Mopa Airport shall include one runway, with half parallel taxiway, three runway exits and in Phase II includes one runway, with full parallel taxiway, seven runway exits including four rapid exits. The other facilities includes Terminal building, Security area and control points, GSE storage, parking, technical area, cargo, maintenance, general and business aviation areas, road network, rail connectivity and airport city. The estimated cost of the project in Phase I is Rs 1500 Crore. An area of 2271 acres is envisaged for project development.

The airfield consists of one single runway with a takeoff available distance of 3,750 meters and 60 meters of runway width to accommodate the super-jumbo A380 aircraft. The runway will be equipped with both elevated and inset lights for at-all-time operations consisting of a CAT I approach system before both runway thresholds which comprises a row of lights, along the extension of the runway axis, to a distance of 900 m. The area required for these activities, including apron and hangars, is expected to be 15,300 m². The aircraft maintenance facilities are estimated to provide space for 1 hangar.

Ministry of Environment & Forests (MOEF) has approved TOR for the proposed Greenfield International Airport in the 100th Meeting of EAC held on 11th – 12th May 2011. Later certain changes were included and further MOEF issued revised TOR. These changes are as follows:

-
- The revised project boundary is within the latitude and longitude submitted earlier.
 - The land area required for project development has decreased from 4500 acres envisaged earlier to 2271 acres present.
 - 14 houses need to be displaced and R&R Policy of Govt of Goa to be followed.
 - Annual traffic forecast has been updated.

Government of Goa entrusted the task of carrying out EIA study as per initially approved and revised TORs to Engineers India Limited (EIL). EIL is accredited by Quality Council of India for carrying out EIA study for Airports. EIL carried out EIA study and formulated Environmental Management Plan. The summary of EIA & EMP is presented in subsequent sections.

A study area of 10 km radius around the proposed airport at Mopa village is considered for assessment and evaluation of impacts on various components of environment during both construction and operational phases of the project. M/s EMTRC Lab, Ghaziabad (UP), an NABL Accredited Lab collected environmental baseline data in terms of various parameters during the period October 2011 to December 2011.

2.0 BASELINE ENVIRONMENT

Surrounding land use of the airport site is predominantly forest land. The northern and eastern side of site is reserve forest areas, whereas western side is barren and village cultivated land. Meteorology– The temperature varied between 23.0 – 33.0C in the months of October, November and December. Generally light to moderate winds prevails throughout these months. The predominant wind directions were North-East.

Air environment: Ambient air quality was monitored at 6 locations. The maximum concentrations of PM₁₀ ranged from 41-53 $\mu\text{g}/\text{m}^3$ and for and PM_{2.5} ranged from 23-28 $\mu\text{g}/\text{m}^3$ respectively. The concentrations of SO₂ & NO_x were in the range of 13.2-18.5 $\mu\text{g}/\text{m}^3$, and 16.3 - 21.8 $\mu\text{g}/\text{m}^3$, respectively. The concentrations of PM₁₀ & PM_{2.5}, SO₂, NO_x, CO are found to be well within the NAAQS limits.

Noise environment: Noise levels were monitored at 9 locations. Noise levels ranged between 43.7 - 53.8 dB (A) during day time and 39.5 - 44 dB (A) during night time and the levels were found to be well within limits.

Land environment: Forests is the predominant land use the study area. Soil samples were collected from 5 locations. The pH values ranged from 7.1-8.25, indicating moderate to high alkaline property. Concentrations of heavy metals like chromium and cadmium were found below detectable limits.

Water environment: Three surface and four ground water samples were collected. In the ground water samples, pH, total dissolved solids, hardness, chlorides and sulphates ranged from 6.6-7.7, 102-182 mg/l, 40-90 mg/l, 18-40 mg/l and 4-24 mg/l respectively. At all locations these were within the permissible limits as per IS: 10500. pH, hardness, suspended solids, chlorides and sulphates ranged from 6.9-7.4, 80-1780 mg/l, 14-28 mg/l, 18-3640 mg/l and 12-530 mg/l respectively.

Biological environment: A total of 385 species of plants (including wild, ornamental and cultivated) belonging to 88 plant families were identified in the study area. A total of 86 bird species, 33 butterfly species, 5 amphibian species, 12 reptile species, 11 mammal species are documented in the study area. The present proposed airport site is falling under Pernem taluka of North Goa district. The Pernem taluka has not been included in the Ecologically Sensitive Areas submitted by High Level Working Group.

Socio-economic conditions: As per Census data (2011), study area features 1641 households with total population of 7298.

2.1 Anticipated Environmental Impacts and Mitigation measures

Summary of potential impacts during construction and operational phases of the project are identified and is given in Table 2.0.

Table 2.0: Summary of Identified Impacts

Activities	Physical				Biological		Socio-economic	
	Ambient air quality	Ground / surface water (quantity / quality)	Ambient noise	Land (land use, topography & drainage, soil)	Flora	Fauna	Livelihood & occupation	Infrastructure
CONSTRUCTION								
Civil and mechanical works	x	x	x	x	x	x	x	x
Movement of vehicles	x		x			x		x
Waste water generation, handling and disposal		x		x				x
Solid waste generation, handling and disposal				x				x
OPERATION								
movement of Aircrafts during landing and takeoff	x		x					
Storage of Fuel	x							
Cleaning & maintenance		x		x				
Operation of emergency power generation facility	x		x					
Waste water generation, handling and disposal		x		x				
Solid waste generation, handling and disposal				x				
Movement of vehicles	x		x			x		x

2.1.1 AIR ENVIRONMENT

Construction Phase

Impacts (Significance - Low)

- Dust will be generated from earth-moving, grading and civil works, and movement of vehicles on unpaved roads.
- PM, CO, NOx, & SOx will be generated from operation of diesel sets and diesel engines of machineries and vehicles.

Mitigation Measures

- Ensuring preventive maintenance of vehicles and equipment.
- Ensuring vehicles with valid Pollution under Control certificates are used.
- Implementing dust control activities such as water sprinkling on unpaved sites.
- Ensure vertical stacks with height sufficient for dispersion as per CPCB guideline for DG stacks.

Operation Phase

Impacts (Significance - Medium)

- HC, NOx and CO generation during aircraft movement within airport
- PM, CO, NOx, & SOx generation due to passenger traffic movement.

Mitigation Measures

- Developing peripheral green belt in the proposed Airport premises.
- Ensuring preventive maintenance of vehicles and equipment.

2.1.2 WATER ENVIRONMENT

Construction Phase

Impacts (Significance: Water consumption – Medium, Effluent generation - Low)

- Water required for construction phase will be sourced from Tillari irrigation canal.
- Effluent streams will include cleaning and washing waste water from vehicle and equipment maintenance area, and sewage and grey water from construction camps and work sites.

Mitigation Measures

- Monitoring water usage at construction camps to prevent wastage.
- Ensuring that the STP at construction camps/ sites and the proposed facilities are properly designed to handle peak waste water load and properly maintained.
- Ensuring supply of temporary/ portable toilets for construction staff.

Operation Phase

Impacts (Significance: Water consumption – Medium, Effluent generation - Low)

- Water required for Airport during phase 1(2020) will be 1.2 MLD, the same will be sourced from Tillari irrigation canal. 80% of the same will be generated as sewage.
- The maximum water demand and sewage generation beyond year 2045 is estimated as 6 MLD and about 5 MLD, respectively.

Mitigation Measures

- Tracking of raw water consumption through water meters.
- Installation of rainwater harvesting structures
- Exploring opportunities for drip irrigation system for greenbelt development.

2.1.3 LAND ENVIRONMENT

Construction Phase

Impacts (Significance: Land-use & topography – Low, Soil quality - Low)

1. The impact on land environment during construction phase shall be due to generation of debris/construction material, which shall be properly collected and disposed off.
2. Covering of bauxite ore

Mitigation Measures

- Avoiding rainy season for construction so as to avoid soil erosion.
- Restricting all construction activities inside the project boundary.
- Ensuring the top soil stock pile is not contaminated with any type of spills.
- Ensuring any material resulting from clearing and grading should not be deposited on approach roads, streams or ditches, which may hinder the passage and/or natural water drainage.

Operation Phase

Impacts (Significance: Soil Quality - Low)

Generation of hazardous and solid waste. The same will be collected, stored and disposed in their respective disposal facility owned by Government of Goa.

Mitigation Measures

- Developing and maintaining dedicated waste storage areas,
- Ensuring hazardous waste storage areas are provided with secondary containment.

2.1.4 NOISE ENVIRONMENT

Construction Phase

Impacts (Significance - Low)

Noise generation due to operation of heavy equipment and machinery, operation of DG sets and movement of heavy vehicles.

Mitigation Measures

- Ensuring preventive maintenance of equipment and vehicles
- Ensuring DG sets are provided with acoustic enclosures and exhaust mufflers
- Ensuring vehicle movement is avoided at night, and close to sensitive receptors (such as schools, hospitals, places of worship).

Operation Phase

Impacts (Significance - Medium)

Noise generation due to aircraft landing, takeoff and ground noise.

Mitigation Measures

- On top of the quota system, there is also an absolute limit on the number of flights permitted at the airport.
- The noisiest aircraft use 16 points of the quota, and they're called QC16s (QC = Quota Count). The next noisiest have eight points – QC8s. As planes get quieter, their points get smaller until the quietest planes have just half a point or are exempt altogether.
- During the night quota period the noisiest types of planes are not permitted to be scheduled. Because there is a limit on the airport's total quota of points for night-time flying, this system encourages airlines who want to fly at night to use the quietest aircraft.
- Pilots are encouraged not to use reverse thrust between 23:00 and 06:00 except in the interests of safety.

2.1.5 BIOLOGICAL ENVIRONMENT

Construction Phase

Impacts (Significance –Medium)

The area acquired for proposed airport have only few trees, mainly bushes. These will be cleared during site preparation. Open pipeline trench and un-barricaded waste/waste water pits may lead to injury of animals which fall in them.

Mitigation Measures

- Keeping a tally of trees cut.
- Avoid cutting of trees wherever possible.
- Closing of trenches as soon as possible after pipeline laying, if any.
- Prohibiting use of firewood in project camps and making use of cooking gas mandatory.
- Regulating speeding of vehicles.

Operation Phase

Impacts (Significance - Medium)

Road kills of animals/birds due to movement of project-related vehicles/aircraft.

Mitigation Measures

- Proper maintenance of green belt developed.
- Regulating speeding of vehicles on the approach road of Airport.

2.1.6 SOCIO-ECONOMIC ENVIRONMENT

Construction Phase

Impacts (Significance –Low)

- Influx of construction workers
- Local employment and business generation (positive impact).

Mitigation Measures

- Training contractors on company road safety policy requirements.
- Determining safe, legal load limits of all bridges and roads that will be used by heavy vehicles and machinery.

Operation Phase

Impacts (Significance –Low)

Limited local employment and petty contracts for supplying water, providing security services, housekeeping and maintenance etc. (benefits)

Mitigation Measures

Ensure implementation of disaster management plan.

3.0 ENVIRONMENT MANAGEMENT AND MONITORING PLAN

- A Health, Safety and Environment (HSE) management system will be established. Dedicated environmental managers will be stationed.
- Environment Management Plan (EMP) for the project covers the additional resource requirements required to implement the proposed mitigation measures and monitoring program.
- Environment Monitoring Program for the proposed project describes the parameters, location and frequency for monitoring the effectiveness of the mitigation measures. It covers ambient air quality, ambient noise levels, stack emissions, source noise, raw water quality and effluent quality monitoring.

4.0 PROJECT BENEFITS

The significant positive impact on employment and occupation is envisaged on account of:

- Generate direct and indirect employment.
- Improve the social and economic environment in the vicinity and meets the fuel needs of the state.
- Better economic status of the community due to better earnings.
- Higher inputs towards infrastructural facilities.

APPROVED TOR COMPLIANCE STATEMENT

Sl. No.	Statement	Status
1	Describe the project site, geology, topography, climate, transport and connectivity, demographic aspects, socio cultural and economic aspects, villages, settlements and meteorological data.	Description of project site in terms of location, connectivity is given in chapter 1 & 2. Baseline environmental status of project site in terms of climate, demographic aspects, socio economic status and other parameters like land use, noise water quality etc are given in chapter 4 .
2	Details of master plan and integration of the airport in the regional plan.	A comprehensive master plan prepared by M/s Louis Berger Group, USA including the design of layout and other details is attached separately.
3	Examine details of land use around 10 km radius of the project site. Analysis should be made based on latest satellite imagery for land use with raw images.	Land use in terms of built up land, agriculture land, wastelands, water bodies and other forms is mapped using satellite imagery and the thematic map is attached as Annexure IX.
4	Examine the details of the impact on the nearby pond due to the project.	From project site, there exits a pond in eastern direction at a distance of about 5 kms. However, before the pond Kalna river is flowing. In view of the same, the drainage from the airport site joins Kalna river and there will be no impact on the pond. This is depicted in thematic maps and are attached in annexure IX and X.
5	Environmental data to be considered in relation to the airport development would be a) land, b) groundwater, c) surface water, d) air, e) biodiversity, f) noise and vibrations, g) socioeconomic and health	All mentioned parameters are considered in EIA Study and presented in chapter 4
6	Examine baseline environmental quality along with projected incremental load due to the project shall be studied.	Baseline data of various components of environment collected during 2011 is described in various sections of chapter 4. Further, fresh baseline data collected during Nov 2014 to Jan 2015 is given in annexure XX. A comparative analysis s described in chapter 4. The impact of incremental load on various components of environment is assessed and evaluated in terms of significance value and is given in various sections of chapter 5.
7	Examine the details of ambient air quality	Ambient air quality in terms of various parameters during 2011 is described in section 4.1.2 of chapter 4 .

		Further, fresh baseline data collected during Nov 2014 to Jan 2015 is given in annexure XX. A comparative analysis s described in chapter 4.
8	Examine the impact of airport location on the nearest settlements.	The impact of airport location on nearest settlements in terms of noise during take off and landing is assessed and evaluated. The same is given in section 5.3.4 of chapter 5 . In addition, the general impacts on socioeconomic environment due to development of new airport is given in section 5.3.6 of chapter 5 .
9	Examine and submit contour map showing the slopes, drainage pattern of the site and surrounding area of the site. Examine in detail the diversion of surface drain system because of low lying area.	A comprehensive assessment on run-off, drainage in 10 kms buffer zone and within the proposed site is estimated and is given in section 5.3.3 of chapter 5 . The same is assessed and evaluated. The drainage map is superimposed on contour map and is shown in figure 5.1 of chapter 5 .
10	Examine and submit levels, quantity required for filling, source of filling material and transportation details etc.	The proposed airport is predominantly a tabletop plateau and requires no cutting and filling.
11	Examine and submit details of geo-technical studies	Thematic map indicating geological features is given in annexure XI. Quality soil in terms of various parameter are given in Incorporated in Chapter 4 of section 4.4.1 NOC from Mining Department has been obtained and is included in Annexure XIX.
12	Examine road/rail connectivity to the project site and Impact on the traffic due to the proposed project. A detailed traffic and transportation study should be made for existing and projected passenger and cargo traffic.	Thematic map indicating transportation features in terms of road and rail in buffer zone and its connectivity to the project site is attached as annexure XIV and annexure XV. Traffic forecast for existing and projected passenger and cargo traffic has been done in section 2.2 of chapter 2 . Existing traffic count at 2 locations connecting to Mopa site is carried out and given in 4.3 Impact due to traffic is also assessed in section 5.3.4 of chapter 5 .
13	Examine the details of parking requirement for various type of vehicles and circulation plan.	Details of parking requirement have been given in general aviation in section 2.4.1 of Chapter 2 . Area has been depicted in airport layout plan that is attached as

		annexure VIII.
14	Examine the details of construction material and its transportation.	Details of construction material have been given in section 10.1.5 of chapter 10.
15	Examine the details of probability of flooding of the agricultural land and other area due to the proposed development/construction of the airport.	Details have been provided in section no. section 5.3.3 of chapter 5.
16	Examine the details of afforestation measures indicating land and financial outlay. Landscape plan, green belts and open spaces may be described. A thick green belt should be planned all around the nearest settlement to mitigate noise and vibrations. The identification of species/ plants should be made based on the botanical studies.	Details of plantation to be done at various locations within the airport complex have been identified and are incorporated in section 10.4 and section 10.5 of Chapter 10.
17	Examine and submit the details of noise modeling studies and mitigative measures.	Details of noise modeling studies is provided in section 5.3.4 of Chapter 5.
18	Examine soil characteristics and depth of ground water table for rainwater harvesting before and after the rainy season.	Depth of ground water table is given in annexure IV. Soil characteristic is given in Table No. 4.9 in chapter 4. Suitable locations for rain water harvesting are identified and are shown in Annexure II. A detailed General Arrangement drawing of such pits is shown in Annexure III.
19	Examine the details of water requirement, use of treated waste water and prepare a water balance chart. Source of water.	Details of water requirement and water balance are given in section 2.3.4 of chapter 2. Wastewater generation and reuse is given in section 2.3.5 of chapter 2.
20	Rain water harvesting proposals should be made with due safeguards for ground water quality. Maximize recycling of water and utilization of rain water.	Suitable locations for rain water harvesting are identified and are shown in Annexure II. A detailed General Arrangement drawing of such pits is shown in Annexure III. The treated sanitary waste water is provisioned for use in development of green belt.
21	Examine details of solid waste generation treatment and its disposal.	Solid waste collected during operation phase will be disposed in disposal facility owned by Government of Goa. The significance of impact is given in section 5.3.3 of chapter 5.
22	Examine the details of fuel storage.	Fuel storage details are incorporated in section 2.5 of chapter 2.

23	Examine details of the energy requirement and conservation measures using alternate source of energy.	Energy requirement is given in section 2.3.7 of chapter 2 . Energy conservation measures are suggested in section 10.2.4 of chapter 10 .
24	Seismic nature of the area shall be taken into consideration in the design.	The proposed site falls in Seismic Zone III and is considered in developing master plan
25	The terminal building should carefully incorporate the features of local architecture in and around the area as well as take special measures to highlight the Indian antiquity through a museum like corner depicting the same.	Master plan is developed considering local architectural features and is attached separately.
26	Identify, predict and assess the environmental and sociological impacts on account of the project.	The environmental and sociological impact assessment is done in section 5.3.6 of chapter 5.
27	Examine separately the details for construction and operation phases both for Environmental Management Plan and Environmental Monitoring plan with cost and parameters.	Environmental management plan is given in chapter 10 and environmental monitoring plan is given in chapter 6 .
28	Submit details of a comprehensive Disaster Management Plan including emergency evacuation during natural and man-made disaster.	Comprehensive Disaster Management Plan is given in Annexure VI
29	Submit details of Corporate Social Responsibilities (CSR).	Presently, Govt. of Goa is the owner of the proposed Greenfield international Airport at Mopa, Goa. Under such circumstances Govt. of Goa cannot separately formulate the CSR. Accordingly communication has sent to MoEF to waive off the CSR point of point no. xxix in the approved TOR.
30	Details of economics of agricultural land loss in longer period for the proposed development.	The land required has been acquired based on approved compensation as per Govt. of Goa
31	Public Hearing to be conducted for the project as per provisions of EIA notification 2006 and issues raised by the public should be addressed in EMP.	Public Hearing was conducted on 01.02.2015. The proceedings of Public Hearing including its compliance is given in Annexure XXI .

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CHAPTER 1

INTRODUCTION

1.0 INTRODUCTION

India is a fast-growing aviation market and it is expected to be among the four to five biggest aviation markets by 2020 and third in terms of domestic market after US and China. The major driving forces behind this rapid growth are Deregulation of the aviation sector, Positive macro-economic trends, Tourism, and Emergence of low cost and premium service carriers.

Goa, well known for its beaches and places of worship in India, promotes tourism as its prime industry. As tourism continues to flourish, the demands of the existing Dabolim Airport in Goa are increasing at an unprecedented rate. Capacity constraints and military restrictions are putting an ever increasing strain on the existing facilities for aircraft and passengers alike.

In view of the same, the Government of Goa has undertaken the development of a new Greenfield Airport for Goa, near the Village of Mopa. The Village of Mopa is located in North Goa near the Maharashtra border, approximately 35 kilometres north of the Panaji, the Goa State Capital. The project is being developed by the Government of Goa under a public-private partner-ship (PPP) model in accordance with the Greenfield Airports Policy of the Ministry of Civil Aviation.

The Government of India has formalized its Policy on Greenfield Airports as of April 2008. Under that policy and the rules preceding its adoption, the Government of Goa had applied for and been granted 'in-principle' approval in March 2000. Consistent with the Policy on Greenfield Airports, project development is continuing under the guidance of an airport Steering Committee chaired by the Chief Minister of the Government of Goa.

Ministry of Environment and Forest & Climate change (MoEF & CC) has approved terms of reference (TOR) for EIA study wide letter no. 10-29/2011.IA.III dated 11-12th May 2011. Accordingly Govt. of Goa has entrusted the task of carrying out EIA to Engineers India Limited (EIL) as per approved TOR.

1.1 PURPOSE OF THE PROJECT

Commercial air service to Goa is currently concentrated in the Goa International Airport at Dabolim, located in South Goa. This airport handled just over 3 million annual passengers during the fiscal year (2010-11) and is the 9th busiest airport in India. Airport facilities are shared with Navy which has resulted in important restrictions on commercial operations including reserved hours of operation and priority for operations in addition to the restricted hours.

The proposed airport will attract 4.4 million international and domestic passengers in phase I (2020) and 5.8 million passengers in phase II development. This will subsequently generate employment opportunities for both airport requirements and additional commercial requirements. This will also lead to development of ancillary inductees namely Hotels, Tourism, automobile repair shops etc. The addition of air cargo operations is expected to shift the current ground-based movements in Goa and attract air operations currently conducted outside the area.

1.2 BRIEF DESCRIPTION OF PROJECT

Development of the Airport site will further meet the goals of the Regional Plan for Goa 2021 which sets out the area as a hub for economic development, and benefit the local area including nearby towns and cities in the neighboring states of Maharashtra and Karnataka.

The summary of the proposed Airport site is given in Table 1.1.

Table – 1.1 Project Site Description

S. No	Particulars	Details
1	Latitude	N 15°44'30"
2	Longitude	E 73°52'00"
3	Elevation	140 to 170 m above MSL
4	Revenue Village	Mopa
5	Tehsil	Pernem
6	District and state	North Goa, Goa
7	Nearest Highway	NH-17 & NH-4
8	Total area	2271 Acres
9	Nature of Soil	Laterite / Reddish brown sandy soil
10	Nearest Railway Station	Pernem railway station at approx. 11 km
11	Nearest Water bodies	1. Kalna River (also called Chandel River) which is a tributary of Charpora River 2. Tillari Irrigation Canal
12	Seismic Zone	Zone – III (as per IS-1893, Part III: 2002)
13	Inter-state boundaries	State Maharashtra is located about 2 Km from the project location

1.3 SCOPE OF THE EIA STUDY

TOR for the proposed Greenfield International Airport was approved in the 100th Meeting of EAC held on 11th – 12th May 2011 in New Delhi. After this certain changes has been made and sorted for revised TOR. The changes were,

- The revised project boundary is within the latitude and longitude submitted earlier.
- The land area required for project development has decreased from 4500 acres envisaged earlier to 2271 acres present.
- 14 houses need to be displaced and R&R Policy of Govt of Goa to be followed.
- Annual traffic forecast has been updated.

Due to the above changes revised TOR had been issued and the same is attached as **Annexure –I**.

1.4 FRAME WORK OF ASSESSMENT

The Environmental Impact Assessment (EIA) report shall cover the environmental components such as air, water, land, noise, biological and socio-economic aspects within a radius of 10 km from the project location. Major impact on account of development of the proposed green field airport shall be due to the following:

- Location of airport
- Construction activities
- Airport operation, including air traffic and associated noise & emissions, and
- Cargo handling & storage, and land transport

Therefore, Chronological frame work for assessment of impacts has been made in three discrete phases of the project as:

- Construction phase
- Operation Phase

1.5 COVERAGE OF ENVIRONMENTAL IMPACT ASSESSMENT STUDY

According to EIA Notification dated 14th September 2006, and amended in 2009 and past experience of EIL and as per provisions of section of Environment Act a corridor encompassing of area within 10km radius of proposed project location is considered as spatial frame for the impact assessment.

The coverage of EIA report is outlined in the following sections.

1.5.1 PROJECT SETTING, DESCRIPTION AND ANALYSIS OF SITE AND TECHNOLOGY

The proposed project site details, main Airport facilities have been defined and the description also gives details of wastes (gaseous / liquid / solid / noise) generation sources from the proposed Airport.

1.5.2 IDENTIFICATION OF IMPACTS

This includes impact identification of each of the environmental parameters. In order to identify the impacts comprehensively, all the activities associated with the proposed airport facilities are analysed during the construction as well as operational phase of the project.

1.5.3 BASELINE DATA COLLECTION

Once the affected environmental parameters are identified, various environmental parameters of concern are identified to establish its background quality. For this project, baseline data was provided by Client which was collected by M/s EMTRC Lab, EMTRC Consultants private limited, Ghaziabad (UP). This is an NABL Accredited Lab (ISO/IEC: 17025), ISO: 9001, OHSAS: 18001. The environmental data was collected for the period of October 2011 to December 2011 by M/s EMTRC Lab; Data thus collected has been utilized here to establish baseline quality of various environmental parameters.

1.5.4 ENVIRONMENTAL IMPACT PREDICTION & EVALUATION

In this part of the report the sources of emissions (Gaseous, Liquid, Solid, Noise) due to the proposed activities will be identified and based on their emission loads their impacts are to be predicted. Such predictions are then superimposed on baseline quality (wherever there is an additional impact) and quantitative/qualitative assessments have been made for the impacts.

1.5.5 ENVIRONMENTAL MANAGEMENT PLAN (EMP)

In order to mitigate or minimise the negative impacts of the proposed project, an effective EMP is called for. Therefore, in the final part of the report the planning and implementation of various pollution abatement strategies including the proposed monitoring/surveillance network has been described.

1.6 ADDITIONAL STUDIES

In addition to the above Disaster Management plan was carried out by EIL and is presented in chapter 7 of the EIA Report.

CHAPTER 2

PROJECT DESCRIPTION

2.1 DESCRIPTION OF THE PROPOSED SITE

The project site (N 15°44'30", E 73°52'00") is located near the Village of Mopa, Pernem Taluka in northern-most Goa along the Maharashtra border. The site is comprised of property acquired from six villages viz., Varconda, Casarvornem, Amberem, Uguem, Mopa and Chandel. Location of the project site is shown in figure 2.1 and **Annexure XIII**.

The airport development site is accessed from National Highway 17 which runs north-south through Goa and connects along the coastline to Panvel in Maharashtra to the north and in the south through Karnataka to Edappalli in Kerala. The proposed approach road to the new airport begins from NH-17 at Dhargal village and passes through land in the villages of Ozorim, Varconda and Casarvornem. The Konkan Railway Line runs virtually parallel to NH 17 near the airport and also connects Goa to the other states of India. The Regional Plan for Goa also envisions improvements in the railway network including double tracking and connection to the proposed airport.

An area of 2271 acres is envisaged for project development. The expected cost of the project in phase 1 excluding airport city is INR 1500 crores.

The components in phase I includes one runway, with half parallel taxiway, three runway exits and in phase II includes one runway, with full parallel taxiway, seven runway exits including four rapid exits and other facilities discussed in detail in later sections.

Figure 2.1a: Location Map of Project Site

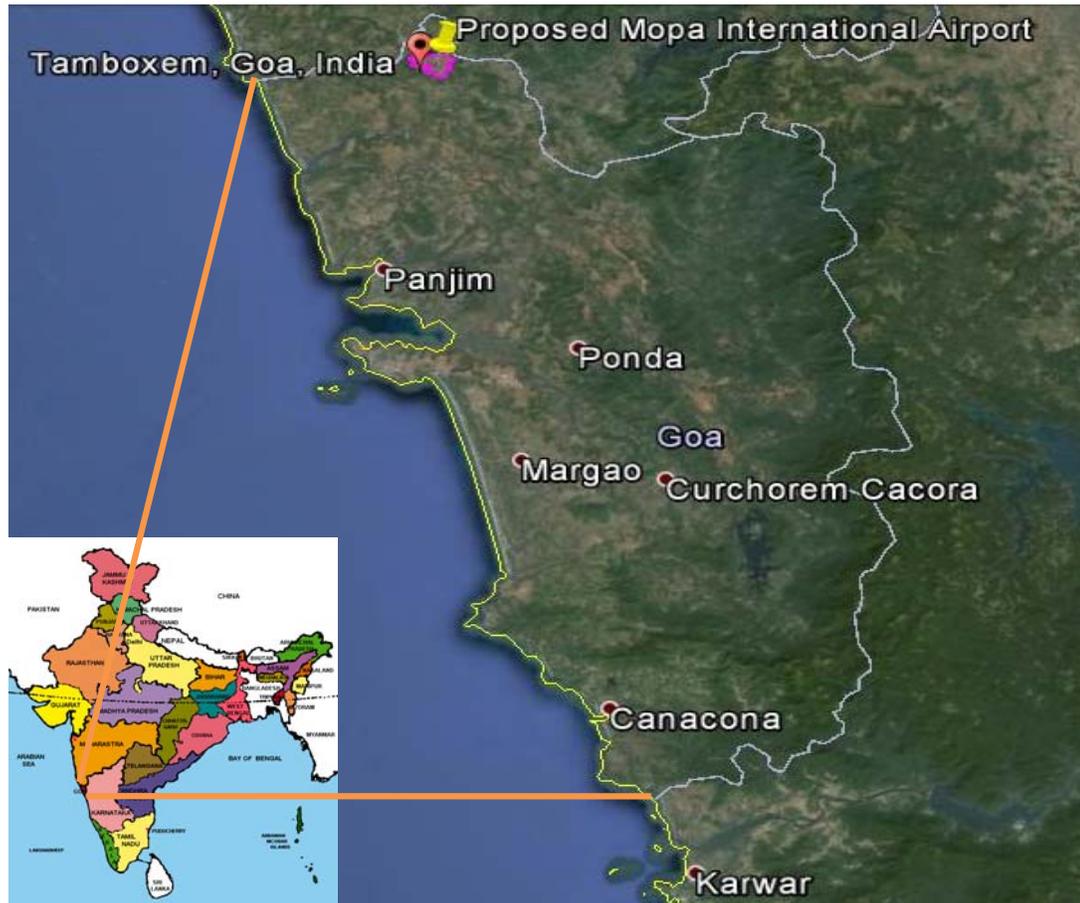


Figure 2.1b: Location Map of Project Site



The land originally designated by the Government of Goa for development of the new Greenfield airport is predominantly a tabletop plateau area surrounded by steep slopes that act as natural drains. The approximate ground level of the plateau areas ranges between 140 and 170 meters (m) above mean sea level (MSL) while the proposed approach road ground level ranges from 6 to 155 m above. Hydro geomorphology of Goa state & Geomorphology map of state Maharashtra within 10 km radius have been attached as **Annexure XI**.

Transport network, settlement location and village boundary map have been attached as **Annexure XII**.

Goa has a well-connected roadway network linking all places in the state. Improvements are planned for the national Highway system including widening NH 17 to four (4) lanes in the vicinity of the new airport. Other improvements envisioned in the Regional Plan for Goa 2021 include a new bifurcated NH-4 as shown on the Goa Road Network Map in **Annexure XIV**.

The Konkan Railway Line runs virtually parallel to NH 17 near the airport and also connects Goa to the other states of India. The Regional Plan for Goa envisions improvements in the railway network including double tracking and connection to the proposed airport. The Railway network is illustrated in **Annexure XV**.

During monsoon season water flows on and from the site through natural drains. There is no surface water available at the plateau elevation. Water supply for the airport is available from the nearby Kalna River (also called Chandel River) which is a tributary of Charpora River, in combination with the Tillari Irrigation Canal. Sustainability strategies will be employed for the airport site and building development including rainwater harvesting, recycling, shading and solar options.

State Maharashtra is falling within 1km from the proposed Greenfield airport. Therefore Villages falling in state within 10 km radius of Maharashtra region are also considered for assessment. A village and transport network map of Maharashtra region is given **Annexure XII**.

Details of Environmentally sensitive area falling within 15 Km from the project boundary is given in below Table – 2.1

Table – 2.1 Environmentally sensitive areas

Environmental sensitive area	Goa	Maharashtra
Archaeologically important places / Monuments	Fort of Alorna - Alorna village, Statue of Buddha/Fortress of Colvale	None
National Park / Wildlife Sanctuary	None	None
Reserved Forests	Present	None
Protected Forests	None	None
Defense Installations	None	None
Critically polluted areas as identified by the CPCB	None	None
Areas occupied by sensitive man-made land uses (hospitals, schools etc)	None near project location	None
Wet lands	Present (Two)	None
Water bodies	Chapora river, Kalna river, Tiracol rivel, Moide river	None
State / national boundaries	State boundary for Maharashtra	None
Tourist Places	None	None
Industrial estate	Four	None
Major industries	Two	None

2.2 TRAFFIC FORECAST

Dabolim faces a series of operational constraints that represent a serious inconvenience for users. These include:

1. The restriction on the hours of operations, with the hours between 08:30 and 13:00 on weekdays reserved for military training flights.
2. Congested air space during afternoon hours (particularly for international carriers)
3. Limited capacity of the existing passenger terminal building and aircraft parking apron, which leads to insufficient slots
4. Antiquated substandard facilities (no aerobridges, no air conditioning)

5. Lack of public transportation service

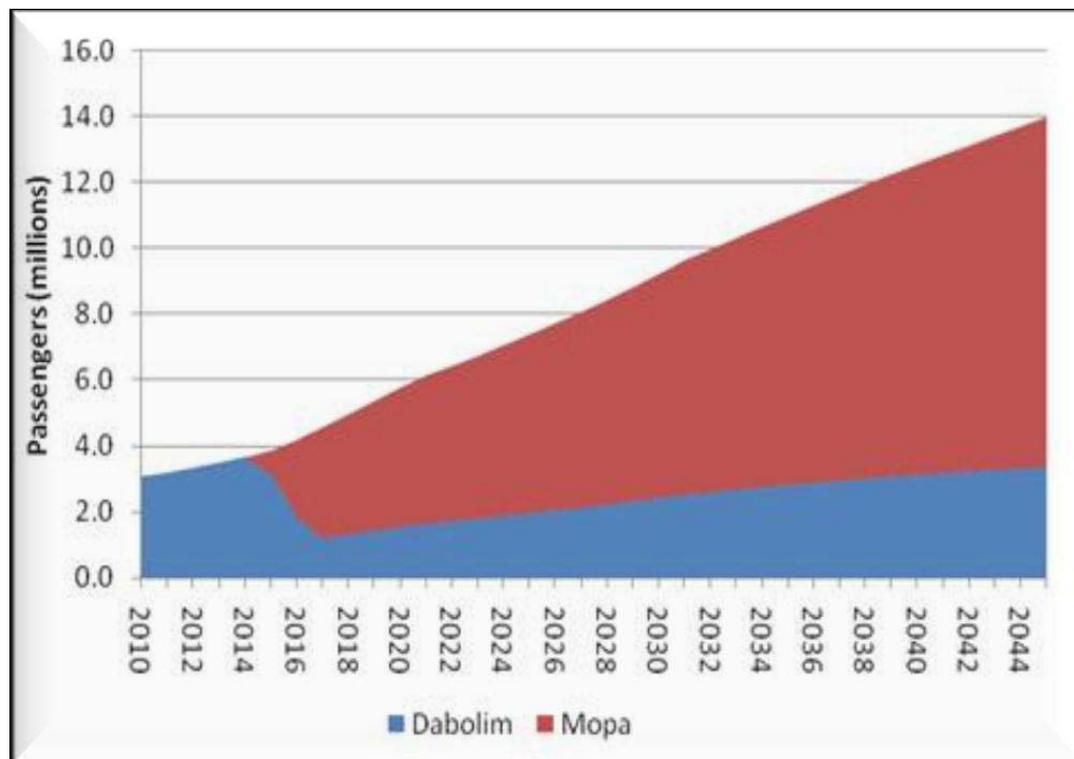
While the first two these issues are due to the fact that the airport shared with the Navy and are unlikely to be resolved, Dabolim will soon be undertaking a major infrastructure expansion and improvement program that should significantly alleviate capacity and facilities issues.

