ENVIRONMENTAL IMPACT ASSESSMENT AND RAPID RISK ASSESSMENT STUDY FOR NATURAL GAS PIPELINE PROJECT FOR KRISHNAGIRI-COIMBATORE PIPELINE SECTION OF KOCHI – KKBMPL-II PROJECT OF M/s GAIL (INDIA) LIMITED

Report No.: B411-RP-1742-2301 R1 **February 2024**

Project Proponent:

GAIL (India) Limited

Environmental Consultant:

इंजीनियर्स इंडिया लिमिटेड ENGINEERS INDIA LIMITED

Baseline Data Collection Agency:

M/s Idma Laboratories Limited, Panchkula, Haryana

Baseline Data Collection Period:

December 2021 to March 2022

Category- A

Sector – 27 (NABET) & Sector - 6(a) (MoEFCC)

EIL - CERTIFICATE NO.: NABET/EIA/21-24/SA 0214

ENVIRONMENTAL IMPACT ASSESSMENT AND RAPID RISK ASSESSMENT STUDY REPORT FOR NATURAL GAS PIPELINE PROJECT
FOR
KRISHNAGIRI-COIMBATORE PIPELINE SECTION
OF
KOCHI – KKBMPL-II PROJECT
OF
M/s GAIL (INDIA) LIMITED

Rev. No	Date	Purpose	Prepared by	Reviewed by	Approved by
1	26.02.2024	ISSUED AS FINAL	RM/ CP/ VS	PKG	PKG
0	11.12.2023	ISSUED FOR COMMENTS	RM/ CP/ VS	PKG	PKG

DECLARATION BY EXPERTS CONTRIBUTING TO THIS REPORT

Declaration by experts contributing to the EIA / RRA Study for Natural Gas Pipeline Project for Krishnagiri - Coimbatore Pipeline Section of Kochi– KKBMPL-II Project of M/s GAIL (INDIA) Limited

I, hereby, certify that I was a part of the EIA team in the following capacity that developed the above EIA which is coming under Category A – "Oil & gas transportation pipeline (crude and refinery/petrochemical products)", Sector 27 as per NABET Scheme & Category 6 (a) (MoEFCC) as per 2006 EIA Notification.

EIA COORDINATOR:

Name: Parveen Kumar Goel

26/02/2024

Signature & Date:
Email: [illegible]

FUNCTIONAL AREA EXPERTS:

Functional Areas	Name of the experts	Involvement (Period & Task)	Signature
AP	Jayant Kumar Joshi / Dr. Srikumar Malakar	September, 2021 – February, 2024 Identification of impacts on AP and suggesting mitigation measures.	
WP	Parveen Kumar Goel	September, 2021 – February, 2024 Review of proposed water requirements for the project, verification and analysis of baseline data, impact assessment, and preparation of environmental management plan for water environment.	
SHW	Parveen Kumar Goel	September, 2021 – February, 2024 Identification of storage and disposal of solid and hazardous waste for the proposed plant. Finalization of Environmental Monitoring Plan and Environmental Management Plan.	

SE	Raja Subbaratna Prasad	September, 2021 – February, 2024 Review of demographic characteristics, and supervision of baseline data collection. Collection and analysis of perception study carried out for the proposed project.	
EB	Dr. Chiranjibi Pattanak	September, 2021 – February, 2024 Site visit, 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.	
HG	Parveen Kumar Goel	September, 2021 – February, 2024 Assessment of ground water sampling results with available secondary data to interpret current conditions.	
AQ	Raja Subbaratna Prasad	September, 2021 – February, 2024 Verification of meteorological data, air quality assessment, air quality impact assessment, Preparation of environmental management plan for the proposed project.	
NV	S.V.R. Subramanyam	September, 2021 – February, 2024 Verification of noise and traffic baseline data, impact assessment, Preparation of environmental management plan for noise environment.	
LU	Raja Subbaratna Prasad	September, 2021 – February, 2024 Assessment of soil sampling results with available secondary data to interpret current conditions.	
RH	Deepak Kumar	September, 2021 – February, 2024 The Rapid Risk Assessment Report is prepared for the proposed project considering all safety measures.	
SC	Raja Subbaratna Prasad	September, 2021 – February, 2024 Sampling and analysis of soil parameters, assessment of impacts on soil and mitigation measures for soil conservation.	

TEAM MEMBER DETAILS

EIA Coordinator	Name of the Team Member	Involvement (Period & Task)
Sector 27	Ravikant Sharma R Menaka	September, 2021 – February, 2024 **Assist to Mr. Parveen Kumar Goel**, EIA Co-ordinator in Sector 27.
Functional Areas	**Name of the Team Member**	**Involvement (Period & Task)**
AP, AQ	Divya Dutta	September, 2021 – February, 2024 **Assist to Mr. J. K. Joshi & Dr. Srikumar Malakar for:** Identification of impacts on AP and suggesting mitigation measures. **Assist to Mr. R. S. Prasad for:** Verification of meteorological data, air quality assessment and impact assessment, Preparation of environmental management plan for the proposed project.
HG	R Menaka	September, 2021 – February, 2024 **Assist to Mr. Parveen Kumar Goel for:** Assessment of ground water sampling results with available secondary data to interpret current conditions.
LU, SC	Ravikant Sharma	September, 2021 – February, 2024 **Assist to Mr. R. S. Prasad for:** Assessment of soil sampling results with available secondary data to interpret current conditions. Sampling and analysis of soil parameters, assessment of impacts on soil and mitigation measures for soil conservation.
NV	Krishnakant Venkata Pudipeddi	September, 2021 – February, 2024 **Assist to S.V.R. Subramanyam for:** Verification of noise and traffic baseline data, impact assessment, Preparation of environmental management plan for noise environment.

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

I, Parveen Kumar Goel, hereby, confirm that the above mentioned experts prepared the **EIA / RRA Study for Natural Gas Pipeline Project for Krishnagiri - Coimbatore Pipeline Section of Kochi– KKBMPL-II Project of M/s GAIL (INDIA) Limited**

I, also confirm that the consultant organization shall be fully accountable for any misleading information mentioned in the statement.

Signature:

Name	: Mr. Parveen Kumar Goel
Designation	: Head – EIA & Sustainability and Water
Name of the EIA Consultant Organization	: Engineers India Limited (EIL)

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXURES

CHAPTER – 1

INTRODUCTION

1.0 INTRODUCTION

GAIL (India) Limited, is executing Kochi–Koottanad–Bangalore–Mangalore Natural Gas Pipeline (KKBMPL) project in two phases. Pipelines under Phase-I have been completed and commissioned. Under Phase-II, 30”/24” trunk-lines are being laid covering the states of Kerala, Karnataka & Tamilnadu. Execution of Phase-II is divided into various sections and these are at various stages of completion.

GAIL has entrusted Engineers India Limited (EIL) for preparing EIA report for the part of Krishnagiri – Coimbatore pipeline section of KKBMPL-II. EIL is also the Project Management Consultancy (PMC) for execution of Krishnagiri – Coimbatore section of KKBMPL-II.

1.1 BRIEF DESCRIPTION OF THE NATURE OF PROJECT

The KKBMPL project is having a total main pipeline length of approx. 890 km excluding spur lines (which includes approx. 450 km of Kochi-Mangalore section and approx. 440 km of Koottanad-Bangalore).

The Krishnagiri – Coimbatore Pipeline (KCPL) section is part of Koottanad-Bangalore pipeline of KKBMPL-II in the state of Tamilnadu. The pipeline will be traversing through the states of Kerala, Karnataka and Tamil Nadu.

Project Name:	Krishnagiri - Coimbatore Pipeline Section of KKBMPL-II
Service:	Regasified LNG
Size (OD):	610 mm (24”)
From:	Krishnagiri, Tamilnadu
To:	Coimbatore, Tamilnadu

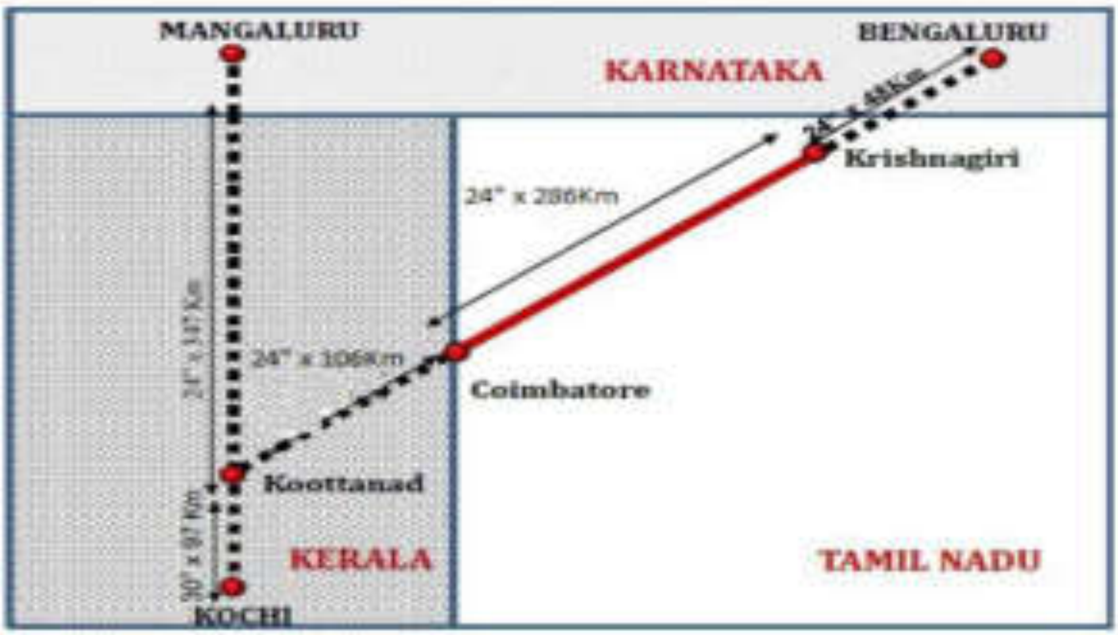


Figure -1.1: **Krishnagiri – Coimbatore Pipeline project**

The Pipeline System configuration (Under Krishnagiri - Coimbatore Section) has been finalized based on Route Survey details and the locations of Intermediate Pigging Stations & SV Stations have been determined based on spacing requirements of stations, as per PNGRB Regulations (GSR 808 E) and Location Classes of pipeline route.

Pipeline Size & Approx. Length	24" (610 mm), 293.7 km (approx.)
Stations	• Dispatch Terminal: Nil • Receipt Terminal: Nil • Intermediate Pigging Station: 02 Nos. • SVs: 17 Nos.
Material Grade of Line Pipe	API 5L Gr. X-70 PSL-2
Material of Construction for Pipeline	Carbon steel
Corrosion Allowance	• 1.0 mm for Pipeline • 1.5 mm for all Station Piping
External Coating	3 LPE Coating as per EIL Specification
Internal Coating	Liquid Epoxy Coating
Source of Natural Gas	R-LNG is sourced from M/s. Petronet LNG Limited regassification facility at Puthuvypeen with a capacity of 5.0 MMTPA / DBPL pipeline

Krishnagiri - Coimbatore Section of pipeline is also envisaged to be carried out in two phases.

Phase 1: Krishnagiri – Salem (covering Krishnagiri, Dharmapuri & Salem Districts);
Phase 2: Salem – Coimbatore (covering Namakkal, Erode, Tiruppur & Coimbatore Districts

Figure -1.2: Krishnagiri – Coimbatore Pipeline route

1.2 NEED FOR THE PROJECT

GAIL (India) Limited, the largest state-owned Natural gas Processing and Distribution Company receives lot of demand for supply of processed natural gas to various consumers. The demand is available in various industries located at Kochi, Alwaye, Palakkad, Kanjirkkod, Mangalore.

The total demand: 12 MMSCMD
Pipeline design Throughput considered: 16 MMSCMD

The total design throughput is 16 MMSCMD gas of which 12 MMSCMD for GAIL & 4.0 MMSCMD for common carrier as per authorization received from MoPNG.

The demand from various consumers are as follows.

Kochi - Alwaye	-	16.0 MMSCMD
Alwaye - FACT-1/BSES/FACT-II	-	6.0 MMSCMD
Alwaye - Kanjirkkod	-	10.0 MMSCMD
Kanjirkkod – Mangalore	-	6.0 MMSCMD
Kanjirkkod – Bangalore	-	4.0 MMSCMD

1.3 PROJECT COST AND SCHEDULE

Total Project cost including all facilities of KKBMPL pipeline system is Rs. 2817.40 crore. The cost of Krishnagiri-Coimbatore Pipeline section of Kochi – KKBMPL-II Project is 2175.97 crore.

1.4 PROJECT PROPONENT

1.4.1 Address of the Project Proponent

The correspondence address of the project proponent is:

Mr. Subhadeep Banerjee
Gen Manager (Project)
GAIL (INDIA) Limited, GAIL JUBILEE TOWER,
B35 & B36, SECTOR-1,
NOIDA, UP – 201301
Email ID: sbanerjee@gail.co.in

1.4.2 Particulars of EIA Consultant

The EIA consultant is Engineers India Limited. The complete address for correspondence is given below:

Mr. P.K. Goel
Head, EIA, Water & Sustainability Division,
Engineers India Limited,
EIL Office Complex, Sector-16, On NH-8,
Gurugram – 122001, Haryana
Email: pk.goel@eil.co.in.
Website: www.engineersindia.com

1.5 NEED & SCOPE OF THE EIA STUDY

As per project/ activity 6 (a) of Schedule of EIA Notification 2006, oil and gas transportation pipelines which do not pass through national parks, sanctuaries, coral reefs, or ecologically sensitive areas sites do not require Environmental Clearance (EC). The proposed facilities do not pass through any such areas. Therefore, EC under project / activity 6 (a) is not applicable.

However, to get No Objection Certificate (NOC) and Consent to Establish (CTE) from Tamil Nadu Pollution Control Board, An EIA study report along with Environmental Management Plan (EMP) is to be submitted.

Therefore, EIA study is carried out for the proposed pipeline Krishnagiri-Coimbatore Pipeline Section of Kochi – KKBMPL-II Project

1.6 SCOPE OF EIA

The scope of the present EIA study includes detailed characterization of existing status of various environmental components viz., air, noise, water, land, soil, traffic, flora fauna, meteorological and socio-economic conditions in and around pipeline route and 10 km surrounding the project site.

The scope of study broadly includes:

- To establish the baseline environmental status of the study area utilizing three month baseline data (December 2021 to March 2022 by M/s Idma Laboratories Limited, Panchkula (Haryana)
- Assessment of the present status of air, water, noise, traffic, land, soil, flora fauna, and socio-economic components of environment based on field surveys and available literature.
- Identification of likely impacts of various activities proposed to be undertaken during construction as well as operation phases of the project.
- Prediction and evaluating the impact of activities carried out during the construction and operational phases of the project.
- Preparation of an Environmental Management Plan (EMP), which is to be adopted for mitigation of adverse impacts and improving the environmental quality.
- Risk assessment for storage for chemicals/solvents. Action plan for handling & safety system.

1.7 CONTENTS OF THE EIA REPORT

The report has been divided into the following chapters:

Chapter-1.0: Introduction

This chapter provides background information of the proposed project, brief description and objectives of the project, description of the area, scope, methodology and organization of the study.

Chapter-2.0: Project Description

This chapter presents the background information on the proposed pipeline facilities/ activities, process being adopted, sources of pollution and control thereof.

Chapter-3.0: Description of the Environment

This chapter illustrates the description of the existing environmental status of the study area with reference to the prominent environmental attributes (Ambient Air, Noise, Ground Water, Surface Water and Soil environment, Land Use Land Cover).

The existing environmental setting is considered to adjudge the baseline environmental conditions, which are described with respect to climate, atmospheric conditions, water quality, soil quality, noise levels, vegetation pattern, ecology, and socio-economic profiles of people. The objective of this chapter is to define the present baseline environmental status within the study area. This would help in assessing the environmental impacts due to the proposed project.

Chapter-4.0: Anticipated Environment Impacts and Mitigation Measures

This chapter details the inferences drawn from the environmental impact assessment of “The project” during construction and operational phase. It describes the overall impacts of the proposed project and underscores the areas of concern which need mitigation measures.

Chapter-5.0: Analysis of Alternatives (Technology & Site)

This chapter provides Alternative analysis of site & evaluation of the different choices available to achieve a particular project management objective.

Chapter-6.0: Environment Monitoring Program

This chapter provides technical aspects of monitoring the effectiveness of mitigation measures (incl. Measurement methodologies, frequency, location, data analysis, reporting schedules, emergency procedures, detailed budget & procurement schedules).

Chapter-7.0: Additional Studies

This chapter covers risk involved in the proposed pipeline facilities, utilities as well as Rapid Risk Assessment study for pipeline section between Krishnagiri and Coimbatore.

Chapter-8.0: Project Benefits

This chapter presents the details of Local area development programmes that are being undertaken in nearby/surrounding villages along/surrounding Dispatch Terminal, Receipt Terminal & SV’s etc.

Chapter-9.0: Environmental Cost Benefit Analysis

This chapter presents the details of Environmental Cost Benefit analysis; if recommended at the scoping stage.

Chapter-10.0: Environment Management Plan (EMP)

This chapter provides recommendations for Environment Management Plan (EMP) including mitigation measures for minimizing the negative environmental impacts of the project. Environmental monitoring requirements for effective implementation of mitigate measures during construction as well as during operation of the project along with required institutional arrangements for their implementation. Budgetary cost estimates for mitigation measures are also brought out.

Chapter-11.0: Summary & Conclusion

This will constitute the summary of EIA Report.

Chapter-12.0: Disclosure of EIA Consultants

This chapter contains the list of various experts engaged in preparing the EIA report along with brief introduction of the consultancy.

CHAPTER – 2
PROJECT DESCRIPTION

2.0 GENERAL INFORMATION

GAIL (India) Limited, India's principal Gas Transmission and Marketing Company, was set up by the Government of India in August 1984 to create gas sector infrastructure for sustained development of the Natural gas sector in the country.

GAIL (India) Limited, is India's flagship Natural Gas company, integrating all aspects of the Natural Gas value chain (including Exploration & Production, Processing, Transmission, Distribution and Marketing) and its related services. In a rapidly changing scenario, GAIL is spearheading the move to a new era of clean fuel industrialization, creating a quadrilateral of green energy corridors that connect major consumption centre in India with major Gas Fields, LNG terminals and other cross border gas sourcing points. GAIL is also expanding its business to become a player in the International Market.

GAIL (India) Limited intends to carry out Environmental Impact Assessment (EIA) study for proposed Krishnagiri - Coimbatore Pipeline Section of KKBMPL-II in accordance with the relevant Gazette Notification of Ministry of Environment, Forest and Climate Change (MoEFCC). A systematic scientific study is planned to identify, estimate and assess the impact of environment.

This chapter presents detailed description of the proposed project which includes pipeline routes and associated facilities. The section also describes the associated additional utilities, resource consumption, design philosophy & operation philosophy etc.

2.1 SALIENT FEATURES

The salient features of the Krishnagiri to Coimbatore Pipeline section of the proposed gas pipeline project are described in the below sections of the chapter.

Table 2.1: Salient features of Proposed Pipeline Project

Sr. No.	Particulars	Details of Krishnagiri – Coimbatore Pipeline Section of Kochi – KKBMPL-II Project	
1)	Krishnagiri (KCPL Phase-I Start Point)	Longitude	E: 77°55'18.61"
		Latitude	N: .12°36'36.21"
		Chainage (km)	0.000
		State	Tamil Nadu
2)	Salem (KCPL Phase-I End Point) (KCPL Phase-II Start Point)	Longitude	E: 77°53'15.11"
		Latitude	N: 11°30'38.68"
		Chainage (km)	145.965 (0.000 for Phase-II)
		State	Tamil Nadu
3)	Coimbatore (KCPL Phase-II End Point)	Longitude	E: 76°53'39.75"
		Latitude	N: 10°51'29.68"
		Chainage	147.676
		State	Tamil Nadu

Table 2.1: Salient features of Proposed Pipeline Project

Sr. No.	Particulars	Details of Krishnagiri – Coimbatore Pipeline Section of Kochi – KKBMPL-II Project
4)	Total Length (a) Phase-I (Krishnagiri to Salem) (b) Phase-II (Salem to Coimbatore)	293.7 km 145.965 km 147.676 km
5)	Diameter of Pipeline	610 mm (24")
6)	Terminals (Nos.)	Nil
7)	Intermediate pigging stations (IPS) (in Nos.)	1 (Phase I) 1 (Phase II)
8)	Sectionalizing Valve Stations (SV) (in Nos.)	9 (Phase I) 8 (Phase II)
9)	Wildlife Sanctuary/ National Park	The proposed pipeline is not passing through any Wildlife Sanctuary/National Park/Eco-sensitive areas/Coral reefs/ Coastal Regulation Zones.
10)	Tree (Density)	Low
11)	Type of Soil	Predominantly Silty clay and Weathered rock (Phase-I) Predominantly Clayey Silt and Weathered rock, followed by Sand Silt-Mix and Hard rock (Phase-II)
12)	Terrain (km)	
	a) Flat	41.382 (Phase I) 0.749 (Phase II)
	b) Slightly Undulating	100.985 (Phase I) 104.620 (Phase II)
	c) Undulating	2.630 (Phase I) 42.307 (Phase II)
	d) Rolling	0.518 (Phase I) 0 (Phase II)
13)	Surface Features (Kms.)	
	(a) Along NH	102.570 (Phase I) 144.231 (Phase II)
	(b) Along SH	34.013 (Phase I) 1.918 (Phase II)
	(c) Along RoW of Road	1.657 (Phase 1) 1.527 (Phase II)
	(d) Cross Country (Reserved Forest)	5.467 (Phase I) 0 (Phase II)
	(e) Cross Country (Pvt. Land/ Govt. Land)	2.096 (Phase I) 0 (Phase II)
	(f) Cross Country (Along Railway)	0.162 (Phase I) 0 (Phase II)
14)	Road Crossing (Nos.)	

Table 2.1: Salient features of Proposed Pipeline Project		
Sr. No.	**Particulars**	**Details of Krishnagiri – Coimbatore Pipeline Section of Kochi – KKBMPL-II Project**
	(a) National Highway	02 (Phase I) 06 (Phase II)
	(b) State Highway	16 (Phase I) 21 (Phase II)
	(c) Other Roads	193 (Phase I) 261 (Phase II)
	(d) Cart Track	92 (Phase I) 129 (Phase II)
15)	Water Bodies (Nos.)	
	(a) Rivers	2 (Phase I) 5 (Phase II)
	(b) Canal / Distributary/ Minor/Field Channel	5 (Phase I) 12 (Phase II)
	(c) Drain / Nala / Stream	23 (Phase I) 65 (Phase II)
16)	Forest Areas	7.144 km
17)	Railway Crossings (Nos.)	5 (Phase I) 2 (Phase II)
	(a) B. G. Railway	5 (Phase I) 2 (Phase II)
	(a) M. G. Railway	-
18)	Utility Crossings (Nos.)	
	(a) H.T. Line/ Power Line	413 (Phase I) 510 (Phase II)
	(b) Cable Line	2 (Phase I) 1 (Phase II)
	(c) Pipeline (Hydrocarbon/Water)	27 (Phase I) 36 (Phase II)
	(d) Telephone Line	-
19)	Elevations above MSL at (Mts.)	
	(a) Tap Off Point	781.00 (Phase I) 289.14 (Phase II)
	(b) Terminal Point	286.00 (Phase I) 255.30 (Phase II)
	(c) Lowest Elevation	227.00 (Phase I) 165.63 (Phase II)
	(d) Highest Elevation	781.00 (Phase I) 419.46 (Phase II)

Survey route of proposed Krishnagiri-Coimbatore Pipeline section is attached as **Annexure I**.

Schematic Arrangement of Pipeline Facilities for KCPL Phase I (Krishnagiri to Salem) is attached as **Annexure II** and Schematic Arrangement of Pipeline Facilities for KCPL Phase II (Salem to Coimbatore) is attached as **Annexure III.**

2.2 PIPELINE ROUTE DESCRIPTION

2.2.1 Mainline

The Krishnagiri to Coimbatore Pipeline section of the proposed gas pipeline project consists of 24" mainline from Krishnagiri to Coimbatore. The project is executed in two phases.

Phase 1: Krishnagiri – Salem (covering Krishnagiri, Dharmapuri & Salem Districts);
Phase 2: Salem – Coimbatore (covering Namakkal, Erode, Tiruppur & Coimbatore Districts

The line travels through flat and undulating terrain, and mostly passes through crop land and built up area. Pipeline Section comes across 7 nos. railway crossings, 8 nos. national highways and 7 nos. rivers. The pipeline also traverses through forest areas at 2 nos. locations. The proposed pipeline runs in 7 Districts of Tamilnadu. The surveyed length of the proposed pipeline route is 293.7 km.