It is estimated that once this program is complete, Dabolim should have the capacity to handle the following numbers of annual passengers, without reaching saturation or suffering a reduction in level of service:

- International: 1.47 million annual passengers
- Domestic: 7.44 million annual passengers

Figure 2.2 graphically illustrates the allocation process, with the top line representing the aggregate demand for the Goa system. In sum, over the medium to long-term, Mopa would account for approximately 70% of total passengers.

Figure 2.2: The estimated allocation of passengers

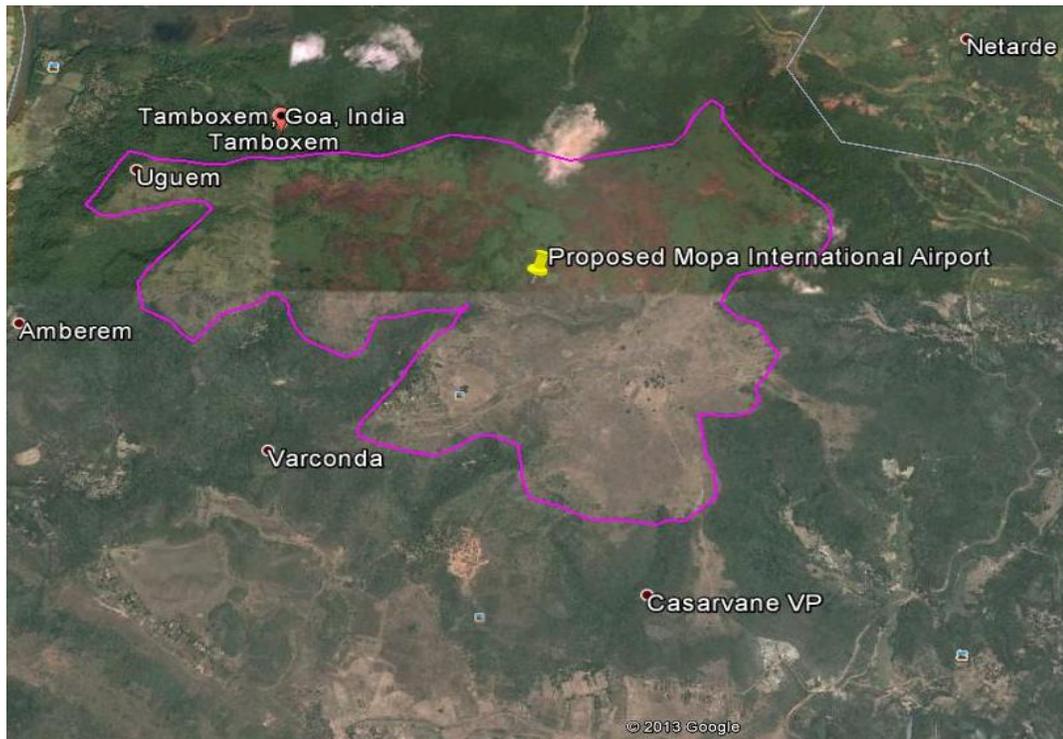


2.3 PROJECT DETAILS

Considering the requirements of present and future development, an area of 2271 acres is required for the proposed airport. The Government of Goa has negotiated for the purchase of 2100 acres to be utilized for development of the airport and commercial facilities at Mopa village. Government of Goa is the owner of the Mopa Airport land. All the compensation awards have been finalized and passed and the entire compensation amount of Rs. 54.79 crore has been placed with Economic Development Corporation, the disbursing agency for the release of claims. Proposed airport location is shown in figure 2.3.

In addition to Airport, a 4 lane approach road from NH-17 to Mopa Airport site has been proposed with a trumpet interchange at NH-17, a bridge over of the Konkan Railway line and various viaducts and other structures. The land for proposed Airport and approach road is shown in **Annexure XIII**.

Figure 2.3: Proposed Airport Location



2.3.1 LAND USE

The land is largely non-cultivated due to an out cropping of lateritic soil and no residential and water bodies are found within the project location except few houses. Vegetation and trees are sparse at the site as illustrated in figure 2.3. A plantation is visible near the boundary of the site and the areas adjoining the site on the northern and eastern sides are reserved forest lands. Land use map for 10 km radius have been attached as **Annexure IX** and existing landuse pattern of the proposed airport location is given below.

Land use	Percentage of coverage
Land with scrub	55
Scrub forest	8
Barren rocky / Stony waste / sheet rock area	22
Kharif	9
Plantations	6

2.3.2. DRAINAGE PATTERN

The Airport site is well located with respect to the storm water drainage as it is a plateau at round 150 to 180m above the mean sea level. The natural drainage from site majorly falls towards the West and South side. The existing catchment divide and the drainage flow are shown in figure 5.1a of chapter 5. The site can be divided into 6 catchments according to the number of outfalls at the boundary which drains to the West and South of the site. The remaining area (shown as hatched) drains to the North and East. With the development of Airport infrastructure, the area contributing to the North or East will reduce and the reduced area will then contribute to the West and South side outfalls. Drainage map for 10 km radius of Goa Region has been attached as **Annexure X**.

2.3.3 RAINFALL PATTERN/ INTENSITY

Meteorological data (Design Rainfall)

Department of Meteorology, Goa has been contacted and 24 hour peak rainfall data for Pernem was obtained for past 5 years. The data obtained is given in Table 2.2 below.

Table 2.2: Hour Peak Rainfall for Pernem, 2005-2010

Date	24- hr peak rainfall (mm)
25 th July 2005	196
23 rd July 2006	101
28 th Sept 2007	178
11 th Aug 2008	163
2 nd July 2009	282
20 th July 2010	166

2.3.4 WATER REQUIREMENT

Total water demand for meeting the proposed airport is 1.2 MLD till phase I and 1.8 MLD including phase II. Water is sourced from Tillari Irrigation canal of irrigation Department, Dhargal division. However, there is a need for alternate water sources during closure of the

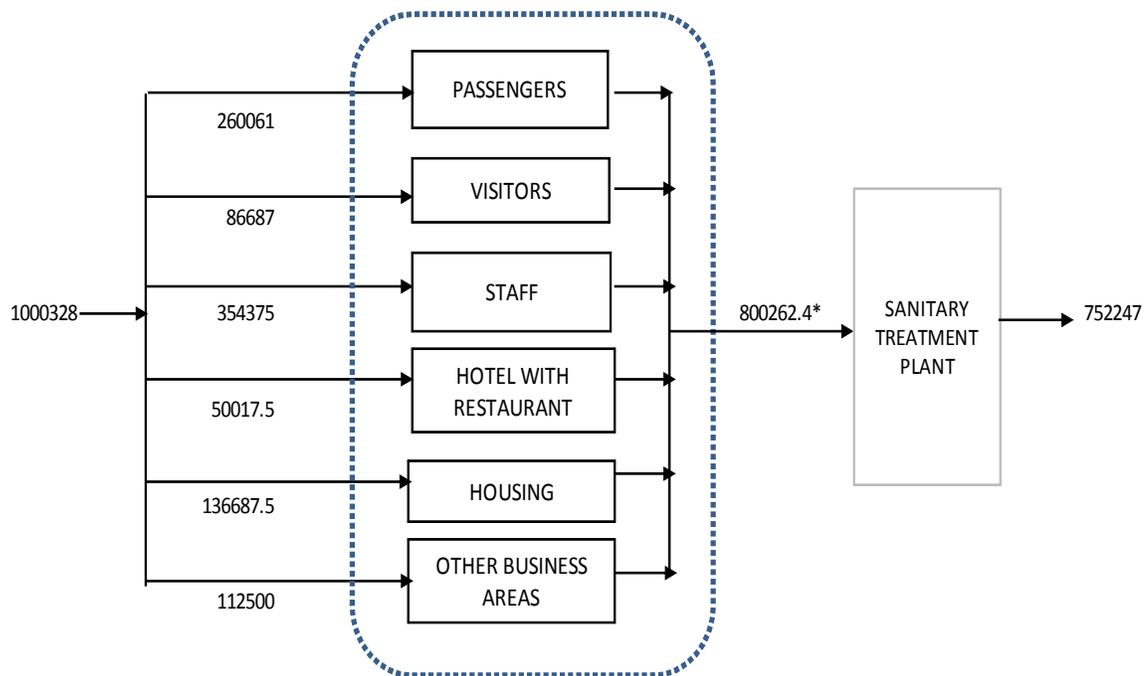
canal for carrying out maintenance activity which is a normal case during monsoon season due to obstruction of canal as result of landslide at cut sections.

It is proposed that main source of water will be the Tillari Irrigation Canal. The water will be tapped at Chainage KM 6 near Chandel village where about 10 cu m of flow is available. The bed of the canal at proposed tapping point is about 28.5 m. The distance of raw water pumping main from tapping point to the proposed raw water storage and treatment site would be about 10 k m.

The standby source would be the Kalna River. The intake point would be near the intake point of the existing 15 MLD Chandel water supply project. A jackwell would be constructed in the river bed with pumping station. This river water will be used during closure of irrigation canal. The distance of raw water pumping main from tapping point to the proposed raw water storage and treatment site would be about 10 km. raw water is used after treatment with conventional water treatment plant having aeration, coagulation, clariflocculation, filtration and chlorination.

The water distribution for the airport usage and water balance is shown in figure 2.4

Figure 2.4 Water balance of phase 1 development:



*The sewage generation is assumed as 80% of the water supply.

All values are mentioned in litres / day

2.3.5 WASTE WATER GENERATION AND REUSE

Source of waste water generation from airport shall be the water supply demand, which will contribute to sewage generation, is 1.8 MLD and 3.0 MLD for the year 2030 and 2045. Therefore with the assumption of 80% of the water supply, the estimated sewage generation is therefore about 1.5 MLD and 2.4 MLD for the year 2030 and 2045, respectively. The maximum water demand and sewage generation beyond year 2045 is

estimated as 6 MLD and about 5 MLD, respectively. The sewage from terminal building, catering, housing, hotels, commercial areas and other business areas would be collected through a gravity sewerage system leading to a sewage pumping station. Sewage treatment plants are designed for 10 years period in modular approach in phased manner as per CPHEEO Manual. The capacity of sewage treatment plant in phases is mentioned in table No. 2.3.

Table No. 2.3: Sewage Treatment Plant

Year	2025	2035	2045	2045 (max)
STP design capacity (cum)	1120	1500	2400	5000

The sewage treatment plant will include tertiary treatment plant for re-using the treated effluent for irrigation of landscaping and garden areas. The aircraft waste will be chemically stabilized as primary treatment before blending into main packaged sewage treatment plant. The effluent quality will be suitable for use in irrigation of landscape / garden areas, flushing of urinals and toilets.

The disposal of untreated effluent will not be allowed at any circumstances. The necessary buffer storage tank will be provided for storage of wastewater during shut-down of the treatment plant for reason.

The excess sludge will be dewatered in dewatering system. The thickened sludge could be used as fertilizer in surrounding agriculture area.

2.3.6 SOLID WASTE GENERATION & DISPOSAL

Solid Waste generated from the various activities within the airport and outside in the nonaeronautical area need to be treated and disposed properly. The solid waste includes both bio-degradable waste and non bio-degradable waste. The solid waste that is generated from the airport area have been estimated of about 6.1 tonnes per day for phase I and 18.2 tonnes per day for phase IV.

Solid waste generated will be disposed in facilities owned by Government of Goa.

2.3.7 POWER REQUIREMENT

Total power required for the proposed airport is 40 MW. Power supply shall be sourced from

- 220/110 KV independent High Tension (HT) lines from Western Grid: Tivim / Colvale/ Mapusa substation
- Southern Grid: Karnataka / Amona – Sesa Goa – Ponda Substation

Emergency / generator power supply system shall be met from 5 numbers of generators each having capacity of 2000 KW.

2.4 PROPOSED AIRPORT FACILITIES

The proposed new International airport shall be capable of handling one B-747 one AB-300 aircraft load corresponding to a peak hour of 500 departing and 500 arriving passengers. The program outlined for the terminal has been designed to respond to both more immediate and longer-term needs anticipated for the airport. Programmatic analysis has

considered facility requirements for the terminal at four key planning horizons: 2020, 2025, 2035 and 2045. This section will provide specific needs in more detail for the first and final phases – years 2020 and 2045. The sections below will address both functional and spatial requirements.

Table 2.4: Peak Hour Numbers used in Terminal Program

		Phase 2020	Phase 2045
Domestic Passengers	Enplaning (departing)	986 pax	2540 pax
	Deplaning (arriving)	842 pax	2171 pax
	Total	1696 pax	4373 pax
International Passengers	Enplaning (departing)	593 pax	1314 pax
	Deplaning (arriving)	578 pax	1282 pax
	Total	921 pax	2042 pax
Combined Passengers	Enplaning (departing)	1394 pax	3506 pax
	Deplaning (arriving)	1003 pax	2422 pax
	Total	2222 pax	5585 pax

2.4.1 PHASE I DEVELOPMENT

The airport is initially designed with a level of service adequate to satisfy the demand of approximately 4.4 million passengers by providing Mopa International Airport with one runway and one processing terminal building with one associated pier.

Runways

In the opening phase, the airfield consists of one single runway with 095° northeast – 275° southwest orientations at the north of the site (designation 09/27) with a takeoff available distance of 3,750 meters and 60 meters of runway width to accommodate the super-jumbo A380 aircraft. The runway includes 7.5-metre wide shoulders at each side of the runway and beyond runway ends, blast pads of 60 x 60 meters at both ends of the runway will be provided with the objective of blast erosion protection. The terrain around the runway will be set up and graded as required by ICAO standards to provide the adequate runway strip with a longitudinal slope not exceeding 1.3% and downward transversal slope not exceeding 2.5%. At both ends of the runway strip a rectangle area of 240 m long x 60 m wide will be prepared for the runway end safety area. Based on the physical characteristics, the primary runway location will be in the north portion of the airport. The maximum land length available to locate the primary runway is 5,100 m. The same has been shown in **Annexure VII**.

Parts of this 5100 m area is located in a vertical cliff area. Runways catering to the very large and wide-body aircraft categorized as code 4F require a precision approach landing

system, either side of the runway end, to guide the aircraft for the final approach segment for landing. This instrument landing system, Category 1 (CAT I – ILS) requires a right-of-way of 500-900 m from the runway end along the runway centre line. The strip of land needed for the ILS will be made available as part of the Mopa airport site. The runway orientation of 95-275 is restricted by the terrain. The maximum available length with these limitations is 3750 m for full blown aircraft operation.

The Mopa International Airport configuration with an initially single runway and one full parallel taxiway assigned to the runway provides enough capacity to handle the air traffic forecast during Phase 1 and Phase 2.

Runway System Requirements

The characteristics of the proposed runway system of the Mopa International Airport are summarized in Table 2.8. The proposed airfield layout requests that one single runway will be operational for all four phases. The airport system would need an additional parallel taxiway to the runway in Phase 4.

Table No 2.5: Principal Characteristics of the Runway System

Characteristic	Main Runway
Orientation	95° NE - 275° SW
Designation	09/27
Centre Line to edge	60 m
Threshold Displacement	20 m
Shoulders	7.5 m
Dimensions	3,750 m x 60 m

NAVAID

The runway will be equipped with both elevated and inset lights for at-all-time operations consisting of a CAT I approach system before both runway thresholds which comprises a row of lights, along the extension of the runway axis, to a distance of 900 m. The runway lighting system is completed with runway centerline inset lights, as recommended by DGCA CAR for precision approach category I when the runway is used by aircraft with high landing speeds or the distance between runway edge lights is greater than 50 meters, and runway edge elevated lights at both sides of the runway. Also, runway threshold lights and runway end lights will be installed. Blue elevated taxiway edge lights will be installed at each runway exit and taxiways. A PAPI approach slope indicator system of a 4-element wing bar placed on the left side of each runway will be installed. Both runway approaches are equipped with Instrument Landing System antennas Category I which consists of a localizer (LOC) antenna located 300 meters from runway ends and a glide path (GP/DME) antenna located 120 meters from runway centerline. A Doppler VHF on midirectional range (D-VOR) with an associated Distance Measurement Equipment (DME) will be installed for providing air navigation support to approaching and departing aircraft near the East border of the airport property. An airport surveillance radar providing monopulse secondary surveillance radar coverage to 120 NM (ASR/MSSR) for terminal approach control will be installed at the top of the cabin of the air traffic control tower,

Runway Exits

In order to optimize the runway occupancy time at this stage to an efficient level of 50 seconds, approximately, for large and heavy aircraft the runway will be provided with two

rapid exits for each approach configuration at an angle of 30° located at 1800 and 2400 from each runway threshold. Also, two perpendicular runway exits at each runway end will be provided with a minimum distance between them of 97.5 meters according to taxiway minimum separation distances. For all runway exits, both perpendicular and at-angle, the taxiway width will be 25 meters plus paved shoulders at each side of the connectors of 17.5 meters wide. The runway exits will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the connectors.

Taxiways

The runway exits connect to a full parallel taxiway of 3750 meters long and 25 meters wide plus paved shoulders of 17.5 meters wide at each side of the taxiway, with a PCN value between 62 and 107, depending on the type of pavement and the CBR values of the sub-grade. The taxiway will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the taxiway. From the main parallel taxiway two perpendicular taxiway connectors 25 meters wide plus paved shoulders of 17.5 meters at each side of the taxiways wide link up to the main aircraft apron. An additional taxiway connector perpendicular to the primary runway and parallel taxiway links to the Naval base. All taxiway connectors will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the taxiway connectors.

Commercial Apron

In Phase I, the main commercial aircraft parking apron will have a paved surface area of approximately 114,000 m², which includes the following elements in compliance with the Minimum Technical Requirements:

- Two (2) remote aircraft stands;
- Eight (8) push-back contact positions for MARS (Multiple Aircraft Ramp Stand) positions served by aerobridge, which are able to accommodate two Code C aircraft at the same time or one Code E aircraft; and
- Vehicle service roads.

Cargo Apron

The cargo apron is located at about 500 meters left of the terminal building and connected by a taxiway of 25 m wide plus shoulders of 17.5 m wide. The cargo apron is designed to accommodate up to 1 wide-body freighters at the same time with a total area of 5,250 m² including:

- A unit loading area of 6 m wide in front of the cargo building terminal,
- A cargo road for ground ramp vehicles of 12 wide,
- A staging area of 18 m wide for storage of ground handling equipment,
- An aircraft nose loading area of 16 m wide,
- Aircraft stand of 75 m long, and
- An apron taxi lane at 50.5 m from the cargo aircraft stands borderline.
- A Cargo terminal building of 5000 m²

The cargo apron area is extended 17.5 meters with paved shoulders and protected of any obstacle within a strip of 57.5 meters with a graded area of 30 m so that the transverse slope does not exceed 2.5% upward or 5% downward from the apron taxi lane. Blue elevated edge lights will be installed at both the taxiway connecting to the commercial apron and the entire shoulder of the cargo apron.

Aircraft Maintenance Area

The area required for these activities, including apron and hangars, is expected to be 15,300 m². The aircraft maintenance facilities are estimated to provide space for 1 hangar. Blue elevated edge lights will be installed at both the taxiway connecting to the hangar apron and the entire shoulder of the hangar apron.

ATC

Following international standards recommendations, an area of 5,000 m² is reserved adjacent to the west side of the airport located right next to the Cargo Area, for accommodating the technical building of aeronautical services, car parking and the control tower. The control tower will have a total height to the ATC cabin of 50 meters.

General Aviation

The general aviation area is located across the commercial apron right of the terminal building. The apron area required General Aviation is 44,000 m². It also has a general aviation terminal of size 2,500 m² and two hangars for general and business aviation purposes with size 2,500 m². The Airport Layout Plan (ALP) is attached as **Annexure VII**.

MOPA AIRPORT PARKING DEMAND FORECAST

Vehicle Type	Parking Spaces Required			
	2020	2025	2035	2045
Car	996	1,302	2,114	2,934
2 Wheelers	318	415	674	935
Bus	51	67	109	151

2.4.2 PHASE II DEVELOPMENT

In the second Phase the airport designed with a level of service adequate to satisfy the demand of approximately 5.8 million passengers by providing Mopa International Airport an expansion to the associated pier.

Commercial Apron

In Phase II, the main commercial aircraft parking apron will have a paved surface area of approximately 159,600 m², which includes the following elements in compliance with the Minimum Technical Requirements:

- Three (3) remote aircraft stands;
- Eleven (11) push-back contact positions for MARS (Multiple Aircraft Ramp Stand) positions served by aerobridge, which are able to accommodate two Code C aircraft at the same time or one Code E aircraft; and

- Vehicle service roads.

2.4.3 PHASE III DEVELOPMENT

In the third Phase the airport designed with a level of service adequate to satisfy the demand of approximately 9.4 million passengers by providing Mopa International Airport an expansion to the associated pier.

Taxiways

From the main parallel taxiway a single perpendicular taxiway located at a distance of 1000 m from the existing taxiway connector connectors, 25 meters wide plus paved shoulders of 17.5 meters at each side of the taxiways, link up to the main aircraft apron. All taxiway connectors will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the taxiway connectors.

Commercial Apron

In Phase III, the main commercial aircraft parking apron will have a paved surface area of approximately 182,400 m², which includes the following elements in compliance with the Minimum Technical Requirements:

- Three (3) remote aircraft stands;
- Thirteen (11) push-back contact positions for MARS (Multiple Aircraft Ramp Stand) positions served by aerobridge, which are able to accommodate two Code C aircraft at the same time or one Code E aircraft; and
- Vehicle service roads.

Cargo Apron

The cargo apron is located at about 500 meters left of the terminal building and connected by a taxiway of 25 m wide plus shoulders of 17.5 m wide. The cargo apron is designed to accommodate up to 1 wide-body freighters at the same time with a total area of 10, 500 m² including:

- A unit loading area of 6 m wide in front of the cargo building terminal,
- A cargo road for ground ramp vehicles of 12 wide,
- A staging area of 18 m wide for storage of ground handling equipment,
- An aircraft nose loading area of 16 m wide,
- Aircraft stand of 75 m long, and
- An apron taxi lane at 50.5 m from the cargo aircraft stands borderline.
- A Cargo terminal building of 8000 m²

Aircraft Maintenance Area

The area required for these activities, including apron and hangars, is expected to be 30,000 m². The aircraft maintenance facilities are estimated to provide space for one hangar.

General Aviation

The general aviation area is located across the commercial apron right of the terminal building. In Phase III, two more hangars for general and business aviation purposes with size 2,500 m².

2.4.4 PHASE IV DEVELOPMENT

In the fourth Phase the airport designed with a level of service adequate to satisfy the demand of approximately 13.1 million passengers.

Taxiways

A partial second parallel taxiway will link the two perpendicular taxiway connectors located a distance of 1000 m apart. The partial parallel taxiway will be protected of any obstacle within a strip of 57.5 meters and providing a graded area of 30 m with a transverse slope not exceeding 2.5% upward or 5% downward from the taxiway centerline at each side of the taxiway connectors.

Commercial Apron

In Phase IV, the main commercial aircraft parking apron will have a paved surface area of approximately 239,400 m², which includes the following elements in compliance with the Minimum Technical Requirements:

- Four (4) remote aircraft stands;
- Seventeen (17) push-back contact positions for MARS (Multiple Aircraft Ramp Stand) positions served by aerobridge, which are able to accommodate two Code C aircraft at the same time or one Code E aircraft; and
- Vehicle service roads.

2.5 FUEL STORAGE

The jet fuel requirements depending on the number of annual aircraft operations and the application are given below.

- Fuel tank volume capacity of approximately 3,000 m³
- Storage capacity for up to 7 days
- Average fuel uplift of 8.5 m³ per aircraft departure.

Period	Fuel Tank (m ³)	Number of Fuel Tanks
2020	6,331	2
2025	8,085	3
2035	12,809	4
2045	17,782	6

CHAPTER 3

ANALYSIS OF ALTERNATIVES

3.1 DESCRIPTION OF ALTERNATIVES:

As described in chapter 2, Based on the expected traffic and capabilities of the existing Airport at Dhabolim the following two options were proposed for development:

A) Option – 1

To develop a new International Terminal at Mopa with the following salient features:

- Design Year : 2020
- Total cost: INR 8748 million.
- Land Requirement : 2271 acres

B) Option – 2

Augmentation of the existing International and Domestic Terminal and utilise it as a new international Terminal.

However due to Capacity constraints and military restrictions Option – 1 is considered as the feasible workable solution.

Alternative Sites:

Following three sites were analyzed for development of the international airport:

- Site 1: at Mopa – 4500 acres (2271 acres revised)
- Site2: at Quitol – 2000 acres
- Site3: at Siolim – 1000 acres

These sites are shown in figure no 3.1. Based on site selection study, Site 1 was found most favorable.

Figure 3.1 Alternative sites



3.2 APPROACH ROAD:

The access to the Greenfield Airport at Mopa is proposed near 495 km of the National Highway 17. A 4 lane approach road from NH-17 to Mopa Airport site has been proposed with a trumpet interchange at NH-17, a bridge over of the Konkan Railway line and various viaducts and other structures. The proposed location for the approach road is shown in **Annexure XIII**.

A traverse survey has been conducted along the corridor previously identified for the approach road. The alignment was found to result in a substantial gradient, and require some realignment to reach the design speed of 65 kmph.

Preliminary survey of traversing suggested requirement of realignment near chainage 0+000 to 1+000 due alignment of canal falls within approach road corridor. Further minor realignment was required to follow design speed 65kmph. Profile of selected corridor in the last section indicated limiting gradient of 5% in substantial length (2250.0m) which further warranted looking for other options of approach road alignments.

In view of above alignment alternative study with option-1, Option-2, Option-3 along with Option 1-b (extreme case i.e. followed existing designated land corridor with ruling gradients) has been done.

Option1-b shows huge cut and fill including viaduct length more than 3.0km with extraordinary height of viaduct in turns preliminary cost would be more than 2.5 times than alignment alternative option-2. Alignment alternative option-3 passes through forest area nearby chainage 7+300 both sides. It is learnt that this land would be earmarked for settlement of people whose land would be acquired in land acquisition requirement of this project. Alignment alternative option-2 has come out better option for approach road alignment with reduce length of viaducts among all the alternative and ease in approach end section gradients to 3.5%. This option comes out with better highway geometrics with least cost.

All these alignment options were discussed and presented in Draft Master Plan stage and Consultants Preferred alignment option-2 with due weightage of ease in gradients in last approach section, reduce length in viaduct in turns reduce cost of alignment alternative of Option-2. Approval of alignment option-2 was conveyed by client on submission/presentation of draft master plan.

Topographic survey along the corridor of approved option has been conducted and preliminary plan and profile drawings have been prepared for approved option accordingly.

CHAPTER 4

DESCRIPTION OF ENVIRONMENT

4.0 BASE LINE DATA COLLECTION

The present chapter highlights various aspects of baseline data and its analysis in the light of proposed project facilities. M/s. EMTRC Consultants Private Limited had been entrusted the task of ambience air, water, soil and noise level monitoring of the area of influence near the proposed airport for a period of three months, starting from October 2011 to December 2011. Data thus collected has been utilized here to establish baseline quality of various environmental parameters.

A fresh environmental baseline data were collected again during the period of November 2014 to January 2015 to see the changes in values from 2011 to 2015. A comparative study of the same is given in their respective sections below. Complete data collected during this period is attached as **Annexure XX**.

4.1 AIR ENVIRONMENT

Total Suspended Particulate Matter (SPM), Respirable Particulate Matter (RPM) during construction phase and unburnt hydrocarbons (HC) and Oxides of Nitrogen (NO_x) during operation phase are the major pollutants in this kind of project. Ambient air quality collected at six (6) locations by EMTRC Consultants Private Limited, within 10 kms around the airport is used as baseline levels. A detailed description of the observations is given in the following sections:

4.1.1 Micro Meteorology

Micrometeorology with respect to wind speed, wind direction, and temperature, recorded at meteorological station in the months of October, November and December 2011 is summarized in the following sections.

1. Temperature

The temperature varied between 23.0 – 33.0°C in the months of October, November and December. The variation of temperature remained same in these three months, which are normally considered as winter season.

2. Wind Speed and Direction

Generally light to moderate winds prevails through out these months. The predominant wind directions were North-East. The wind rose diagrams for these three months are shown in Figure 4.1 a, b and c.

Figure 4.1a: Wind rose diagram (October 2011)

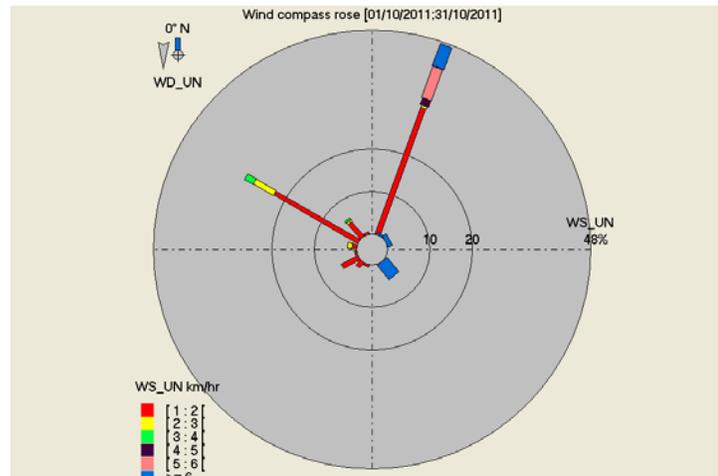


Figure 4.1b: Wind rose diagram (November 2011)

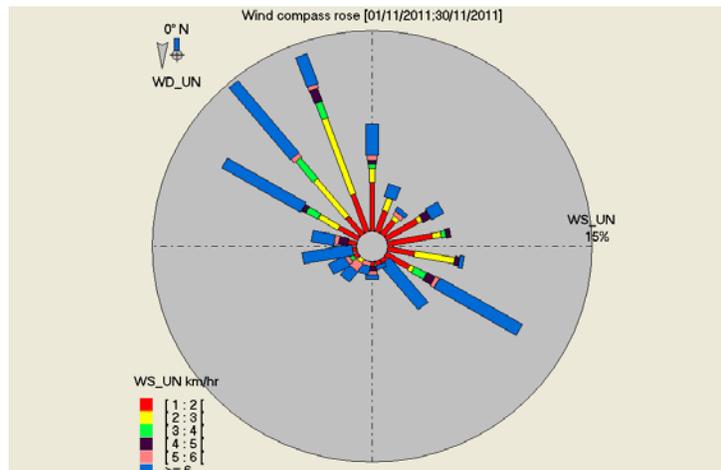
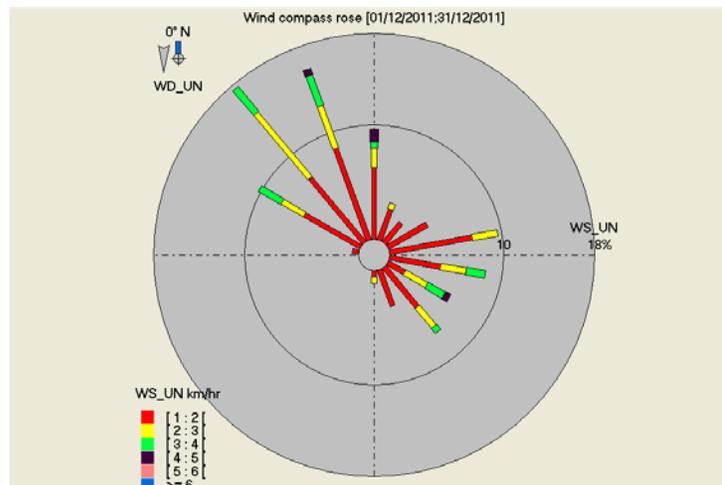


Figure 4.1c: Wind rose diagram (December 2011)

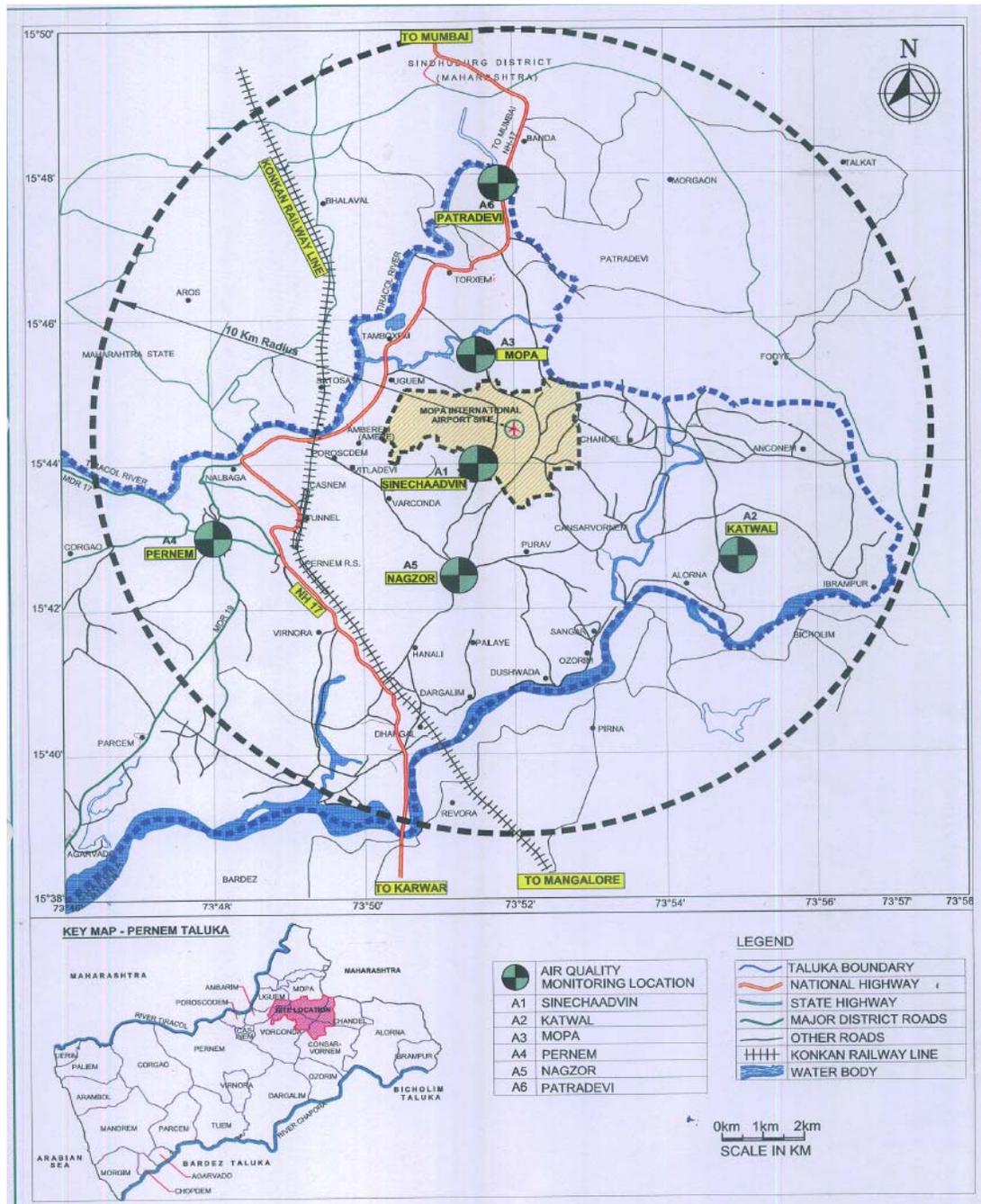


4.1.2 AMBIENT AIR QUALITY

Ambient air quality was monitored in terms of SPM, RPM, SO₂, NO_x, CO and HC at six locations. The locations of AAQ monitoring stations are at Sinechaadvin, Katwal, Mopa village, Pernem, Nagzor and Patradevi within 10 km of study area. The AAQ locations are shown in figure 4.2.