2.2.2 Numbers of Crossings

Numbers of major crossing along the pipeline route are as tabulated below:

Table 2.2: Crossing detail

Type of Crossing	No. of Crossings
Railway Line	07
National Highway	08
State highway	37
Other Road	454
River	07
Canal / Distributary/ Minor/Field Channel	17
Nalas/ Drain/ Stream	88

2.2.3 Stretches in Reserved Forest

As per detailed route survey reports, the pipeline route is passing through 7.144 km of reserved/ protected forest. The reserved forests are as per below table:

Table 2.3: Reserved Forest Crossings

Reserved Forest Name	Chainage	Length
Toppur Reserve Forest (Phase-I)	Ch.79.488 to Ch.84.954	5.467
Manukondamalai Reserved Forest (Phase-I)	Ch.89.171 to Ch.93.570	1.677
Other Forest	-	-

2.2.4 Right of Use (ROU)

ROU details for installation of Pipeline are as under:

- Proposed 24" pipeline from Krishnagiri to Coimbatore shall be laid in 20 m wide ROU.
- In forest areas a restricted ROU of only 10 m shall be available.

2.3 BASIC PIPELINE DATA

The parameters considered for the pipeline design are as below:

Table 2.4: Pipeline Design Parameters

Description	Unit	Value
Fluid to be transported	--	Regasified LNG
Pipeline Design life	Years	30
Pipeline Size	inch	24
Design Pressure	kg/cm^2 (g)	92
Design temperature	°C	(-)29 to 60 for buried (-)29 to 65 for above ground
Material of Construction (MOC) for pipeline	--	Carbon Steel
Pipeline Corrosion Allowance	mm	1.0 (on calculated thickness)
Pigging Facilities	--	Permanent pigging facilities suitable for "Intelligent Pigging" shall be provided. This section of Pipeline shall be designed for Bi-directional flow.
Pipeline roughness	micron	15 micron for internally coated pipe 45 micron for non-internally coated pipe
Subsoil temperature	°C	30 throughout the entire length of the pipeline (1.2 m below ground level)

Gas throughput of pipeline sections Coimbatore to Salem - Krishnagiri:

Pipeline section	Pipeline design Gas Throughput, MMSCMD
Coimbatore to Salem	~3.18
Salem to Krishnagiri	~3.18

<u>Section details of Phase 1: Krishnagiri – Salem:</u>

<u>The details of Phase-1 of KCPL section of KKBMPL-II are as below:</u>

Table 2.5a: Phase-I - Krishnagiri - Salem section details

S.No.	Section	Type: Trunk / Spur Line	Details of Pipeline			State
			Size (Inch)	Length (km)	Rating	
1	Krishnagiri - Salem – (Phase-1 of KCPL)	Trunk Line	24	145.8 Approx.	600#	Tamil Nadu

Section details of Phase 2: Salem – Coimbatore

Gas throughput at Salem – Coimbatore:

Table 2.5b: Phase-II Salem-Coimbatore section details

S.No.	Section	Type: Trunk / Spur Line	Details of Pipeline			State
			Size (Inch)	Length (km)	Rating	
1	Salem – Coimbatore (Phase-2 of KCPL)	Trunk Line	24	147.67 Approx.	600#	Tamil Nadu

Table 2.6: Regasified LNG Composition

S.No.	Gas Component Description	Mole %
1	Methane (C1)	91.71
2	Ethane (C2)	5.38
3	Propane (C3)	1.69
4	Iso-Butane (i C4)	0.44
5	N-Butane (n C4)	0.46
6	Iso-Pentane (i C5)	0.02
7	N-Pentane (n C5)	0.01
8	C6+	0.0
9	Nitrogen	0.29
10	CO_2	0.00
	Total	100

2.4 PIPELINE AND ASSOCIATED FACILITIES

2.4.1 General

Pipeline and intermediate stations shall be designed and engineered in accordance with the standards/ codes referred in section 2.8 of this document. Pipeline shall be designed to withstand all installation, testing and operating conditions/ loads. All necessary calculations shall be carried out to verify structural integrity and stability of the pipeline for the combined effect of pressure, temperature, bending (elastic), soil/ pipe interaction, external loads and other environmental parameters as applicable. Such calculations shall include, but are not limited to following:

- Buoyancy control and stability analysis for pipeline section to be installed in areas subjected to flooding/ submergence.
- Crossing analysis of rivers by HDD.

- Pipeline expansion / contraction and its effect on station piping (above ground/ below ground).
- Pipeline shall also be checked for adequacy against anticipated earthquake loading and any special measures such as increase in wall thickness/ grade/ select backfill etc., as required, to ensure safety and integrity of the pipeline system.

2.4.2 Wall Thickness Calculation

Wall thickness calculation of pipeline shall be performed in accordance with requirements PNGRB Regulations (GSR 808 E) based on internal design pressure. Pipeline shall be designed in accordance with requirements PNGRB Regulations (GSR 808 E) to meet the location class as defined therein, except as modified in Table 2.7 below. Location Class evaluation shall be performed as per latest PDI survey data provided by GAIL. In addition the selected thickness shall have a diameter to wall thickness (D/t) ratio not greater than 96 in order to avoid damage to pipe during handling and transportation. As per GAIL requirement, D/t shall be kept below 60.

Table 2.7: Design Factor

Location Class	Type of Facility	Design Factor
All	Station Piping	0.5 (0.4 for Class-4)
Class 1 & 2	River Crossings:	
	- Open Cut	0.5
	- HDD	0.5
	Lined/ Unlined canal/ Nala /Drain Crossings:	
	- Drilled/ Bored/ Inaccessible/ open cut	0.5
	- HDD	0.5
	Crossings of roads, without casing:	
	- Unimproved Public Roads	0.6
	- State and National Highways	0.5
	- Other Roads	0.5
	Crossings of roads, with casing:	
	- State and National Highways	0.5
	- Other Roads	0.5
	Parallel Encroachments on ROW of Hard Surfaced Roads, Public Streets and	0.5

Table 2.7: Design Factor

Location Class	Type of Facility	Design Factor
	Highways	
	Railway Crossings (including impact radius)	0.4
Class 3	All (Other than railway crossings)	0.5
	Railway Crossings (including impact radius)	0.4
Class 4	All	0.4

Stresses shall be checked for adequacy of wall thickness using method specified in API RP-1102 for pipe sections at crossing such as National/ State Highway / Railway etc.

2.4.3 Anti-Buoyancy Control

Buoyancy control in the form of continuous concrete weight coating shall be provided for pipeline sections across rivers/ water bodies, water logged areas and areas subjected to flooding wherever required.

Continuous Concrete Weight Coating (CCWC) shall be provided on the line pipe at water body crossings. Based on buoyancy calculations, following thickness of continuous concrete weight coating shall be provided:

Table 2.8: Continuous Concrete Weight Coating

Sl. No.	Pipeline Size, Inches (mm)	Density of Concrete (kg/m^3)	CCWC, Minimum Thickness (mm)
1.	24 (610)	2245	100

2.4.4 Elastic Bend Radius Calculation

Minimum elastic bend radius allowable in fully restrained sections shall have to be calculated using standard formula, as per PNGRB Regulations (GSR 808 E) based on the margin available for bending determined in combined stress check.

The maximum permitted value for combined bi-axial stress shall not exceed as defined in PNGRB Regulations (GSR 808 E). Whenever terrain gradient requires lesser elastic bend radius, use of cold field bends (R=40D)/ Long radius bends (R=6D) shall be adopted to ensure that there is no buckling of pipeline.

Table 2.9: Minimum Elastic Bend Radius

Sl. No.	Pipeline Size, Inches (mm)	Minimum Elastic Bend Radius (m)
1.	24 (610)	700

2.4.5 Seismic Analysis

Pipeline shall be checked for adequacy against anticipated earthquake/ seismic loading and special measures shall be provided such as increase in wall thickness, change in material grade, use of select backfill etc., as required, to ensure safety and integrity of the pipeline system. Select backfill material such as Cohesion-less soil (as required by analysis) shall be provided for pipeline section falling in seismic fault lines. The extent of Cohesion-less soil backfill shall be as per seismic analysis.

As per the information provided in the DFR for KKBMPL the study of Earthquake and Seismic fault locations along the pipeline route reveals that:

Proposed pipeline route falls in Zone-II & Zone-III

Pipeline route is directly crossing a few identified major & deep seated seismic faults.

Seismic analysis shall be carried out for the pipeline for all terrains based on which remedial measures / recommendations shall be adopted & implemented by Pipeline Laying Contractor.

Geo Hazard Assessment should include landslide study along with seismic and it should be made part of the detailed design document.

2.4.6 Stress Analysis

For crossings such as Highways & Railways, analysis shall be carried out as per API RP-1102.

Stress analysis for HDD crossings shall be carried out for both during installation and post installation cases. Combined & longitudinal stress check shall be carried out as per ASME B 31.8 (Latest) for all cases (i.e. installation, post installation hydro test and operation).

Detailed analysis of pipeline transition areas between above-ground and below-ground shall be performed to determine the requirements for supports, anchors and expansion loops/ bends. This analysis will consider pipeline axial forces, process parameters and pipe/assembly size, weight and orientation and shall be carried out as per ASME B 31.8 (Latest) for all cases (i.e., installation, post installation hydro test and operation). The pipeline will be adequately supported to prevent excessive expansion and undue loads on connected equipment.

2.4.7 Hydrostatic Test Section Considerations

Primarily following has to be taken into consideration during finalization of hydrostatic test sections:

- Design-location class
- Availability of water source
- Elevation difference considering minimum and maximum test pressures

Wall thickness may be increased, if required, in hilly terrain or in between location classes as required to optimize the hydrostatic test sections.

2.4.8 Marshy Areas / Areas Prone to Flooding

Wherever marshy areas are encountered along the pipeline route, pipeline shall be provided with continuous concrete coating/ Geo-Textile Bags. Unless specified, specific gravity of installation in such areas shall be at least 1.2. Saddle weights are not permitted.

2.4.9 Basis for Selecting HDD Methodology

a) Water Crossings

Following parameters are taken into consideration for selection of crossing methodology for water bodies:

- Perennial in nature or non-perennial
- Water crossing width, depth, bank slopes, flow etc.
- Hydrological survey data
- Geo-technical investigation of sub soil strata.
- Environment sensitivity & associated constraints
- Downstream water users
- Marshy area where installation by Open-cut is not feasible

b) Roads/Highways Crossings

- Roads/Highways with any major/ minor canal or large size nala/ drain running parallel at the pipeline crossing location on one / both sides such that the combined crossing width becomes more than the width feasible to execute by augur boring method.
- If Roads/Highways are at elevated height and either side, the crossing levels are extremely low and as a result; the execution of crossing by augur boring is not feasible due to the limitation of machine.

Considering the above conditions, these types of crossings to be executed by HDD method.

Geo Hazard Assessment should include all hydrological (river meandering, scouring, flooding). While deciding for pipeline route or HDD length, assessment of water bodies geo-hazards such as river meandering etc. with historical trend of its behavior from cadastral maps of different timings including the latest one, should be carried out.

2.4.10 Pipeline in common ROU

New underground pipeline, when running parallel to an existing underground pipeline in same ROU/ROW shall be laid at minimum clear distance of 5.0 m from the existing underground pipeline.

However, the minimum clear distance may be reduced to 3.0 m after careful assessment of construction methodologies. Such areas shall be distinctly identified on ground during construction so that it does not result in unsafe conditions during construction.

Maintenance of statutory clearances may not be feasible in the existing corridor. At all such locations, pipeline laying works shall be carried out manually, taking all precautions to avoid damage to existing running pipeline, cables etc. all measures to safe guard the existing pipeline shall be taken care of during installation. All buried live lines shall be located and marked on ground using high resolution ground penetrating radar/ pipeline locators before start of excavation works. All necessary safety tools and tackled shall be used.

2.4.11 Pipeline Cover & Backfilling

The pipeline shall be buried to ensure a minimum cover of 1.2 meter below natural ground level except at river/ rail/ road/ canal/ waterways crossing where minimum cover shall be as given below or as per the requirements of statutory/ local authorities, whichever is more stringent. Increased cover shall be provided at critical locations and crossings. The minimum pipeline cover for various locations and crossings shall be as per below table:

Table 2.10: Minimum Pipeline Cover

Sl. No.	Location	Minimum Cover (m)
1.0	Industrial, commercial, residential, cultivated, agricultural and barren areas	1.2
2.0	Rocky terrain	1.0
3.0	Minor water crossing / canal / drain / nala / stream	1.5
4.0	River crossings for which scour depth is defined (below scour)	2.5
5.0	River crossings (Bank width < 50 m) (Below lowest bed)	1.5
6.0	Other River crossings (Bank width > 50 m) (below lowest bed level)	2.5 (for normal soil) 1.5 (for rocky strata)
7.0	Water crossing by HDD (below lowest bed and scour)	2.5
8.0	Cased/ uncased road crossing/ Station approach	1.2
9.0	Cased railway crossing	1.7
10.0	HDD Railway Crossing	7.0
11.0	HDD Roads/ NH/ SH	4.0
12.0	Drainage, ditches at roads/ railway crossings	1.2
13.0	Marshy land and Creek area	1.5

Notes:

i. The depth of cover shall be measured from the top of the pipe coating to the top of the undisturbed surface of soil or the top of graded strip, whichever is lower

ii. The cover at crossings shall be measured from the top of road or top of rail, as the case may be.

iii. Wherever the pipeline is running below drain (along the road), minimum cover of 1.5 m shall be provided also PCC/ RCC drain shall be provided

iv. Wherever pipeline is laid along the road in the future expansion area (road widening areas), the pipeline cover shall be kept 2.0 m and half cut Hume pipe shall be provided over the pipeline.

Additional soil cover other than specified above shall be provided at locations indicated by statutory/ local authorities as per agreements between COMPANY and authorities.

In case, any private dwelling, industrial building or place of public assembly falls within 15 m of pipeline, additional cover of minimum 300 mm shall be provided over and above the cover indicated in the above table.

2.4.12 Materials

Intent of selecting materials for pipeline system is to ensure that all materials comply with the design conditions such as pressure, temperature, testing & service conditions including all statutory / mandatory requirements and minimum wall thickness.

2.4.13 Line pipe

Line pipe to be installed for pipeline system shall conform to API 5L. Additional dimensional, NDT and other requirements over and above API 5L shall be identified taking into account the construction, quality control and other aspects.

Table 2.11: Pipeline parameters for thickness calculation

Symbol	Parameter	Value
P	Design Pressure, kg/ cm^2(g)	92
D	Nominal Diameter of pipe, mm	610 mm
S	Specified Minimum Yield Strength of Line Pipe Material	485 MPa (for API 5L X-70 PSL 2 Line pipe)
F	Design Factor	As per location class defined in Section 2.4.2 above
E	Longitudinal Joint factor	1.0 (for API 5L)
T	Temperature de-rating factor	1.0 (as per ASME B 31.8)
CA	Corrosion Allowance	1.0 mm (as per Process Design Basis)
t	Pipeline Wall thickness	As tabulated below

The type of pipe, wall thickness and material grade shall be as follows:

Table 2.12: Line pipe Wall Thickness

Pipeline Size (OD) (inches)	Grade (API 5L) PSL-2	Wall Thickness (mm)				Method of Manufacture
		Location Class			Fabrication of LR bends (Note-1)	
		1 & 2	3	4		
24"	X-70	10.80	12.40 / 12.70	15.50	14.30	SAWL / SAWH

Legend:
SAWL : Submerged-Arc Longitudinal Welded
SAWH : Submerged-Arc Helical Welded

Pipe wall thicknesses confirm to ASME B31.8 and also meet the requirements of notified PNGRB Regulations (GSR 808 E).

2.4.14 Other materials

All other materials including scraper traps, flow tees, insulating joints, valves, flanges, assorted pipes and fittings etc. shall be carbon steel, suitable for the service conditions and shall be compatible with the connecting line pipe material.

Table 2.13: Other Pipeline Material

Item Description	Material Description
Scraper Traps	Carbon Steel (API 5L Gr. X-70, PSL-2)
Flow Tees	Carbon Steel (API 5L Gr. X-70, PSL-2)
Insulating Joints	Carbon Steel (API 5L Gr. X-70, PSL-2)
Valves (Ball, Plug, Check, Globe, Gate)	Refer Datasheets
Assorted Pipes	Refer PMS
Fittings and Flanges	Refer PMS
QOEC	Refer Datasheets

Flow tees shall be used for all branch connections in piggable section of pipelines where the size of branch connection is equal to or exceeding 40% of the size of main-line. Weldolets/ Sockolets shall not be used for branch connections in underground sections of piggable pipelines.

2.4.15 External/ Internal Coating and Painting

Pipeline to be installed below ground shall be protected against external corrosion by a combination of high integrity externally applied 3 Layer Polyethylene (3LPE) external coating having thickness as per specification conforming to ISO 21809-1 and permanent impressed cathodic protection system. 3LPE coating shall be 3.0 mm thick for 24 inch pipeline.

In addition, the pipeline shall be provided with minimum 80 micron thick liquid epoxy internal coating conforming to ISO 15741 “Paints and Varnishes– Friction-reduction coatings for the interior of on- and off-shore steel pipelines for non-corrosive gases”/ API RP 5L2. The coating material shall typically be two pack epoxy paint. Extremities of pipe shall be free from coating over a length of 50± 5 mm.

For field joint coating, heat shrink sleeve shall be used. For field joint coating of HDD strings Fiber Glass Reinforced HSS shall be used.

All buried fittings including Flow Tee, Valves, shall be coated with min. 1.5 mm DFT 100% Solid high-build epoxy to be applied in accordance with EN 10289 Stress Class C.

All above ground structures shall be painted to prevent atmospheric corrosion. Painting of above ground piping and structures shall be as per specifications. Painting shall be suitable for Coating System for Unit Areas for all terminals as defined in applicable Job Specification for surface preparation and protective coating.

Cathodic Protection by impressed current shall be provided for buried portion of the pipeline as indicated in Process Design Basis.

2.4.16 Bends

In order to accommodate changes in vertical and horizontal alignment in piggable section of pipeline, cold field bends R = 40D (D is nominal dia. of pipe) shall be used wherever possible. In congested city areas & above ground and underground interfaces of crossings and intermediate stations, limited use of R=6D bends may be permitted for reasons of space constraints. Miters shall not be permitted.

2.4.17 Insulating Joints

Insulating joints shall be provided to electrically isolate the buried pipeline from above ground pipeline. Insulating joints shall be monolithic type and shall allow smooth passage of pigs. Insulating joints with surge diverters shall be installed in above ground portion of the pipeline, immediately after the buried/ above ground transition at the scraper stations and shall be supported on both sides provided with insulated sheet. Insulating joints shall be provided as indicated in P&IDs.

2.5 OTHER TECHNICAL REQUIREMENTS – PIPELINES

2.5.1 Scraper Stations

Scraper traps shall be provided at the Intermediate Pigging Stations. The scraper traps shall be capable of handling intelligent pigs, displacement and other cleaning pigs. The scraper traps shall be designed in accordance with the requirements of ASME B 31.8 and its end closure shall be designed and fabricated according to ASME Section VIII, Div.1. Adequate arrangements for launching, retraction, handling and lifting of cleaning and instrumented pigs shall be provided at the scraper stations and intermediate stations. These stations shall be provided with access road from the nearest metalled road.

Corrosion resistant coating (3LPE) shall be provided on the pipeline up to a minimum length of 500 mm after it comes aboveground/ before it gets buried underground at terminals/ scraper stations.

The diameter of barrel of Bi-directional Scraper Trap shall be three nominal sizes larger than the pipeline size. Center line elevation of scraper trap shall be at suitable height from grade level. Suitable arrangements shall be provided for handling & lifting of pigs. Traps shall be accessible by walkway/ road for movement of equipment, pigs etc.

Non-intrusive Pig Signalers shall be installed on the Pipeline and Scraper Trap barrels as indicated in the P&IDs.

All valves to be installed in the mainline shall have a fully welded body design as per the document ‘Pipeline Design, Engineering, Construction & Commissioning in GAIL (Doc. No. CIMG-GD-1-2016-0001-R0)’.

The piping system at the terminals shall be designed to have sufficient flexibility to prevent pressure and thermal expansion or contraction from causing excessive stresses on the connected equipment. The piping shall be designed/ fabricated as defined in clause 10.0.

Installation of anchor block in the underground pipeline is not permitted. If required adequate area around the underground pipeline shall be provided with a select backfill to ensure flexibility.

2.5.2 Sectionalizing Valve Stations

Sectionalizing valve stations shall be provided along pipeline route for isolating sections of pipeline as per ASME B 31.8/ OISD-STD-226/ PNGRB Regulations for:

- Limiting the hazard and damage from accidental discharge from pipeline system.
- Facilitating maintenance of pipeline system, and
- Complying with the requirements of applicable codes.

The spacing of sectionalizing valves shall be as per applicable codes taking consideration of terrain features, requirement of safety and operation etc.

All valve locations shall be fixed as per detailed survey report as per location class. Spacing between mainline valves / sectionalizing valve in various Location Classes shall not exceed values given below:

Table 2.14: Distance between SV Stations

Location Class	Distance in km
1#	32#
2	24
3	16
4	8

As per GAIL requirement, line pipe wall thickness shall be combined for Class 1 & 2 class location, however, for SVs spacing original PDI as per survey data shall be used.

Sectionalizing valve on the main pipeline shall be full bore ball valves type, to allow smooth passage of cleaning and intelligent pigs. All the sectionalizing valves shall be gas over oil actuated with butt welding ends. All sectionalizing valves shall be remote operated type.

All Sectionalizing Valves and other buried valves in SV stations shall have fully-welded body design. Wherever underground valves are provided, valves shall be provided with a stem extension in such a way that the center line of the rim of the hand wheel on a horizontal shaft or center of power actuator is at approximately 1.0 m above the finished ground level. Valve surface shall be provided with corrosion protection coating. Valve body vent and drain lines shall be extended and terminated above ground.

The valve stations shall be located at a readily accessible location and shall be provided with an access road from the nearest metalled road. The facilities within valve station shall be secured by a chain link fence enclosure/ boundary wall with gate. The location of valve station shall be clear of overhead power lines and should be located at sufficient distance from any grounding stations of HVDC Power lines/ AC Substations.

At locations, where valve stations are installed along with existing SV/CP/Repeater stations, the safe distances and statutory clearances as per standards shall be followed.

Tap–off shall be provided for supply of Natural Gas to the nearby existing/ probable consumers along the pipeline route at all SVs. Tap-off provisions at all SV Stations to be provided upstream of the valve (upstream of SV considering flow direction from Coimbatore side)

Non-Intrusive Pig Signaler shall be installed at SV Station before and after all Intermediate Pigging stations/ Receipt Stations.

2.5.3 Welding

Welding of pipeline shall be carried out as per specification for welding and welding charts.

2.5.4 Backfilling

In normal cross-country areas, the pipeline trench shall be backfilled with excavated soil. Select backfill/ slope breakers shall be provided in the trench in steep areas (slope generally 10% and more) to prevent erosion. Select backfill shall be provided at approaches to intermediate stations up to transition point (below ground/above ground) inside station. Select back fill shall also be provided as applicable for areas prone to seismic activity.

In case of rivers/ water bodies which are prone to scour and erosion, the cover as indicated in clause 2.4.11 shall be provided below the predicted scour level. In addition to the cover, anti-buoyancy measures in the form of continuous concrete weight coating shall be provided at open cut river crossings.

Pipeline route shall be examined to establish any drainage requirement in hilly terrain. In case required, the drainage design shall prevent trench flooding during construction and protect the integrity of the installed pipeline following completion of all construction activity.

In areas having gravel or hard soil/ strata, trench can be excavated with the help of dozer-ripper and back hoes. In case of areas with hard rock, controlled blasting can also be carried out to speed up the excavation activities in rocks. Where blasting cannot be done due to close proximity of existing facilities, mechanical equipment for rock excavation such as rock breakers can be used. The trench bottom shall have a sand padding of 150 mm. After laying of pipeline, sand padding shall be placed around and on top of the pipe so that thickness of compacted padding on top of pipe corrosion coating shall be at least 150 mm. In rocky areas, rock-shield, along with 150 mm of sand/ soft soil padding around the pipe, shall be provided.

2.5.5 Hydrostatic Testing

After installation, the entire pipeline system shall be hydro-tested with corrosion inhibited water.

The water to be used shall be filtered, shall not be contaminated and shall be free from sand or silt. Company approved corrosion inhibitors, oxygen scavengers and bactericides shall be added to the test water.

The minimum hydrostatic pressure in any section shall be as per ASME B 31.8/ OISD-STD-226/'PNGRB Regulations (GSR 808 E) for gaseous hydrocarbon pipelines. The maximum hydrostatic test pressure at any location of the pipeline shall not exceed the pressure required to produce a hoop stress equal to 95% of SMYS of the pipe material based on minimum wall thickness in the test section. The test duration shall be minimum 24 hours.

The pipeline shall be hydrostatically tested to the minimum test pressure as specified below:

Table 2.15: Minimum Hydrostatic Test Pressures

Pipe Size Inch (mm)	Wall Thickness (mm) for Material Grade X-70, PSL-2	Hydrostatic test Pressure (kg/cm^2 g)	Class
610 (24")	10.80	1.5 x 92 = 138.0	All Classes
	12.40 / 12.70		
	15.50		

The highest point of the test section shall be subjected to the minimum test pressure as specified above.

Pipeline shall be tested at a minimum pressure of 138.0 kg/cm^2(g) irrespective of class locations. However, the maximum hydrostatic test pressure at any location in the pipeline during testing shall not exceed the pressure required to produce hoop stress equal to 95% of SMYS of pipe material based on the minimum wall thickness in the test section. The test duration shall be 24 hrs.