A brief summary of all recorded parameters, monitored during winter season (October - December) are discussed in the following subsections.

Figure 4.2: Ambient Air Quality monitoring locations



A) Suspended Particulate Matter (SPM / PM₁₀)

SPM values recorded at various stations ranged between 35- 47 $\mu\text{g}/\text{m}^3$ with minimum values varying between 29-41 $\mu\text{g}/\text{m}^3$ and maximum values varying between 41- 53 $\mu\text{g}/\text{m}^3$. All the AAQ levels recorded were observed to be well within the 24 hours permissible limit of 100 $\mu\text{g}/\text{m}^3$ prescribed for residential and rural areas. SPM values monitored are given in Table 4.1.

Table 4.1: Ambient Air Quality at Various Monitoring Stations (SPM / PM₁₀)

Locations	Mean	Max	Min
A1	40	46	35
A2	40	46	35
A3	35	41	29
A4	43	51	36
A5	47	53	41
A6	41	48	35

B) Respirable Particulate Matter (RPM / PM_{2.5})

RPM values recorded at various stations ranged between 18 -23 $\mu\text{g}/\text{m}^3$ with minimum values varying between 14 - 18 $\mu\text{g}/\text{m}^3$ and maximum values varying between 23- 28 $\mu\text{g}/\text{m}^3$. All the AAQ levels recorded were observed to be well within the 24 hours permissible limit of 60 $\mu\text{g}/\text{m}^3$ prescribed for residential and rural areas. RPM values monitored are given in Table 4.2.

Table 4.2: Ambient Air Quality at Various Monitoring Stations (RPM / PM_{2.5})

Locations	Mean	Max	Min
A1	20	24	15
A2	20	24	15
A3	18	23	14
A4	22	26	18
A5	23	28	18
A6	20	24	16

C) Sulphur Dioxide (SO₂)

SO₂ values recorded at various stations ranged between 10.2 -14.4 $\mu\text{g}/\text{m}^3$ with minimum values varying between 7.6- 9.8 $\mu\text{g}/\text{m}^3$ and maximum values varying between 13.2 –18.5 $\mu\text{g}/\text{m}^3$. All the AAQ levels recorded were observed to be well within the 24 hours permissible limit of 80 $\mu\text{g}/\text{m}^3$ prescribed for residential and rural areas. SO₂ values monitored are given in Table 4.3.

Table 4.3: Ambient Air Quality at Various Monitoring Stations (SOX)

Locations	Mean	Max	Min
A1	10.2	13.2	7.6
A2	10.2	13.2	7.6
A3	10.3	13.6	8.2
A4	12.6	15.6	9.3
A5	14.4	18.5	9.8
A6	12.4	16.2	8.3

D) Oxides of Nitrogen (NO_x)

NO_x values recorded at various stations ranged between 13 - 16.3 µg/m³ with minimum values varying between 9 - 11.8 µg/m³ and maximum values varying between 16.3 – 21.8 µg/m³. All the AAQ levels recorded were observed to be well within the 24 hours permissible limit of 80 µg/m³ prescribed for residential and rural areas. NO_x values monitored are given in Table 4.4.

Table 4.4: Ambient Air Quality at Various Monitoring Stations (NOX)

Locations	Mean	Max	Min
A1	13	17.8	9.0
A2	13	17.8	9.0
A3	13	16.3	9
A4	16.3	21.8	11.8
A5	16.2	21.2	10.5
A6	14.6	18.2	10.3

Both CO and HC were found <100 µg/m³ at all the locations during the monitoring period.

Comparison:

In the year 2014-15, locations were monitored for parameters of PM₁₀, PM_{2.5}, SO₂, NO_x, CO, HC & Pb. In fresh data collection Lead (Pb) is added as Aircrafts use leaded aviation gasoline as fuel.

Duration	October 2011 to December 2011	November 2014 to January 2015	November 2014 to January 2015	Standard NAAQS
No. of locations	6	3	3	
Pollutants	Maximum values	Maximum values	98 th Percentile values	
PM ₁₀ µg/m ³	41-53	43-54	42-53	100
PM _{2.5} µg/m ³	23-28	27-30	27-30	60
SO ₂ µg/m ³	13.2-18.5	11.8-13.6	11.5-13.5	80
NO _x µg/m ³	16.3-21.8	15.1-18.2	14.9-18.1	80
CO mg/m ³	BDL	0.49-0.61	0.49-0.60	04
HC (ppm)	BDL	5.8 – 6.0	5.80-6.00	-
NMHC (ppm)	--	BDL	BDL	-
Pb (µg/m ³)	Not measured	0.004 at Tamboxem. Remaining two locations it was found to be BDL	0.004 at Tamboxem. Remaining two locations it was found to be BDL	01

BDL: Below Detactable Limit

Locations Katwal & Alorna are located almost close to each other. Therefore a comparative table is presented between these two locations to know the impact on baseline.

Duration	October 2011 to December 2011	November 2014 to January 2015	Standard
location	Katwal	Alorna	
Pollutants	Maximum values	Maximum values	
PM ₁₀ µg/m ³	46	54	100
PM _{2.5} µg/m ³	24	30	60
SO ₂ µg/m ³	13.2	13.6	80
NO _x µg/m ³	17.8	18.2	80
CO mg/m ³	< 100 µg/m ³	0.61	04
HC (ppm)	< 100 µg/m ³	5.8	-
NMHC (ppm)	< 100 µg/m ³	BDL	-
Pb (µg/m ³)	Not measured	BDL	01

BDL: Below Detactable Limit

Baseline data pertaing to Air were found within the standard.

4.2 WATER ENVIRONMENT

The water requirement for the proposed Greenfield airport will be met with the Tillari Irrigation canal. The water will be tapped at chainage 6 km near Chandel village where about 10 cu m of flow is available.

The standby source would be the Kalna river, which is tributary of Chapora river and Tillari irrigation canal. As the project will be implemented in four phases, the estimated water requirements for the year 2020, 2030, 2045 and beyond 2045 are 1MLD, 1.8 MLD, 3 MLD and 6 MLD respectively. Water is used for domestic purposes by the passengers, visitors, staff etc.

The ground water quality is measured at four locations i.e. Mopa village, Pernem, Dargal and Patradevi within 10 km of study area. These are reported in Tables 4.5a and 4.5b. The surface water quality is measured at three locations Chapora river, Tiraikol river and Nala near Mopa village within 10 km of study area. These are reported in Table 4.6. The water sampling locations are depicted in figure 4.3.

Table 4.5a: Ground Water Quality of Mopa village and Pernem.

Sr. No.	Parameters	Unit	Test Methods	Mopa Village (Dug well)	Pernem (Dug well)	Permissible limit IS:10500: 1991
1	Colour	Hazen Unit	APHA-2120B	Colourless	Colourless	25
2	Odour	-	APHA-2150B	Unobjectionable	Unobjectionable	Unobjectionable
3	pH	-	APHA-4500	7.70	6.62	6.5 – 8.5
4	Conductivity	µmhos/cm	APHA-2510	260	190	-
5	Turbidity	NTU	APHA-2030B	2.0	1.0	10
6	Total Dissolved Solids	mg/l	APHA-2540B	182	132	2000
7	Total Hardness as CaCO ₃	mg/l	APHA-2340C	90	40	600
8	Calcium as Ca	mg/l	APHA-4500B	28	8	200
9	Magnesium as Mg	mg/l	APHA-4500B	4.8	4.8	100
10	Chlorides as Cl	mg/l	APHA-4500B	18	35	1000
11	Nitrates as NO ₃	mg/l	APHA-4500	5.8	01	100
12	Phenolic compound	mg/l	APHA-5230D	<0.001	<0.001	0.001
13	Sulphate as SO ₄	mg/l	APHA-4500E	16	04	400
14	Fluoride as F	mg/l	APHA-4500D	0.48	0.23	1.5
15	Phosphates as PO ₄	mg/l	APHA-4500C	0.028	0.018	0.3
16	Iron as Fe	mg/l	APHA-3111B	0.018	0.012	1.0
17	Copper as Cu	mg/l	APHA-3111B	<0.02	<0.02	1.5
18	Lead as Pb	mg/l	APHA-3111B	<0.01	<0.01	0.05
19	Manganese as Mn	mg/l	APHA-3111B	<0.05	<0.05	0.3
20	Zinc as Zn	mg/l	APHA-3111B	0.28	0.20	15
21	Chromium	mg/l	APHA-3111B	<0.05	<0.05	0.05
22	Nickel as Ni	mg/l	APHA-3111B	<0.01	<0.01	0.05
23	Oil & Grease	mg/l	APHA-5520D	Nil	Nil	0.03
24	Cadmium as Cd	mg/l	APHA-3111B	<0.01	<0.01	0.01
25	Mercury as Hg	mg/l	APHA-3111B	<0.001	<0.001	0.001
26	Arsenic as As	mg/l	APHA-3111B	<0.025	<0.025	0.05
27	Total coliform	MPN/100ml	APHA-9230B	Nil	Nil	Nil

Table 4.5b: Ground Water Quality of Dargal and Patradevi

Sr. No.	Parameters	Unit	Test Methods	Dargal (Dug well)	Patradevi (Dug well)	Permissible limit IS:10500: 1991
1	Colour	Hazen Unit	APHA-2120B	Colourless	Colourless	25
2	Odour	-	APHA-2150B	Unobjectionable	Unobjectionable	Unobjectionable
3	pH	-	APHA-4500	7.10	6.64	6.5 – 8.5
4	Conductivity	µmhos/cm	APHA-2510	150	190	-
5	Turbidity	NTU	APHA-2030B	1.0	2.0	10
6	Total Dissolved Solids	mg/l	APHA-2540B	102	128	2000
7	Total Hardness as CaCO ₃	mg/l	APHA-2340C	40	50	600
8	Calcium as Ca	mg/l	APHA-4500B	12	14	200
9	Magnesium as Mg	mg/l	APHA-4500B	2.4	3.6	100
10	Chlorides as Cl	mg/l	APHA-4500B	40	25	1000
11	Nitrates as NO ₃	mg/l	APHA-4500	2.1	9.6	100
12	Phenolic compound	mg/l	APHA-5230D	<0.001	<0.001	0.001
13	Sulphate as SO ₄	mg/l	APHA-4500E	11.2	24	400
14	Fluoride as F	mg/l	APHA-4500D	0.36	0.26	1.5
15	Phosphates as PO ₄	mg/l	APHA-4500C	0.019	0.038	0.3
16	Iron as Fe	mg/l	APHA-3111B	0.022	0.021	1.0
17	Copper as Cu	mg/l	APHA-3111B	<0.02	<0.02	1.5
18	Lead as Pb	mg/l	APHA-3111B	<0.01	<0.01	0.05
19	Manganese as Mn	mg/l	APHA-3111B	<0.05	<0.05	0.3
20	Zinc as Zn	mg/l	APHA-3111B	0.22	0.14	15
21	Chromium	mg/l	APHA-3111B	<0.05	<0.05	0.05
22	Nickel as Ni	mg/l	APHA-3111B	<0.01	<0.01	0.05
23	Oil & Grease	mg/l	APHA-5520D	Nil	Nil	0.03
24	Cadmium as Cd	mg/l	APHA-3111B	<0.01	<0.01	0.01
25	Mercury as Hg	mg/l	APHA-3111B	<0.001	<0.001	0.001
26	Arsenic as As	mg/l	APHA-3111B	<0.025	<0.025	0.05
27	Total coliform	MPN/100ml	APHA-9230B	Nil	Nil	Nil

Table 4.6: Surface Water Quality

Sr. No.	Parameters	Unit	Test Methods	Chapora River	Tiraikol River	Nala Near Mopa Village
1	pH	-	APHA-4500	7.25	7.44	6.92
2	Conductivity	µmhos/cm	APHA-2510	13356	15300	340
3	Colour	Hazen Unit	APHA-2120B	Colourless	Colourless	Colourless
4	Odour	-	APHA-2150B	Unobjectionable	Unobjectionable	Unobjectionable
5	Turbidity	NTU	APHA-2030B	4	6	3
6	Total Dissolved Solids	mg/l	APHA-2540B	8690	9980	258
7	Suspended solids	mg/l	APHA-2540D	24	28	14
8	Total Alkalinity	mg/l	APHA-2320B	150	120	110
9	Total Hardness as CaCO ₃	mg/l	APHA-2340C	1460	1780	80
10	Dissolved Oxygen	mg/l	APHA-4500C	5.2	4.9	5.4
11	BOD, 5days 20°C	mg/l	APHA-5210B	4.8	5.4	4.6
12	COD	mg/l	APHA-5220C	12	16	12
13	Calcium as Ca	mg/l	APHA-4500B	168	224	24
14	Magnesium as Mg	mg/l	APHA-4500B	252	306	4.9
15	Chlorides as Cl	mg/l	APHA-4500B	2800	3640	18
16	Sulphate as SO ₄	mg/l	APHA-4500E	430	530	12
17	Nitrates as NO ₃	mg/l	APHA-4500	12.5	19.2	4.5
18	Fluoride as F	mg/l	APHA-4500D	0.22	0.28	0.28
19	Phenolic compound	mg/l	APHA-5230D	<0.001	<0.001	<0.001
20	Arsenic	mg/l	APHA-3114	<0.025	<0.025	<0.025
21	Mercury	mg/l	APHA-3112	<0.01	<0.01	<0.01
22	Cadmium	mg/l	APHA-3111B	<0.01	<0.01	<0.01
23	Chromium	mg/l	APHA-3111B	<0.05	<0.005	<0.05
24	Iron as Fe	mg/l	APHA-3111B	0.018	0.016	0.022
25	Copper as Cu	mg/l	APHA-3111B	<0.02	<0.02	<0.02
26	Lead as Pb	mg/l	APHA-3111B	<0.01	<0.01	<0.01
27	Manganese as Mn	mg/l	APHA-3111B	<0.05	<0.05	<0.05
28	Zinc	mg/l	APHA-3111B	1.2	0.92	0.26
29	Oil & Grease	mg/l	APHA-4500D	Nil	Nil	Nil
30	Total coliform	MPN/100ml	APHA-9230B	180	260	160

Comparison:

Baseline data collected for water environment during 2011 is compared with 2014 data to assess the changes and the same is represented in below tables.

Ground water			
Duration	October 2011 to December 2011	November 2014 to January 2015	Standard IS:10500:1991
No. of locations	4	3	
Pollutants			
pH	6.62-7.7	6.75 – 7.58	6.5 – 8.5
TDS (mg/l)	102-182	40 - 85	2000
Hardness (mg/l)	40-90	24 - 52	600
Chlorides (mg/l)	18-40	5-20	1000
Sulfates (mg/l)	4-24	3 - 6	400

Surface water			
Duration	October 2011 to December 2011	November 2014 to January 2015	Standard IS:10500:1991
No. of locations	3	3	
Pollutants			
pH	6.92-7.44	6.72-7.19	6.5 – 8.5
TDS (mg/l)	258-9980	60-3173	2000
Hardness (mg/l)	80-1780	36-236	600
Chlorides (mg/l)	18-3640	5-1530	1000
Sulfates (mg/l)	12-530	0-162	400
Coliforms (MPN/100ml)	160-260	62-224	50 or less

Baseline data for ground water quality was carried out at Pernem during both the time of 2011 & 2014. Therefore a comparative table is presented to know the impact on baseline.

Ground water			
Duration	October 2011 to December 2011	November 2014 to January 2015	Standard IS:10500:1991
No. of locations	4	3	
Pollutants	Pernem	Pernem	
pH	6.62	7.58 – 7.62	6.5 – 8.5
TDS (mg/l)	132	85 – 98	2000
Hardness (mg/l)	40	52 – 64	600
Chlorides (mg/l)	35	16 – 24	1000
Sulfates (mg/l)	04	1.1 - 6	400

A comparative table is presented to know the impact on baseline between Chapora River & Chernel which is close by.

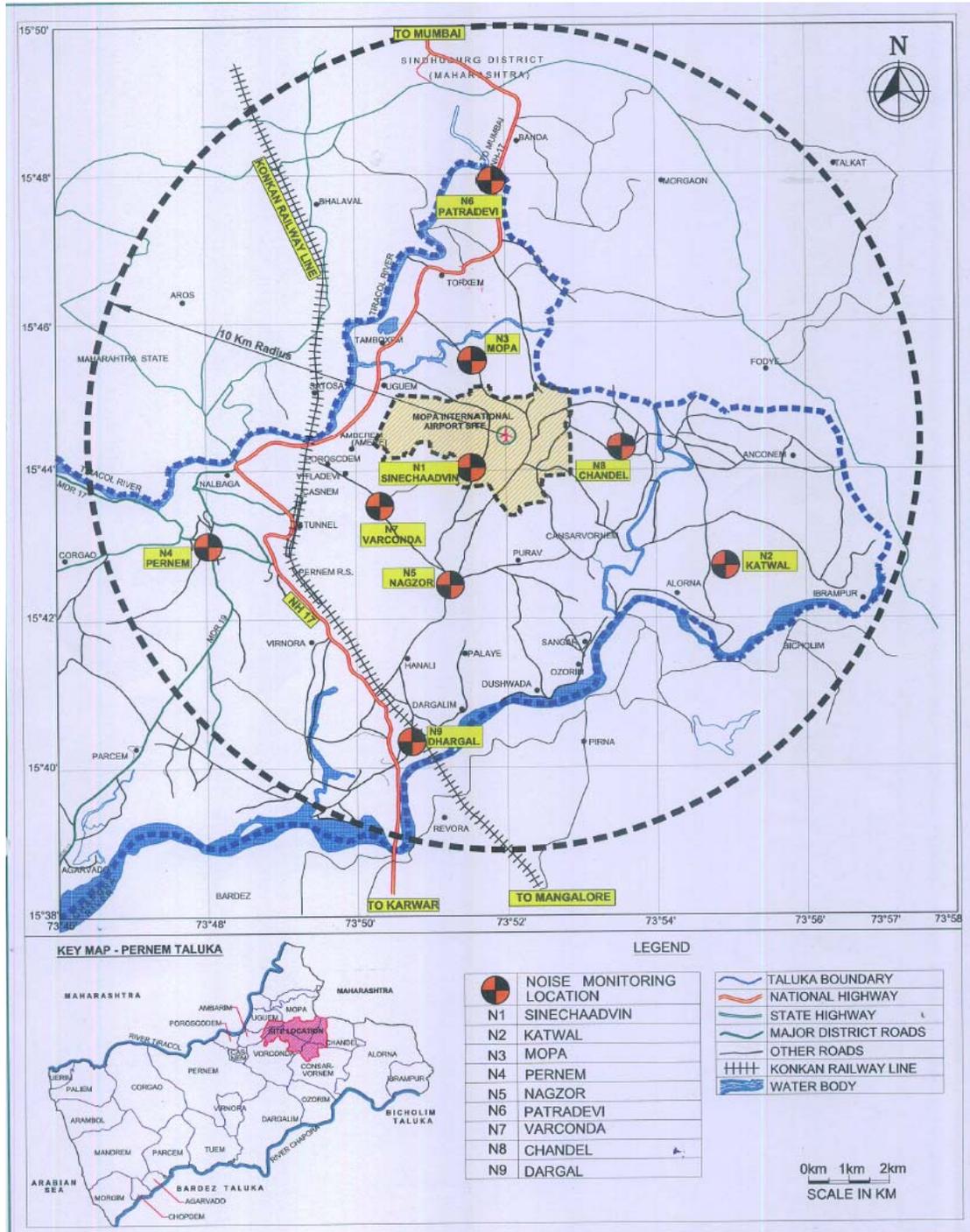
Surface water			
Duration	October 2011 to December 2011	November 2014 to January 2015	Standard IS:10500:1991
No. of locations	4	3	
Pollutants	Chapora River	Chernol	
pH	7.25	7.09	6.5 – 8.5
TDS (mg/l)	8690	358	2000
Hardness (mg/l)	1460	92	600
Chlorides (mg/l)	2800	98	1000
Sulfates (mg/l)	430	72	400

All values were found within the standard for ground water. For surface water, there is reduction in values.

4.3 NOISE ENVIRONMENT:

Noise levels were measured at nine different locations within study area. The noise monitoring locations are depicted in figure 4.4. The computed noise level parameters, L_{day} and L_{night} for all the nine sampling locations presented in Table 4.7.

Figure 4.4: Noise Monitoring Locations



a) Day time Noise Levels

The noise level in all the locations ranged from 43.7 - 53.8 dB (a), with the maximum (53.8) being recorded in Pernem. The noise levels were observed within the limits in their respective categories.

b) Night time Noise Levels

The noise level in all the locations ranged from 39.5 – 44 dB(a), with the maximum 44 being recorded in Patradevi. The noise levels were observed within the limits in their respective categories.

Table 4.7: Ambient Noise Level [in Leq dB(A)]

Sl. No.	Name of Location	Day Time	Night Time
1	Sinechaadvin	45.6	40.4
2	Katwal	48.8	41.2
3	Mopa	43.7	39.5
4	Pernem	53.2	43.5
5	Nagzor	52.8	42.5
6	Patradevi	53.8	44.0
7	Varconda	52.8	42.1
8	Chandel	48.5	41.2
9	Dargal	51.8	40.9

The standard ambient noise levels in different categories are given below in Table 4.8.

Table 4.8: Noise Level [in Leq dB(A)] (Standard)

Area code	Category of area	Limits in db (A) Leq	
		Day time	Night time
A	Industrial area	75	70
B	Commercial area	65	55
C	Residential area	55	45
D	Silence zone	50	40

Comparison:

Duration	October 2011 to December 2011	November 2014 to January 2015	Standard	
No. of locations	9	3	Industrial	Residential
L _{day} dBA	43.7-53.8	51.3-57.2	75	55
L _{night} dBA	39.5-44.0	40.0-44.5	70	45

Baseline data for noise was carried out at Pernem during both the time of 2011 & 2014. Therefore a comparative table is presented to know the impact on baseline.

Duration	October 2011 to December 2011	November 2014 to January 2015	Standard	
location	Pernem	Pernem	Industrial	Residential
L _{day} dBA	53.2	57.2	75	55
L _{night} dBA	43.5	43.1	70	45

All values were found within the standard except for pernem during day time. This may be due to vehicular movement and other activities as Pernem includes twenty village panchayats and one municipality. Pernem is well connected by road NH 17 and the Konkan railway.

Traffic Density

Hourly traffic measurements were made at 2 locations once in a month (November, December-14 and January -15) during 3 months study period. The number of each type of vehicle (passenger cars, LMV, HMV, etc) were recorded and the traffic density has been expressed in terms of Passenger Car Units (PCU) in Table 3.11. The PCU is calculated on the following basis.

Equivalent value of PCU:

Heavy Motor Vehicles (HMV) – 1 HMV = 3 PCU

Low Motor Vehicles (LMV) _ 1 LMV = 1 PCU

Two wheelers (TW) -- 1 TW = 1 PCU

Traffic data

(Once in a month during 3 months study period)

Code/location	Average (PCU)		
	November-14	December-14	January-15
T1- On NH17 near Uguem	183	180	154
T2- On NH17 near Pernem	107	108	108

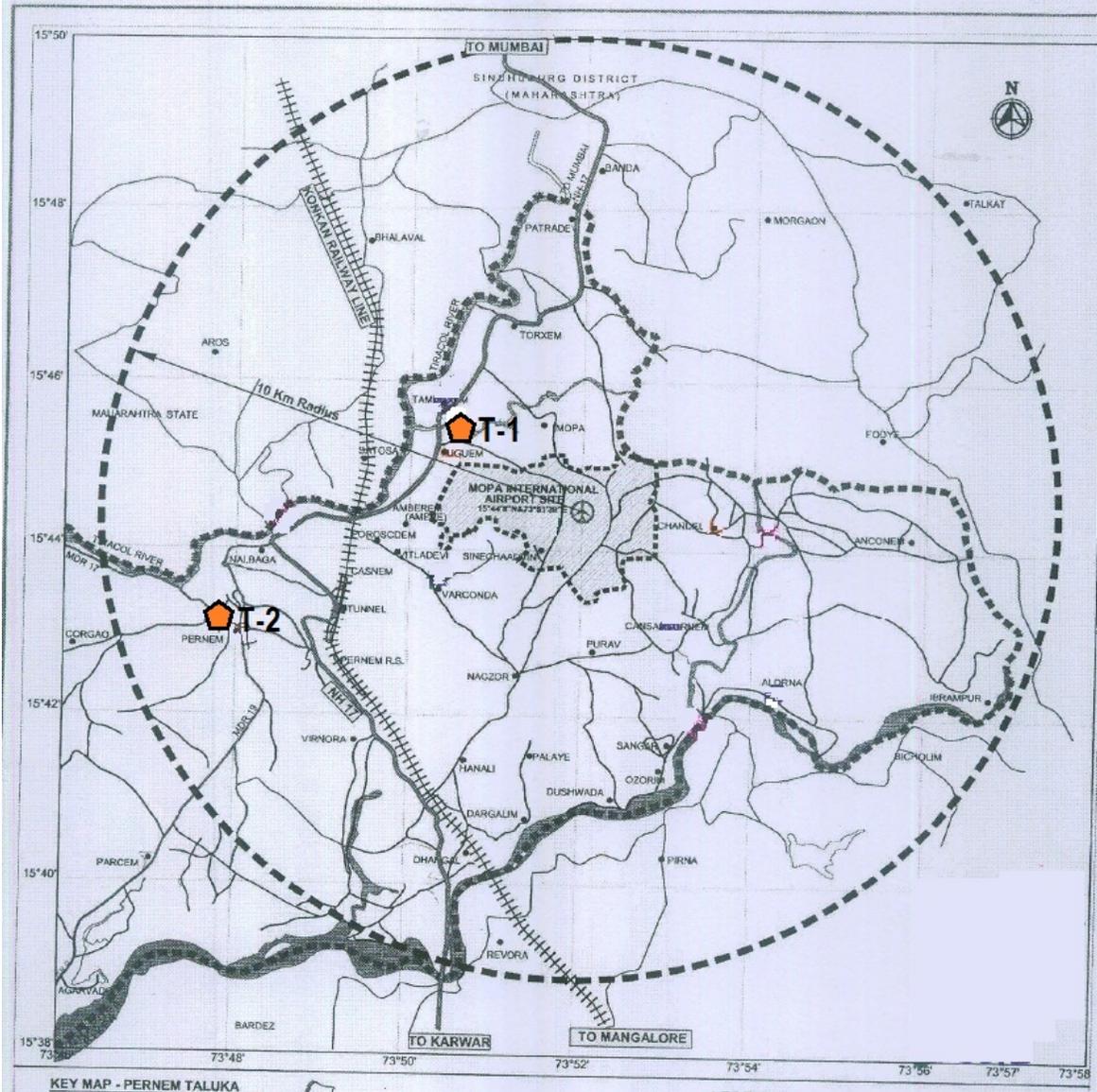


Fig. 4.5: Traffic locations

Code	Location Name	Distance	Direction
T1	On NH17 near Uguem	2.5	NW
T2	On NH17 near Pernem	5.3	SW

4.4 LAND ENVIRONMENT:

Surrounding land use of the airport site is predominantly forest land. The northern and eastern side of site is reserve forest areas, whereas western side is barren and village cultivated land. The existing land use plan is attached as **Annexure IX**.

Table 4.9: Soil quality of agriculture fields

	Parameters	Sinechaad vin	Nagzor	Pernem	Katwal	Mopa
1	pH (20% slurry)	7.10	7.12	6.90	8.25	7.32
2	Conductivity (20% slurry), µmhos/cm	158	182	169	172	185
3	Texture	Sandy	Sandy	Sandy	Sandy	Sandy
4	Bulk Density; g/cm ³	1.69	1.52	1.64	1.51	1.63
5	Infiltration, Cm/hr	6.36	7.15	6.75	8.56	7.35
6	Water Holding Capacity, %	28.50	25.75	29.50	24.30	26.74
7	Cation Exchange Capacity, Meq/100 gm	1.23	1.10	1.15	1.10	1.20
8	Sodium Absorption Ration (SAR)-	8.52	8.85	8.74	7.10	7.95
9	Porosity, %	41.5	45.10	44.10	47.60	43.80
10	Sodium, mg/100 gm	20	24	20	17	23
11	Potassium, mg/100 gm	11.80	11.95	11.10	8.90	10.95
12	Phosphate, mg/100 gm	25	22	18	13	23
13	Iron as Fe, mg/kg	1.36	2.54	2.12	2.86	0.45
14	Manganese, mg/kg	7	6	8	5	6
15	Lead, mg/kg	0.05	0.05	0.09	0.06	0.04
16	Copper, mg/kg	2.0	1.0	3.0	2.0	3.0
17	Chromium, mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01
18	Cadmium, mg/kg	<0.01	<0.01	<0.01	<0.01	<0.01

4.5 SOCIO-ECONOMIC ENVIRONMENT

The project site for the new Greenfield airport in the state of Goa is predominantly a tabletop plateau area surrounded by steep slopes with the proposed approach road to the new airport beginning from NH-17 at Dhargal village and passing through land in the villages of Ozorim, Varconda and Casarvornem. For this project an area of 2271 acres is required which inter alia requires properties acquired from six villages viz., Varconda, Casarvornem, Amberem, Uguem, Mopa and Chandel. The land in the project site is largely uncultivated with sparse vegetation and trees. The Government of Goa has negotiated for the purchase of land to be utilized for development of the airport and commercial facilities. Property acquisition is underway for the access road to the site for which the Rehabilitation & Relocation policy of the Goa State would be followed.

Figure 4.7: Project Site



Baseline Information of the Project Site

The Government of Goa has undertaken the development of the new Greenfield Airport at Goa, near the village Mopa which is located in North Goa close to the Maharashtra border. Mopa comes in Pernem tehsil of North Goa district and is approximately 35 kilometres north of Panaji, the Goa State Capital.

The North Goa District has an area of 1736 sq kms and shares its boundaries with Ratnagiri and Kolhapur districts of Maharashtra and South Goa district. As per the 2011 Census, the North Goa district had a population of 8,18,008 with 1,91,766 households. The languages spoken in the district are Konkani, Marathi, Hindi, English & Portuguese.

Demographic characteristics of the North Goa district based on the Census Data for the year 2011 are given below:

Table 4.10: Population break-up of North Goa District

	Population	No. of Households	Male Population	Female Population
North Goa				
Total	818008	191766	416677	401331
Rural	324927	74704	163908	161019
Urban	493081	117062	252769	240312
Maharashtra				
Kavthani	1078	240	528	550
Satose	1187	282	594	593
Netarde	990	252	479	511
Sasoli	1774	428	860	914
Phondye	31	9	15	16
Kalane	951	231	454	497
Ugade	284	77	144	140
Adali	671	153	303	368
Dongarpal	315	91	149	166
Dingne	844	196	423	421
Galel	359	88	185	174
Morgaon	1122	255	538	584
Padve majgaon	451	113	218	233
Padve	112	23	52	60
Degave	1501	351	723	778
Banda	6611	1645	3342	3269
Sherle	2330	538	1159	1171
Madure	1789	440	892	897
Ronapal	617	153	311	306
Sateli T.Satarda	784	178	384	400

Source: 2011 Population Census of India

The detailed demographic profile including literates of the North Goa District as per 2011 Census is given below:

Table 4.11a: Demographic profile North Goa district

Population	Total	Males	Females
Total	818,008	416,677	401,331
In the age group 0-6 years	77,705	40,081	37,624
Scheduled Castes (SC)	17,606	8,712	8,894
Scheduled Tribes (ST)	56,606	27,824	28,782
Literates	663,060	351,738	311,322
Illiterate	154,948	64,939	90,009
Total Workers	327,658	239,125	88,533

Source: 2011 Population Census of India

Table 4.11b: Demographic profile of Maharashtra region

Name of villages	In the age group of 0 to 6 years			Scheduled Castes (SC)			Scheduled Tribes (ST)			Literates			Illiterate			Total Workers		
Kavthani	110	49	61	49	22	27	0	0	0	816	437	379	262	91	171	294	262	32
Satose	107	53	54	41	21	20	0	0	0	953	519	434	234	75	159	607		
Netarde	85	42	43	46	26	20	0	0	0	726	386	340	264	93	171	573	280	293
Sasoli	148	73	75	139	70	69	0	0	0	1414	750	664	360	110	250	928	523	405
Phondye	0	0	0	11	6	5	0	0	0	29	14	15	2	1	1	13	7	3
Kalane	62	29	33	56	19	37	5	2	3	742	394	348	209	60	149	379	243	136
Ugade	20	11	9	62	32	30	0	0	0	220	126	94	64	18	46	70	54	16
Adali	63	31	32	17	7	10	1	1	0	495	249	246	176	54	122	199	181	18
Dongarpal	17	10	7	0	0	0	0	0	0	267	134	133	48	15	33	102	85	17
Dingne	61	31	30	111	49	62	0	0	0	557	319	238	287	104	183	241	212	29
Galel	25	13	12	10	5	5	0	0	0	295	161	134	64	24	40	111	98	13
Morgaon	102	54	48	188	92	96	0	0	0	885	459	426	237	79	158	350	283	67
Padve majgaon	45	18	27	28	9	19	0	0	0	340	191	150	111	28	83	170	112	58
Padve	5	2	3	0	0	0	0	0	0	82	45	37	30	7	23	27	27	0
Degave	101	55	46	33	16	17	5	2	3	1225	623	602	276	100	176	492	377	115
Banda	583	307	276	339	181	158	51	23	28	5483	2843	2640	1128	499	629	2264	1798	466
Sherle	202	100	102	189	90	99	1	1	0	1871	993	878	459	166	293	1130	679	451
Madure	126	65	61	108	50	58	8	5	3	1419	753	666	373	139	231	656	462	194
Ronapal	54	27	27	0	0	0	0	0	0	467	258	209	150	53	97	311	168	143
Sateli T.Satarda	61	30	31	66	32	34	0	0	0	613	319	294	171	65	106	251	200	51

The 2011 Census data shows that the percentages of Agricultural Labourers (main and marginal workers) and Cultivators (main and marginal workers) are just 3% and 4.35 % of the total working population of 3,27,658 persons. This indicates that a very small percentage of the total working population in the North Goa district engaged in agricultural activities.

Demographic characteristics of Project Affected Villages:

As mentioned earlier, the project site comprises of land acquired from six villages viz., Varconda, Casarvornem, Amberem, Uguem, Mopa and Chandel. The demographic profile of the six villages is given below:

Table 4.12: Demographic profile of villages in project site

Villages	No. of Households	Population	Scheduled Caste
Varconda	507	2208	71
Amberem	75	341	0
Uguem	234	1133	61
Mopa	243	1082	68
Chandel	272	1152	35
Cansarvornem	310	1382	33
TOTAL	1641	7298	268
%		100	3.67

Source: 2011 Population Census of India

The total population of the six villages in the study area is 7298 living in 1641 households. When compared to the overall population in the North Goa district, these six villages form just around 1 % of the total district's population. The percentage of population belonging to the Scheduled Caste is only 3.67% of the total population in the study area, while there are no persons belonging to the Scheduled Tribes in this area.

Literacy Rates in Project Affected Villages:

The total number of literates in the six villages comprising the study area is 5507 which is 75.45% of the total population of the study area. The break-up of literacy rates for male and female populations in the six villages in the study area is given below:

Table 4.13: Literacy rates of project affected villages

Villages	Literates	Illiterates
Varconda	1707	501
Amberem	234	107
Uguem	924	209
Mopa	836	246
Chandel	775	377
Cansarvornem	1031	351
TOTAL	5507	1791

Source: 2011 Population Census of India

The above table 4.13 shows that the literate population in the project affected villages is less than one per cent of the North Goa district's literate population. However, the literacy rate in the study area is 75.5%.

Table 4.14: Public Amenities in North Goa District

Public amenities	No. of units
Post Offices	162
Govt Hospital	5
Rural Medical Dispensaries	19
Private Hospitals	75
Community Health Centres	3
Primary Health Centres	11

The health facilities in North Goa District include five Government Hospitals, 19 rural medical dispensaries, 75 private hospitals, 11 Primary Health Centres and 3 Community Health centres, as per the Goa Statistical Handbook of 2008-09.

4.6 BIOLOGICAL ENVIRONMENT

Ecological studies are one of the important aspects of Environmental Impact Assessment with a view to conserve environmental quality and biodiversity. Ecological systems show complex inter-relationships between biotic and biotic components including dependence, competition and mutualism. Biotic components comprise of both plant and animal communities, which interact not only within and between themselves but also with the biotic components viz. physical and chemical components of the environment.

Generally, biological communities are good indicators of climatic and edaphic factors. Studies on biological aspects of ecosystems are important in Environmental Impact Assessment for safety of natural flora and fauna. The biological environment includes terrestrial and aquatic ecosystems.

The animal and plant communities co-exist in a well-organized manner. Their natural settings can get disturbed by any externally induced anthropological activities or by naturally occurring calamities or disaster. So, once this setting is disturbed, it sometimes is either practically impossible or may take a longer time to come back to its original state. Hence changes in the status of flora and fauna are an elementary requirement of Environmental Impact Assessment studies, in view of the need for conservation of environmental quality and biodiversity. Information on flora and fauna was collected within the study area.

Objectives of Ecological Studies

The objective of the present study was undertaken with a view to understand the present ecosystem on the following lines:

- To assess the distribution of vegetation in and around the proposed airport site;
- To assess the distribution of animal life in the proposed plant areas as well as surrounding areas;
- To assess the biodiversity and to understand the resource potential; and
- To understand the nature of pollution and the impact of pollution on the ecosystem.

Methodology Adopted for the Survey

To achieve above objectives a detailed study of the area was undertaken in 10-km radius area with the proposed project site as its centre. The different methods adopted were as follows:

- * Compilation of secondary data with respect to the study area from published literature and Government agencies;

- * Generation of first hand data by undertaking systematic ecological studies in the area;
- * Interrogating local people so as to elicit information for local plants, animals and their uses

The present report gives the review of published secondary data and the results of field sampling conducted during winter season 2013.

Methodology – Flora & Fauna

Floral diversity

The study was aimed at enumeration of the available plant resources and obtaining a broad representation of the existing floristic variations in and around the proposed project site. The site was surveyed through random sampling and the floristic diversity was enumerated. All floral elements encountered in the field were photographed. All the species encountered were identified with the help of local authentic published flora.

Faunal diversity

Random walk and opportunistic observations were used for documenting the birds. With the aid of a pair of binoculars the bird sampling were carried out during morning (06:00 to 10:00 hrs) and evening (17:00 to 19:00 hrs) hours. Point count methods were used for enumerating the avifauna in mudflat areas. Birds were monitored by road transects up to 200 metres distance to obtain information on population. Data on fishes were collected from secondary sources and interview with fisher folk of the area. During the present study period, both direct and indirect methods (tracks & signs and visual encounter survey) were used to document the mammals occurring in the area. Visual Encounter Survey (VES) method was followed for the survey of the herpetofauna (amphibians and reptiles) in the study area during the present study. VES is a method one in which field personnel walk through an area or habitat for a prescribed time period systematically searching for animals.

Floral diversity

The area falling under the 10 km radial distance is surrounded by both aquatic and terrestrial ecosystems. Diverse systems such as dense and open forest, cultivated lands, sand dune vegetation, wetlands and human habitation were present in the study area that supported diverse floral species.

A total of 385 species of plants (including wild, ornamental and cultivated plants) belonging 88 plant families were documented and identified in the 10 km radial distance from the proposed project sites of the study area. The identified plant species with scientific name, family, habit, habitat and type are given in Table 4.15

Table 4.15: Distribution of plants in the study area and its surrounding

Sl. No.	Plant Name	Family	Habit	Habitat	Type
1	Abelmoschus manihot (L.) Medic.	Malvaceae	Herb	Terrestrial	Wild
2	<i>Abrus precatorius</i> L.	Fabaceae	Straggler	Terrestrial	Wild
3	<i>Abutilon indicum</i> (L.) Sweet	Malvaceae	Shrub	Terrestrial	Wild
4	<i>Acacia auriculiformis</i> A. Cunn ex Benth.	Fabaceae	Tree	Terrestrial	Exotic
5	<i>Acacia catechu</i> (L. f.) Willd.	Mimosaceae	Tree	Terrestrial	Wild
6	<i>Acacia chundra</i> (Rottl.) Willd.	Mimosaceae	Tree	Terrestrial	Wild
7	<i>Acacia leucophloea</i> (Roxb.) Willd.	Fabaceae	Tree	Terrestrial	Wild
8	<i>Acacia pennata</i> (L.) Willd.	Mimosaceae	Tree	Terrestrial	Wild

9	<i>Acalypha indica</i> L.	Euphorbiaceae	Herb	Terrestrial	Wild
10	<i>Acanthospermum hispidum</i> DC.	Asteraceae	Herb	Terrestrial	Wild
11	<i>Achras zapota</i> Linn.	Sapotaceae	Tree	Terrestrial	Cultivated
12	<i>Achyranthes aspera</i> L.	Amaranthaceae	Herb	Terrestrial	Wild
13	<i>Aegle marmelos</i> (L.) Correa	Rutaceae	Tree	Terrestrial	Wild
14	<i>Aeluropus lagopoides</i> (Linn.) Trin. ex Thw.	Poaceae	Grass	Semi- aquatic	Wild
15	<i>Aeschynomene indica</i> L.	Fabaceae	Herb	Terrestrial	Wild
16	<i>Ailanthus excelsa</i> Roxb.	Simaroubaceae	Tree	Terrestrial	Wild
17	<i>Alangium salviifolium</i> (L.f.) Wang.	Alangiaceae	Tree	Terrestrial	Wild
18	<i>Albizia lebbek</i> (L.) Willd.	Fabaceae	Tree	Terrestrial	Wild
19	<i>Alstonia scholaris</i> (L.) R.Br.	Apocynaceae	Tree	Terrestrial	Cultivated
20	<i>Alternanthera paronychioides</i> A. St.-Hilaire	Amaranthaceae	Herb	Terrestrial	Wild
21	<i>Alternanthera pungens</i> Kunth	Amaranthaceae	Herb	Terrestrial	Wild
22	<i>Alternanthera sessilis</i> (L.) R.Br. ex DC.	Amaranthaceae	Herb	Aquatic	Wild
23	<i>Alternanthera tenella</i> Colla.	Amaranthaceae	Herb	Semi- aquatic	Wild
24	<i>Alysicarpus monilifer</i> (L.) DC.	Fabaceae	Herb	Terrestrial	Wild
25	<i>Alysicarpus vaginalis</i> (L.) DC.	Fabaceae	Herb	Terrestrial	Wild
26	<i>Amaranthus spinosus</i> L.	Amaranthaceae	Herb	Terrestrial	Wild
27	<i>Amaranthus viridis</i> L.	Amaranthaceae	Herb	Terrestrial	Wild
28	<i>Ammannia baccifera</i> Linn.	Lythraceae	Herb	Semi- aquatic	Wild
29	<i>Anacardium occidentale</i> L.	Anacardiaceae	Tree	Terrestrial	Planted
30	<i>Andropogon pumilus</i> Roxb.	Poaceae	Grass	Terrestrial	Wild
31	<i>Anisomeles indica</i> (L.) Kuntze	Lamiaceae	Herb	Terrestrial	Wild
32	<i>Annona squamosa</i> L.	Annonaceae	Tree	Terrestrial	Cultivated
33	<i>Anthocephalus cadamba</i> (Roxb.) Miq.	Rubiaceae	Tree	Terrestrial	Cultivated
34	<i>Argemone mexicana</i> L.	Papaveraceae	Herb	Terrestrial	Exotic
35	<i>Aristida adscensionis</i> L.	Poaceae	Grass	Terrestrial	Wild
36	<i>Aristida funiculata</i> Trin & Rupr.	Poaceae	Grass	Terrestrial	Wild
37	<i>Aristida hystrix</i> L.	Poaceae	Grass	Terrestrial	Wild
38	<i>Aristida setacea</i> Retz.	Poaceae	Grass	Terrestrial	Wild
39	<i>Aristolochia indica</i> L.	Aristolochiaceae	Climber	Terrestrial	Wild
40	<i>Artabotrys hexapetalus</i> (L.f.)	Annonaceae	Tree	Terrestrial	Cultivated
41	<i>Asparagus racemosus</i> Willd.	Asparagaceae	Straggler	Terrestrial	Wild
42	<i>Avicennia marina</i> (Forsk.) Vierh.	Acanthaceae	Tree	Semi- aquatic	Wild
43	<i>Azadirachta indica</i> A. Juss.	Meliaceae	Tree	Terrestrial	Wild
44	<i>Bambusa arundinacea</i> (Retz.) Willd.	Poaceae	Grass	Terrestrial	Wild
45	<i>Bambusa vulgaris</i> Schrad. ex Wendl.	Poaceae	Grass	Terrestrial	Ornamental

46	<i>Barleria buxifolia</i> L.	Acanthaceae	Herb	Terrestrial	Wild
47	<i>Barleria prionitis</i> L.	Acanthaceae	Herb	Terrestrial	Wild
48	<i>Bassia latifolia</i> Roxb.	Sapotaceae	Tree	Terrestrial	Wild
49	<i>Bauhinia purpurea</i> L.	Fabaceae	Tree	Terrestrial	Cultivated
50	<i>Bauhinia racemosa</i> Lam.	Fabaceae	Tree	Terrestrial	Wild
51	<i>Bidens pilosa</i> L.	Asteraceae	Herb	Terrestrial	Wild
52	<i>Biophytum candolleianum</i> Wt.	Oxalidaceae	Herb	Terrestrial	Wild
53	<i>Blainvillea acmella</i> (L.) Philipson	Asteraceae	Herb	Terrestrial	Wild
54	<i>Blepharis maderaspatensis</i> (L.) Heyne ex Roth	Acanthaceae	Herb	Terrestrial	Wild
55	<i>Blepharis repens</i> (Vahl) Roth	Acanthaceae	Herb	Terrestrial	Wild
56	<i>Blumea lacera</i> (Burm.f) DC.	Asteraceae	Herb	Terrestrial	Wild
57	<i>Blumea mollis</i> (D.Don) Merr.	Asteraceae	Herb	Terrestrial	Wild
58	<i>Boerhavia diffusa</i> L.	Nyctaginaceae	Herb	Terrestrial	Wild
59	<i>Boerhavia erecta</i> L.	Nyctaginaceae	Herb	Terrestrial	Wild
60	<i>Bombax ceiba</i> L.	Bombacaceae	Tree	Terrestrial	Wild
61	<i>Borassus flabellifer</i> L.	Arecaceae	Tree	Terrestrial	Wild
62	<i>Bothriochloa pertusa</i> (L.) A. Camus	Poaceae	Grass	Terrestrial	Wild
63	<i>Bougainvillea spectabilis</i> Comm. ex. Juss.	Nyctaginaceae	Straggler	Terrestrial	Ornamental
64	<i>Breynia retusa</i> (Dennst.) Alston	Euphorbiaceae	Shrub	Terrestrial	Wild
65	<i>Buchanania lanzan</i> Spreng.	Anacardiaceae	Tree	Terrestrial	Wild
66	<i>Bulbostylis barbata</i> (Rottb.) C.B. Clarke	Cyperaceae	Herb	Terrestrial	Wild
67	<i>Butea monosperma</i> (Lam.) Taub.	Fabaceae	Tree	Terrestrial	Wild
68	<i>Caesalpinia crista</i> L.	Caesalpiniaceae	Climber	Terrestrial	Wild
69	<i>Cajanus cajan</i> (L.) Huth	Fabaceae	Shrub	Terrestrial	Cultivated
70	<i>Callophyllum inophyllum</i> L.	Clusiaceae	Tree	Terrestrial	Wild
71	<i>Calotropis procera</i> (Ait.) R.Br.	Apocynaceae	Shrub	Terrestrial	Wild
72	<i>Calycopteris floribunda</i> Lam.	Combretaceae	Climber	Terrestrial	Wild
73	<i>Canavalia cathartica</i> Thouars	Fabaceae	Straggler	Terrestrial	Wild
74	<i>Capparis sepiaria</i> L.	Capparidaceae	Straggler	Terrestrial	Wild
75	<i>Capparis zeylanica</i> L.	Capparidaceae	Straggler	Terrestrial	Wild
76	<i>Capsicum annum</i> L.	Solanaceae	Shrub	Terrestrial	Cultivated
77	<i>Carallia brachiata</i> (Lour) Merr.	Rhizophoraceae	Tree	Aquatic	Wild
78	<i>Cardiospermum halicacabum</i> L.	Sapindaceae	Climber	Terrestrial	Wild
79	<i>Careya arborea</i> Roxb.	Barringtoniaceae	Tree	Terrestrial	Wild
80	<i>Careya arborea</i> Roxb.	Barringtoniaceae	Tree	Terrestrial	Wild
81	<i>Carica papaya</i> L.	Caricaceae	Tree	Terrestrial	Cultivated
82	<i>Caryota urens</i> L.	Arecaceae	Tree	Terrestrial	Wild
83	<i>Casearia elliptica</i> Willd..(C. tomentosa Willd..)	Flacourtiaceae	Tree	Terrestrial	Wild
84	<i>Cassia fistula</i> L.	Fabaceae	Tree	Terrestrial	Wild
85	<i>Cassia occidentalis</i> L.	Caesalpiniaceae	Herb	Terrestrial	Wild

86	<i>Cassia siamea</i> Lam.	Fabaceae	Tree	Terrestrial	Wild
87	<i>Cassia tora</i> L.	Caesalpiniaceae	Herb	Terrestrial	Wild
88	<i>Casuarina equisetifolia</i> L.	Casurinaceae	Tree	Terrestrial	Planted
89	<i>Cayratia elongata</i> (Roxb.) Susseng.	Vitaceae	Climber	Terrestrial	Wild
90	<i>Ceiba pentandra</i> (L.) Gaertn.	Bombacaceae	Tree	Terrestrial	Wild
91	<i>Celastrus paniculata</i> Willd.	Celastraceae	Shrub	Terrestrial	Wild
92	<i>Celosia argentea</i> L.	Amaranthaceae	Herb	Terrestrial	Wild
93	<i>Cenchrus ciliaris</i> L.	Poaceae	Grass	Terrestrial	Wild
94	<i>Cereus pterogonus</i> Lem.	Cactaceae	Herb	Terrestrial	Wild
95	<i>Chloris barbata</i> Sw.	Poaceae	Grass	Terrestrial	Wild
96	<i>Chloris dolichostachya</i> Lagasca	Poaceae	Grass	Terrestrial	Wild
97	<i>Chloris tenella</i> Koen. ex Roxb.	Poaceae	Grass	Terrestrial	Wild
98	<i>Chromolaena odorata</i> (L.) King & Robinson	Asteraceae	Shrub	Terrestrial	Exotic
99	<i>Cissampelos pareira</i> L.	Menispermaceae	Climber	Terrestrial	Wild
100	<i>Cleome monophylla</i> L.	Capparaceae	Herb	Terrestrial	Wild
101	<i>Cleome viscosa</i> L.	Capparidaceae	Herb	Terrestrial	Wild
102	<i>Clitoria ternatea</i> L.	Fabaceae	Climber	Terrestrial	Wild
103	<i>Coccinia grandis</i> (L.) Voigt	Cucurbitaceae	Climber	Terrestrial	Wild
104	<i>Cocculus hirsutus</i> (L.) Diels	Menispermaceae	Climber	Terrestrial	Wild
105	<i>Cocculus pendulus</i> (Forst.) Diels	Menispermaceae	Straggler	Terrestrial	Wild
106	<i>Cocos nucifera</i> L.	Arecaceae	Tree	Terrestrial	Cultivated
107	<i>Colubrina asiatica</i> (L.) Brongn.	Rhamnaceae	Shrub	Terrestrial	Wild
108	<i>Combretum albidum</i> G. Don	Combretaceae	Climber	Terrestrial	Wild
109	<i>Commelina benghalensis</i> L.	Commelinaceae	Herb	Terrestrial	Wild
110	<i>Commelina clavata</i> Clarke	Commelinaceae	Herb	Terrestrial	Wild
111	<i>Commelina longifolia</i> Lam.	Commelinaceae	Herb	Terrestrial	Wild
112	<i>Convolvulus arvensis</i> L.	Convolvulaceae	Climber	Terrestrial	Wild
113	<i>Corchorus aestuans</i> L.	Tiliaceae	Herb	Terrestrial	Wild
114	<i>Corchorus trilocularis</i> L.	Tiliaceae	Herb	Terrestrial	Wild
115	<i>Cordia dichotoma</i> G. Forst.	Boraginaceae	Tree	Terrestrial	Wild
116	<i>Cordia myxa</i> L.	Boraginaceae	Tree	Terrestrial	Wild
117	<i>Cordia sebestena</i> L.	Boraginaceae	Tree	Terrestrial	Ornamental
118	<i>Crotalaria juncea</i> L.	Papilionaceae	Shrub	Terrestrial	Wild
119	<i>Crotalaria mucronata</i> Desv.	Fabaceae	Herb	Terrestrial	Wild
120	<i>Crotalaria pallida</i> Dryand. var. <i>pallida</i> (G. Don) Polhill	Fabaceae	Herb	Terrestrial	Wild
121	<i>Croton bonplandianum</i> Baill.	Euphorbiaceae	Herb	Terrestrial	Wild
122	<i>Cryptolepis buchananii</i> Roem. & Schult.	Asclepiadaceae	Straggler	Terrestrial	Wild
123	<i>Cucumis melo</i> L.	Cucurbitaceae	Climber	Terrestrial	Wild
124	<i>Cuminum cyminum</i> L.	Apiaceae	Shrub	Terrestrial	Cultivated
125	<i>Curculigo orchioides</i> Gaertn.	Hypoxidaceae	Herb	Terrestrial	Wild
126	<i>Cuscuta reflexa</i> Roxb.	Convolvulaceae	Climber	Terrestrial	Wild

127	<i>Cyclea peltata</i> (Lamk.) Hook.f. & Thoms.	Annonaceae	Climber	Terrestrial	Wild
128	<i>Cynodon dactylon</i> (L.) Pers.	Poaceae	Grass	Terrestrial	Wild
129	<i>Cynoglossum zeylanicum</i> (Vahl ex Hornem.) Thunb. ex Lehm.	Boraginaceae	Herb	Terrestrial	Wild
130	<i>Cyperus articulatus</i> L.	Cyperaceae	Herb	Aquatic	Wild
131	<i>Cyperus difformis</i> L.	Cyperaceae	Herb	Semi-aquatic	Wild
132	<i>Cyperus exaltatus</i> Retz.	Cyperaceae	Herb	Aquatic	Wild
133	<i>Cyperus iria</i> L.	Cyperaceae	Herb	Semi-aquatic	Wild
134	<i>Cyperus rotundus</i> L.	Cyperaceae	Herb	Terrestrial	Wild
135	<i>Dactyloctenium aegyptium</i> (L.) Willd.	Poaceae	Grass	Terrestrial	Wild
136	<i>Dalbergia sissoo</i> Roxb.	Fabaceae	Tree	Terrestrial	Planted
137	<i>Datura metal</i> L.	Solanaceae	Shrub	Terrestrial	Wild
138	<i>Delonix elata</i> (L.) Gamble	Fabaceae	Tree	Terrestrial	Wild
139	<i>Delonix regia</i> (Boj. ex Hook) Rafin.	Fabaceae	Tree	Terrestrial	Wild
140	<i>Derris scandens</i> (Roxb.) Benth.	Fabaceae	Climber	Semi-aquatic	Wild
141	<i>Derris scandens</i> (Roxb.) Benth.	Fabaceae	Shrub	Terrestrial	Wild
142	<i>Derris trifoliata</i> Lour.	Fabaceae	Climber	Semi-aquatic	Wild
143	<i>Desmodium laxiflorum</i> DC.	Fabaceae	Shrub	Terrestrial	Wild
144	<i>Desmodium triangulare</i> (Retz.) Merr.	Fabaceae	Shrub	Terrestrial	Wild
145	<i>Dichrostachys cinerea</i> (L.) Wight & Arn.	Fabaceae	Shrub	Terrestrial	Wild
146	<i>Dicoma tomentosa</i> Cass.	Asteraceae	Herb	Terrestrial	Wild
147	<i>Digera muricata</i> (L.) Mart.	Amaranthaceae	Herb	Terrestrial	Wild
148	<i>Dillenia indica</i> L.	Dilleniaceae	Tree	Terrestrial	Wild
149	<i>Dillenia pentagyna</i> Roxb.	Dilleniaceae	Tree	Terrestrial	Wild
150	<i>Diospyros montana</i> Roxb.	Ebenaceae	Tree	Terrestrial	Wild
151	<i>Diplocyclos palmatus</i> (L.) Jeffrey	Cucurbitaceae	Climber	Terrestrial	Wild
152	<i>Dolichandrone spathacea</i> (L.f.) K.Schum.	Bignoniaceae	Tree	Terrestrial	Planted
153	<i>Dolichos lablab</i> L.	Fabaceae	Climber	Terrestrial	Cultivated
154	<i>Drosera indica</i> L.	Droseraceae	Herb	Aquatic	Wild
155	<i>Echinochloa colona</i> (L.) Link	Poaceae	Grass	Semi-aquatic	Wild
156	<i>Echinops echinatus</i> Roxb.	Asteraceae	Herb	Terrestrial	Wild
157	<i>Eclipta prostrata</i> (L.) L.	Asteraceae	Herb	Semi-aquatic	Wild
158	<i>Elaeocarpus serratus</i> L.	Tiliaceae	Tree	Terrestrial	Wild
159	<i>Emblia ribes</i> Burm.f.	Mysinaceae	Shrub	Terrestrial	Wild
160	<i>Emilia sonchifolia</i> (L.) DC.	Asteraceae	Herb	Terrestrial	Wild

161	<i>Eragrostis nutans</i> (Retz.) Nees ex Steud.	Poaceae	Grass	Terrestrial	Wild
162	<i>Eragrostis pilosa</i> P. Beauv	Poaceae	Grass	Terrestrial	Wild
163	<i>Eragrostis unioides</i> (Retz.) Nees ex Steud.	Poaceae	Grass	Terrestrial	Wild
164	<i>Eragrostis viscosa</i> (Retz.) Trin.	Poaceae	Grass	Terrestrial	Wild
165	<i>Erythrina stricta</i> Roxb.	Fabaceae	Tree	Terrestrial	Planted
166	<i>Eucalyptus teriticornis</i>	Myrtaceae	Tree	Terrestrial	Planted
167	<i>Euphorbia geniculata</i> Ortega	Euphorbiaceae	Herb	Terrestrial	Wild
168	<i>Euphorbia hirta</i> L.	Euphorbiaceae	Herb	Terrestrial	Wild
169	<i>Euphorbia nivulia</i> L.	Euphorbiaceae	Shrub	Terrestrial	Wild
170	<i>Euphorbia rosea</i> Retz.	Euphorbiaceae	Herb	Terrestrial	Wild
171	<i>Euphorbia thymifolia</i> L.	Euphorbiaceae	Herb	Terrestrial	Wild
172	<i>Euphorbia tirucalli</i> L.	Euphorbiaceae	Tree	Terrestrial	Wild
173	<i>Evolvulus alsinoides</i> (L.) L.	Convolvulaceae	Herb	Terrestrial	Wild
174	<i>Evolvulus nummularius</i> (L.) L.	Convolvulaceae	Herb	Terrestrial	Wild
175	<i>Ficus arnottiana</i> Miq.	Moraceae	Tree	Terrestrial	Wild
176	<i>Ficus benghalensis</i> L.	Moraceae	Tree	Terrestrial	Wild
177	<i>Ficus microcarpa</i> var. <i>microcarpa</i> L.f.	Moraceae	Tree	Terrestrial	Wild
178	<i>Ficus racemosa</i> L.	Moraceae	Tree	Terrestrial	Wild
179	<i>Ficus religiosa</i> L.	Moraceae	Tree	Terrestrial	Wild
180	<i>Filicium decipiens</i> (Wight & Arn.) Thw.	Sapindaceae	Tree	Terrestrial	Wild
181	<i>Fimbristylis aestivalis</i> (Retz.) Vahl.	Cyperaceae	Herb	Terrestrial	Wild
182	<i>Fimbristylis argentea</i> (Rottb.) Vahl.	Cyperaceae	Herb	Aquatic	Wild
183	<i>Fimbristylis dichotoma</i> (L.) Vahl.	Cyperaceae	Herb	Semi-aquatic	Wild
184	<i>Fimbristylis ovata</i> (Burm. F.) Kern.	Cyperaceae	Herb	Terrestrial	Wild
185	<i>Firmiana colorata</i> (Roxb.) R.Br. (<i>Sterculia colorata</i> Roxb.)	Sterculiaceae	Tree	Terrestrial	Wild
186	<i>Flacourtia indica</i> (Burm.f.) Merr.	Flacourtiaceae	Tree	Terrestrial	Wild
187	<i>Foeniculum vulgare</i> Mill.	Apiaceae	Herb	Terrestrial	Wild
188	<i>Garuga pinnata</i> Roxb.	Burseraceae	Tree	Terrestrial	Wild
189	<i>Glinus lotoides</i> Linnaeus	Aizoaceae	Herb	Aquatic	Wild
190	<i>Gliricidia sepium</i> (Jacq.) Kunth ex Walp.	Fabaceae	Tree	Terrestrial	Exotic
191	<i>Gloriosa superba</i> L.	Colchicaceae	Herb	Terrestrial	Wild
192	<i>Gmelina arborea</i> Roxb.	Verbenaceae	Tree	Terrestrial	Wild
193	<i>Gomphrena serrata</i> L.	Amaranthaceae	Herb	Terrestrial	Wild
194	<i>Goniogyna hirta</i> (Willd.) Ali	Fabaceae	Herb	Terrestrial	Wild
195	<i>Grewia tiliaefolia</i> Vahl.	Tiliaceae	Tree	Terrestrial	Wild
196	<i>Gymnema sylvestre</i> (Retz.) R.Br. ex Schult.	Asclepiadaceae	Climber	Terrestrial	Wild
197	<i>Haldinia cordifolia</i> (Roxb.)	Rubiaceae	Tree	Terrestrial	Wild

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198	<i>Hedyotis biflora</i> (L.) Lam.	Rubiaceae	Herb	Terrestrial	Wild
199	<i>Hedyotis corymbosa</i> (L.) Lam.	Rubiaceae	Herb	Terrestrial	Wild
200	<i>Helicteres isora</i> L.	Sterculiaceae	Shrub	Terrestrial	Wild
201	<i>Heliotropium curasavicum</i> L.	Boraginaceae	Herb	Terrestrial	Wild
202	<i>Hemidesmus indicus</i> (L.) R. Br.	Asclepiadaceae	Climber	Terrestrial	Wild
203	<i>Heteropogon contortus</i> (L.) P.Beauv	Poaceae	Grass	Terrestrial	Wild
204	<i>Hibiscus rosa-sinensis</i> L.	Malvaceae	Shrub	Terrestrial	Cultivated
205	<i>Hibiscus tiliaceus</i> L.	Malvaceae	Tree	Terrestrial	Planted
206	<i>Hibiscus vitifolius</i> L.	Malvaceae	Shrub	Terrestrial	Wild
207	<i>Holarrhena pubescens</i> (Buch.- Ham.) Wall. ex G.Don	Apocynaceae	Shrub	Terrestrial	Wild
208	<i>Holigarna arnottiana</i> Hook.f.	Anacardiaceae	Tree	Terrestrial	Wild
209	<i>Holoptelea integrifolia</i> (Roxb.) Planch.	Ulmaceae	Tree	Terrestrial	Planted
210	<i>Hydnocarpus laurifolia</i> (Dennst.) Sleumer	Flacourtiaceae	Tree	Terrestrial	Wild
211	<i>Hyptis suaveolens</i> (L.) Poit.	Lamiaceae	Herb	Terrestrial	Wild
212	<i>Ichnocarpus frutescens</i> (L.) R.Br.	Asclepiadaceae	Climber	Terrestrial	Wild
213	<i>Impatiens inconspicua</i> Benth. Ex Wt. & Arn.	Balsaminaceae	Herb	Terrestrial	Wild
214	<i>Imperata cylindrica</i> (L.) Beauv.	Poaceae	Grass	Terrestrial	Wild
215	<i>Indigofera linifolia</i> (L.f.) Retz.	Fabaceae	Herb	Terrestrial	Wild
216	<i>Indigofera linnaei</i> Ali	Fabaceae	Herb	Terrestrial	Wild
217	<i>Indoneesiella echioides</i> (L) Nees.	Acanthaceae	Herb	Terrestrial	Wild
218	<i>Ipomoea alba</i> L.	Convolvulaceae	Climber	Terrestrial	Wild
219	<i>Ipomoea aquatica</i> Forssk.	Convolvulaceae	Climber	Aquatic	Wild
220	<i>Ipomoea carnea</i> Jacq.	Convolvulaceae	Shrub	Aquatic	Wild
221	<i>Ipomoea hederifolia</i> L.	Convolvulaceae	Climber	Terrestrial	Wild
222	<i>Ipomoea pes-tigridis</i> L.	Convolvulaceae	Climber	Terrestrial	Wild
223	<i>Ipomoea pres-caprae</i> (L.) R.Br.	Convolvulaceae	Climber	Terrestrial	Wild
224	<i>Ipomoea quamoclit</i> L.	Convolvulaceae	Climber	Terrestrial	Ornamental
225	<i>Ipomoea staphylina</i> Roem. & Schultes	Convolvulaceae	Climber	Terrestrial	Wild
226	<i>Ischaemum indicum</i> (Houtt.) Merr.	Poaceae	Grass	Terrestrial	Wild
227	<i>Ixora arborea</i> Roxb. ex Sm.	Rubiaceae	Tree	Terrestrial	Wild
228	<i>Ixora coccinea</i>	Rubiaceae	Shrub	Terrestrial	Wild
229	<i>Jasminum scandens</i> Vahl	Oleaceae	Climber	Terrestrial	Wild
230	<i>Jatropha curcas</i> L.	Euphorbiaceae	Shrub	Terrestrial	Planted
231	<i>Jatropha gossypifolia</i> L.	Euphorbiaceae	Shrub	Terrestrial	Wild
232	<i>Justicia adhatoda</i> L.	Acanthaceae	Shrub	Terrestrial	Ornamental
233	<i>Justicia betonica</i> Linn.	Acanthaceae	Shrub	Terrestrial	Wild
234	<i>Kydia calycina</i> Roxb.	Malvaceae	Tree	Terrestrial	Wild

235	<i>Lagascea mollis</i> Cav.	Asteraceae	Herb	Terrestrial	Wild
236	<i>Lagerstroemia microcarpa</i> Hance	Lythraceae	Tree	Terrestrial	Wild
237	<i>Lannea coromandelica</i> (Houtt.) Merr.	Anacardiaceae	Tree	Terrestrial	Wild
238	<i>Lantana camara</i> L.	Verbenaceae	Shrub	Terrestrial	Exotic
239	<i>Launaea sarmentosa</i> (Willd.) Schultz-Bip.ex Kuntze	Asteraceae	Climber	Terrestrial	Wild
240	<i>Lawsonia inermis</i> L.	Lythraceae	Shrub	Terrestrial	Planted
241	<i>Leea indica</i> (Burm.f) Merr.	Vitaceae	Shrub	Terrestrial	Wild
242	<i>Leea indica</i> (Burm.f) Merr.	Vitaceae	Shrub	Terrestrial	Wild
243	<i>Leptadenia reticulata</i> Wight & Arn.	Asclepiadaceae	Climber	Terrestrial	Wild
244	<i>Leucaena leucocephala</i> (L.) Gills	Fabaceae	Tree	Terrestrial	Exotic
245	<i>Leucas aspera</i> (Willd.) Link	Lamiaceae	Herb	Terrestrial	Wild
246	<i>Limonia acidissima</i> L.	Rutaceae	Tree	Terrestrial	Cultivated
247	<i>Ludwigia adscendens</i> (L.) Hara	Onagraceae	Herb	Aquatic	Wild
248	<i>Ludwigia perennis</i> L.	Onagraceae	Herb	Semi- aquatic	Wild
249	<i>Ludwigia peruviana</i> (L.) Hara	Onagraceae	Herb	Semi- aquatic	Wild
250	<i>Luffa acutangula</i> (L.) Roxb.	Cucurbitaceae	Climber	Terrestrial	Cultivated
251	<i>Macaranga peltata</i> (Roxb.) Muell.-Arg.	Euphorbiaceae	Tree	Terrestrial	Wild
252	<i>Malachra capitata</i> (L.) L.syst	Malvaceae	Herb	Terrestrial	Wild
253	<i>Malvastrum coromandelianum</i> (L.) Garcke	Malvaceae	Herb	Terrestrial	Wild
254	<i>Mangifera indica</i> L.	Anacardiaceae	Tree	Terrestrial	Planted
255	<i>Maytenus emarginata</i> (Willd.) Ding Hou	Celastraceae	Shrub	Terrestrial	Wild
256	<i>Melastoma malabathricum</i> L.	Melastomataceae	Shrub	Terrestrial	Wild
257	<i>Melochia corchorifolia</i> L.	Sterculiaceae	Herb	Terrestrial	Wild
258	<i>Memecylon umbellatum</i> Burm.f.	Melastomaceae	Tree	Terrestrial	Wild
259	<i>Merremia tridentata</i> (L.) Hall.f.	Convolvulaceae	Herb	Terrestrial	Wild
260	<i>Microcos paniculatus</i> L.	Tiliaceae	Tree	Terrestrial	Wild
261	<i>Millingtonia hortensis</i> L.f.	Bignoniaceae	Tree	Terrestrial	Ornamental
262	<i>Mimosa hamata</i> Willd.	Fabaceae	Shrub	Terrestrial	Wild
263	<i>Mimusops elengi</i> L.	Sapotaceae	Tree	Terrestrial	Ornamental
264	<i>Mitragyna parvifolia</i> (Roxb.) Korth.	Rubiaceae	Tree	Terrestrial	Wild
265	<i>Mollugo pentaphylla</i> L.	Molluginaceae	Herb	Aquatic	Wild
266	<i>Momordica charantia</i> L.	Cucurbitaceae	Climber	Terrestrial	Wild
267	<i>Moringa oleifera</i> Lam.	Moringaceae	Tree	Terrestrial	Cultivated
268	<i>Moullava spicata</i> (Dalzell) Nicolson	Fabaceae	Climber	Terrestrial	Wild
269	<i>Mucuna prurita</i> Hook.	Fabaceae	Climber	Terrestrial	Wild