2.5.6 Dewatering and swabbing

Dewatering, swabbing and pre-commissioning operations shall be carried out after hydro-testing and prior to commissioning of the pipeline. For gaseous hydrocarbon pipeline the line shall be dried. The dewatering & swabbing shall be carried out as per relevant specification. After swabbing operation the pipeline sections shall be dried to achieve water dew point at atmospheric pressure as mentioned in commissioning specifications.

2.5.7 Pipeline Pigging Requirements

The 24" pipeline (Krishnagiri to Coimbatore) shall be equipped with permanent pig launcher and receiver in order to carryout preventive maintenance and inspection requirements.

Permanent scraper traps shall be designed to accommodate all types of pigs for cleaning and inspection purposes (Intelligent pigging). Scraper traps shall be designed in accordance with ASME B31.8 and EIL Specification.

Quick Opening end Closure (QOC) shall be designed as per ASME Section VIII Div.1.

The following considerations shall be taken into account during the design of the pipeline and scraper trap layout in order to carry out pigging activities:

- Location and access to the permanent scraper traps
- Handling facilities
- Isolation requirements necessary for pig launching and pig receiving
- Venting and draining requirements for commissioning and operation
- Direction of pigging

Permanent pig launcher/receiver shall be capable of handling intelligent inspection tools. Pig Launcher/Receiver length shall be suitable for the longest intelligent pig tool plus a margin of 10 percent.

Pipeline Base Line Survey using intelligent pig shall be carried out after hydro testing, dewatering, swabbing and shall be done for the entire pipeline from Launcher to Receiver during Pre-commissioning stage using suitable medium such as Nitrogen.

Intelligent pigging shall be carried out after hydro-testing, dewatering and swabbing and prior to commissioning of the pipeline to get base line data.

In any case, for pipe sizes above 12inch, Pig handling equipment that will include jib crane / lifting arrangement with wire rope & pulley arrangement and trolley with arrangement for pushing-in and retrieval of pigs into/ from pig barrels shall be provided.

2.5.8 River/ Canal Crossings

Minimum cover of river/ canal crossings shall be as per clause 2.4.11 above or as per requirement of local/ statutory authorities, whichever is more. Crossing shall be carried out by open cut or Horizontal Directional Drilling (HDD) method depending upon width, depth, bank slopes, soil type, flow etc. Wherever there is an evidence of bank erosion, the banks shall be protected by using gravel and boulders filled embankment mattresses of galvanized iron wire to be laid over the backfilled, compacted and graded banks. All major irrigation canals shall be crossed using trenchless technique (Jacking –Boring/ HDD). All minor canal and nala crossings shall be carried out with conventional open cut method unless directed otherwise by the concerned authorities.

All minor canal crossings shall be carried out with conventional open cut method unless directed otherwise by the concerned authorities.

2.5.9 Railway Crossing

Pipeline at rail crossings shall be provided with casing pipe. The casing pipe shall be four nominal pipe sizes larger than carrier pipe and shall be installed by boring/ jacking. Casing insulators and end seals shall be provided to ensure electrical isolation of carrier pipe and casing pipe. Casing insulators and its fasteners shall be non-metallic type. Sacrificial anode or filler material should not be used. The annular space between Casing pipe and Carrier pipe shall be filled in line with relevant Specification for Cathodic Protection, attached elsewhere in the bid document.-

The rail crossing shall comply with the requirements of API RP 1102, and Indian Railway Authorities. The crossing angle shall be as close to 90º as possible. ROW limits shall be defined by the railway authorities. Casing pipe shall be extended for a distance up to 0.6 m beyond railway ROW limits on either side. In case Boring is not possible due to site conditions, Railway Crossing shall be carried out by HDD method.

As per Railway guidelines, higher thickness pipe with design factor of 0.4 shall be provided in Railway land and up to distance of impact risk radius (as defined in ASME B31.8S) outside the Railway boundary on either side.

2.5.10 Road Crossing

Road crossings shall comply with the requirements of API RP 1102 and the requirements of the concerned road authorities. All national highways and state highways shall be crossed by Boring/ Jacking (with casing) or HDD method (without casing). Provision of casing at other locations shall be decided based on type of road crossing and in consultation with local authorities if necessary. The casing pipe shall be four nominal pipe sizes larger than carrier pipe. The crossing angle shall be as close to 90º as possible. Casing insulators and end seals shall be provided to ensure electrical isolation of carrier pipe and casing pipe. Casing insulators and its fasteners shall be non-metallic type. Sacrificial anode or filler material should not be used. The annular space between Casing pipe and Carrier pipe shall be filled in line with relevant Specification for Cathodic Protection, attached elsewhere in the bid document. The casing pipe shall be installed by Boring/Jacking method. Higher thickness carrier pipes shall be used at crossings.

Road crossings other than national highway or state highway shall be installed by open cut method.

However, at locations, where it is not feasible to cross the road by open cut method, boring/ jacking method shall be used.

2.5.11 Overhead Power line Crossing

For Power line ≥11 kV crossings, protection measures as per EIL standard No. 7-71-0025 shall be provided.

2.5.12 Existing Pipeline Crossing

In case any existing pipeline needs to be crossed, the new pipeline shall be laid at least 500 mm below such existing pipeline and a physical barrier in the form of 80 mm thick concrete slab shall be provided. The existing pipeline shall be properly supported during and after the construction activities. Suitable C.P. bonding shall be provided between the crossing pipelines.

2.5.13 Underground Cable Crossing

In case any existing cable needs to be crossed, the new pipeline shall be laid at least 500 mm below such existing cable and a physical barrier in the form of 80 mm thick concrete slab shall be provided. Suitable C.P bonding or electromagnetic shielding, as required, shall be provided between the pipeline and cable.

2.6 TECHNICAL REQUIREMENTS-PIPING

2.6.1 General

This section describes the design requirements of piping applicable for Intermediate pigging stations, sectionalizing valve stations and tap-off stations (as applicable).

All piping and equipment shall be designed as per ASME B31.8. All piping materials shall be as per Piping Material Specification (PMS).

Utility piping to be provided shall be designed in accordance with the provisions of ASME B31.3.

All piping shall be designed for combined effects of pressure, weight and temperature significantly affecting the pipe material stresses in addition to fluid pressure without over stressing the piping, valves or equipment. All piping shall be adequately supported, guided or anchored to prevent undue vibration and deflection.

2.6.2 Piping flexibility/ stress analysis

All piping shall be designed for thermal expansion under start up, operating and shut down conditions without over stressing the piping, valves or equipment. Provisions for expansion shall normally be made with bends and offsets.

All piping shall be adequately supported, guided or anchored so as to prevent undue vibration, deflection or loads on connected equipment such as filters, meters etc. Equipment/ valves requiring periodical maintenance shall be supported in such a way that the valves and equipment can be removed with minimum temporary pipe supports.

2.6.3 Piping layout

- Piping will be located above - ground wherever possible within the terminals. A minimum ground clearance of 300 mm shall be maintained from pipe bottom.
- Piping shall be designed considering skin temperature of piping material under empty conditions as 65ºC or design temperature of pipeline whichever is higher.
- Buried piping inside the terminal area will have a minimum depth of cover of 1.2 m.
- Where buried pipes come out of the ground, the underground coating on the pipe will continue for a distance of 500 mm above ground.
- Painting above ground piping and structures shall be as per specifications enclosed in the Bid package.
- Platforms, crossovers shall be provided for ease of operation, maintenance.

2.6.4 Valves

The type of valves shall be provided in accordance with P&IDs. Application of various types of valves shall be as follows:

Valve type	Typical application
Globe	Throttling, (low throttling/ less noisy cage type)
Ball (ENP Coated)	On/off, Isolation (on main line)
Plug (ENP Coated)	On/off, Isolation (in the terminals)
Swing Check Valve	Unidirectional flow

Ball, Plug & Check valves of size 2” & above shall comply with the requirements of API 6D. In order to minimize potential leak sources, valves used in mainline shall be with butt-weld ends. Valve installed within the terminal to isolate the mainline/ pipeline shall also be provided with butt welding ends. However terminal valves shall be flanged ends. Flanges may be used where frequent access or removal of equipment is required. Isolation valves in the pressure tappings shall be provided with valve similar to line isolation valve. Double isolation valves shall be provided for 900# & above. Valves used in buried portion shall be with butt-welded joints only. Buried ball valves shall have welded body design.

Wherever underground valves are provided, valves shall be provided with a stem extension in such a way that the centerline of the rim of the hand wheel on a horizontal shaft or center of power actuator as approximately 1.0 m above the finished ground level. Valve surface shall be provided with suitable corrosion protection coating.

2.6.5 Branch Connections

Flow tees shall be used for all branch connections in piggable section of pipelines where the size of branch connection is equal to or exceeding 40% of the size of main-line. **Weldolets / Sockolets shall not be used for branch connections in underground sections of piggable pipelines**.

Minimum size of any tapping from the underground pipeline shall be 2" NB and shall be provided with an isolation valve located at a minimum distance from the pipeline.

2.6.6 Pig Signalers

Pig signalers shall be installed as a minimum at the following locations:

- Downstream side of pig launcher
- Upstream side of pig receiver
- On Pig Launcher/ Receiver (Major & Minor Barrels)
- On last SVs upstream of each IPs & RT

Pig signaler shall be non-intrusive bi-directional type with trigger mechanism, suitable for maintenance with pipeline under operating pressure.

2.6.7 Welding

Welding of piping shall be carried out as per specification for welding and welding charts.

2.6.8 Hydrostatic Testing

Hydrostatic testing of terminals shall be carried out separately. Terminals as well as other intermediate facilities shall be tested at 1.5 times the design pressure. The test duration shall be 6 hours. Mainline valves shall be installed after successful completion of hydrostatic testing.

2.7 RESOURCE REQUIREMENT:

Water requirement:

There is no major requirement of water for operation of the pipeline system. There will be 6 permanent GAIL staffs and 27 temporary persons for the proposed pipeline. Total water requirement for the proposed pipeline will be 3 KLD during operation phase. The water will be sourced from local dispatch & receipt terminals and local supply for SV stations. For construction purpose, water shall be availed from local sources through tankers. Packaged drinking water will be supplied through local sources for drinking purpose.

Land Requirement:

Land acquisition is not required for laying of pipeline. However, tentative area requirement for each of the SV stations is 18 m x 9 m and for each Intermediate Pigging Stations (IPS) is 40 m x 25 m. Typical Layout Plan of Sectionalizing Valve (SV) stations and Intermediate Pigging Stations (IPS) is attached as **Annexure – IV.**

Manpower Requirement:

The requirement of manpower is expected to be met through internal deployment of GAIL as well as by induction of competent personnel. The manpower requirement during operation of the pipeline would be around 33 consisting of 6 officers and 27 temporary persons (17 for 17 SV stations and 10 Line Patrolmen). GAIL staffs will hold the position at both terminals.

Power Requirement:

Power requirement for the proposed project shall be as given in below Table 2.16.

Table 2.16: Power Requirement for proposed pipeline section

PHASE	NORMAL POWER DEMAND (in KVA)	PEAK POWER DEMAND (in KVA)	REMARKS
KCPL PH-I	302	516	Peak load includes battery boost charging load
KCPL PH-II	248	424	Peak load includes battery boost charging load
TOTAL	**550**	**940**	

Power will be sourced from Solar Power System and backup power shall be obtained from State Grid power supply.

Effluent generation:
Domestic effluents of 2.4.KLD will be generated. Treatment through bio-digesters shall be adopted for SVs and IPS.

2.8 APPLICABLE CODES AND STANDARDS

Pipelines and associated facilities envisaged shall be designed and engineered primarily in accordance with the provisions of the PNGRB Regulations (GSR 808 E). Requirements, as applicable to Gas service, of following codes/ standards shall be also be complied with.