270	<i>Mukia maderaspatana</i> (L.) M. Roem.	Cucurbitaceae	Climber	Terrestrial	Wild
271	<i>Murraya koenigii</i> (L.) Spreng.	Rutaceae	Tree	Terrestrial	Planted
272	<i>Musa paradisiaca</i> L.	Musaceae	Shrub	Terrestrial	Cultivated
273	<i>Nepuntia oleracea</i> Lour.	Mimosaceae	Herb	Aquatic	Wild
274	<i>Nyctanthes arbor-tristis</i> L.	Oleaceae	Tree	Terrestrial	Ornamental
275	<i>Nymphaea nouchali</i> Burm.f.	Nymphaeaceae	Herb	Aquatic	Wild
276	<i>Nymphaea pubescens</i> Willd.	Nymphaeaceae	Herb	Aquatic	Wild
277	<i>Ocimum canum</i> Sims.	Lamiaceae	Herb	Terrestrial	Wild
278	<i>Oldenlandia umbellata</i> L.	Rubiaceae	Herb	Terrestrial	Wild
279	<i>Opuntia stricta</i> (Haw.) Haw.	Cactaceae	Shrub	Terrestrial	Wild
280	<i>Parthenium hysterophorus</i> L.	Asteraceae	Herb	Terrestrial	Exotic
281	<i>Pavonia odorata</i> Willd.	Malvaceae	Herb	Terrestrial	Wild
282	<i>Pavonia procumbens</i> (Wall ex Wight & Arn.) Walp.	Malvaceae	Herb	Terrestrial	Wild
283	<i>Pavonia zeylanica</i> (L.) Cav.	Malvaceae	Herb	Terrestrial	Wild
284	<i>Pedaliium murex</i> L.	Pedaliaceae	Herb	Terrestrial	Wild
285	<i>Peltophorum pterocarpum</i> (DC.)	Fabaceae	Tree	Terrestrial	Planted
286	<i>Pentatropis microphylla</i> L.	Asclepiadaceae	Climber	Terrestrial	Wild
287	<i>Pergularia daemia</i> (Forssk.) Chiov.	Asclepiadaceae	Climber	Terrestrial	Wild
288	<i>Peristrophe bicalyculata</i> (Forssk.) Brummitt.	Acanthaceae	Herb	Terrestrial	Wild
289	<i>Persea macrantha</i> (Nees) Kosterm	Lauraceae	Tree	Terrestrial	Wild
290	<i>Phoenix sylvestris</i> (L.) Roxb.	Arecaceae	Tree	Terrestrial	Planted
291	<i>Phyllanthus emblica</i> L.	Euphorbiaceae	Tree	Terrestrial	Planted
292	<i>Phyllanthus maderaspatensis</i> L.	Euphorbiaceae	Herb	Terrestrial	Wild
293	<i>Phyllanthus reticulatus</i> Poir.	Euphorbiaceae	Shrub	Terrestrial	Wild
294	<i>Phyllanthus urinaria</i> L.	Euphorbiaceae	Herb	Terrestrial	Wild
295	<i>Physalis minima</i> Linn.	Solanaceae	Herb	Terrestrial	Wild
296	<i>Pithecellobium dulce</i> (Roxb.) Benth.	Fabaceae	Tree	Terrestrial	Planted
297	<i>Plumeria alba</i> L.	Apocynaceae	Tree	Terrestrial	Ornamental
298	<i>Plumeria rubra</i> L.	Apocynaceae	Tree	Terrestrial	Ornamental
299	<i>Polyalthia longifolia</i> (Sonner.) Thw.	Annonaceae	Tree	Terrestrial	Ornamental
300	<i>Polycarpaea corymbosa</i> (L.) Lam.	Caryophyllaceae	Herb	Terrestrial	Wild
301	<i>Polygala elongata</i> Klein ex Willd.	Polygalaceae	Herb	Terrestrial	Wild
302	<i>Pongamia pinnata</i> (L.) Pierre	Fabaceae	Tree	Terrestrial	Wild
303	<i>Portulaca oleracea</i> L.	Portulacaceae	Herb	Terrestrial	Wild
304	<i>Portulaca quadrifida</i> L.	Portulacaceae	Herb	Terrestrial	Wild
305	<i>Psidium guajava</i> L.	Myrtaceae	Tree	Terrestrial	Planted
306	<i>Pterolobium hexapetalum</i> (Roth.) Sant. & Wagh	Fabaceae	Straggler	Terrestrial	Wild

307	<i>Punica granatum</i> L.	Punicaceae	Tree	Terrestrial	Cultivated
308	<i>Pupalia lappacea</i> (L.) Juss.	Amaranthaceae	Herb	Terrestrial	Wild
309	<i>Quisqualis indica</i> L.	Combretaceae	Climber	Terrestrial	Cultivated
310	<i>Rauvolfia serpentina</i> (L.) Benth. ex kurz	Apocynaceae	Herb	Terrestrial	Wild
311	<i>Rhizophora mucronata</i> Poir.	Rhizophoraceae	Tree	Aquatic	Wild
312	<i>Rotala densiflora</i> (Roth ex Roem. & Schultes) Koehne	Lythraceae	Herb	Terrestrial	Wild
313	<i>Ruellia tuberosa</i> L.	Acanthaceae	Herb	Terrestrial	Wild
314	<i>Saccharum spontaneum</i> L.	Poaceae	Grass	Semi-aquatic	Wild
315	<i>Salicornia brachiata</i> Miq.	Chenopodiaceae	Shrub	Semi-aquatic	Wild
316	<i>Sapindus emarginatus</i> Vahl.	Sapindaceae	Tree	Terrestrial	Wild
317	<i>Sapium insigne</i> (Royle) Benth.	Euphorbiaceae	Tree	Terrestrial	Wild
318	<i>Schleichera oleosa</i> (Lour.) Oken	Sapindaceae	Tree	Terrestrial	Wild
319	<i>Scoparia dulcis</i> L.	Scrophulariaceae	Herb	Semi-aquatic	Wild
320	<i>Sebastiania chamaelea</i> (L.) Muell.-Arg.	Euphorbiaceae	Herb	Terrestrial	Wild
321	<i>Senna alata</i> (L.) Roxb.	Fabaceae	Shrub	Terrestrial	Ornamental
322	<i>Senna auriculata</i> (L.) Roxb.	Fabaceae	Shrub	Terrestrial	Wild
323	<i>Senna occidentalis</i> (L.) Link	Fabaceae	Herb	Terrestrial	Wild
324	<i>Senna tora</i> (L.) Roxb.	Fabaceae	Herb	Terrestrial	Wild
325	<i>Sesamum indicum</i> L.	Pedaliaceae	Shrub	Terrestrial	Cultivated
326	<i>Sesbania sesban</i> (Jacq.) W.Wight	Fabaceae	Tree	Terrestrial	Planted
327	<i>Sesuvium portulacastrum</i> (L.) L.	Aizoaceae	Herb	Aquatic	Wild
328	<i>Setaria italica</i> (L.) P. Beauv	Poaceae	Grass	Terrestrial	Wild
329	<i>Sida acuta</i> Burm.f.	Malvaceae	Herb	Terrestrial	Wild
330	<i>Sida cordata</i> (Burm. f.) Borss.	Malvaceae	Herb	Terrestrial	Wild
331	<i>Sida cordifolia</i> L.	Malvaceae	Herb	Terrestrial	Wild
332	<i>Sida rhombifolia</i> L. var. rhombifolia	Malvaceae	Herb	Terrestrial	Wild
333	<i>Smilax zeylanica</i> L.	Smilacaceae	Climber	Terrestrial	Wild
334	<i>Solanum surattense</i> Burm. f.	Solanaceae	Herb	Terrestrial	Wild
335	<i>Sonchus oleraceus</i> L.	Asteraceae	Herb	Terrestrial	Wild
336	<i>Sonneratia caseolaris</i> (L.) Engl.	Sonneratiaceae	Tree	Aquatic	Wild
337	<i>Spermacoce hispida</i> L.	Rubiaceae	Herb	Terrestrial	Wild
338	<i>Spermacoce ocymoides</i> Burm.f.	Rubiaceae	Herb	Terrestrial	Wild
339	<i>Spinifex littoreus</i> (Burm.f.) Merr.	Poaceae	Climber	Terrestrial	Wild
340	<i>Stephania japonica</i> (Thunb) Miers	Menispermaceae	Climber	Terrestrial	Wild
341	<i>Sterculia villosa</i> Roxb.ex DC.	Sterculiaceae	Tree	Terrestrial	Cultivated
342	<i>Streblus asper</i> Lour.	Moraceae	Tree	Terrestrial	Wild
343	<i>Striga asiatica</i> (L.) Kuntze	Scrophulariaceae	Herb	Terrestrial	Wild
344	<i>Strychnos nux-vomica</i> L.	Strychnaceae	Tree	Terrestrial	Wild
345	<i>Suaeda nudiflora</i> (Willd) Moq.	Chenopodiaceae	Herb	Semi-aquatic	Wild

346	<i>Synedrella nodiflora</i> (L.) Gaertn.	Asteraceae	Herb	Terrestrial	Wild
347	<i>Syzygium caryophyllatum</i> L.	Myrtaceae	Tree	Terrestrial	Wild
348	<i>Syzygium caryophyllatum</i> (L.) Alston	Myrtaceae	Tree	Terrestrial	Wild
349	<i>Syzygium cumini</i> (L.) Skeels	Myrtaceae	Tree	Terrestrial	Planted
350	<i>Tamarindus indica</i> L.	Fabaceae	Tree	Terrestrial	Planted
351	<i>Tectona grandis</i> L.f.	Verbenaceae	Tree	Terrestrial	Wild
352	<i>Tephrosia purpurea</i> (L.) Pers.	Fabaceae	Herb	Terrestrial	Wild
353	<i>Tephrosia villosa</i> (L.) Pers.	Fabaceae	Herb	Terrestrial	Wild
354	<i>Terminalia alata</i> Heyne ex Roth	Combretaceae	Tree	Terrestrial	Wild
355	<i>Terminalia arjuna</i> (Roxb.ex DC.) Wight & Arn.	Combretaceae	Tree	Terrestrial	Wild
356	<i>Terminalia catappa</i> L.	Myrtaceae	Tree	Terrestrial	Cultivated
357	<i>Terminalia paniculata</i> Roxb.	Combretaceae	Tree	Terrestrial	Wild
358	<i>Thespesia lampas</i> (Cav.) Dalz. & Gibs	Malvaceae	Shrub	Terrestrial	Wild
359	<i>Thespesia populnea</i> (L.) Sol.ex Corr.	Malvaceae	Tree	Terrestrial	Wild
360	<i>Thespesia populnea</i> (L.) Soland ex Correa	Malvaceae	Tree	Terrestrial	Wild
361	<i>Thevetia peruviana</i> K.Schum	Apocynaceae	Tree	Terrestrial	Wild
362	<i>Thunbergia grandiflora</i> Roxb.	Acanthaceae	Straggler	Terrestrial	Ornamental
363	<i>Tinospora cordifolia</i> (Willd.) Miers ex Hook. f. & Thoms.	Menispermaceae	Climber	Terrestrial	Wild
364	<i>Trewia nudiflora</i> L.	Euphorbiaceae	Tree	Terrestrial	Wild
365	<i>Trianthema portulacastrum</i> L.	Aizoaceae	Herb	Aquatic	Wild
366	<i>Tribulus terrestris</i> L.	Zygophyllaceae	Herb	Terrestrial	Wild
367	<i>Trichodesma indicum</i> (L.) R. Br.	Boraginaceae	Herb	Terrestrial	Wild
368	<i>Tridax procumbens</i> L.	Asteraceae	Herb	Terrestrial	Wild
369	<i>Trigonella foenum-graecum</i> L.	Fabaceae	Herb	Terrestrial	Cultivated
370	<i>Triumfetta rhomboidea</i> Jacq.	Tiliaceae	Herb	Terrestrial	Wild
371	<i>Typha angustifolia</i> L.	Poaceae	Grass	Aquatic	Wild
372	<i>Urena lobata</i> L. subsp. <i>lobata</i>	Malvaceae	Herb	Terrestrial	Wild
373	<i>Vernonia cinerea</i> (L.) Less.	Asteraceae	Herb	Terrestrial	Wild
374	<i>Vigna mungo</i> (L.) Wilczek	Fabaceae	Herb	Terrestrial	Cultivated
375	<i>Vigna radiata</i> (L.) Verdc.	Fabaceae	Herb	Terrestrial	Cultivated
376	<i>Vigna trilobata</i> (L.) Verdc.	Fabaceae	Herb	Terrestrial	Wild
377	<i>Vitex altissima</i> Linn.f.	Verbenaceae	Tree	Terrestrial	Wild
378	<i>Waltheria indica</i> L.	Sterculiaceae	Herb	Terrestrial	Wild
379	<i>Xanthium indicum</i> Koen.	Asteraceae	Herb	Terrestrial	Wild
380	<i>Xylia xylocarpa</i> (Roxb.) Taub.	Fabaceae	Tree	Terrestrial	Wild
381	<i>Zanthoxylum rhetsa</i> (Roxb.) DC	Rutaceae	Tree	Terrestrial	Wild
382	<i>Ziziphus mauritiana</i> Lam.	Rhamnaceae	Tree	Terrestrial	Wild
383	<i>Ziziphus oenoplia</i> (L.) Mill.	Rhamnaceae	Straggler	Terrestrial	Wild
384	<i>Ziziphus xylopyrus</i> (Retz.) Will.	Rhamnaceae	Tree	Terrestrial	Wild
385	<i>Zornia gibbosa</i> Span.	Fabaceae	Herb	Terrestrial	Wild



Hemidesmus indicus



Mucuna prurita



Caryota urens



Helicteres isora



Ficus racemosa



Strychnos nux-vomica

Habitat wise representation

Based on habit types, among the 385 plant species, herbaceous plants were dominant in the study area and was represented with 142 species, followed by trees (121 species), shrubs (42 species) grasses (26 species) and climbers/stragglers with 43 species. Habitat wise representation of plants from the study area is given in table 4.16.

Table 4.16 Habit wise representations of plants from the study area

Habit	No of species
Herb	142
Tree	121
Climber	43
Shrub	42
Grass	26
Straggler	11
Grand Total	385

Endangered plants

Floristic studies were conducted during November 2013 to January 2014 to know the presence of any endangered/threatened/endemic plant species in and around proposed plant area and surrounding 10 km radius. The study area did not record the presence of any critically threatened species.

Medicinal plants

During our survey, many medicinal plants were identified. The plant parts and their uses are provided below.

Sl. No.	Plant Name	Habit	Plant part	Uses
1	<i>Abrus precatorius</i> L.	Climber	Leaves, root	Sore throat, dry cough
2	<i>Adhatoda vasica</i> (L.) Nees	Shrub	Leaves, root	Cold, asthma
3	<i>Aegle marmelos</i> (L.) Correa	Tree	Leaves, fruit	Jaundice, dysentery
4	<i>Alangium salviifolium</i> (L.f.) Wang.	Tree	Root, bark	A purgative, antidote
5	<i>Albizia lebbeck</i> (L.) Willd.	Tree	Leaves, bark	Piles, Diarrhoea
6	<i>Alstonia scholaris</i> (L.) R.Br.	Tree	Leaves, bark	Ulcer, Fever
7	<i>Anacardium occidentale</i> L.	Tree	Bark, apple	Ringworm, scurvy
8	<i>Annona squamosa</i> L.	Tree	Leaves, bark	Boils, ulcers
9	<i>Argemone mexicana</i> L.	Herb	Root, seed	Gonorrhoea, Blisters
10	<i>Asparagus racemosus</i> Willd.	Climber	Root	Dysentery, tumor
11	<i>Azadirachta indica</i> A. Juss.	Tree	Leaves, flower	Malaria, Small-pox
12	<i>Butea monosperma</i> (Lam.) Taub.	Tree	Leaves, bark	Heartborn, Diabetes
13	<i>Callophyllum inophyllum</i> L.	Tree	Bark, root	Sore eyes, ulcer
14	<i>Cassia fistula</i> L.	Tree	Leaves, pods	Rheumatism, skin disease
15	<i>Bombax ceiba</i> L.	Tree	Leaves, root	Gonorrhoea, fever
16	<i>Cynodon dactylon</i> (L.) Pers.	Herb	Entire plant	Haematuria, vomiting
17	<i>Datura metal</i> L.	Shrub	Leaves, stem	Asthma, bronchitis
18	<i>Erythrina stricta</i> Roxb.	Tree	Leaves, bark	Round & tape worms
19	<i>Ficus benghalensis</i> L.	Tree	Leaf buds, latex	Dysentery, piles
20	<i>Ficus religiosa</i> L.	Tree	Bark, figs	Toothache, sores

21	Gmelina arborea Roxb.	Tree	Leaves, root	Epilepsy, cough
22	Holarrhena pubescens (Buch.-Ham.) Wall. ex G.Don	Shrub	Bark, seed	Piles, colic
23	Lannea coromandelica (Houtt.) Merr.	Tree	Tender branches	Sore eyes, dyspepsia
24	Mangifera indica L.	Tree	Bark, seed	Leucorrhoea
25	Mimusops elengi L.	Tree	Leaves, root	Fevers, teeth trouble
26	Mimosa hamata Willd.	Shrub	Leaves, root	Piles, fistula
27	Murraya koenigii (L.) Spreng.	Tree	Leaves, bark	Diarrohea, vomiting
28	Piper nigrum L.	Climber	Berries	Flatulence, cough
29	Rauvolfia serpentina (L.) Benth. ex kurz	Herb	Root	Blood pressure, insanity
30	Strychnos nux-vomica L.	Tree	Wood, seed	Cholera, insomnia
31	Syzygium cumini (L.) Skeels	Tree	Leaves, fruit	Diabetes, spongy gums
32	Tamarindus indica L.	Tree	Leaves, seed	Jaundice, sprains
33	Tectona grandis L.f.	Tree	Bark, wood	Dyspepsia, headache
34	Terminalia paniculata Roxb.	Tree	Bark	Ulcer, bronchitis
35	Tinospora cordifolia (Willd.) Miers ex Hook. f. & Thoms.	Climber	Entire plant	Rheumatism, jaundice
36	Ziziphus mauritiana Lam.	Tree	Leaves, bark	Boils, Dysuria

National Park/Sanctuary

As per Ministry of Environment & Forests Notifications and local forest notifications, there are no wildlife/bird sanctuaries/national parks/ biospheres in 10-km radius from plant site.

Avifauna

A total of 86 species of birds were observed during the present survey in the 10 km radial distance from the proposed project sites. The habitat types of the area include agricultural land, scrub jungle, plantation, seasonal ponds, marshlands and fallow grasslands. The common terrestrial species of the area include Indian Robin (*Saxicoloides fulicata*), Green Bee-eater (*Merops orientalis*), Blue Rock Pigeon (*Columba livia*) and Red vented Bulbul (*Pycnonotus cafer*). The list of avifauna is presented in the following Table 4.17. Indian Peafowl is the only schedule-I species found in the surrounding areas of the airport site. They mostly found in the agricultural lands and scrub forest areas. The family wise species distribution is given in table 4.18.

Table 4.17 List of birds documented during the study period

SI.No	Common Name	Scientific Name	Family	Migratory Status
1	Alexandrine Parakeet	<i>Psittacula eupatria</i>	Psittacidae	O
2	Ashy Drongo	<i>Dicrurus leucophaeus</i>	Dicruridae	R
3	Asian Koel	<i>Eudynamys scolopacea</i>	Cuculidae	R
4	Asian Openbill-Stork	<i>Anastomus oscitans</i>	Ciconiidae	R
5	Asian Palm Swift	<i>Cypsiurus balasiensis</i>	Apodidae	R

6	Asian Paradise-Flycatcher	<i>Terpsiphone paradisi</i>	Muscicapidae	R
7	Asian Pied Starling	<i>Gracupica contra</i>	Sturnidae	R
8	Bank Myna	<i>Acridotheres ginginianus</i>	Sturnidae	R
9	Baya Weaver	<i>Ploceus philippinus</i>	Ploceinae	R
10	Black Drongo	<i>Dicrurus macrocercus</i>	Dicruridae	R
11	Black Kite	<i>Milvus migrans</i>	Accipitridae	R
12	Black-naped Oriole	<i>Oriolus chinensis</i>	Oriolidae	R
13	Black-shouldered Kite	<i>Elanus caeruleus</i>	Accipitridae	R
14	Black-winged Stilt	<i>Himantopus himantopus</i>	Recurvirostridae	M
15	Blue Rock Pigeon	<i>Columba livia</i>	Columbidae	R
16	Blue-tailed Bee-eater	<i>Merops philippinus</i>	Meropidae	R
17	Brahminy Kite	<i>Haliastur indus</i>	Accipitridae	R
18	Cattle Egret	<i>Bubulcus ibis</i>	Ardeidae	R
19	Common Flameback Woodpecker	<i>Dinopium javanense</i>	Picidae	R
20	Common Hoopoe	<i>Upupa epops</i>	Upupidae	R
21	Common Iora	<i>Aegithina tiphia</i>	Aegithinidae	R
22	Common Myna	<i>Acridotheres tristis</i>	Sturnidae	R
23	Common Red Shank	<i>Tringa totanus</i>	Scolopacidae	M
24	Common Sandpiper	<i>Charadrius dubius</i>	Scolopacidae	M
25	Common Swallow	<i>Hirundo rustica</i>	Hirundinidae	M
26	Common Tailorbird	<i>Orthotomus sutorius</i>	Cisticolidae	R
27	Coppersmith Barbet	<i>Megalaima haemacephala</i>	Megalaimidae	R
28	Crested Serpent Eagle	<i>Spilornis cheela</i>	Accipitridae	R
29	Eurasian Collared Dove	<i>Streptopelia decaocto</i>	Columbidae	O
30	Eurasian Coot	<i>Fulica atra</i>	Rallidae	O
31	Glossy Ibis	<i>Plegadis falcinellus</i>	Threskiornithidae	R
32	Golden Fronted Leafbird	<i>Chloropsis aurifrons</i>	Chloropseidae	R
33	Great Cormorant	<i>Phalacrocorax carbo</i>	Phalacrocoracidae	O
34	Greater Coucal	<i>Centropus sinensis</i>	Cuculidae	R
35	Greater Short-toed Lark	<i>Calandrella brachydactyla</i>	Alaudidae	O
36	Green Bee-eater	<i>Merops orientalis</i>	Meropidae	R
37	Grey Heron	<i>Ardea cinerea</i>	Ardeidae	M
38	House Crow	<i>Corvus splendens</i>	Corvidae	R
39	House Sparrow	<i>Passer domesticus</i>	Passeridae	R
40	House Swift	<i>Apus nipalensis</i>	Apodidae	R
41	Indian Cuckoo	<i>Cuculus micropterus</i>	Cuculidae	R
42	Indian Peafowl	<i>Pavo cristatus</i>	Phasianidae	R
43	Indian Pond-Heron	<i>Ardeola grayii</i>	Ardeidae	R
44	Indian Robin	<i>Saxicoloides fulicata</i>	Muscicapidae	R
45	Indian Roller	<i>Coracias benghalensis</i>	Coraciidae	R
46	Intermediate Egret	<i>Mesophoyx intermedia</i>	Ardeidae	R
47	Jungle Babbler	<i>Turdoides striata</i>	Leiothrichidae	R

48	Jungle Crow	<i>Corvus macrorhynchos</i>	Corvidae	R
49	Jungle Myna	<i>Acridotheres fuscus</i>	Sturnidae	R
50	Large Pied Wagtail	<i>Motacilla maderaspatensis</i>	Motacillidae	R
51	Lesser Coucal	<i>Centropus bengalensis</i>	Cuculidae	R
52	Lesser Golden-backed Woodpecker	<i>Dinopium benghalense</i>	Picidae	O
53	Little Cormorant	<i>Phalacrocorax niger</i>	Phalacrocoracidae	R
54	Little Egret	<i>Egretta Garzetta</i>	Ardeidae	R
55	Little Ringed Plover	<i>Charadrius dubius</i>	Charadriidae	R
56	Oriental Magpie-Robin	<i>Copsychus saularis</i>	Muscicapidae	R
57	Oriental White Ibis	<i>Threskiornis melanocephalus</i>	Threskiornithidae	R
58	Paddyfield Pipit	<i>Anthus rufulus</i>	Motacillidae	R
59	Pied Bush Chat	<i>Saxicola caprata</i>	Muscicapidae	R
60	Pied Crested Cuckoo	<i>Clamator jacobinus</i>	Cuculidae	M
61	Pied Kingfisher	<i>Ceryle rudis</i>	Cerylidae	R
62	Plain Prinia	<i>Prinia inornata</i>	Cisticolidae	R
63	Purple Heron	<i>Ardea purpurea</i>	Ardeidae	R
64	Purple Sunbird	<i>Nectarinia asiatica</i>	Nectariniidae	R
65	Purple-rumped Sunbird	<i>Nectarinia zeylonica</i>	Nectariniidae	R
66	Red Whiskered Bulbul	<i>Pycnonotus jacosus</i>	Pycnonotidae	R
67	Red-rumped Swallow	<i>Hirundo daurica</i>	Hirundinidae	R
68	Red-vented Bulbul	<i>Pycnonotus cafer</i>	Pycnonotidae	R
69	Red-wattled Lapwing	<i>Vanellus indicus</i>	Charadriidae	R
70	Rose-ringed Parakeet	<i>Psittacula krameri</i>	Psittacidae	R
71	Rufous Treepie	<i>Dendrocitta vagabunda</i>	Corvidae	R
72	Rufous Woodpecker	<i>Micropternus brachyurus</i>	Picidae	O
73	Small Blue Kingfisher	<i>Alcedo atthis</i>	Alcedinidae	R
74	Spotted Dove	<i>Streptopelia chinensis</i>	Columbidae	R
75	Spotted Owlet	<i>Athene brama</i>	Strigidae	O
76	Stork-billed Kingfisher	<i>Pelargopsis capensis</i>	Halcyonidae	O
77	Watercock	<i>Gallicrex cinerea</i>	Rallidae	R
78	Whiskered Tern	<i>Chlidonias hybrida</i>	Sternidae	R
79	White Wagtail	<i>Motacilla alba</i>	Motacillidae	R
80	White-breasted Kingfisher	<i>Halcyon smyrnensis</i>	Alcedinidae	R
81	White-breasted Water hen	<i>Amaurornis phoenicurus</i>	Rallidae	R
82	White-cheeked Barbet	<i>Megalaima viridis</i>	Megalaimidae	O
83	White-headed Babbler	<i>Turdoides leucocephala</i>	Timaliidae	R
84	White-rumped Munia	<i>Lonchura striata</i>	Estrildidae	O
85	Wood Sandpiper	<i>Tringa glareola</i>	Scolopacidae	R
86	Yellow Wagtail	<i>Motacilla flava</i>	Motacillidae	R

Note: R-Resident; M-migratory, O-Occasional

Table 4.18 Family wise distribution in and around the study area

Family	No of Species
Ardeidae	6
Cuculidae	5
Accipitridae	4
Motacillidae	4
Muscicapidae	4
Sturnidae	4
Columbidae	3
Corvidae	3
Picidae	3
Rallidae	3
Scolopacidae	3
Alcedinidae	2
Apodidae	2
Charadriidae	2
Cisticolidae	2
Dicruridae	2
Hirundinidae	2
Megalaimidae	2
Meropidae	2
Nectariniidae	2
Phalacrocoracidae	2
Psittacidae	2
Pycnonotidae	2
Threskiornithidae	2
Aegithinidae	1
Alaudidae	1
Cerylidae	1
Chloropseidae	1
Ciconiidae	1
Coraciidae	1
Estrildidae	1
Halcyonidae	1
Leiothrichidae	1
Oriolidae	1
Passeridae	1
Phasianidae	1
Ploceinae	1
Recurvirostridae	1
Sternidae	1
Strigidae	1
Timaliidae	1
Upupidae	1
Grand Total	86

Butterflies

A total of 33 butterfly species belonging to 5 families were recorded during the present study (Table 4.19). At family level, the family Nymphalidae is the dominant one with 16 species followed by Pieridae with 6 species, Lycaenidae with 5 species and Papilionidae with 5 species. The family wise distribution of butterflies is given in Table 4.20. Species such as Common Jezebel, Plain Tiger, Common Indian Crow, and Common Grass Yellow were commonly seen in and around the proposed project site. Crimson Rose, Danaid Eggfly and Common Pierrot are protected under schedule-I of Indian Wildlife Protection Act 1972. Crimson Rose are endemic species found occurring in the present study area, the distributions of which are restricted to the Peninsular India and Srilanka (Kunte, 2000).

Table 4.19 List of butterflies in and around the study area

S.No	Common Name	Scientific Name	Family
1	Angled Pierrot	<i>Caleta caleta</i>	Lycaenidae
2	Blue Pansy	<i>Junonia orithya</i>	Nymphalidae
3	Blue Tiger	<i>Tirumala limniace</i>	Nymphalidae
4	Chocolate Pansy	<i>Junonia iphita</i>	Nymphalidae
5	Common Emigrant	<i>Catopsilia pomona</i>	Pieridae
6	Common Grass Yellow	<i>Eurema hecabe</i>	Pieridae
7	Common Gull	<i>Cepora nerissa</i>	Pieridae
8	Common Indian Crow	<i>Euploea core</i>	Nymphalidae
9	Common Jay	<i>Graphium doson</i>	Papilionidae
10	Common Jezebel	<i>Delias eucharis</i>	Pieridae
11	Common Leopard	<i>Phalanta phalanta</i>	Nymphalidae
12	Common Lime Butterfly	<i>Papilio demoleus</i>	Papilionidae
13	Common Mormon	<i>Papilio polytes</i>	Papilionidae
14	Common Pierrot	<i>Castalius rosimon</i>	Lycaenidae
15	Common Rose	<i>Pachliopta aristolochiae</i>	Papilionidae
16	Common Sailor	<i>Neptis hylas</i>	Nymphalidae
17	Common Wanderer	<i>Pareronia valeria</i>	Pieridae
18	Crimson Rose	<i>Pachliopta hector</i>	Papilionidae
19	Danaid Eggfly	<i>Hypolimnas misippus</i>	Nymphalidae
20	Glassy Tiger	<i>Parantica algea</i>	Nymphalidae
21	Great Eggfly	<i>Hypolimnas bolina</i>	Nymphalidae
22	Grey Pansy	<i>Junonia atlites</i>	Nymphalidae
23	Lemon Pansy	<i>Junonia lemonias</i>	Nymphalidae
24	Lesser Grass Blue	<i>Zizina otis</i>	Lycaenidae
25	Mottled Emigrant	<i>Catopsilia pyranthe</i>	Pieridae
26	Peacock Pansy	<i>Junonia almana</i>	Nymphalidae
27	Plain Tiger	<i>Danaus chrysippus</i>	Nymphalidae
28	Plains Cupid	<i>Chilades pandava</i>	Lycaenidae
29	Plum Judy	<i>Abisara echerius</i>	Riodinidae
30	Striped Tiger	<i>Danaus genutia</i>	Nymphalidae
31	Tawny Coster	<i>Acraea terpsicore</i>	Nymphalidae
32	Yamfly	<i>Loxura atymnus</i>	Lycaenidae
33	Yellow Pansy	<i>Junonia hierta</i>	Nymphalidae

Table 4.20: Family wise distribution of butterflies in the study area

Family	No of species
Nymphalidae	16
Pieridae	6
Lycaenidae	5
Papilionidae	5
Riodinidae	1
Grand Total	33

Amphibians

Based on field observations and the available secondary information, a total of 5 species of amphibians were recorded from the study area as given in the following Table 4.21.

Table 4.21: List of amphibians recorded in the study area

SI No	Common Name	Scientific Name	Family
1	Asian Common Toad	<i>Bufo melanostictus</i>	Bufoidae
2	Common Tree Frog	<i>Polypedates maculatus</i>	Rhacophoridae
3	Indian Skipper Frog	<i>Euphlyctis cyanophlyctis</i>	Ranidae
4	Indus Valley Toad	<i>Duttaphrynus stomaticus</i>	Bufoidae
5	Paddyfield Frog	<i>Fejervarya limnocharis</i>	Dicroglossidae

Reptiles

Based on field observations and the available secondary information, a total of 12 species of reptiles were recorded from the study area as given in the following Table 4.22.

Table 4.22: List of reptiles recorded in the study area

SI No	Common Name	Scientific Name	Family
1	Asian House Gecko	<i>Hemidactylus frenatus</i>	Gekkonidae
2	Banded Racer	<i>Argyrogena fasciolata</i>	Colubridae
3	Brahminy worm snake	<i>Ramphotyphlops braminus</i>	Typhlopidae
4	Checkered Keelback	<i>Xenochrophis piscator</i>	Colubridae
5	Common House Gecko	<i>Hemidactylus flaviviridis</i>	Gekkonidae
6	Common Krait	<i>Bungarus Coeruleus</i>	Elapidae
7	Common Kukri Snake	<i>Oligodon arnensis</i>	Colubridae
8	Common Skink	<i>Mabuya macularia</i>	Scincidae
9	Common Trinket Snake	<i>Coelognathus helena Helena</i>	Colubridae
10	File Snake	<i>Acrochordus granulatus</i>	Acrochordidae
11	freshwater crocodile	<i>Crocodylus johnsoni</i>	Crocodylidae
12	Green Vine Snake	<i>Ahaetulla nasuta</i>	Colubridae
13	Indian Chameleon	<i>Chamaleon zeylanicus</i>	Chamaeleonidae
14	Indian Cobra	<i>Naja naja</i>	Elapidae
15	Indian fan-throated lizard	<i>Sitana ponticeriana</i>	Agamidae

16	Indian Rat Snake	<i>Ptyas mucosa</i>	Colubridae
17	Little Skink	<i>Lygosoma punctata</i>	Scincidae
18	Oriental Garden Lizard	<i>Calotes versicolor</i>	Agamidae

Mammals

There are no major wild animals in the study area of 10 km radius and 11 mammals were recorded in study area (Table 4.23). There is no visual sighting of any threatened species as mentioned in the Indian Wildlife Protection Act, 1972.

Table 4.23: Mammals recorded in the study area

SI No	Common Name	Scientific Name	Family	IUCN Category
1	Bengal Fox	<i>Vulpes bengalensis</i>	Canidae	LC
2	Black-napped Hare	<i>Lepus nigricollis</i>	Leporidae	LC
3	Common House Mouse	<i>Mus musculus</i>	Muridae	LC
4	Common House Rat	<i>Rattus rattus</i>	Muridae	LC
5	Common Mongoose	<i>Herpestes edwardsi</i>	Herpestidae	DD
6	Domestic Cat	<i>Felis catus</i>	Felidae	LC
7	Domestic Cattle	<i>Bos taurus</i>	Bovidae	LC
8	Domestic Dog	<i>Canis familiaris</i>	Canidae	LC
9	Jackal	<i>Canis aureus</i>	Canidae	LC
10	Three-striped Palm squirrel	<i>Funambulus palmarum</i>	Sciuridae	LC

Fish Diversity

Fishing is one of the extractive occupations of mankind older than agriculture. Fish assumes greater significance to the people of Goa as it forms one of the most important items of the food of more than 90% percent of population. In fact fish forms an integral part of Goan life. Fish and Rice together form a significant staple food. Subramanian (2000) says, "Per capita fish consumption in Goa is 7.4 kg as against the national average of 5 kg, and the recommended average of 11 kg.

Fishing also serve as a means of livelihood to a large number of people of Goa. Altogether more than 5 percent of total working population are engaged in fishing activities. Apart from tourism, mining and manufacturing fishing industry forms the second largest industry both in terms of employment and income. In addition to fishing, the number of ancillary and subsidiary activities has grown around fish harvesting, which, in turn, stimulates the growth of Goa's economy.

Several literature were studied and data collected on fish diversity of Goa during our field survey. Some of the major fish species caught in the sea as well as rivers of Goa are mentioned below.