ASME B 31.3	:	Process Piping
ASME B 31.8	:	Gas Transmission and Distribution Piping Systems
API RP 1102	:	Recommended Practice for Steel Pipelines Crossing Railroads & Highways
API Std. 1104	:	Standard for Welding of Pipelines and Related Facilities
The Petroleum Rules, 2002	:	Chapter III, Transport of Petroleum (Part V, Transport by Pipelines)
OISD 138	:	Inspection of Cross Country Pipelines-Onshore
ASME B31.8S	:	Managing System Integrity of Gas Pipeline
CIMG-GD-1-2016-0001-R0	:	Pipeline Design, Engineering Constriction & Commissioning in GAIL (Guidance Document)
F. No. Infra/ IM/ NGPL/ 12010	:	PNGRB IMS Regulations – 2012
NACE RP 0104	:	The Use of Coupons for Cathodic Protection Monitoring Applications
NACE SP 0177	:	Mitigation of Alternating Current and Lightning Effects on Metallic Structures and Corrosion Control Systems
NACE RP 0104	:	The Use of Coupons for Cathodic Protection Monitoring Applications
OISD-188	:	Standard Operating Procedure for Integrity Assessment of Petroleum and Natural Gas Pipeline

OISD-226	:	Natural Gas Transmission Pipelines and City Gas Distribution Networks
RDSO BS-105	:	Railway Guidelines On Pipe Line Crossings Under Railway Track
---	:	EIL Standards & Specifications

In addition to the codes/standards mentioned above, the latest edition of the below listed equivalent codes and standards shall also be used for design of proposed pipeline. The listing includes, but is not limited to, the following:

API 5L	Specification for Line pipe
API 5L1	Recommended Practice for Railroad Transportation of Line pipe
API 5LW	Recommended Practice for Transportation of Line pipe on Barges & Marine Vessels
API 6D	Specification for pipeline valves (Steel Gate, Plug, Ball and Check Valves)
API 602	Compact Steel Gate Valves-Flanged, Threaded, Welding & Extended Body ends.
ASTM A694	Forgings, Carbon & Alloy steel for Pipe Flanges, Fittings, Valves & parts for High Pressure Transmission Service.
MSS-SP-6	Finishes for Contact Faces of connecting End Flanges of Ferrous Valves and Fittings.
MSS-SP-25	Standard Marking System for Valves, Fittings & Unions
MSS-SP-44	Steel Pipeline Flanges
ANSI B16.5	Pipe Flanges and Flanged Fittings
ANSI 16.20	Ring-joint Gaskets & Grooves for Steel Pipe Flanges
ASTM A105	Forgings, Carbon Steel for Piping Components
ASTM A193	Carbon & Alloy Steel Bolts & Studs for High Temperature Service
API 601	Standard for Metallic Gaskets for Raised-Face Pipe Flanges & Flanged Connections
ANSI B16.9	Factory Made Wrought Steel Butt Welding Fittings
ANSI B16.11	Forged Fittings, Socket Welded & Threaded
ANSI B16.26	Butt Welding Ends
ASTM A234	Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A694	Forgings, Carbon & Alloy Steel for Pipe Flanges, Fittings, Valves & Parts for High Pressure Transmission Service.
MSS-SP-75	Specification for High Test Wrought Butt Welding Fittings
MSS-SP-97	Integrally Reinforced Forced Branch Outlet Fittings – Socket Welding, Threaded and Butt Welding Ends.
PFI-ES-24	Pipe Bending Methods, Tolerances, Processes & Material Requirements
ANSI/AWS D1.1	Structural Steel Welding

AWS A3.0	Welding Terms and Definitions
AWS A5.1	Welding Electrodes
AWS A5.5	Specification for Low Alloy Steel Covered Arc Welding Electrodes
ASTM E165	Liquid Dye Penetrant Inspection of Pipeline Welds
ASTM A370	Standard Methods and Definitions for Mechanical Testing of Steel Products.
ASTM E18	Standard Hardness Test for Metals
ASTM E23	Standard for Impact Test for Metals
ASTM E84	Standard Test Method for Micro-hardness of Metals
ASTM E92	Standard Test Method for Vickers Hardness of Metallic Materials
ASTM E110	Standard Test Method Indentation Hardness for Metallic Materials by Portable Hardness Testers
ASTM E709	Standard Guides for Magnetic Particle Examination
MSS-SP-53	Quality Standard for Steel Casting & Forging-Magnetic Particle Method
MSS-SP-54	Quality Standard for Steel Casting & Forging-Radiographic Examination
MSS-SP-55	Quality Standard for Steel Castings & Forgings-Visual Method.
SIS-05-59	Pictorial Surface Preparation Standards for Painting Steel Surfaces
SSPC-SP-01	Solvent Cleaning
SSPC-SP-03	Power Tool Cleaning
SSPC-SP-05	Joint Surface Preparation Standard: White Metal Blast Cleaning
SSPC-SP10	Structural Steel Painting Council – Joint Surface
NACE No.2	Preparation Standard - Near-White Metal Blast Cleaning
SSPC-PA-02	Measurement of Dry Paint Thickness and Magnetic Gauges
ASTM E12	Measurement of Pipeline Dry Film Coating Thickness
ASTM-G6	Abrasion Resistance of Pipeline Coating
ASTM G8	Cathodic Disbonding of Pipeline Coatings
NACE-RP-0274	High Voltage Electrical Inspection of Pipeline Coatings Prior to Installation
BS 4164: 2002	Specification for Coal-Tar Based Hot-Applied Coating Materials for Protecting Iron and Steel, including Suitable Primer
AWWA C203-02	Standard for Coal Tar Protective Coatings and Linings for Steel Water Pipeline Enamels and Tape-Hot Applied
BS105	Guidelines on Pipeline Crossings under Railway Track
	IP Model Code of Safe practice in the Petroleum Industry Parts 3, 6 and 9

CHAPTER – 3

DESCRIPTION OF THE ENVIRONMENT

3.0 DESCRIPTION OF THE ENVIRONMENT

GAIL (India) Limited intends to carryout Environmental Impact Assessment Study (EIA), Environmental Management Plan (EMP) for laying of Krishnagiri – Coimbatore Pipeline (KCPL) section which is a part of Koottanad-Bangalore pipeline of KKBMPL-II in the state of Tamilnadu in accordance to the relevant Gazette Notification of Ministry of Environment, Forest & Climate Change (MoEFCC). A systematic scientific study is planned to identify, estimate and assess the impacts of the environment. Based on assessment study mitigation measures for minimization of impacts shall be formulated. Inorder to assess the impacts, existing status of environmental parameters such as Air, Water, Noise, Land, flora & fauna and Socio economic are necessary.

The main objectives of describing the environment, which may be potentially affected, are (i) to assess existing environmental quality and the environmental impacts and (ii) to identify environmentally significant factors that could preclude pipeline laying and the study area with reference to the prominent environmental attributes.

BASELINE DATA COLLECTION

Baseline data was collected for various environmental attributes like ambient air, noise, traffic, water, soil, flora & fauna and socio-economics during three (03) months study period from December 2021 to March 2022.Engineers India Limited (EIL) has entrusted the job of collecting baseline data to M/s. Idma Laboratories Limited, Panchkula (Haryana)which is recognized by MoEF&CC, Government of India, New Delhi and also accredited by Quality Council of India (NABL).

3.1 LAND USE & LAND COVER

The present land use pattern of the study area (i.e. 500 m of the whole pipeline route from Krishnagiri – Coimbatore Pipeline and 10 km radius area of start and end points of the pipeline and 2 nos intermediate pigging stations has been assessed based on Satellite (1:50,000) data and validated from on field visit and data collection. The land use analysis shows that the area is of predominantly Crop Land, followed by Open Scrub and Built-up area and some Forest land.

There will be no change in the land use categorization after laying of the proposed pipeline. Where, there will be change in land use pattern due to the excavating activities, the land use will be restored to near original conditions. Hence, the impact on land use is temporary.

In the study, both digital image processing and visual interpretation technique were used to generate output of Land use / land cover map of study area. The spatial distribution of various land use/ land cover is given in the below Figures. The data base on land use/ land cover belongs to 10 km radius of the start and end point of the pipeline section, IPS and 500m around the pipeline route as given in below figures. A standard False Colour Composite (FCC) image has also been generated on the same scale. The land use pattern of the study area is given in the figures below:

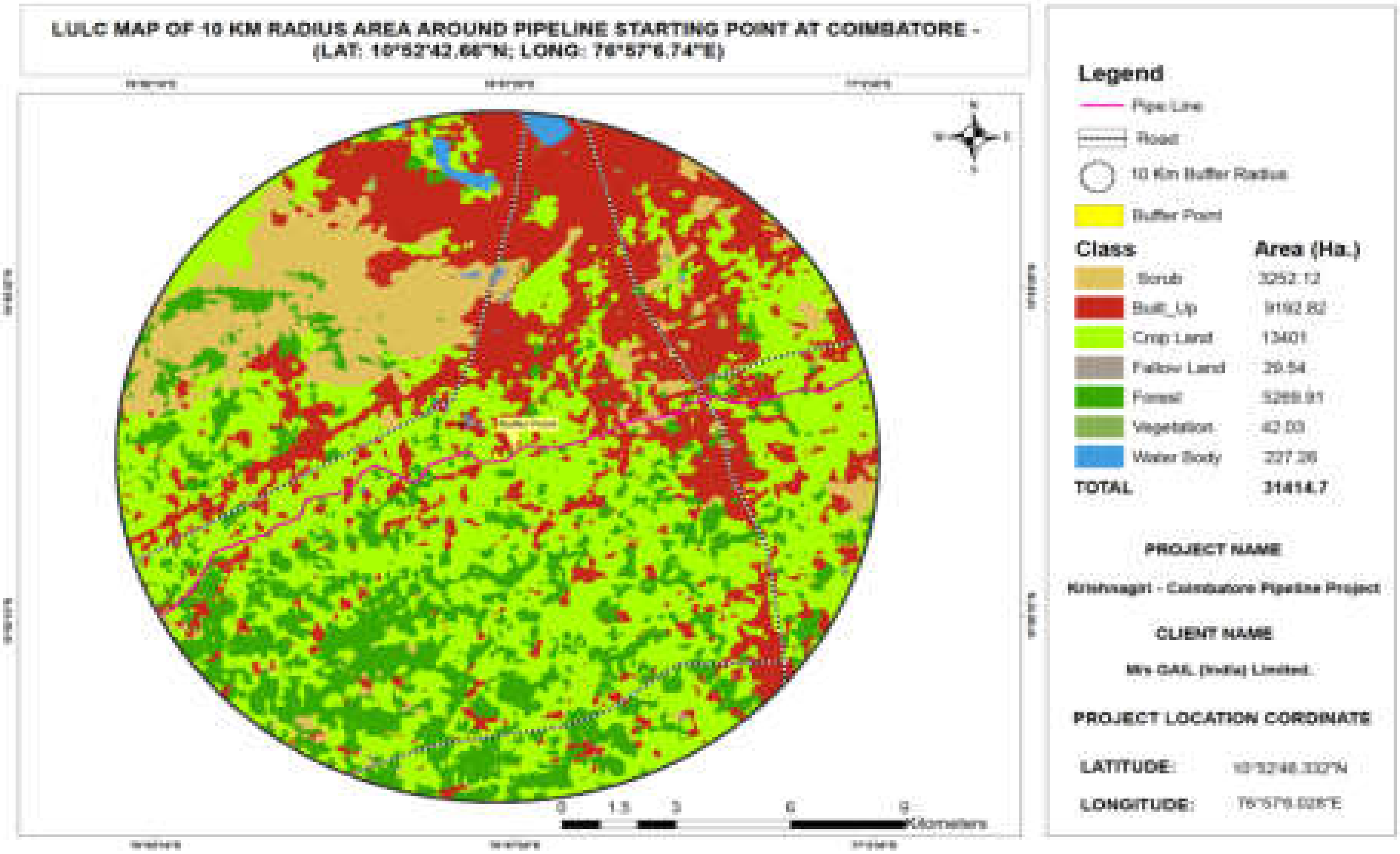


Figure-3.1: LULC map of Pipeline starting point at Coimbatore within 10 km radius area