List of fish species found in Goa

SI No	Species Name	Local Name	Family
1	<i>Lethrinus nebulosus</i>	Tamso	Lethrinidae
2	<i>Lutjanus argentimaculatus</i>	Tamso	Lutjanidae
3	<i>Lutjanus malabaricus</i>	Palu	Lutjanidae
4	<i>Lutjanus johni</i>	Palu	Lutjanidae
5	<i>Thunnus albacares</i>	Bugde	Scombridae
6	<i>Thunnus obesus</i>	Rogtado	Scombridae

7	<i>Thunnus tonggol</i>	Rogtado	Scombridae
8	<i>Rastrelliger kanagurta</i>	Bangdo	Scombridae
9	<i>Istiophorus platypterus</i>	Tarso Masso	Istiophoridae
10	<i>Makaira indica</i>	Tarso Masso	Istiophoridae
11	<i>Scomberomorus commerson</i>	Wiswan	Scombridae
12	<i>Scomberomorus guttatus</i>	Wiswan	Scombridae
14	<i>Nibea maculata</i>	Dodiario	Sciaenidae
15	<i>Protonibea diacanthus</i>	Dodiario	Sciaenidae
16	<i>Tenuulosa toli</i>	Pede	Clupeidae
17	<i>Sardinella longiceps</i>	Tarlo	Clupeidae
18	<i>Psettodes erumei</i>	Lep	Psettodidae
19	<i>Chirocentrus dorab</i>	Karli	Chirocentridae
20	<i>Anodontostoma Chacunda</i>	Gibber	Clupeidae
21	<i>Sphyraena jello</i>	Tonki	Sphyraenidae
22	<i>Sphyraena obtusata</i>	Tonki	Sphyraenidae
23	<i>Parastromateus Niger</i>	Surgunteo	Carangidae
24	<i>Pampus argenteus</i>	Paplet	Stromatidae
25	<i>Arius caelatus</i>	Sangot	Ariidae
26	<i>Pomadasys maculatus</i>	Korkoro	HAEMULIDAE
27	<i>Mugil cephalus</i>	Shevto	Mugilidae
28	<i>Pampus argenteus</i>	Paplet	Stromateidae
29	<i>Pampus chinensis</i>	Paplet	Stromateidae
30	<i>Parastromateus niger</i>	Paplet	Stromateidae
31	<i>Metapenaeus affinis</i>	Sungot	Penaeidae
32	<i>Metapenaeus monoceros</i>	Sungot	Penaeidae
33	<i>Penaeus monodon</i>	Vagee	Penaeidae
34	<i>Trichiurus lepturus</i>	Ballo	Trichiuridae
35	<i>Gerres filamentosus</i>	Shatuk	GERREIDAE

Ecologically Sensitive Zones

Ministry of Environment and Forests had constituted a High Level Working Group (HLWG) under the Chairmanship of Dr. K. Kasturirangan, Member (Science), Planning Commission vide office order dated 17.08.2012 to study the preservation of the ecology, environmental integrity and holistic development of the Western Ghats in view of their rich and unique biodiversity. HLWG submitted its report to the MoEF on 15th April 2013. HLWG identified 37% of natural landscape having high biological richness, low forest fragmentation, low population density and containing Protected Areas, World Heritage Sites and Tiger and Elephant corridors as an Ecologically Sensitive Areas (ESA).

The present proposed airport site is falling under Pernem taluka of North Goa district. The Pernem taluka has not been included in the Ecologically Sensitive Areas submitted by HLWG. The MoEF order on ESA is attached as **Annexure XVI**.

CHAPTER 5

IMPACT ANALYSIS AND MITIGATION MEASURES

5.0 IMPACT PREDICTION

In chapter four, various environmental elements, which are susceptible to impacts and the project activities that are likely to cause these impacts, have been identified. In this chapter the likely impacts have been evaluated by assessing their magnitude. Assessment is then carried out by weighting the magnitude of such impacts vis-a-vis the importance in terms of the environment.

The impact of the proposed facilities on the environment has been studied by comparing the load on environment before and after implementation of the proposed green field. The impact of the project has been studied for various phases for implementation i.e., during construction and operation.

5.1 METHODOLOGY

The methodology adopted for assessing the potential positive and negative environmental impacts from the proposed project is described below.

Step1: Identification of environmental impacts

All potential releases (emissions to air, generation of noise, effluent discharge, spills & leaks, etc.) from the construction & operation phases of the proposed project are identified. The potential positive and negative environmental impacts from these releases and other activities of the project have been identified.

Step2: Environmental impact assessment

The Significance (S) of the Environmental Impacts is identified and assessed by the following characteristics:

- Intensity (I) of the environmental impact;
- Spatial extension (Sp) of the environmental impact;
- Temporal duration (T) of the environmental impact;&
- Environmental Vulnerability (V) of the impacted area.

Determination of Impact Intensity (I)

Impact Intensity has been assessed based on the following criteria:

H (High):

- Emissions/generation of highly pollutant substances, emissions/generation of high quantity of pollutant substances and/or high noise emission
- High consumption of resources (such as energy, water, land, fuel, chemicals)
- Felling of large of trees or death of fauna

M (Medium):

- Emissions/generation of moderately pollutant substances, emissions/generation of moderate quantity of pollutant substances and/or moderately high noise emission
- Moderate consumption of resources (such as energy, water, land, fuel, chemicals)
- Felling of few trees or physical damage of fauna

L (Low):

- Emissions/generation of low pollutant substances, emissions/generation of low quantity of pollutant substances and/or low noise emission
- Low consumption of resources (such as energy, water, land, fuel, chemicals)
- Damage to few trees or disturbance/ disorientation of fauna

N (Negligible):

- Emissions/generation of very low pollutant substances, emissions/generation of very low quantity of pollutant substances and/or very low noise emission
- Very low consumption of resources (such as energy, water, land, fuel, chemicals)
- No measurable damage to flora/fauna

Determination of Impact Spatial extension (Sp) and Spatial Criteria (Is)

Impact Spatial extension has been assessed based on the following criteria:

- **H (High):** the impact extends in a wide area outside the site (about 10 km or more)
- **M (Medium):** the impact extends in a restricted area outside the site (< 10 km)
- **L (Low):** the impact extends inside the site.
- **N (Negligible):** the impact extends in a restricted area inside the site.

The product of Impact Intensity and Impact Spatial extension gives the impact evaluation as per Spatial criteria (Is).

Table 5.1: Matrix for Evaluating Spatial criteria

Impact evaluation as per SPATIAL CRITERIA (Is)		Impact Spatial extension (Sp)			
		HIGH	MEDIUM	LOW	NEGLIGIBLE
Impact Intensity (I)	HIGH	H	H	H	H
	MEDIUM	H	M	M	M
	LOW	M	L	L	L
	NEGLIGIBLE	N	N	N	N

Determination of Impact Temporal duration (T) and Temporal Criteria (It)

Impact Temporal Duration has been assessed based on the following criteria:

- **H (Very High):** the impact has an important long-term effect (> 5 years)
- **H (High):** the impact has an important long-term effect (1-5 years)
- **M (Medium):** the impact has a medium-term effect (1 week – 1 year)
- **L (Low):** the impact has a temporary and short-term effect (1 day – 1 week)
- **N (Negligible):** the impact has an immediate effect and it is solved in a very short time.

The product of Impact Temporal duration and Spatial criteria gives the impact evaluations as per Temporal Criteria (It).

Table 5.2: Matrix for Evaluating Temporal criteria

Impact evaluation as per TEMPORAL CRITERIA (It)		Impact Temporal duration (T)				
		VERY HIGH	HIGH	MEDIUM	LOW	NEGLIGIBLE
Impact Is	HIGH	H	H	H	H	H
	MEDIUM	H	M	M	M	L
	LOW	M	M	L	L	L
	NEGLIGIBLE	N	N	N	N	N

Determination of Environmental Vulnerability (V) and Significance (S)

Environmental Vulnerability has been assessed based on the following criteria:

- **H (High):** Particular interesting area from the environmental, historical, social point of view. Parks, natural reserves and / or special areas of conservation. Contaminated areas in which a further impact may generate non-compliance with local environmental limits.
- **M (Medium):** Interesting area from the environmental, historical, social point of views. Residential areas with low population density. Agricultural areas, forests, public parks.
- **L (Low):** Industrial and commercial areas.

The product of Vulnerability and Temporal criteria gives the Significance of the impact.

Table 5.3: Matrix for Evaluating Significance

Impact evaluation as per VULNERABILITY CRITERIA (SIGNIFICANCE S)		VULNERABILITY (V)		
		HIGH	MEDIUM	LOW
Impact It	HIGH	H	H	M
	MEDIUM	H	M	M
	LOW	M	M	L
	NEGLIGIBLE	L	N	N

The Impact Significance (S) levels obtained from the above-matrix are defined as follow:

- **H (High):** Causes severe and acute effects to receptors, severe and irreversible deterioration of the quality of environment, and irreversible modification of landscape or of ecological equilibrium.

- **M (Medium):** Causes moderate effects to receptors, reversible deterioration of the quality of environment, and reversible modifications of landscape or ecological equilibrium.
- **L (Low):** Causes limited effects to receptors, quickly reversible deterioration of the quality of environment, and slight and reversible modification of landscape or ecological equilibrium.
- **N (Negligible):** Causes negligible or no effects to receptors, slight and reversible deterioration of quality of the environment, no measurable changes at landscape or ecological level.

The assessment has been carried out for each of the potential environmental impacts during both construction and operation, and has been discussed in this chapter.

5.2 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

The environmental impacts associated with the proposed project on various environmental components such as air, water, noise, soil, flora, fauna, land, socioeconomic, etc. has been identified using Impact Identification Matrix (**Table 5.4**).

Table 5.4: Impact Identification Matrix

Activities	Physical				Biological		Socio-economic	
	Ambient air quality	Ground / surface water (quantity / quality)	Ambient noise	Land (land use, topography & drainage, soil)	Flora	Fauna	Livelihood & occupation	Infrastructure
CONSTRUCTION								
Civil and mechanical works	x	x	x	x	x	x	x	x
Movement of vehicles	x		x			x		x
Waste water generation, handling and disposal		x		x				x
Solid waste generation, handling and disposal				x				x
OPERATION								
movement of Aircrafts during landing and takeoff	x		x					
Storage of Fuel	x							
Cleaning & maintenance		x		x				
Operation of emergency power generation facility	x		x					
Waste water generation, handling and disposal		x		x				
Solid waste generation, handling and disposal				x				
Movement of vehicles	x		x			x		x

5.3 IMPACT EVALUATION AND MITIGATION MEASURES

5.3.1 AIR ENVIRONMENT

Construction Phase

Impact Evaluation

Potential emissions sources during construction phase include the following:

- Operation of construction equipment and machinery for earth-moving, grading and civil works at proposed Airport location.
- Storage and handling of construction material (e.g. sand, cement) at airport site
- Operation of temporary Diesel Generator (DG) sets
- Movement of vehicles carrying equipment, construction material and project-related personnel

The impacts are described below:

- Dust will be generated from earth-moving, grading and civil works, and movement of vehicles on unpaved roads.
- PM, CO, NO_x, & SO_x will be generated from operation of diesel sets and diesel engines of machineries and vehicles.

The significance of the impacts of air emissions on ambient air quality during construction phase is summarized in **Table 5.5**.

Table 5.5: Impact of air emissions (construction phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Emissions of low quantity/Low consumption of power
Spatial	Low	Impact extends inside the site
Temporal	Low	The impact has a temporary and short term effect (1 day – 1 week)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	Low	By combining intensity and spatial factors as per methodology given in Section 5.1
Impact(I _t)	Low	By combining I _s and temporal factors as per methodology given in Section 5.1
Overall Significance Value of Impact (S)	Low	By combining I _t and Vulnerability factors as per methodology given in Section 5.1

Mitigation Measures

- Ensuring preventive maintenance of vehicles and equipment.
- Ensuring vehicles with valid Pollution under Control certificates are used.
- Avoiding unnecessary engine operations.
- Implementing dust control activities such as water sprinkling on unpaved sites.
- Ensure vertical stacks with height sufficient for dispersion as per CPCB guidelines.

Operation Phase

Impact Evaluation

The potential emissions sources during operation phase include the following:

- Movement of Aircrafts during takeoff and landing
- Operation of emergency power generator sets
- Storage of fuel
- Movement of vehicles.

Impact due to Air movement

Aviation Turbine Fuel (ATF) in a turbofan or turboprop engine releases gases into the atmosphere. The most important emission types to be considered are: carbon dioxide or CO₂, water (vapor) or H₂O, nitrogen oxides or NO_x, carbon monoxide or CO, hydrocarbons or C_xH_y, sulfur dioxide or SO₂, and soot. CO₂ and H₂O are the products of complete burning of which fixed amounts are formed with the burning of each kg of fuel. NO_x is formed under high pressure and temperature in the combustion chamber the amounts of NO_x produced depend on engine working conditions and thrust setting. Substances resulting from incomplete burning, such as CO, C_xH_y and soot are mainly produced when the engines are not operating at optimal conditions, which particularly occur during landing, taxiing, take-off and climb-out. SO₂ is produced as a consequence of the small sulphur content in ATF. The most important pollution problems experienced at ground level to which aircraft engine emissions contribute are smog formation (due to emissions of NO_x and C_xH_y) (AERO Model, 1994, Dutch Civil Aviation Authority).

The emissions of HC, CO and NO_x from different types of aircrafts i.e small , medium and large are estimated using emission indices given in Emission Database of International Civil Aviation Organization (ICAO) and are given below:

Table 5.6: Emissions of air pollutants

Engine Model	Take off	Climbing off	Approaching	Idle	Highest EI g/kg of fuel used (1)	Condition	Fuel flow at that Condition (Kg/s) (2)	Time in minutes	Emission for one flight in g/s ((1) x (2))
Emission index for HC in g/Kg									
A 320									
CFM 56 - 5 A1	0.23	0.23	0.40	1.4					
Boeing 737									
CFM56-7B27	0.10	0.10	0.10	1.70					
CFM56-7B27/2	0.05	0.06	4.21	5.56	5.56	Idling	0.115	19	0.64
Boeing 777-200LR									
GE 90-115B	0.04	0.03	0.06	4.24					
Emission index for CO in g/Kg									
A 320									
CFM 56 – 5 A1	0.9	0.9	2.5	17.6					

Boeing 737									
CFM56-7B27	0.20	0.50	1.40	17.90					
CFM56-7B27/2	0.54	1.97	24.28	38.73					
Boeing 777-200LR									
GE 90-115B	0.08	0.07	1.98	39.11	39.11	Idling	0.380	26	14.86
					Emission index for NO_x in g/Kg				
A 320									
CFM 56 – 5 A1	24.6	19.6	8.0	4.0					
Boeing 737									
CFM56-7B27	30.90	23.70	11.00	4.80					
CFM56-7B27/2	20.81	15.59	7.53	4.36					
Boeing 777-200LR									
GE 90-115B	50.34	35.98	16.5	5.19	50.34	Take off	4.690	0.7	236

From the above table, it can be noted that the maximum emission of HC and CO shall be 0.64 g/s and 14.86 g/s for a period of 19 minutes and 26 minutes respectively & 236 g/s of NO_x for a period of 42 seconds only, which are insignificant. It is to be noted that the release occurs in such short time intervals and in an open corridor present on both sides of runway emissions shall get dispersed and impact remains within the boundaries.

Hence, there shall be marginal addition of pollutants in the operational phase owing to clean fuel and time gap between the operations, the proposed project has no impact on air environment at ground level. Moreover, the impact shall be limited to within the boundaries of airport.

Impact due to increase in Passenger Traffic

Traffic increase shall also have an impact on air quality. Ambient air qualities monitored in terms of SPM, RPM, SO₂, NO_x, HC and CO at six locations were found well within permissible limits, and are summarised below.

Parameter	Monitored Value (µg/m ³)	NAAQS (µg/m ³)
SPM	29- 53	200
RPM	14- 28	100
SO ₂	7.6- 18.5	80
NO _x	9- 21.8	80

Both CO and HC were found <100 µg/m³

Emission from Emergency power generation set

Emergency power generation sets at the airport facilities are expected to run for a maximum of 3 – 4 hours in a day leading to minimal impact on air environment.

All fuel tanks are of light hydrocarbons which has negligible fugitive HC emissions.

The significance of the impacts of air emissions on ambient air quality during operation phase is summarized in **Table 5.7**.

Table 5.7: Impact of air emissions (operation phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Emissions of low quantity. Existing baseline concentrations for all the pollutants are found well within prescribed National Ambient Air Quality Standards (NAAQS)
Spatial	Low	Dispersion of these emissions leading to Ground level concentration (GLC) lies inside the site.
Temporal	High	the impact has an important long-term effect (1-5 years)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	Low	By combining intensity and spatial factors as per methodology given in Section 5.1
Impact(I _t)	Medium	By combining I _s and temporal factors as per methodology given in Section 5.1
Overall Significance Value of Impact(S)	Medium	By combining I _t and Vulnerability factors as per methodology given in Section 5.1

Mitigation measures

- Developing peripheral green belt in the proposed new premises.
- Ensuring preventive maintenance of vehicles and equipment.
- Avoiding unnecessary engine operations (e.g. equipment with intermitted use switched off when not working)
- Ensuring vehicles with valid Pollution under Control certificates are used.

5.3.2 WATER ENVIRONMENT

Construction Phase

Impact Evaluation

The impact on water environment during the construction phase of the proposed changes shall be in terms of water demand and waste water generation due to construction activities. Approximately, 2 MLD of water will be required for construction and domestic purposes.

The significance of the impact of raw water consumption on local water resources during construction phase is summarized in **Table 5.8**.

Table 5.8: Impact of water consumption (construction phase)

Factors of assessment	Value of assessment	Justification
Intensity	Medium	Moderate consumption of raw water
Spatial	Medium	the impact extends in a restricted area outside the site (< 10 km)
Temporal	Low	The impact has a temporary and short term effect (1 day – 1 week)
Vulnerability	Low	Designated Industrial area
Evaluation of factors		
Impact(I _s)	Medium	By combining intensity and spatial factors
Impact(I _t)	Medium	By combining I _s and temporal factors
Overall Significance Value of Impact(S)	Medium	By combining I _t and Vulnerability factors

The effluent streams that will be generated regularly during construction stage include the following:

- Sewage and grey water from construction camps and work sites
- Cleaning and washing water for vehicle and equipment maintenance area.
- During construction phase, used construction water is the only effluent generated due to construction activities and most of the effluent generated will be so small that it will either get percolated to ground or get evaporated. And sanitary waste generated will be treated in STP package.

The significance of the impact of raw water consumption on local water resources during construction phase is summarized in **Table 5.9**.

Table 5.9: Impact of effluent generation (construction phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Releases of low quantity
Spatial	Low	Impact extends in a restricted area outside the site (< 1 km)
Temporal	Low	The impact has a temporary and short term effect (1 day – 1 week)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	Low	By combining intensity and spatial factors
Impact(I _t)	Low	By combining I _s and temporal factors
Overall Significance Value of Impact(S)	Low	By combining I _t and Vulnerability factors

Mitigation Measures

- Monitoring water usage at construction camps to prevent wastage.
- Ensuring there are no chemical or fuel spills at water body crossings.
- Ensuring that the STP at construction camps/ sites and the proposed facilities are properly designed to handle peak waste water load and properly maintained.
- Ensuring supply of temporary/ portable toilets for construction staff.

Operation Phase

Impact Evaluation

The impact on water environment during the operation phase of the proposed changes shall be in terms of water consumption and waste water generation. As the project will be implemented in four phases, the estimated water requirements for the year 2020, 2030, 2045 and beyond 2045 are 1MLD, 1.8 MLD, 3 MLD and 6 MLD respectively. Water is used for domestic purposes mainly.

The impact of water consumption on local resources during operation phase is summarized in **Table 5.10**.

Table 5.10: Impact of water consumption (operation phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Low consumption of raw water at each site
Spatial	Medium	the impact extends in a restricted area outside the site (< 10 km)
Temporal	High	the impact has an important long-term effect (1-5 years)
Vulnerability	Low	Designated Industrial area
Evaluation of factors		
Impact(I _s)	Medium	By combining intensity and spatial factors
Impact(I _t)	Medium	By combining I _s and temporal factors
Overall Significance Value of Impact (S)	Medium	By combining I _t and Vulnerability factors

The estimated sewage generation is assumed as 80% of the water supply. The estimated sewage generation is therefore about 1.5 MLD and 2.4 MLD for the year 2030 and 2045, respectively. The maximum water demand and sewage generation beyond year 2045 is estimated as 6 MLD and about 5 MLD, respectively.

The sewage from terminal building, catering, housing, hotels, commercial areas and other business areas would be collected through a gravity sewerage system leading to a sewage pumping station. The treated effluent quality will be suitable for use in landscape/garden area, flushing of urinals and toilets etc.

The impact of effluent generation during operation phase is summarized in **Table 5.11**.

Table 5.11: Impact of effluent generation (operation phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Releases of low quantity
Spatial	Low	Impact extends in a restricted area outside the site (< 1 km)
Temporal	Low	The impact has a temporary and short term effect (1 day – 1 week)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	Low	By combining intensity and spatial factors
Impact(I _t)	Low	By combining I _s and temporal factors
Overall Significance Value of Impact (S)	Low	By combining I _t and Vulnerability factors

Mitigation Measures

- Tracking of consumption and installing water meter at any new water abstraction source.
- Installation of rainwater harvesting structures to collect and use rainwater, thereby reducing abstraction. A general arrangement of rain water pits is shown **Annexure III**. Location of the rainwater harvesting pits has been marked in **Annexure II**.
- Exploring opportunities for recharging of rainwater to augment local ground water resources.
- Exploring opportunities for drip irrigation system for greenbelt development to reduce water demand.

5.3.3 LAND ENVIRONMENT

Drainage Pattern of Study Area

Topography

The topography at the airport site consists of mildly undulating plateau type of ground sloping gently upward from west to east of levels from 140m to 170m above mean sea level (MSL). There are three natural drains over the plateau flowing westward. The natural surface consists of a layer of laterite of various thickness and strengths. Shallow layers of reddish brown sandy soil are found at several depressed locations. Compact coarse to medium grained sand containing soil layer generally underlies the laterite

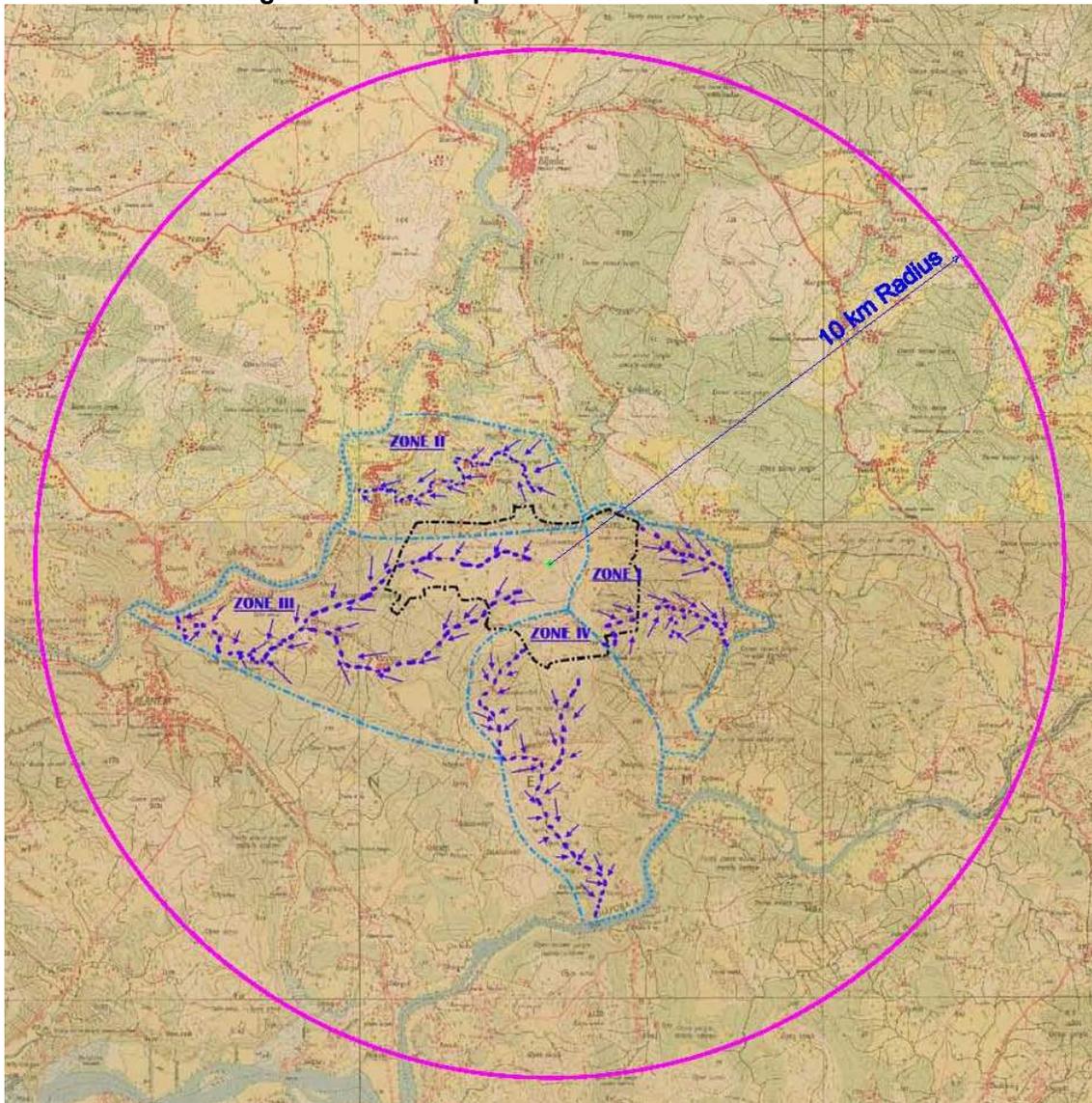
Geology

The Airport site consists of Bauxite ore for which NOC has been obtained from Mining department for construction of Airport. A copy of the same is attached as **Annexure VIII**.

Climate

Goa features a tropical monsoon climate under the Koppen climate classification. Goa, being in the tropical zone and near the Arabian Sea, has a hot and humid climate for most of the year. The month of May is the hottest, seeing day temperatures of over 35 °C (95 °F) coupled with high humidity. The monsoon rains arrive by early June and provide a much needed respite from the heat. Most of Goa's annual rainfall is received through the monsoons which last till late September. The site can be divided into 4 catchments according to the number of outfalls at the boundary which drains to the West and South of the site. The remaining area drains to the North and East. With the development of Airport infrastructure, the area contributing to the North or East will reduce and the reduced area will then contribute to the West and South side outfalls. Therefore there will not be any adverse impact on the drainage on the North and East side of site

Fig. 5.1.a Zonal map of run-off distribution



Peak Hour Discharge from Outfalls:

The discharge calculation is done using the Rational Formula $Q = C.I.A$
where,

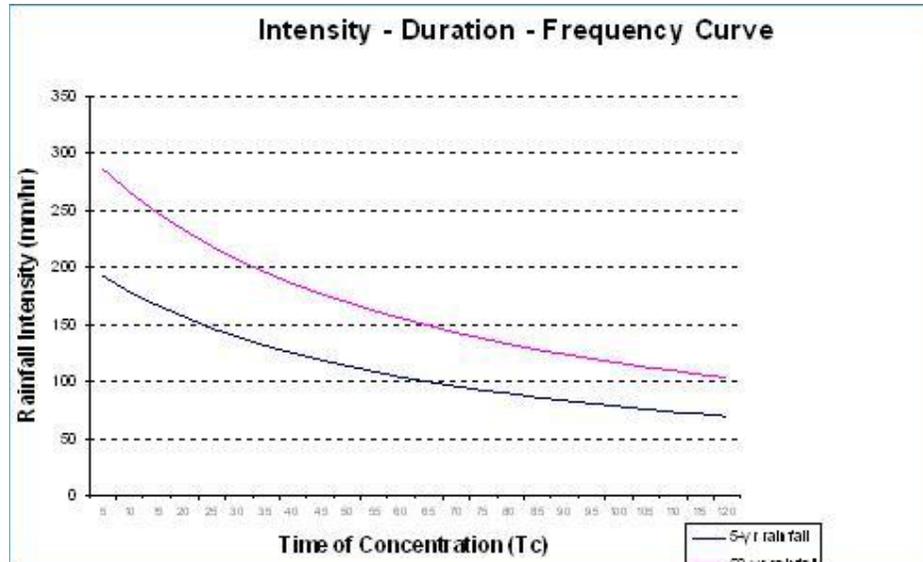
C= Coefficient of runoff (considered as 0.7, for lightly covered plateaus)

I = Intensity corresponding to time of concentration as per Fig 5.2b.

A = Catchment Area

Time of Concentration has been calculated using the formula $T_c = (0.87 L^3 / H)^{0.385}$

Fig. 5.1.b Intensity- Duration- Frequency Curve



The calculated discharges at the outfalls are given in Table 5.12a and Table 5.12b.

Table 5.12 a: Estimation of run-off in buffer zone of 10 km radius

Before construction of Airport								
zone	area(km2)	in hectares	c=coeffecient	length in km.	height diff	tc	intensity	flow (m3)
1	10.144	1014.4	0.7	2.4375	150	0.384384	250	656824
2	9.7	970	0.7	2.84	120	0.500073	250	628075
3	19	1900	0.7	8.12	100	1.811008	250	1230250
4	14.28	1428	0.7	4.88	120	0.93601	250	924630

Table 5.12 b: Estimation of run-off within the project boundary

zone	After construction of Airport							
	area(km ²)	in hectares	c=coeffecient	length in km.	Elevation diff	tc	Intensity	flow (m ³)
1	2.8	280	0.7	2.4375	150	0.384384	250	181300
2	1.15	115	0.7	2.84	120	0.500073	250	74462.5
3	5.07	507	0.7	8.12	100	1.811008	250	328282.5
4	0.89	89	0.7	4.88	120	0.93601	250	57627.5

Peak Daily Discharge from Outfalls:

Run-off zone-I:

It is approximately 2.80 sq. km area in east side of proposed site area. Total 2,91,512 m³ of rain water during peak hour(7,84,840m³ peak daily) of rainy season run down through natural slopes to lower elevated land and get accumulated primarily at Kalna River which is seasonal water body.

From project site, there exists a pond in eastern direction at a distance of about 5 kms. However, before the pond Kalna river is flowing. In view of the same, the drainage from the airport site joins Kalna river and there will be no impact on the pond.

Run-off zone-II:

It is approximately 1.15 sq. km area in north, and north-west of the proposed site area. Total 1,20,306 m³ of rain water during peak hour(3,23,906 m³ peak daily) of rainy season run down through natural slopes to lower elevated land and get accumulated primarily at KadasiNala which further drains into Terekhol River which is seasonal water body.

Run-off zone-III:

It is approximately 5.07 sq. km area in west and south west of site. Total 5,27,500 m³ of rain water during peak hour(14,20,192 m³ peak daily) of rainy season run down through natural slopes to lower elevated land and get accumulated primarily at Terekhol River(at south west boundary of site)

Run-off zone-IV:

It is approximately 0.89 sq. km area in south side of site area. Total 92,543 m³ of rain water during peak hour(2,49,154 m³ peak daily) of rainy season run down through natural slopes to lower elevated land and get accumulated primarily at Chapora River.

Based on the above drainage pattern study, quantity of rainwater falling on unpaved area will be collected through storm water channels and sent to nearest water body. Quantity of the same is calculated. The proposed project site is located at higher elevation, provision shall be made to route the water through channel by gravity to nearest water body.

The water falling on the paved area and buildings will be routed to rain water harvesting pits. Therefore no flooding condition shall occur after construction of the proposed airport and there will be no net effect on the downstream areas.

Construction Phase

Impact Evaluation

The impact on land environment during construction phase shall be due to generation of debris/construction material, which shall be properly collected and disposed off.

Debris will be segregated and whatever is resalable will be sold to buyers and rest of the waste will be used for filling up of low lying area and development of internal roads.

The impact on land use and topography during construction phase is summarized in **Table 5.13 a**.

Table 5.13 a: Impact on land use & topography (construction phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Complete land required for development of facilities is acquired on permanent basis. Site consists of bauxite ore and considered low as the impact extends inside the site and NOC have been obtained.
Spatial	Low	The impact extends inside the site.
Factors of assessment	Value of assessment	Justification
Temporal	Medium	the impact has a medium-term effect (1 week – 1 year)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	Low	By combining intensity and spatial factors
Impact(I _t)	Low	By combining I _s and temporal factors
Overall Significance Value of Impact (S)	Low	By combining I _t and Vulnerability factors

There is potential for impact on soil quality due to project-related spills and leaks of fuel and chemicals and uncontrolled disposal of wastes and wastewater. Care will be taken to avoid spills and leaks of hazardous substances and all project-related wastes. Littering of sites and areas beyond the site will be controlled.

The impact on soil quality during construction phase is summarized in **Table 5.13 b**.

Table 5.13 b: Impact on soil quality (construction phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Disposal includes on construction waste material which is non hazardous
Spatial	Low	The impact extends inside the site.
Temporal	Medium	the impact has a medium-term effect (1 week – 1 year)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	Low	By combining intensity and spatial factors
Impact(I _t)	Low	By combining I _s and temporal factors
Overall Significance Value of Impact (S)	Low	By combining I _t and Vulnerability factors

Mitigation Measures

- Avoiding rainy season for construction so as to avoid soil erosion.
- Restricting all construction activities inside the project boundary.
- Ensuring the top-soil stock pile is not contaminated with any type of spills.
- Ensuring any material resulting from clearing and grading should not be deposited on approach roads, streams or ditches, which may hinder the passage and/or natural water drainage.
- Restoration of construction camp sites before abandonment.
- After final site grading is complete, ensuring that the excess excavated material is not dumped indiscriminately but used for filling low lying areas or berm construction by locals and keeping a record of the same.
- Developing project specific waste management plan and hazardous material handling plan for the construction phase.
- Providing drip trays and liners while working with hazardous liquid materials such as fuels and chemicals.
- Developing and maintaining dedicated waste storage areas, with secondary containment for hazardous wastes.

Operation Phase

Impact Evaluation

The impact on land environment during operational phase shall be due to disposal of solid waste generated during operation.

Solid waste collected during operation phase will be disposed in disposal facility owned by Government of Goa.

Hazardous waste management: From Airport, used oil, lubricants, electronic wastes shall be generated and the same shall be disposed through SPCB authorized reprocessor. Used batteries will be given to dealer as part of buy back arrangement.

The impacts on soil quality during operation phase are summarized in **Table 5.14**.

Table 5.14: Impact on soil quality (operation phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Releases of low quantity
Spatial	Low	The impact extends inside the site.
Temporal	Medium	the impact has a medium-term effect (1 week – 1 year)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I_s)	Low	By combining intensity and spatial factors
Impact(I_t)	Low	By combining I_s and temporal factors
Overall Significance Value of Impact (S)	Low	By combining I_t and Vulnerability factors

Mitigation Measures

- Developing and maintaining dedicated waste storage areas,
- Ensuring hazardous waste storage areas are provided with secondary containment.
- Disposing of hazardous wastes to vendors authorized by the concerned authorities.

5.3.4 NOISE ENVIRONMENT

Construction Phase

Impact Evaluation

The main sources of noise emissions during construction phase are operation of heavy equipment and machinery, operation of emergency power generation sets and movement of vehicles (heavy vehicles carrying materials and light vehicles carrying project related personnel).

Construction noise levels associated with typical machinery based on “BS 5228: 1997 Noise and Vibration Control on Construction and Operation Sites” are summarized in the **Table 5.15**.