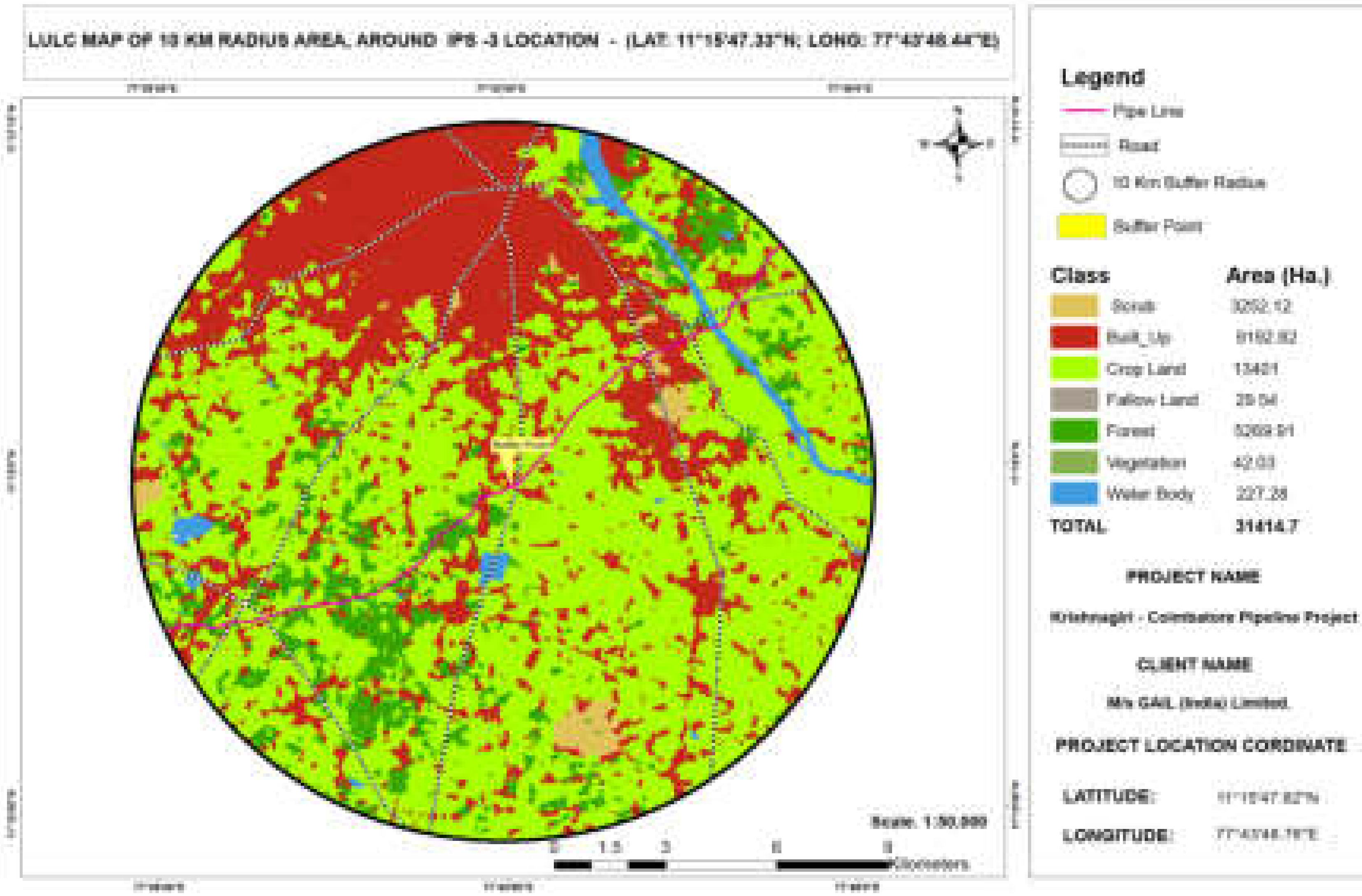


Figure-3.2: LULC map of Near IPS-3 location at Erode within 10 km radius area

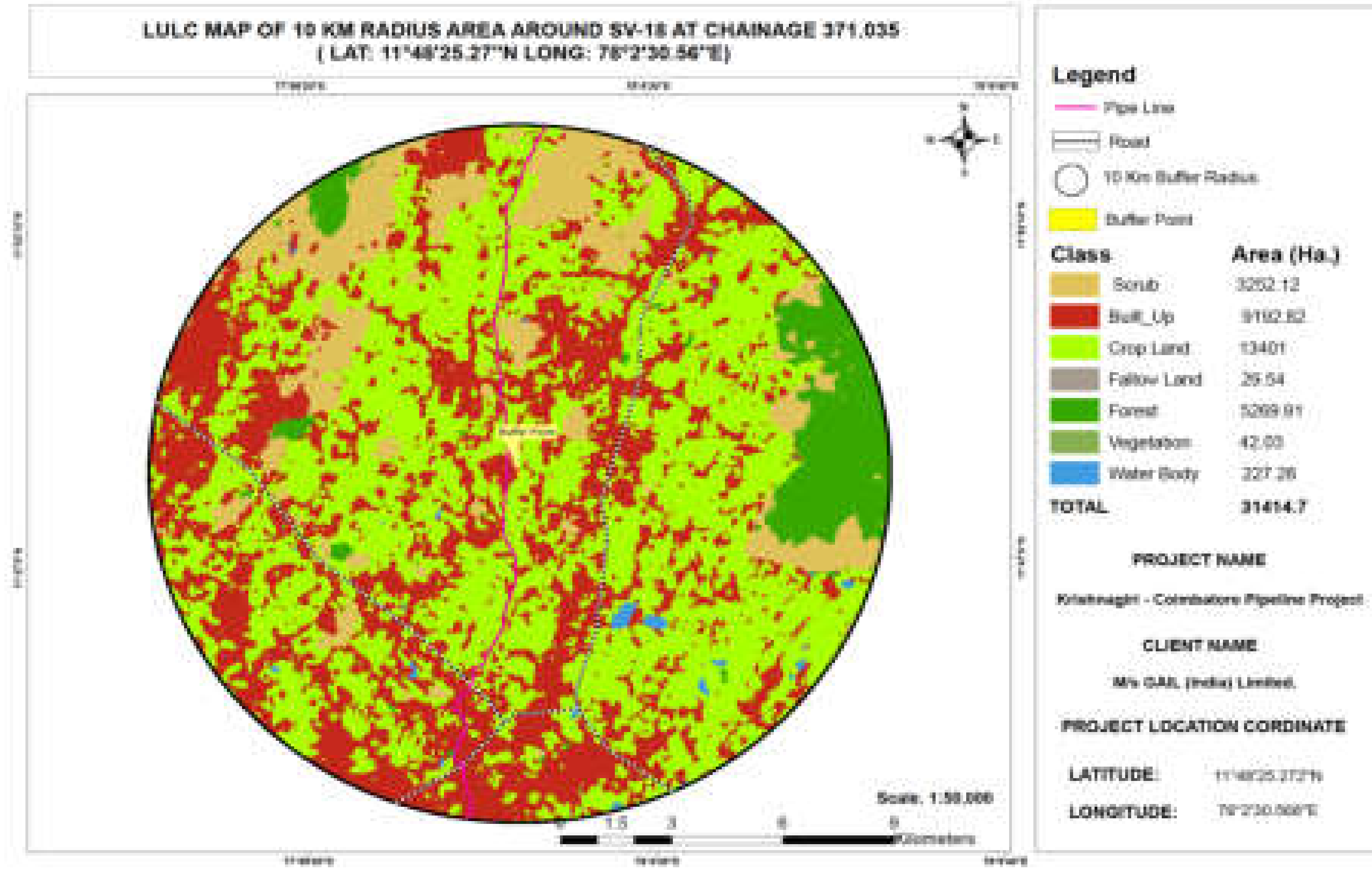


Figure-3.3: LULC map of Near SV-18 at Salem within 10 km radius area

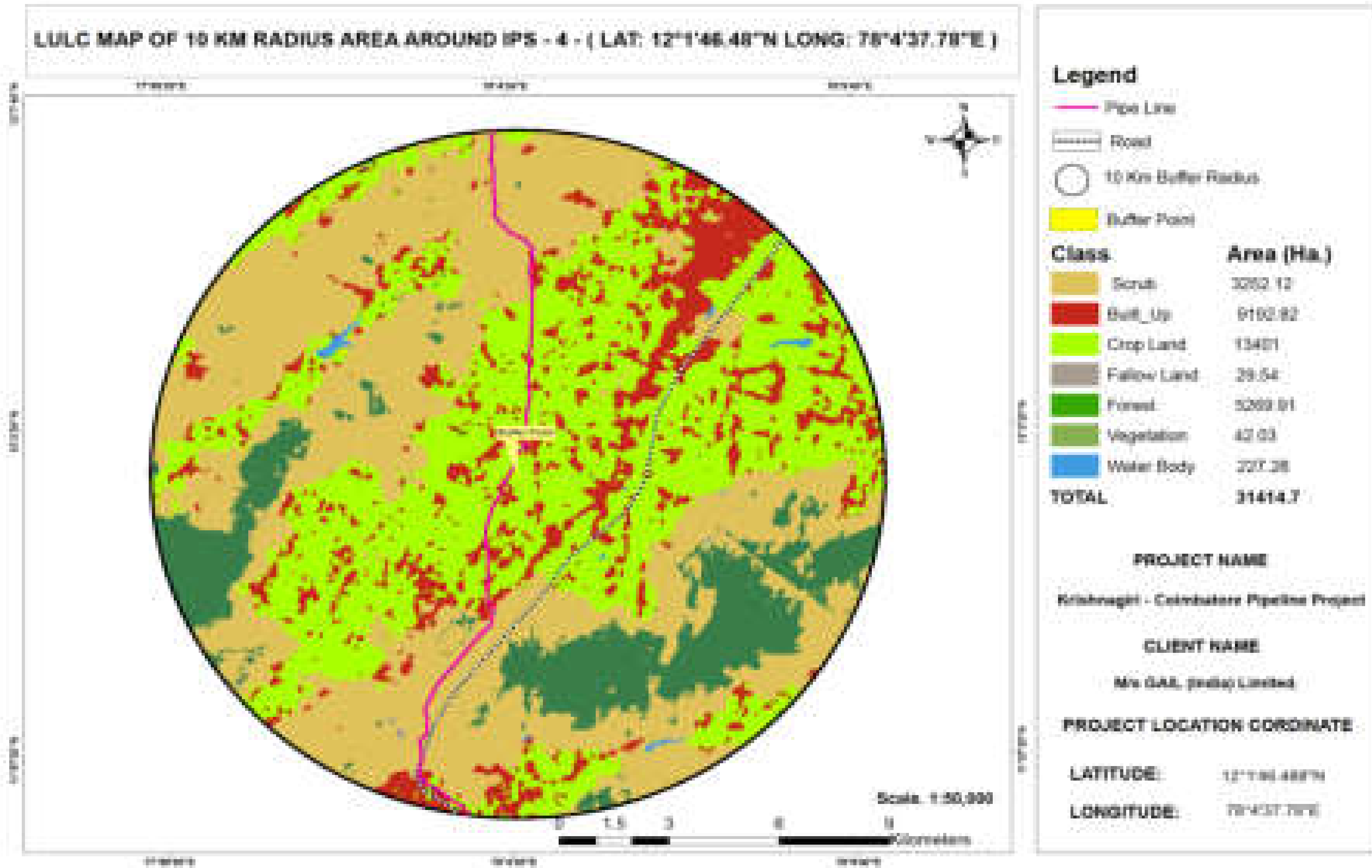


Figure-3.4: LULC map of Near IPS-4 at Dharmapuri within 10 km radius area

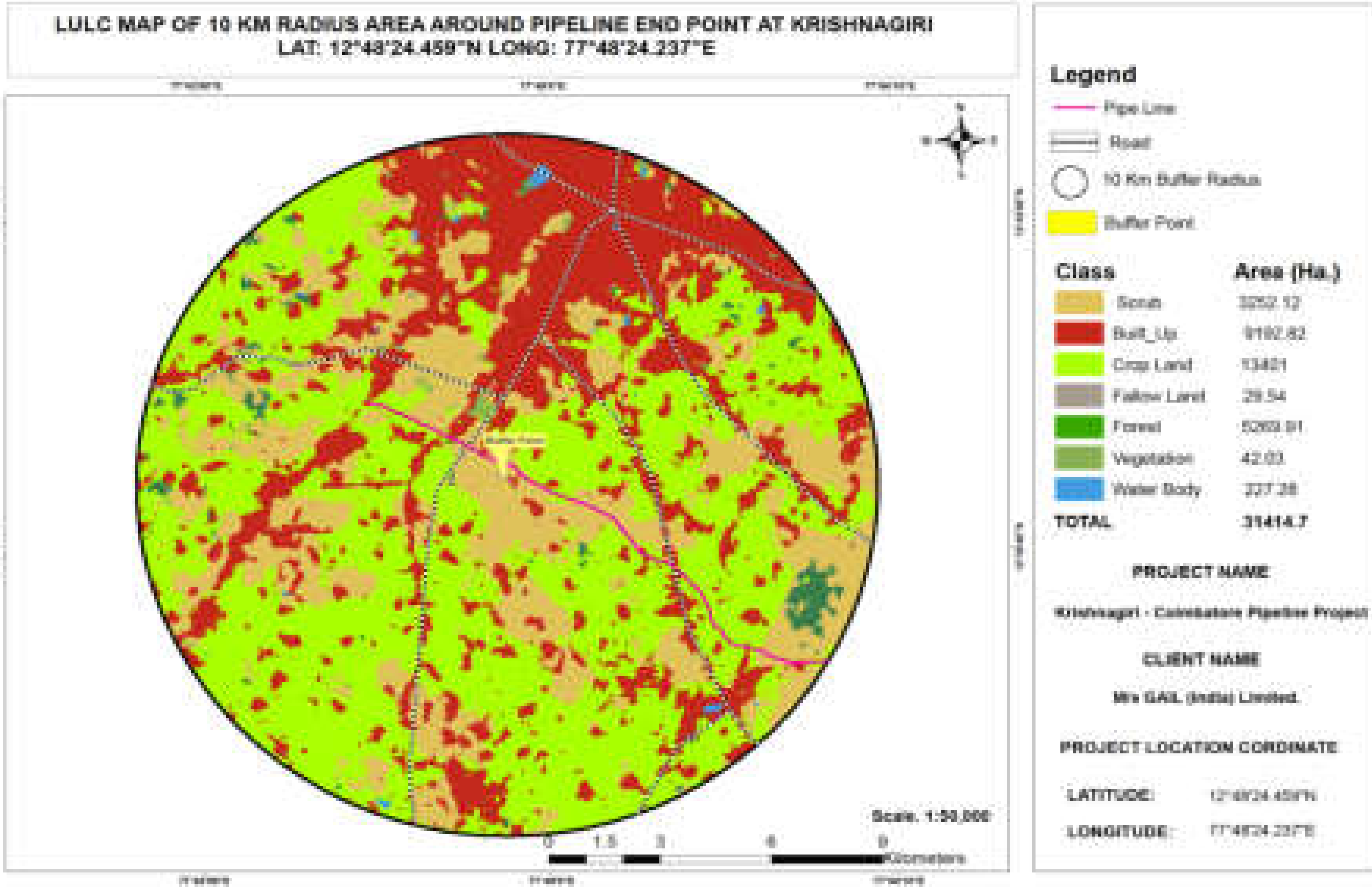


Figure-3.5: LULC map of Pipeline end point at Krishnagiri within 10 km radius area