Table 5.15: Sound Pressure (noise) levels of Construction Machinery

Item Description	Noise Level dB(A)	Reference Distance
<u>Earth Movers</u>		
Front Loaders	72-84	0.9 m
Backhoes	72-93	"
Tractors	72-96	"
Scrapers, Graders	80-93	"
Pavers	86-88	"
Trucks	82-94	"
<u>Material Handlers</u>		
Concrete Mixers	75-88	0.9 m
Concrete Pumps	81-83	"
Cranes (movable)	75-86	"
Cranes (derrick)	86-88	"
<u>Stationary Equipment</u>		
Pumps	69-71	0.9 m
Generators	71-82	"
Compressors	74-86	"

The impact of noise emission on ambient noise levels are summarized in **Table 5.16**:

Table 5.16: Impact on ambient noise (construction phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Releases of low quantity
Spatial	Medium	Impact extends in a restricted area outside the site (< 1 km)
Temporal	Low	The impact has a temporary and short term

		effect (1 day – 1 week)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I_s)	Low	By combining intensity and spatial factors
Impact(I_t)	Low	By combining I_s and temporal factors
Overall Significance Value of Impact (S)	Low	By combining I_t and Vulnerability factors

Mitigation Measures

- Ensuring preventive maintenance of equipment and vehicles
- Avoiding unnecessary engine operations (e.g. equipment with intermitted use switched off when not working)
- Ensuring DG sets are provided with acoustic enclosures and exhaust mufflers
- Ensuring vehicle movement is avoided close to sensitive receptors (such as schools, hospitals, places of worship).

Operation Phase

Impact Evaluation

During operation phase of the Airport, following are the main causes of noise emission:

- Aircraft landing and taking off.
- Ground Noise

Noise emission due to aircraft:

Noise emission from a aircraft is caused by two things: **Airframe noise & Engine noise.**

Airframe noise occurs when air passes over the plane's body (the fuselage) and its wings. This causes friction and turbulence, which make a noise.

Engine noise is created by the sound from the moving parts of the engine, and also by the air being expelled at high speed once it has passed through the engine. Most of the engine noise comes from the exhaust or jet behind the engine as it mixes with the air around it.

Ground noise shall be due to the following sources/factors:

aircraft engine tests, airside vehicular traffic, Using reverse thrust to increase braking during landing, Planes travelling between the run-way and stands (their 'parking space'), Planes sitting on their stands with their power units running, DG Sets, pumps etc.

Transport links to an airport, particularly private vehicles and trains, can also make a significant contribution to noise around airports.

Noise emission during night time:

Many people are not bothered by aircraft noise during the day, but they can be affected at night. The existing Goa Dabolim Airport is allowed to operate a limited service at night. There are restrictions on the level of night time noise that is allowed and the number of planes that can fly at night. There shall be increase in noise generation due to increase in air traffic with the operation of new international terminal.

Noise Model: Aircraft today are much quieter than they were in olden days and these will be replaced by even quieter aircraft in the future. But, there are more planes flying today considering the past. A software namely INM (Integrated Noise Model) is used to assess the

increase in noise due to the proposed international Airport. Details of the same are described below.

The Integrated Noise Model (INM) is a computer model that evaluates aircraft noise impacts in the vicinity of airports.

The INM computer program calculates noise exposure contours in the vicinity of airports by using a large database of aircraft flight performance and acoustic data along with airport-specific user-input data. The INM graphical user interface provides a versatile, user-friendly, windows-style means for users to specify operational scenarios to be modeled and to review the noise results.

INM outputs include noise contours used in land use compatibility studies, noise impacts by aircraft on individual flight tracks, and user-defined point analysis of noise impacts.

Inputs considered in the present study

- Airport characteristics :
 - Runway length: 3750 m,
 - width: 60 m,
 - threshold displacement: 20 m and
 - Orientation: 95 NE- 275 SW
- Aircraft :
 - Boeing 777-200
- ❖ Approach and departure tracks in 10 km radius
- ❖ Flight operations
- ❖ Noise Metric
 - LAEQ

Output obtained from INM

- Noise contours (contours of equal values of a noise metric)

Noise contours are plotted in INM considering following cases.

- (1) Aircraft Take-off from East side and landing from West side of runway.
- (2) Aircraft Take-off from North-East side and landing from South-west side of runway.
- (3) Aircraft Take-off from West side and landing from East side of runway.
- (4) Aircraft Take-off from North-west side and landing from South-east side of runway.

10 Km radius around proposed airport is considered for the purpose of noise study. The contours are provided in figure no. 5.2 to 5.5.

The anticipated noise levels obtained from the study are less than 90 dB at the runway location. The noise levels started depreciating as the aircraft moves away from the runway where as it started appreciating while landing as the aircraft approaches runway. Considering the worst scenario of human exposure to this noise level, 8 hours continuous exposure is permitted for such noise levels, which is unlikely in the airport as the noise will not be continuous considering the proposed aircraft movements.

Figure 5.2 Aircraft Take-off from East side and landing from West side of runway (Noise model case 1)

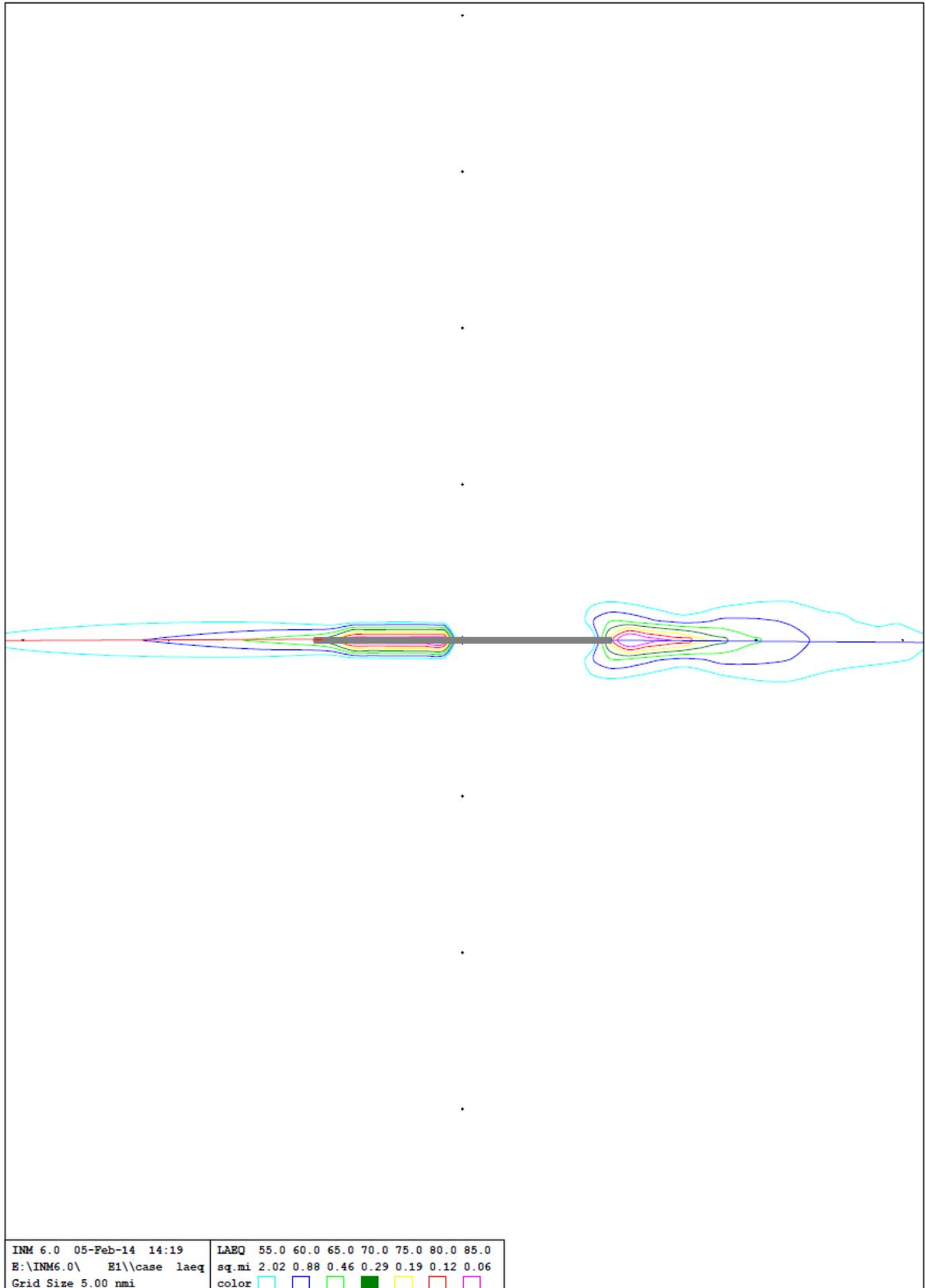


Figure 5.3 Aircraft Take-off from North-East side and landing from South-west side of runway
(Noise model case 2)

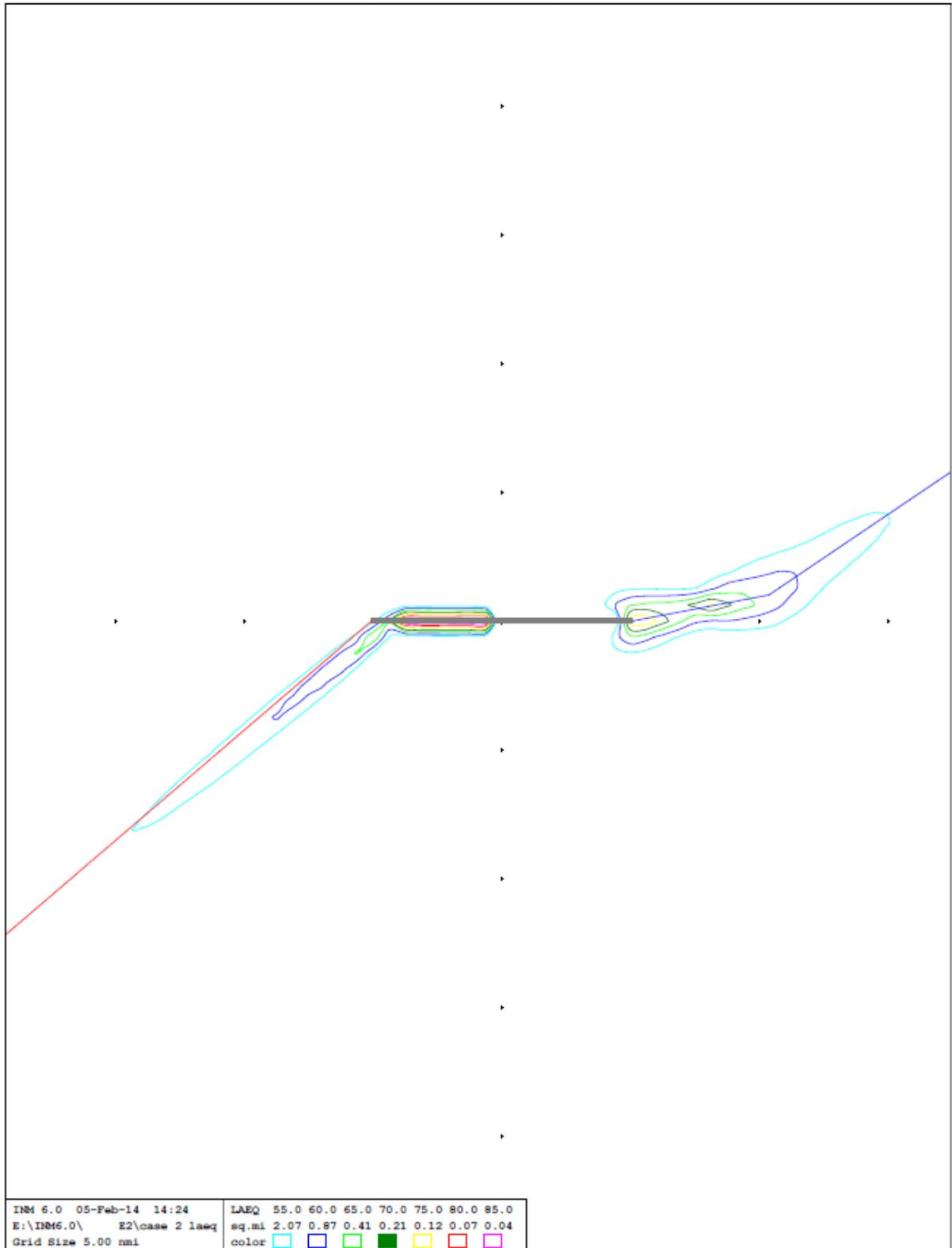


Figure 5.4 Aircraft Take-off from West side and landing from East side of runway
(Noise model case 3)

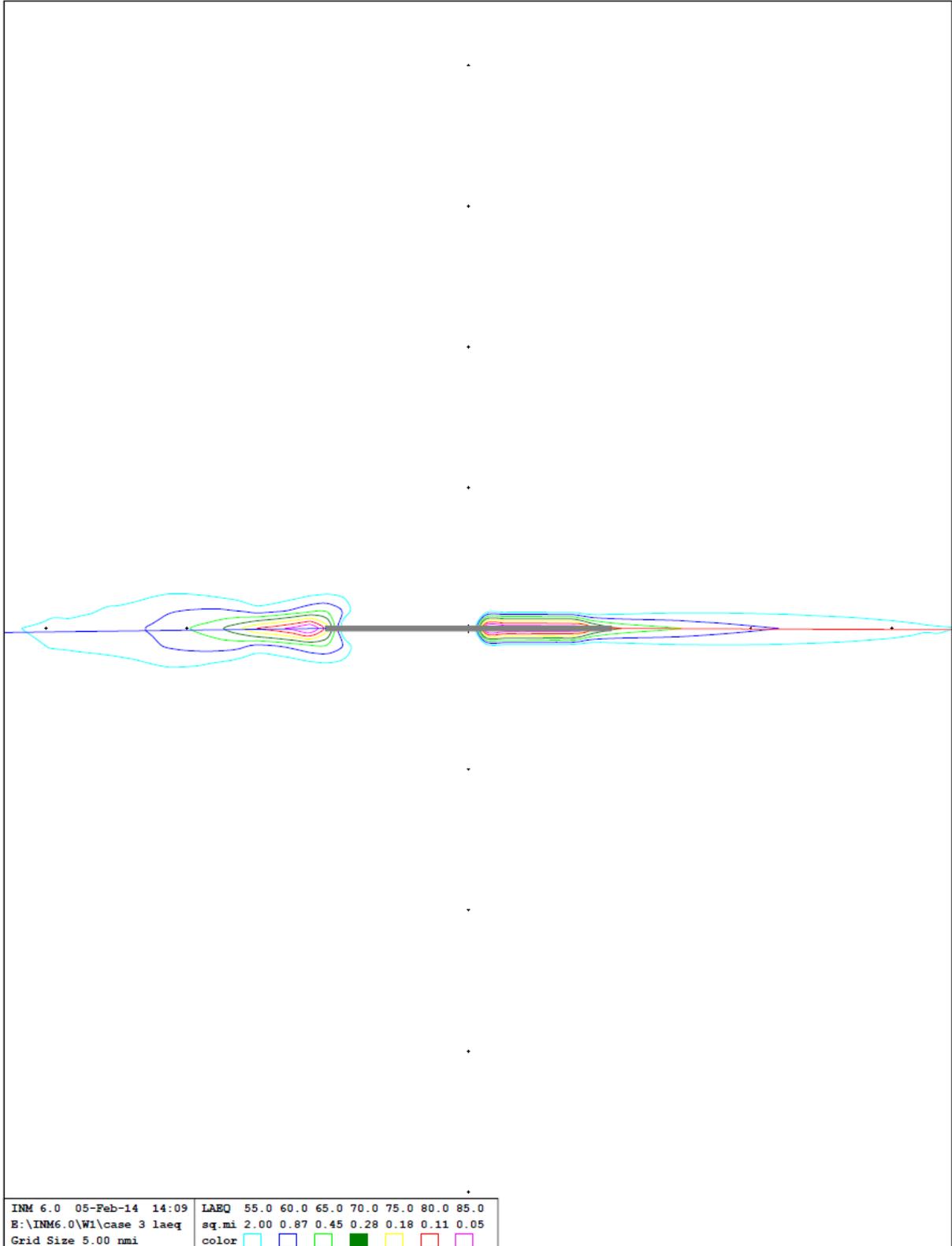
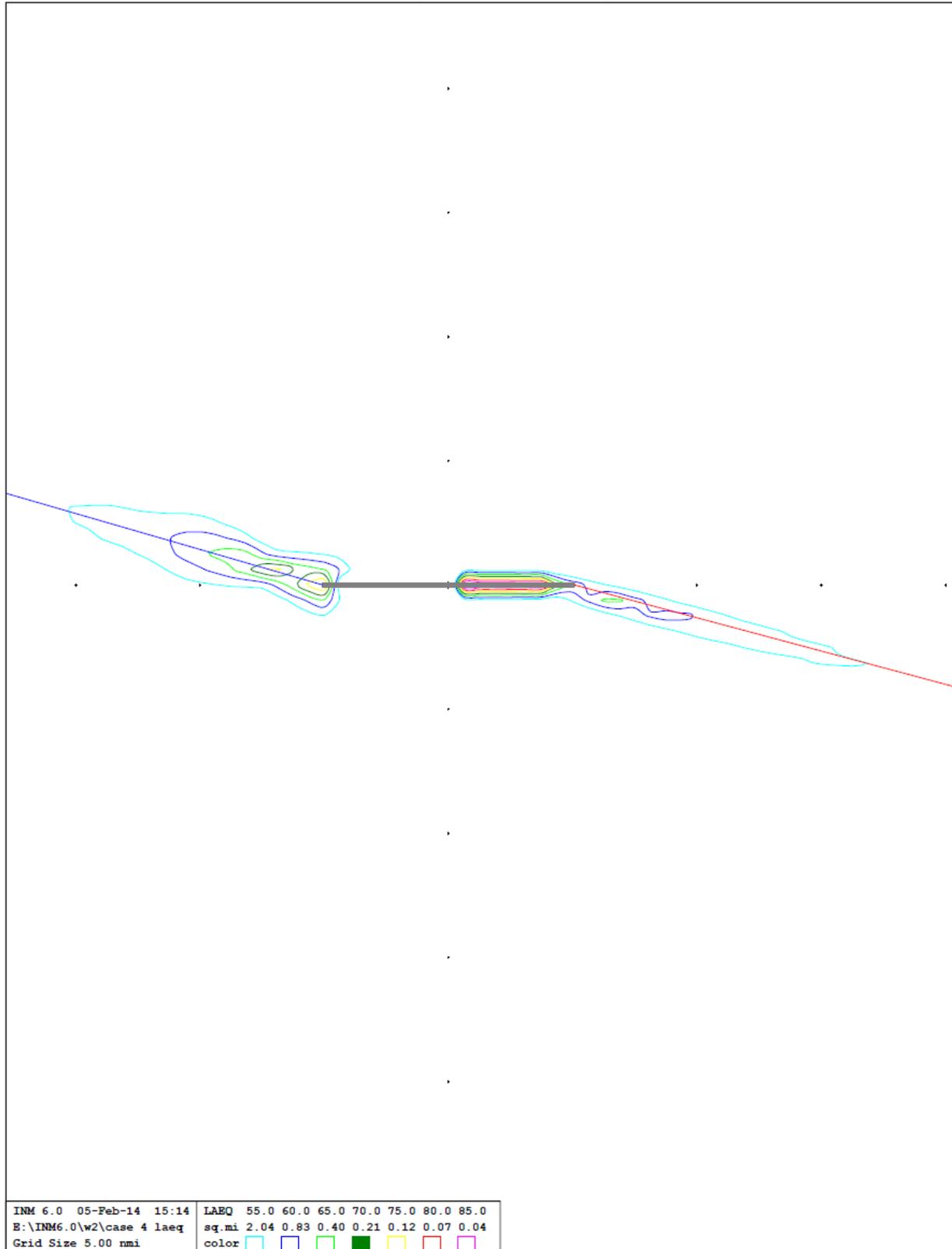


Figure 5.5 Aircraft Take-off from North-west side and landing from South-east side of runway
(Noise model case 4)



The impact of these noise emissions during operation is summarized in **Table 5.17**.

Table 5.17: Impact on ambient noise (operation phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Releases of low quantity
Spatial	Low	The impact extends inside the site.
Temporal	High	The impact has an important and long term effect (1 – 5 years)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I_s)	Low	By combining intensity and spatial factors
Impact(I_t)	Medium	By combining I_s and temporal factors
Overall Significance Value of Impact (S)	Medium	By combining I_t and Vulnerability factors

Mitigation Measures

- Avoiding continuous (more than 8 hrs) exposure of workers to high noise areas.
- Provision of ear muffs at the high noise areas
- Ensuring preventive maintenance of equipment.
- Ensuring DG sets have acoustic enclosures and exhaust mufflers as per design.
- On top of the quota system, there is also an absolute limit on the number of flights permitted at the airport. Under the quota system, the airport has a total number of 'quota points', which are then used up by night time flights. Different types of planes use up different numbers of points, depending on how noisy they are.
- The noisiest aircraft use 16 points of the quota, and they're called QC16s (QC = Quota Count). The next noisiest have eight points – QC8s. As planes get quieter, their points get smaller until the quietest planes have just half a point or are exempt altogether.
- During the night quota period the noisiest types of planes are not permitted to be scheduled. Because there is a limit on the airport's total quota of points for night-time flying, this system encourages airlines who want to fly at night to use the quietest aircraft.
- Pilots are encouraged not to use reverse thrust between 23:00 and 06:00 except in the interests of safety.
- Planes shall be plugged into the mains electrical supply while they are on stand. This is a system known as Fixed Electrical Ground Power (FEGP) to replace the noisy auxiliary power units (APU) on the plane itself. It allows things like interior lighting and the air conditioning systems to operate.
- Above all, the proposed Mopa Airport is located in mountain top and is mostly far from the habitations. Hence, there will be less impact due to noise on the habitations.

IMPACT DUE TO TRAFFIC

Construction phase

The impact on noise environment during the construction phase of the proposed Airport shall be due to movement of quarrying and borrow material, construction material and movement of construction workers etc.

Design & operation phase

Traffic – Road

The main connecting habitation places to the project site is are NH 17. Traffic is counted for Heavy, Medium and Light vehicles on these connecting road to project site.

It is to be noted that the increase due to the proposed Airport activities and there shall be an increase in vehicles up to 100 per day. The existing traffic count is around 200 PCU. All proper traffic management measures will be adopted towards reduction in movement of vehicles. This shall lead to optimum carbon foot print. There shall not be an increase in linear proportions over a long run period. Also adequate funds will be allocated towards implementation of traffic management measures on these roads as a Corporate Social Responsibility.

Traffic – Rail

The most common, preferred and presently used route is by road. The alternate route is by Train. Konkan Railway line is facilitating connections to all major industrial towns and population centers at Goa. There will be additional load on the rail network due to the proposed project activities and passenger travel from South Goa to reach the Airport.

Figure 5.6: Konkan Railway line



Traffic – Water

The another option shall be by inland waterways. But there will be no additional load on the inland water network due to the proposed Airport.

Traffic – Air

The airport is located about 35 km from the capital of Goa-Panaji. Some of the major towns and villages within the study area are

Accordingly, there will be additional load on the air network which will be met from the proposed International Airport at Goa.

5.3.5 BIOLOGICAL ENVIRONMENT

Construction Phase

Impact Evaluation

The area acquired for proposed airport has only few trees but mainly bushes. These will be cleared during site preparation.

The impacts on flora and fauna during construction phase are summarized in **Table 5.18**.

Table 5.18: Impact on Biological Environment (construction phase)

Factors of assessment	Value of assessment	Justification
Intensity	High	Felling of trees
Spatial	Medium	Impact extends in a restricted area outside the site (< 1 km)
Temporal	High	The impact has an important and long term effect (1 – 5 years)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	High	By combining intensity and spatial factors
Impact(I _t)	High	By combining I _s and temporal factors
Overall Significance Value of Impact (S)	Medium	By combining I _t and Vulnerability factors

Mitigation measures

- Keeping a tally of trees cut – viz. no., species taluka-wise.
- Avoid cutting of trees wherever possible, especially the endangered species observed in the study area.
- Closing of trenches as soon as possible of construction.
- Hard barricading of hydro test water disposal pits.
- Prevent littering of work sites with wastes, especially plastic and hazardous waste.
- Regulating speeding of project-related vehicles.

Operation Phase

Impact Evaluation

The movement of operation related vehicles may result in road kills of animals.

The impacts on flora and fauna during construction phase are summarized in **Table 5.19**.

Table 5.19: Impact on Biological Environment (operation phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Releases of low quantity
Spatial	Medium	Impact extends in a restricted area outside the site (< 1 km)
Temporal	High	Impact has an important and long term effect (1 – 5 years)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	Low	By combining intensity and spatial factors
Impact(I _t)	Medium	By combining I _s and temporal factors
Overall Significance Value of Impact (S)	Medium	By combining I _t and Vulnerability factors

Mitigation Measures

- Keeping a tally of trees cut – viz. no., species taluka-wise
- Avoid cutting of trees wherever possible
- Training of drivers to maintain speed limits and avoid road-kills

5.3.6 SOCIO ECONOMIC ENVIRONMENT

Construction Phase

Impact Evaluation

The impact on socio-economic environment during construction phase shall be due to acquisition of land for the project and the rehabilitation & relocation of households for the same.

In the construction phase an influx of construction workers will have impact on some people, as the demand for goods and services in the area would increase. This impact can be negative in the short run but in the long term the impacts are reversible in nature and may lead to growth of overall infrastructure and commercial activities in the study area. Moreover, the project affected people would be rehabilitated by Government of Goa. Over the period of time, there shall be positive impact with better connectivity and transport facilities.

There will be increase in employment opportunities with impetus for skilled jobs both from the project and the new international terminal along with secondary and tertiary sector services/ businesses. Further, both traffic congestion and distance to travel to reach new airport shall be less due to connectivity to existing highway and the proposed approach road, which would also bring business opportunities for transport services. Aggregative there shall be positive impact on socio-economic environment due to development of infrastructure in the area, growth of secondary and tertiary sector businesses and subsequent enhancement in the standards of living of the local populace.

The impact of construction activities on socio-economic environment during construction phase is summarized in **Table 5.20**:

Table 5.20: Impact on Socio-Economic Environment (construction phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Involvement of labor, infrastructure and other utilities in marginal quantities/Nos.
Spatial	Medium	Impact extends in a restricted area outside the site (< 1 km)
Temporal	Medium	The impact has an medium term effect (1 week – 1 year)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	Low	By combining intensity and spatial factors
Impact(I _t)	Low	By combining I _s and temporal factors
Overall Significance Value of Impact(S)	Low	By combining I _t and Vulnerability factors

Rehabilitation & Resettlement

Government of Goa is the owner of the Mopa Airport land. All the compensation awards have been finalized and passed and the entire compensation amount of Rs. 54.79 crore has been placed with Economic Development Corporation, the disbursing agency for the release of claims. The Government of Goa will suitably consider rehabilitation and resettlement if some families are to be relocated.

Mitigation Measures

- Ensuring early payment of compensation
- Training contractors on company road safety policy requirements
- Monitoring speed and route of project-related vehicles
- Determine of the safe, legal load limits of all bridges and roads that will be used by heavy vehicles and machinery.
- Determining allowable traffic patterns in the affected area throughout the work week will be made based on community use, include a consideration of the large turning requirements of certain vehicles/machineries that might increase congestion and traffic hazards
- Upgrading local roads, wherever required, to ensure ease of project activity and community safety
- Consolidating deliveries of materials and personnel to project sites, whenever feasible, to minimize flow of traffic
- Minimizing interruption of access to community use of public infrastructure
- Providing prior notice to affected parties when their access will be blocked, even temporarily.
- Returning all roads to a passable condition before the end of each working day
- Monitoring construction camp safety and hygiene
- Preventing use of drugs and alcohol in project-sites
- Preventing possession of firearms by project-personnel, except those responsible for security
- Ensuring project-related waste and wastewater is disposed in a responsible manner

Operation Phase

Impact Evaluation

There will be increase in employment opportunities with impetus for skilled jobs both from the project and the new international terminal along with secondary and tertiary sector services/ businesses. Further, both traffic congestion and distance to travel to reach new airport shall be less due to connectivity to existing highway and the proposed approach road, which would also bring business opportunities for transport services. Aggregative there shall be positive impact on socio-economic environment due to development of infrastructure in the area, growth of secondary and tertiary sector businesses and subsequent enhancement in the standards of living of the local populace.

The impact of these activities on socio-economic environment during operation phase is summarized in **Table 5.21**:

Table 5.21: Impact on Socio-Economic Environment (operation phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Involvement of labor, infrastructure and other utilities in marginal quantities/Nos.
Spatial	Medium	Impact extends in a restricted area outside the site (< 1 km)
Temporal	Medium	The impact has an medium term effect (1 week – 1 year)
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I _s)	Low	By combining intensity and spatial factors
Impact(I _t)	Low	By combining I _s and temporal factors
Overall Significance Value of Impact (S)	Low	By combining I _t and Vulnerability factors

Mitigation Measures

- Ensure implementation of disaster management plan.

5.4 SUMMARY OF IMPACT EVALUATION

Based on the above evaluation the significance value of impact on various components of environment during construction and operation phases is summarized and is given in **Table 5.22**.

Table 5.22: Summary of Impact Evaluation in terms of Significance Value

Environmental component		Construction	Operation
Air		Low	Medium
Water	Consumption of Raw Water	Medium	Medium
	Generation of Effluent	Low	Low
Land	Land use & Topography	Low	-
	Soil Quality	Low	Low
Noise		Low	Medium
Biological		Medium	Medium
Socio-Economic		Low	Low

CHAPTER 6

ENVIRONMENTAL MONITORING PLAN

6.0 INTRODUCTION

Regular monitoring of environmental parameters is of immense importance to assess the status of environment during project operations. With the knowledge of baseline conditions, the monitoring programmed will serve as an indicator for any deterioration in environmental conditions due to operation of the project, to enable taking up suitable mitigation steps in time to safeguard the environment. Monitoring is as important as that of pollution since the efficiency of control measures can only be determined by monitoring.

Usually, as in the case of the study, an impact assessment study is carried out over short period of time and the data cannot bring out all variations induced by the natural or human activities. Therefore, regular monitoring programme of the environmental parameters is essential to take into account the changes in the environmental quality.

6.1 ENVIRONMENTAL MONITORING

6.1.1 AMBIENT AIR QUALITY

Ambient air quality shall be monitored for NO_x and SPM around the premises of the airport. The proposed monitoring program for the field monitoring and laboratory analysis of air is given in the following table 6.1

Table 6.1 Proposed monitoring programme (Air)

Monitoring	Parameters to be monitored	Monitoring location/site	Sampling duration	Frequency	Method of monitoring
Ambient air quality	NO _x and SPM	Locations around the premises*	Twice a week, 4 weeks in a season	Seasonal	As per CPCB standards for NAAQM, 1994

- Monitoring locations to be finalised in consultation with State Pollution Control Board

6.1.2 NOISE LEVELS

Ambient Noise levels shall be monitored around the premises of the airport, near DG sets and at the main entrance/boundary of airport. The proposed monitoring programme for the Ambient noise levels is given in the following Table 6.2

Table 6.2 Proposed monitoring programme (Noise)

Monitoring	Parameters to be monitored	Monitoring location/site	Sampling duration	Frequency	Method of monitoring
Ambient Noise levels	Noise levels in dB(A)	Near the airport site, main entrance, near DG sets	Once a week	Weekly	Instrument: Noise level meter IS: 4954-1968 as adopted by CPCB

6.1.3 WATER QUALITY

Water quality parameters shall be for one year before and for at least three years after completion of the proposed project. Monitoring shall be carried out at least four times a year to cover seasonal variations. Water quality shall be analysed by the standard technique (IS:2488, Standard methods American Public Health Association (APHA)). The parameters for monitoring would be:

PH, Dissolved oxygen, BOD, COD, Total coliform count, TDS, Temperature, Total Hardness, Calcium, Magnesium, Iron, Manganese, Chlorides, Sulphates, Nitrates, Fluorides, Mercury, Cadmium, Arsenic, Cyanides, Lead, Zinc, Total Nitrogen and Phosphates

The monitoring points shall be bore wells of airport and treated STP water at discharge point.

6.1.4 SOIL CONSERVATION

Soil erosion rates, slope stability of land faces, effectiveness of soil conservation measures, change in soil texture and structure should be monitored at frequent intervals.

CHAPTER 7

ADDITIONAL STUDIES

7.0 PUBLIC CONSULTATION

This Environmental Public Hearing for the proposed Green Field International Airport was conducted on 01/02/2015 AT 10.30 A.M at Simechen Adven, Mopa, Pernem Taluka as per the Revised EIA Notification dated 14/09/2006

The Collector and District Magistrate (North), Smt. Nila Mohanan, welcomed the public for the Environmental Public Hearing, and requested the public present to express their views/objections/suggestions if any, after the applicant / project proponent gives its presentation and the same will be recorded and forwarded to the Concerned Regulatory Authority, for obtaining Environmental Clearance.

The Representatives of the applicant / Project Proponent thereafter made a Power Point presentation by explaining the contents thereof in Konkani language.

Thereafter, the Chairman called upon those present to seek information or clarification on the project from the applicant, if desired.

A compliance statement has been prepared for the comments raised by public during Public hearing held on 01.02.2015 at Porvorim, Goa along with written communication from public is attached as **Annexure XXI**.

7.1 DISASTER MANAGEMENT PLAN

Various hazards have been identified and a plan for mitigating disasters during pre & post phases are given in **Annexure VI**.

CHAPTER 8

PROJECT BENEFITS

8.0 INTRODUCTION:

It has been observed that the airports and especially International airports have become the catalysts for local economic development. Experts in the field are of the opinion that airports will shape business location and urban development in this century as much as seaports did in the 18th Century, railroads in the 19th Century and highways in 20th Century.

Today's airports are big business impacting the social, economic and political life and fabric of today's communities. The employment generation has two aspects i.e. direct and indirect. Direct employment is the employment attributed to the operation and management of the airport, airline operations and associated services. Indirect employment is the employment in non-aviation industries that result from airport activity. Employment generated to support direct airport related employment.

Following are the benefits of land side commercial developments.

- Source of Revenue for Airport
- Facilitates and supports development of cargo and passenger air services
- Economic Benefits to Community

Since the rise of commercial aviation during the mid-twentieth century, airports have become integral components of the economic activity of urban settings. The contribution of airports to local economic activity was traditionally oriented around their gateway for people and products, but in the last decade, the pursuit of non-aeronautical revenues has resulted in many airports leveraging their property assets to generate commercial development activity.

Tourism is Goa's primary industry: it handles 12% of all foreign tourist arrivals in India. Goa has two main tourist seasons: winter and summer. In the winter time, tourists from abroad (mainly Europe) come to Goa to enjoy the climate. In the summer time (which, in Goa, is the rainy season), tourists from across India come to spend the holidays. Goa is the smallest state with less than 2% of India's land mass- and yet it accounts for nearly 46% of all the mining leases granted nationwide. It is anticipated that the airport development will not only increase and support tourism, but also accommodate the projected growth in business travel and cargo movements in Goa.

8.1 INFRASTRUCTURE:

The aviation linked commercial development has been evolved around airport including Basic Amenities , shopping plaza and office parks, hospitality industry, promotional activities of tourism, logistic park and housing. Following are the envisaged development.

8.1.1 Roads:

The four-to-six lane express road measuring about 8 km between NH-17 and airport site is proposed. The approach road is passing from barren land and reserved forest areas. The proposed approach road crosses Konkan railway and irrigation canal near Dangal village a starting point of express highway. According to Regional Plan a growth hub is proposed near Pernem and will also be connected via 25 m wide road.

8.1.2 Public Amenities:

Essential amenities listed in Table 8.1 are provided as per the requirements of Airport City as per the standards and norms suggested in UDPFI norms

Table 8.1: Public amenities areas.

S. No	Components	Area (Sq. m)	No.	Total area (sq. m)
1.	Post Office	200	1	200
2.	Telephone Exchange	5000	1	5000
3.	Police Station	1600	1	1600
4.	Conveniences	1000	2	2000
5.	Health Center / Hospital	10000	1	10000
	Total			18,800

It is assumed that the public amenities would be required at the beginning of the operations of the project and hence proposed to be developed by 2020.

8.1.3 Hospitality and Office space:

The demand assessment for hospitality components is indicated in table 8.2:

Table 8.2: Assessment for Hotel rooms (year-wise)

	2010	2015	2020	2025	2030
Forecast of Beds	46,051	50,590	66,538	77,093	89,321
Number of passengers per room	2	2	2	2	2
Forecast of Rooms required	23026	25295	33269	38547	44661
Gap in number of Rooms w.r.t. current availability		2,269	10,243	15,521	21,635
% of Rooms may be considered at proposed Airport Project		10%	10%	10%	10%
Number of Rooms		227	1024	1552	2164

Based on the above, total 1500 number of rooms has been considered for the proposed project. The distribution of rooms in different categories based on the current distribution of rooms in Goa and area requirements is as given in Table 8.3

Table 8.3: Hotel area requirement

Category	% Distribution	Rooms (no.)	Unit area (sq. Mt)	Total area (sq. Mt)
5 Star Hotel	40%	600	50	30,000
Eco, Adventure and Wellness Resort	20%	300	Lump sum	1,500,000
3 Star / Budget Hotel	40%	600	30	18,000
Total	100%	1500		78,000

Based on the above estimates the development of hospitality components is proposed in 2 phases.

An emerging trend is the strategic placement of Factory Outlet Shops on or adjacent to airport lands in order to benefit from the regional population trade area capture, airport activity, tourists draw and highway locations that airport lands offer.

Table 8.4: Requirement for Commercial Space

Particulars	Unit	Area required Sq. Mt	Total built up Sq. Mt
Shopping plaza and office spaces	200 shops	40X 200 = 8000	38000
	250 offices	40X 250 = 10000	
	Mall	20000	

The above office space also includes the office space for Airline office. Based on the above estimates the development of shopping mall and plaza is proposed in 2 phases. The ultimate capacity of may be provided by 2025.

8.1.4 Visitor's centre and Convention centre:

The visitor centre has been proposed to provide services to passengers, airport employees, and meters and greeters such as leisure, entertainment, and cultural venues. It is a place for tourists to have a quick glance and exposor to Goa's art and crafts, culture and tradition. Broadly the following activities are envisaged in the Visitors Centre.

- Information desks and kiosks
- Tourist facilities, rest rooms
- Conference area
- Café and recreation
- Display of art and craft of Goa
- Indoor and outdoor exhibition space.
- Cultural centre and museum
- Amphitheatre
- Open Exhibition ground

The activity wise area statement is worked out as follows (table 8.5):

Table 8.5: Visitors Center Area Requirement

No.	Particular	Area in Sq. Mt.	No.	Area
1	Reception, waiting lounge and foyer	15mt X15mt = 225	1	225
2	VIP lounge with washroom	10mt X 10 mt.=100	1	100
3	Admin with general storage area	10mt X 10mt = 100	1	100
4	Rest rooms	5mt X 4 mt =20	30	600
5	Conference area for 50 people	50 person X 3 sqmt=150	3	450
6	Café + kitchen	20mt X 20mt =400	1	400
7	Information desks and Kiosks	15mt X 15mt = 225	1	225
8	Indoor exhibition space	25mt X 15mt = 625	1	625
9	Cultural Museum	20mt X 20mt =400		400
10	Auditorium for 500 capacity	500 person X 3mt.	1	1500
11	Library	20mt X 20mt =400	1	400
12	Art and Craft workshop and display area	20mt X 20mt =400	1	400
13	Recreation club	30mt X 30mt=900		900
		Total area		6325
		Add 15 % passage area		950
		Add 10% service area		632
		Add 10% structure area		632
		Total of built up		8540
14	Open exhibition ground			5 0,000
		Grand Total of Area		5.85 Ha.

Convention centre:

The Indian Convention Industry is currently at a nascent stage, contributing only a small proportion of the world conventions business. In terms of number of meetings, India has a share of 1% and in terms of delegate arrivals/ participation, 0.7% of the world figures.

As per the study conducted by Ministry of Tourism, the conventions/conference market is estimated at Rs. 4,000-5,500 crores annually. The entire tourism sector accounts for 2.2 percent of GDP (2005 estimates) of which conventions tourism contributes around 5-7 percent of total tourism revenues, comparable to that in other convention destinations but small in terms of India's potential. Conferences and tradeshows are the most important categories of events. A few venues account for the bulk of events and certain sectors such as the medical and pharmaceutical industries predominate. Participation is largely domestic and there is considerable seasonality in the conventions industry.

India is at an inflection point as far as the conventions and conferences business is concerned. With the emergence of India as a key economic hotspot along with China, and the country's recent tourism boom (with an increase in inbound travel from several international destinations for leisure, business and medical tourism), convention tourism has enormous possibilities in the country. India is growing strength in the Information Technology arena, as well the booming civilian Airlines industry has prompted prominent international bodies to host trade shows and conventions in the country and similar prominence in the bio-technology area and manufacturing sector is also expected to bring convention revenues to the country in the coming years.

Four metro cities (New Delhi, Mumbai, Kolkata, Chennai) and 6 other locations (Bangalore, Hyderabad, Kochi, Agra, Jaipur and Goa) account for more than 70% of all conventions held in India.

Convention Facilities in Goa:

The International Convention Centre at Panaji, caters to the growing need for a proper convention facility in this city/ state. Currently, the Hotels having conference facilities are Fort Aguada Beach Resort, The Leela Goa, Majorda Beach Resort, Cidade De Goa, Part Hyatt Goa Resort and Spa, Goa Marriott Resort, Taj Exotica Goa etc. Most of these hotels have capacities for 300-450 delegates.

Proposed Convention Center:

Based on the above it is proposed to develop convention facility of 1000 delegates over an area of 5 ha. Apart from the main hall of 1000 capacity, smaller break-out rooms/meeting rooms (1 room of 100 pax, 2 rooms of 50 pax and 2 rooms of 30 pax) have also been proposed.

The convention center has good revenue potential and Goa is one of the most appropriate destinations of India for such facilities. Hence it is proposed to develop the convention center of 1000 delegates' capacity by 2025.

8.1.5 Residential Township:

The airport activates as well as associated commercial activities will generate employments in turn housing need for the people. Ultimate area required for staff housing is 0.8 Ha.

8.1.6 Logistic Facilities:

The logistics facilities are proposed to be located in the proximity to the Cargo Terminal /Hangers to have shortest distance and smooth flow of goods. It is also provided away from other commercial activities like hotels, shopping plaza, office space, visitors and convention centre to avoid traffic disturbances generated by the goods movements.

The Key Success Factors of providing Air Cargo Facilities are listed below. The planning has been done considering these factors.

- a. Identification of a viable market
- b. Highly focused positioning strategy
- c. Geographic Proximity to Demand
- d. Efficient Airside Infrastructure
- e. Efficient Cargo Handling Facilities
- f. Effective Ground Handling Equipment
- g. Smooth Customs Clearance
- h. Efficient Road Access

The proposed complex for logistic facility would include following activities:

- a. logistic operators offices
- b. custom clearing offices
- c. Warehouses
- d. Cold storages
- e. packaging centre
- f. Truck parking, drivers facilities, petrol pumps and other support services

Demand Assessment and Component Sizing:

- As per the UDPFI norms the land requirement is 1 ha Per 300 Tones of daily goods inflow into the complex.
- It is estimated that by the year 2045 total cargo handled would be 41406 Tones per annum
- Assuming 3 days cycle for the cargo the storage space requirement by the year 2045 would be 1 ha.
- Considering the UDPFI norms the components and area requirements are as follows :

Table 8.6: Logistics facility program

Use	Percentage Area (as per UDPFI Norms)	2020	2025	2035	2045
Transport operators office , godowns etc	30 %	0.45	0.6	0.8	1.5
Service industry petrol pump	6 %	0.40	0.5	0.8	1.2
Public /semi public police post, post office, telephone, first aid etc.	3%	0.35	0.45	0.80	1.2
Government Offices	3%	0.35	0.45	0.80	1.2
Parking	18%	0.40	0.50	0.80	1.35
Open spaces	10%	0.40	0.50	0.80	1.25
Circulation	28%	0.45	0.55	0.80	1.45
Others	2%	0.35	0.45	0.80	1.15
Total	100%	3.15	4.00	6.40	10.3
Total Area Requirement (including Storage Space (ha)		3.00	4.35	7.12	11.43

Total Area Requirement would be: Storage Space + other components

1.13 ha + 10.3 ha

11.43 ha

Say 12 ha

T

he total area required for Public amenities, Hotels, Shopping mall, Visitor's centre, Exhibition ground, convention centre, residential centre and logistic facilities will be 53.43 ha

CHAPTER 9

ENVIRONMENTAL COST BENEFIT ANALYSIS

9.0 ENVIRONMENTAL COST BENEFIT ANALYSIS

Finally, before the construction of new International Airport started, we also have to look at the cost benefit analysis.

9.1 INTERNAL RATES OF RETURN

It is expected by the development of new airport will give economic return to the state. By encouraging more investors and tourists throughout the world come to Goa, it is belief it will increase the demand for local industries especially in hotel and resorts, restaurants and so forth as the new interesting place to visit. A large position of investment is required to develop this airport. Therefore, the margin rate of return also should be high.

9.2 ECONOMIC BENEFITS

The new airport also will give economic benefit to the state. According to economic analyst, the major benefits will be (i) incremental net visitor expenditures, (ii) time savings of passengers, and (iii) the value of foregone passenger and cargo traffic. Besides that, the cost savings in domestic aircraft operation and time landed in the airport will also included in the analysis.

9.3 PROJECT COSTS

The allocation of the project cost will be approved by the government. This cost includes the following:

- (i) civil works,
- (ii) construction
- (iii) equipment and its installation, and
- (iv) consulting engineering design and supervision.

Besides that, the abatement cost also should take into consideration in order to reduce the pollution which will harm the community and human beings.

9.4 MONITORING AND REPORTING COSTS

During the construction period, the monitoring process should be required in order to make sure that the construction of the airport is according to the schedule and the quality of the building is according to the world standard. Therefore, it will incur some cost that should be borne by the contractor. The minor cost of the equipment required for monitoring environmental impacts is also included in the project cost.

9.5 NONQUANTIFIED ENVIRONMENTAL IMPACTS

The construction of the new airport also will produce the non quantified environmental impacts from airport development and increased other development off-site, including noise pollution, air pollution, and surface water pollution, were considered marginal, and additional economic assessment. Therefore, as mentioned earlier, the abatement cost also should be included in the project cost.

CHAPTER 10

ENVIRONMENTAL MANAGEMENT PLAN

10.0 ENVIRONMENT MANAGEMENT

Environmental Management Plan (EMP) is planning and implementation of various pollution abatement for any proposed project. The EMP lists out all these measures not only for the operational phase of the plant but also for the construction phase and planning phase. The EMP is prepared keeping in view all possible strategies oriented towards impact minimisation.

The EMP for the proposed project is divided into two phases i.e. Construction and Operational phase. The construction and operational phase details out the control/abatement measures to be adopted during these phases.

10.1 CONSTRUCTION PHASE

The overall impact of the pollution on the environment during construction phase is localised in nature and is for a short period. However, the control of Environmental pollution during construction phase even though for a shorter period is of vital importance. The required mitigatory measures with complete details have been considered. In order to develop effective mitigatory measures, it is important to conceive the specific activities during construction phase causing environmental pollution.

The following subsections describe the mitigatory measures to be taken for controlling the pollution/disturbance of the environment during construction phase.

10.1.1 AIR ENVIRONMENT

The suspended particulate pollution generated during transportation will be mitigated by proper planning of bringing the construction material, to avoid traffic disturbances and dust generation. Any significant dust generation activities shall be carried out in night time as possible.

10.1.2 NOISE ENVIRONMENT

Noise emissions from construction equipment will be kept to a minimum by regular maintenance. Heavy and noisy construction work will be avoided during night time.

10.1.3 WATER ENVIRONMENT

The drinking and sanitation facilities will be provided to the construction workforce. This is necessary to reduce pollution of any receiving water body and also to prevent hazards due to water borne vectors. Potable water shall be provided to the workers.

10.1.4 SOCIO ECONOMIC ENVIRONMENT

- Local population is to be employed to the extent possible.
- Adequate facilities, such as water supply and sanitation, are to be provided to the labourers.
- Timely off-loading of trucks (construction materials) is to be ensured to minimize their waiting period.

10.1.5 LAND ENVIRONMENT

For the construction of buildings and other structures following building material are proposed. These building materials with low carbon foot print and very low embodied energy in use shall be promoted for building material apart from quarrying material.

- a) Industrial waste fly ash can be used as alternative construction material. Fly ash has the properties of cement and very low embodied energy is used. in combination with cements. Fly ash can be use in building blocks, reinforce concrete also in plaster and masonry.
- b) Pre-cast hollow concrete blocks: These are manufactured using lean cement concrete mixes and extruded through block-making machines of egg laying or static, type, need lesser cement mortar and enable speedy construction as compared to brick masonry; the cavity in the blocks provide better thermal insulation, and also do not need external/internal plastering.
- c) Pre-cast stone blocks: Pre-cast stone blocks are of larger size than normal bricks. These are manufactured by using waste stone pieces of various sizes with lean cement concrete and enable a rationalized use of locally available materials. This saves cement, reduces thickness of stone walls, and eliminates the use of plasters on internal/external surface. Use native or quarried stone where available within the delivery radius <100–150 kms, which has a very low-embodied energy content, negligible transport energy costs, and needs only shaping. Light weight stone, which is made from cement and recycled aggregates or furnace clinkers, can also be a resourceful option.
- d) Perforated brick masonry: Perforated brick masonry comprises of high strength hollow bricks with perforations of 50%–60%. These perforations act as sound and heat insulators and provide considerable savings in materials.
- e) Stabilized compressed earth blocks: These blocks are made up of mud stabilized with 5% cement lime and compacted in block-making machines with no burning. The soil to be used for the blocks should have the requisite component of clay, silt, and sand. Soil-stabilized hollow and interlocking blocks can provide better thermal insulation
- f) Composite ferrocement system: This system is simple to construct and made of ferrocement, that is, rich mortar reinforced with chicken and welded wire mesh. This system reduces thickness of the wall and allows larger carpet area. Pre-cast ferrocement units in trough shape are integrated with RCC columns. Ferro cement units serve as a permanent skin unit and a diagonal strut between columns. Inside cladding can be done with mud blocks or any locally viable material.
- g) Alternatively, rapidly renewable materials/products, which are made from small diameter trees and fast growing low utilized species harvested within a 10 year cycle or shorter such as bamboo, rubber, eucrasia, eucalyptus, poplar, jute/cotton stalks, and so on. Rubber trees are grown to harvest rubber and at the end of their useful life, they are cut down. Thus, rubber tree wood can be utilized as a substitute for other woods. Bamboo is a rapidly renewable plant, which grows in 4–7 years. Thus, products made from bamboo can also be utilized. These products include engineered products, bamboo ply boards, rubber, jute stalk boards, and so on.
- h) Composite wood products such as hardboards, block boards, lumber-core plywood, veneered Panels, particleboards, medium/low density fiberboards made from recycled wood scrap from sawmill dusts or furniture industry bonded with glue or resin under heat and pressure, can also be used as low-energy finishes in interiors/partition walls.

- i) Products, which utilize industrial waste such as wood waste, agricultural waste, and natural fibres like sisal, coir, and glass fibre in inorganic matrices like gypsum, cement, and other binders such as fibrous gypsum plaster boards etc. can also be used.
- j) Products, which use recycled materials like glass, crushed stone and other waste, such as terrazzo or which are resource efficient finishes such as finished concrete flooring, ceiling tiles, and ceramic tiles are useful.

Gypsum board partitions use 92% gypsum, which can either be sourced naturally or is produced as a by-product of power plants. Thus, gypsum used for partitions can contain 100% postindustrial recycled content. Gypsum has high recyclability potential as well

10.2 OPERATION PHASE

It is envisaged that with strict adherence to the pollution prevention and control measures during the design stage of the complex, the environmental impacts could be moderated to the minimum possible level during the operation phase.

The environmental management plan during the operational phase shall therefore be directed towards the following :

- Ensuring the operation of aircrafts as per specified international aviation standards.
- Strict adherence to maintenance schedule for various machinery/equipment.
- Good House keeping practices.
- Post project environmental monitoring.

The following subsections discuss in brief the management plan for individual components of environment.

10.2.1 AIR ENVIRONMENT

In-plant Control Measures

Some of the important operational measures which can reduce the impact on air environment are as follows:

- Movement of cargo buses, passenger buses and other vehicles to be planned properly to reduce vehicular emissions.
- Scheduling of aircrafts to have minimum number of cars in the parking to be carried out.

Ambient Air Quality Monitoring

At present ambient air quality at the airport and the surrounding area is measured on continuous/periodic basis with six number of monitoring stations. The pollutants monitored are SPM, RPM, SO₂, NO_x, CO and HC. The monitoring of these pollutants will be continued in future also, on periodic basis.

DG set stack height

Minimum stack height shall be provided as per CPCB guidelines.

10.2.2 NOISE ENVIRONMENT

Proper management and allocation of aircrafts stopping areas is to be carried out to avoid noise disturbances to staff for cleaning and maintaining the aircrafts. Also at present noise monitoring is carried out at seven locations which shall be continued in future also, on periodic basis.

Following measures are adopted in the design of airport buildings to reduce impact of the noise in operation phase:

- The terminal building shall be provided with sound absorbing material such as acoustical tile, carpets and drapes placed on ceiling floor or wall surface.
- Provision of adequate provisions at the airport to allow aircrafts to avoid over running on auxiliary power units during turn around time.
- DG sets shall be provided with acoustic enclosure
- Noise levels shall be monitored continuously.

10.2.3 WATER ENVIRONMENT

Rainwater harvesting and drainage pattern study have been done in the project site area. The details of the same have been described in section 5.3.2 and section 5.3.3 of chapter 5.

The wastewater generated at the new international terminal shall be collected and treated and reused in irrigation of landscape/gardening, flushing of urinals and toilets.

10.2.4 SOCIO-ECONOMIC ENVIRONMENT

Expansion of air port will have positive impacts such as increase in tourism, transportation, communication, employment generation, and revenue income to state government. The local population is to be given opportunities afforded by the increased economic activities in the area.

Energy Conservation measures

Properly implemented energy saving measures may reduce considerable amount of expenditure and emission of green house gases. Various measures have been envisaged in the Project area to conserve energy.

The suggested measures are as follows:

- a) Use of CFL/LED.
- b) Use of Low-pressure sodium lamps for outdoor lighting along the road and security lighting with Solar Street Lights mix.
- c) Solar lighting will be provided in the main control room and in areas where safety related equipment are located.
- d) Use of solar water heaters for hospital, guest house.
- e) Automatic timing control mechanism will be incorporated in the street lighting to save energy. Mechanism will involve staggering of on-off sequence of street lights.
- f) Designing the structures having proper ventilation and natural light.
- g) The hostels, guest house, hospital etc. shall have solar water heating systems. The street lights shall have 20% mix of solar lights.
- h) The street lighting shall be controlled by staggering of putting on-off of lights in particular sequence.

Use of Renewable and Alternate Source of Energy

A detailed survey of the site is carried out during environmental data collection for use of renewable and alternate source of energy such as wind energy and solar energy. However, based on techno-economic considerations, the following are suggested:

- a) Use of solar heaters and solar lights at public buildings such as guest houses, canteens, hospital etc
- b) Use of solar lights for street lighting limited to 20%. The street lighting shall be controlled by staggering of putting on-off of lights in particular sequence.

10.2.5 LAND ENVIRONMENT

The main solid waste generated from the airport like plastic cups, office waste and food material. Solid waste collected during operation phase will be disposed in disposal facility owned by Government of Goa.

Hazardous waste management: From Airport, used oil, lubricants, electronic wastes shall be generated and the same shall be disposed through SPCB authorized reprocessor. Used batteries will be given to dealer as part of buy back arrangement.

10.3 HEALTH AND SAFETY

In order to provide safe working environment and safeguard occupational health and hygiene, the following measures will be undertaken:

- Exposure of workers to hazardous/toxic substances will be minimized by adopting suitable engineering controls.
- All the employees shall be trained in Health, Safety and Environment (HSE) aspects related to their job.
- Periodic compulsory health check up will be carried for all the site employees. Particular attention will be given to respiratory and hearing disorders. The yearly statistics along with observations will be reported each year to the chief executive of the plant.

10.4 GREENBELT DEVELOPMENT PLAN

A proper greenbelt plan for Mopa International airport is envisaged in the design phase. The greenbelt development should be met the 33% of total area as per MoEF stipulated norms. The greenbelt programme is proposed in phased manner.

Guidelines for Plantation

The plant species identified for greenbelt development will be planted using pitting technique. The pit size will be either 45 cm x 45 cm x 45 cm or 60 cm x 60 cm x 60 cm. Bigger pit size is preferred on marginal and poor quality soils. Soil proposed to be used for filling the pit will be mixed with well decomposed farm yard manure or sewage sludge at the rate of 2.5 kg (on dry weight basis) and 3.6 kg (on dry weight basis) for 45 cm x 45 cm x 45 cm and 60 cm x 60 cm x 60 cm size pits respectively. The filling of soils will be completed at least 5 - 10 days before the actual plantation. Healthy seedlings of identified species will be planted in each pit.

Species Selection

Based on the regional background and soil quality, greenbelt will be developed. In greenbelt development, monocultures are not advisable due to its climatic factor and other environmental constrains. Greenbelt with varieties of species is preferred to maintain species diversity, rational utilization of nutrients and for maintaining health of the trees. Prepared in this way, the greenbelt will develop a favorable microclimate to support different micro-organisms in the soil and as a result of which soil quality will improve further.

During the course of survey, it has been observed that the soil quality of the plant site is fairly good and can support varieties of dry deciduous plant species for greenbelt development. Manure and vermin-compost may be mixed with the soil used for filling the pit for getting better result for survival of plant species. Adequate watering is to be done to maintain the growth of young seedlings. Based on the regional background, extent of pollution load, soil quality, rainfall, temperature and human interactions, a number of species have been suggested to develop greenbelt in and around the proposed airport. These species can be planted in staggering arrangements within the airport premises. Some draught resistant plant species have been identified which can be planted for greenbelt development if sufficient water is not available. The suitable species for greenbelt development programme are given in Table 10.1.

Table 10.1 List of tree species suggested for green belt development

Sl. No.	Binomial name	Family	Type of planting
	<i>Anthocephalus cadamba</i>	Rubiaceae	All areas
2.	<i>Alstonia scholaris</i>	Apocynaceae	All areas
3.	<i>Bambusa arundinaceae</i>	Poaceae	Parking areas
4.	<i>Bambusa vulgaris</i>	Poaceae	Roadside
5.	<i>Calophyllum inophyllum</i>	Clusiaceae	All areas
6.	<i>Couroupita guianensis</i>	Lecythidaceae	All areas
7.	<i>Hibiscus tiliaceous</i>	Malvaceae	All areas
8.	<i>Lagerstroemia reginae</i>	Lythraceae	All areas
9.	<i>Bassia latifolia</i>	Sapotaceae	All areas
10.	<i>Ailanthes excelsa</i>	Simaroubaceae	Avenue trees
11.	<i>Mangifera indica</i>	Anacardiaceae	Avenue trees
12.	<i>Manilkara hexandra</i>	Sapotaceae	All areas
13.	<i>Mimusops elengi</i>	Sapotaceae	All areas
14.	<i>Plumeria acuminata</i>	Apocynaceae	Roadside
15.	<i>Plumeria alba</i>	Apocynaceae	Roadside
16.	<i>Plumeria rubra</i>	Apocynaceae	Roadside
17.	<i>Syzygium cumini</i>	Myrtaceae	All areas
18.	<i>Terminalia arjuna</i>	Combretaceae	Avenue trees
19.	<i>Terminalia catappa</i>	Combretaceae	All areas
20.	<i>Thespesia populnea</i>	Malvaceae	All areas
21.	<i>Ficus benghalensis</i>	Moraceae	Avenue trees
22.	<i>Ficus religiosa</i>	Moraceae	Avenue trees
23.	<i>Ficus racemosa</i>	Moraceae	Avenue trees
24.	<i>Ficus microcarpa</i>	Moraceae	Avenue trees

Sl. No.	Binomial name	Family	Type of planting
25.	<i>Murraya paniculata</i>	Rutaceae	Roadside
26.	<i>Phyllanthus emblica</i>	Euphorbiaceae	All areas
27.	<i>Tectona grandis</i>	Verbenaceae	Avenue trees
28.	<i>Cassia siamea</i>	Caesalpiniaceae	Avenue trees
29.	<i>Cassia fistula</i>	Caesalpiniaceae	All areas

The species suggested here are commonly seen in and around the project area, fast growing and drought resistant. Seedlings / saplings of these species can be easily procured from local nurseries. The selection of plant species for the green belt development depends on various factors such as climate, elevation and soil. The plants suggested for green belt were selected based on the following desirable characteristics.

- Fast growing and providing optimum penetrability.
- Evergreen with minimal litter fall.
- Wind-firm and deep rooted.
- The species will form a dense canopy.
- Indigenous and locally available species.
- Trees with high foliage density, larger of leaf sizes and hairy on surfaces.
- Ability to withstand conditions like inundation and drought.
- Soil improving plants, such as nitrogen fixing plants, rapidly decomposable leaf litter.
- Attractive appearance with good flowering and fruit bearing.
- Bird and insect attracting plant species.
- Sustainable green cover with minimal maintenance
- Species which can trap/sequester carbon

In addition, a lawn and floral garden with the varieties of small flowering plants may be developed near the office site for aesthetic value of the entire complex.

Plantation scheme

Plant sapling will be planted in pits of about 3.0 to 4.0 m intervals so that the tree density is about 1500 trees per ha. The pits will be filled with a mixture of good quality soil and organic manure (cow dung, agricultural waste, kitchen waste) and insecticide. The saplings / trees will be watered using the effluent from the sewage treatment plant and treated discharges from project. Sludge from the sewage treatment plant will be used as manure. In addition kitchen waste from plant canteen can be used as manure either after composting or by directly burying the manure at the base of the plants. Since, tests have shown that availability of phosphorus, a limiting nutrient, is low, phosphoric fertilisers will also be added. The saplings will be planted just after the commencement of the monsoons to ensure maximum survival. The species selected for plantation will be locally growing varieties with fast growth rate and ability to flourish even in poor quality soils.

A total of more than 33% of total project area will be developed as green belt or green areas in project area and other areas. The greenbelt will be developed along the project boundary, depending on the availability of space. The areas, which need special attention regarding green belt development in the project area, are:

1. Parking areas
2. Entrance and exit points
3. Vacant Areas of the airport
4. Around Office Buildings, Garage, Stores etc.
5. Along Road Sides (Avenue Plantation)

Post plantation care

Immediately after planting the seedlings, watering will be done. The wastewater discharges from different sewage treatment plant / out falls will be used for watering the plants during non-monsoon period. Further watering will depend on the rainfall. In the dry seasons watering will be regularly done especially during February to June. Watering of younger saplings will be more frequent. Organic manure will be used (animal dung, agricultural waste, kitchen waste etc.). Younger saplings will be surrounded with tree guards. Diseased and dead plants will be uprooted and destroyed and replaced by fresh saplings. Growth / health and survival rate of saplings will be regularly monitored and remedial actions will be undertaken as required.

10.5 ESTIMATED COST FOR IMPLEMENTATION OF ENVIRONMENTAL MANAGEMENT PLAN

Considering all measures suggested above, cost is worked out for implementation of environmental management plan and is given in Table 10.2 and Table 10.3 . The total estimated budget for implementation of EMP is worked out as Rs. 300.0 Lakhs towards capital cost and Rs.90.0 Lakhs towards recurring cost per anum.

Table 10.2: BUDGET OF ENVIRONMENTAL MANAGEMENT PLAN (Capital Cost)

Sl. No.	Activity	Site A	Time Frame*
		(Rupees in Lakhs)	in years
1	Air Environment		
1.1	Plantation Activities	300	1
2	Noise Environment		
2.1	Plantation Activities	Included in 1.1	Included in 1.1
2.2	Audiometric tests	1	1.5
3	Water Environment		
3.1	Rain water Harvesting pits	15	0.5
3.2	storage tank for treated wastewater and distribution network	2	0.5
4	Land Environment		
4.1	Plantation Activities	Included in 1.1	Included in 1.1
4.2	Solid waste management tracking and development of manure pits	2	1
5	Biological Environment		
5.1	Plantation Activities	Included in 1.1	Included in 1.1
6	Corporate Social Responsibility		
6.1	Energy Conservation Measures	10	2
6.2	Use of Renewable Sources of Energy	5	2
6.3	Development of Carbon Manual & carbon footprint software	15	2
6.4	Infrastructure upgradation for Education & Health	20	2

6.5	Support for teaching aids and medical equipment	10	2
	Budget for EMP (Capital Cost)	380	

* Time frame: time required for completion of the activity from the date of completion of Airport

**Table 10.3: BUDGET OF ENVIRONMENTAL MANAGEMENT PLAN
(Recurring Cost per Anum)**

Sl. No.	Activity	Cost (Rupees in Lakhs)
1	Air Environment	
1.1	Plantation Activities	80
2	Noise Environment	
2.1	Plantation Activities	Included in 1.1
2.2	Audiometric tests	0.5
3	Water Environment	
3.1	Rain water Harvesting pits	0.5
3.2	storage tank for treated wastewater and distribution network	0.2
3.3	Training for marine environmental monitoring	0.6
4	Land Environment	
4.1	Plantation Activities	Included in 1.1
4.2	Solid waste management tracking and development of manure pits	1
5	Biological Environment	
5.1	Plantation Activities	Included in 1.1
6	Corporate Social Responsibility	
6.1	Energy Conservation Measures	2
6.2	Use of Renewable Sources of Energy	1
6.3	Development of Carbon Manual & carbon footprint software	5
	Total Amount	25.5
	Total amount for the complete project	80
6.4	Awareness and Community Development Programmes (Neighbouring and Periphery Areas)	10
	Budget for EMP (Recurring Cost per Anum)	90

All activities shall be monitored every 6 months

CHAPTER 11

CONSULTANT'S DISCLOSURE

11.0 INTRODUCTION

Environment Division of Engineers of India Limited (EIL) was established in 1975 with the objective of providing specialised services in the field of environment protection to the different industrial sectors served by EIL. The division is assisted by a multi-disciplinary team with engineers and scientists with experience ranging from seven to thirty years or more and equipped with the latest computer software and hardware. It is capable of providing the entire range of services related to environmental pollution assessment, control and management to the following major sectors of industry in India and abroad:

- Airports
- Petroleum Refining
- Petrochemicals
- Oil and Gas Processing
- Metallurgy (Non-Ferrous only)
- Thermal Power Plants
- Infrastructure projects

EIL is also capable of providing environment related services for various other industries like textile, leather, pulp and paper etc. besides the different industries mentioned above. The Division has a unique advantage of utilising technological and engineering competence and experience, which is available to them in house from other specialised departments of EIL to provide the entire range of services related to environmental management.

The Division has been instrumental in designing and commissioning a large number of industrial water treatment plants, wastewater treatment plants, Environmental Impact Assessment (EIA) studies and solid and hazardous waste management. During the past two decades, several schemes have been implemented for handling wastewater as well as gaseous effluents, solid as well as hazardous wastes so that these meet the stringent regulations imposed by statutory authorities from time to time.

Much of the Division's rich and varied experience is derived from the experience of working with International funding agencies like the World Bank, International Financial Consortium and Asian Development Bank etc. The Division has worked for many World Bank funded jobs including the one concerning development of guidelines for carrying out environmental audits for small and medium scale industries. Many of these projects being grass root projects in nature have large socio-economic and cultural dimensions besides the associated environmental problems.

The present EIA report has been prepared by EIL, an engineering and consultancy organization in the country. EIL has been preparing regularly EIA / EMP reports for different projects. The environmental Engineering Division of EIL has carried out more than 300 numbers of Environmental Impact Assessment projects.

National Accreditation Board for Education and Training (NABET) - under the Accreditation Scheme for EIA Consultant Organizations has accredited EIL as EIA consultant for 10 EIA Sectors including Petroleum Refining industry. The list of sectors for which the accreditation has been accorded by NABET is published by NABET-QCI as Minutes of Meeting (MOM) in NABET website "www.qcin.org" and the same MOM is given in Fig 11.1.

Fig 11.1: Minutes of Meeting showing EIL as EIA Consultant Organization accredited by NABET-QCI

NATIONAL ACCREDITATION BOARD FOR EDUCATION & TRAINING			
QUALITY COUNCIL OF INDIA			
QCI Office, 7 th Floor, ITPI Building, Ring Road, I.P. Estate, New Delhi			
Scheme for Accreditation of EIA Consultant Organizations			
Minutes of 9 th Accreditation Committee Meeting for Re-Accreditation held on			
Jan. 10, 2014			
Present			
1.	Prof. C. K. Varshney	-	Member
2.	Prof. A. K. Maitra	-	Member
3.	Dr. B. Sengupta	-	Member
Leave of absence was granted to Dr. Prodipto Ghosh, Dr. A. N. Jha, Sh. K. P. Nyati and Sh. Chandra Bhushan. Prof. Varshney chaired the meeting.			
NABET Secretariat was represented by:			
Mr. A. K. Ghose – Principal Advisor, Dr. Hari Prakash – Joint Director and Mr. Abhay Sharma			
The following were discussed/ decided:			
1.	The minutes of 8 th RA AC meeting dated Dec. 18, 2013 were considered and approved.		
2.	Cases covering clarifications		
	i.	Ghosh Bose & Associates Pvt. Ltd., Kolkata	
	ii.	Engineers India Limited, Gurgaon	
	iii.	Kadam Environmental Consultants, Vadodra	
	iv.	Anacon Laboratories, Nagpur	
	v.	B S Envitech Pvt. Ltd., Hyderabad	
	vi.	Ramky Enviro Engineers, Hyderabad	

2.2 Engineers India Limited, Gurgaon (EIL)

Case of EIL was discussed earlier in RA AC meeting dated Dec. 6, 2013 and kept on hold for a) non-receipt of payments against assessment and b) pending further details on EIA related experience in SHW for Sh. P. K. Goel and Sh. Mayank Gupta. EIL has cleared the pending dues, however, experience submitted for Sh. Goel and Sh. Gupta was not found complete and further details with respect to work carried in SHW were sought to assess the actual work.

Closure action taken by EIL on NCs and Obs. raised in SA were verified.

Results of the Re-accreditation (RA) assessment are given below:

The ACO has overall obtained more than 60% marks and therefore qualifies for Cat. A. However, in respect of Completeness & quality of EIAs prepared, the marks are less than 60 % indicating scope of improvement vide points mentioned below in relevant section.

2.2.1 Scope of Accreditation

Sl. No.	Sector No. as NABET Scheme	Name of Sector	Cat.
1	1 (OC)	Mining of minerals – open cast only	On Hold
2	4	Thermal power plant	A
3	8	Metallurgical industry (Non Ferrous only)	A
4	10	Petroleum refining industry	A
5	16	Chemical Fertilizers	A
6	18	Petrochemical complexes	A
7	27	Oil & Gas transportation pipelines	A
8	29	Airports	A
9	32	TSDf	B
10	33	Ports and Harbours	A
11	39	Township and Area development projects	B

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