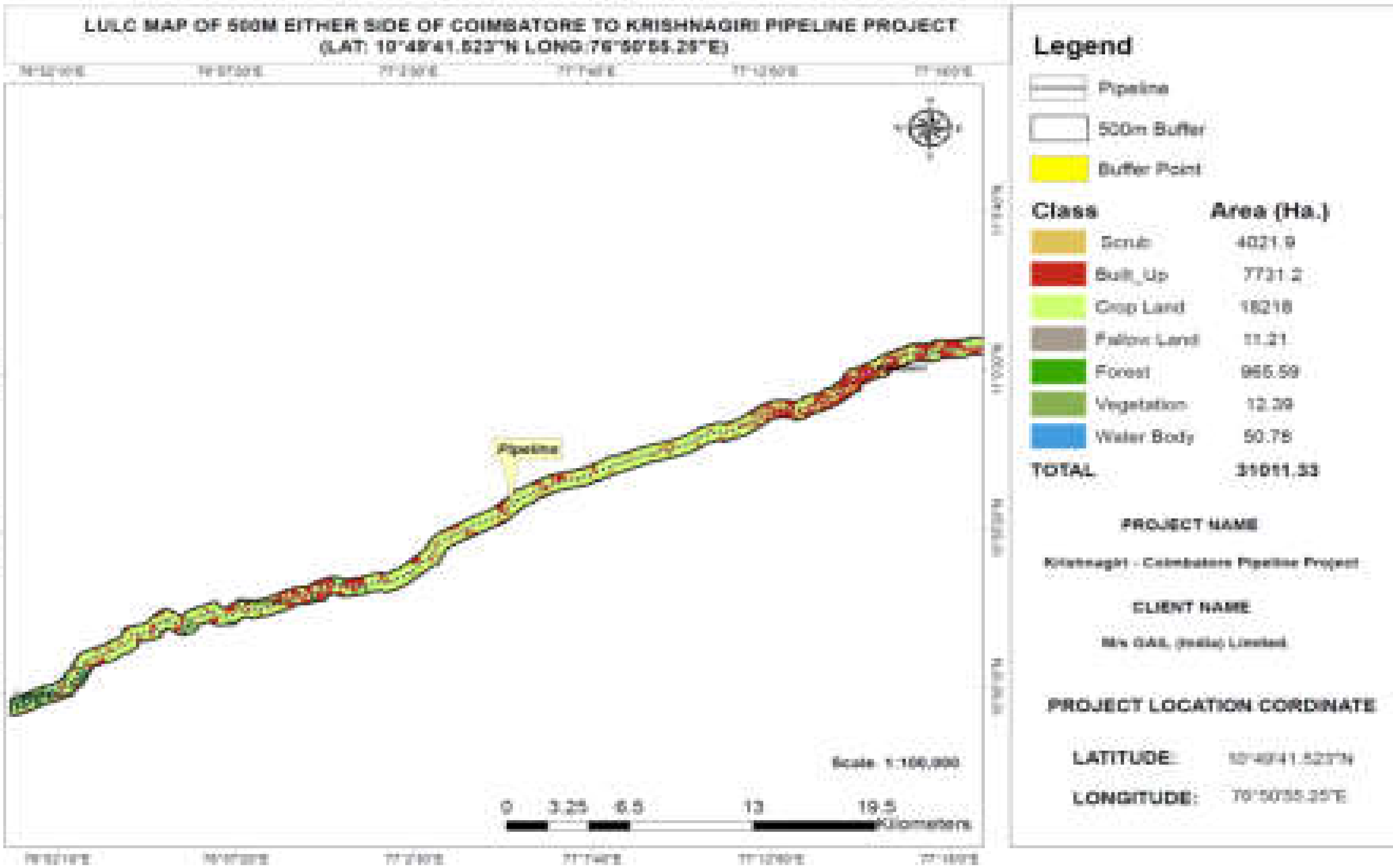


Figure-3.6: LULC map of 500 meter either side of Coimbatore to Krishnagiri pipeline project

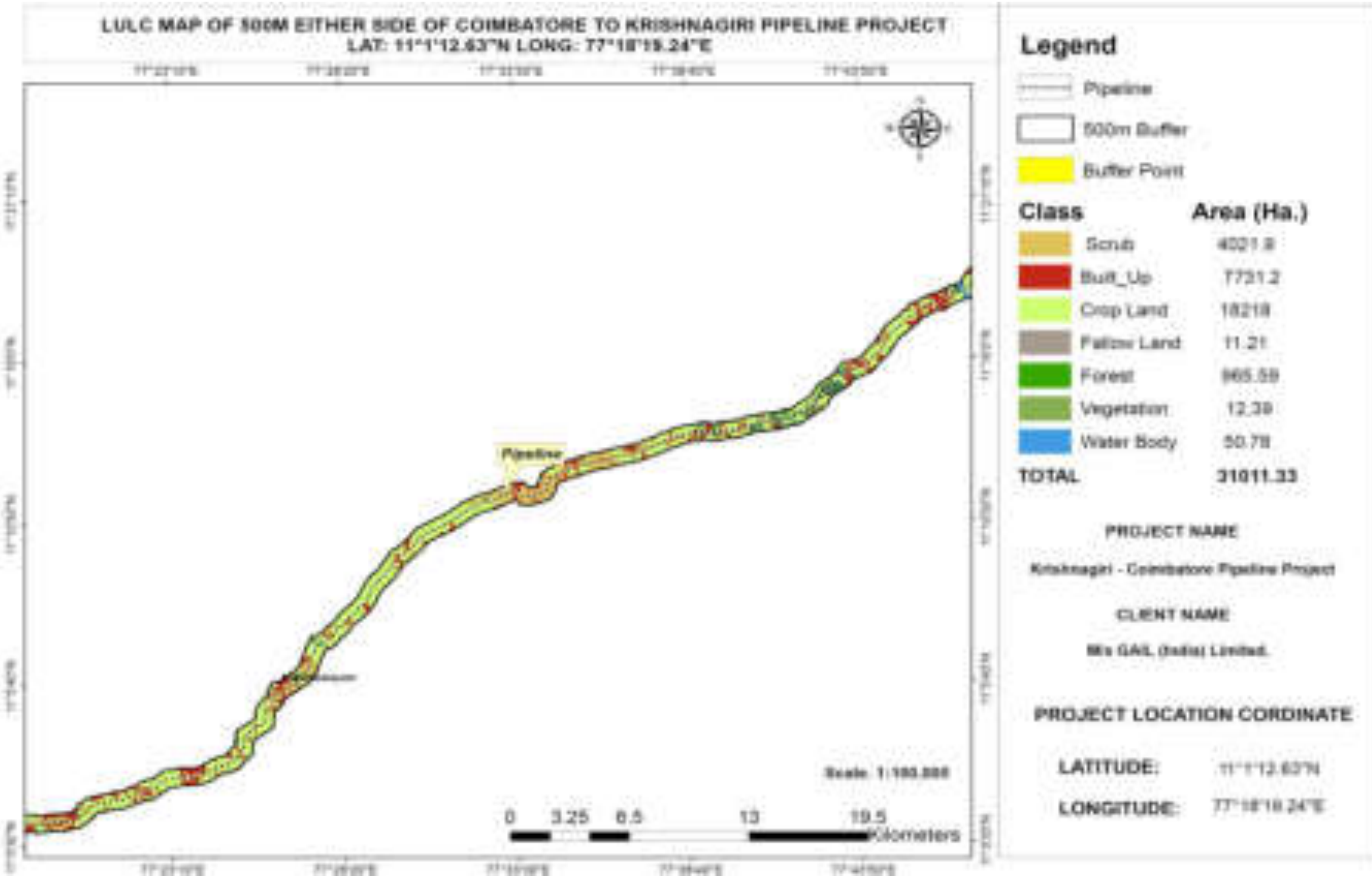


Figure-3.7: LULC map of 500 meter either side of Coimbatore to Krishnagiri pipeline project

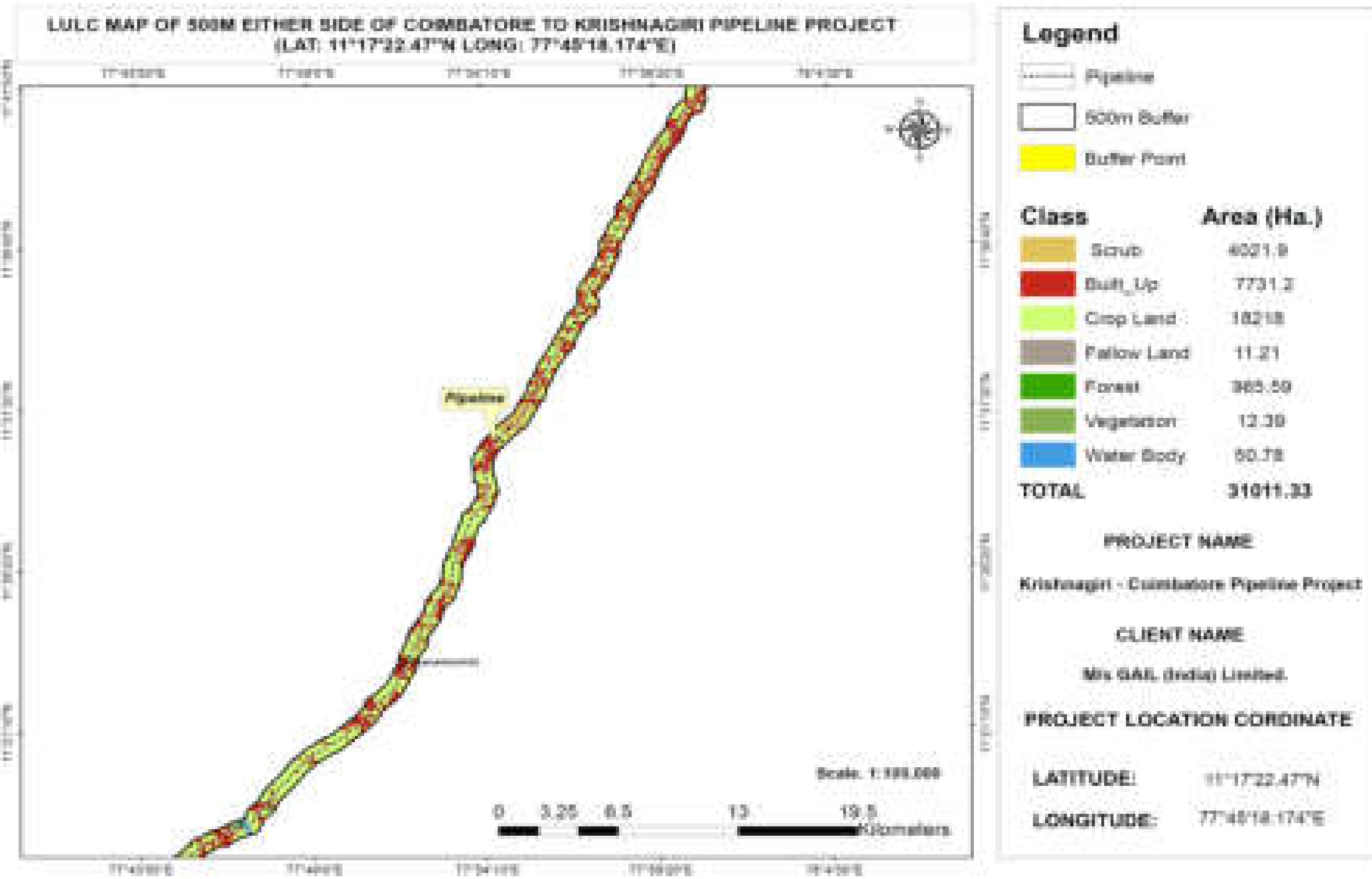


Figure-3.8: LULC map of 500 meter either side of Coimbatore to Krishnagiri pipeline project

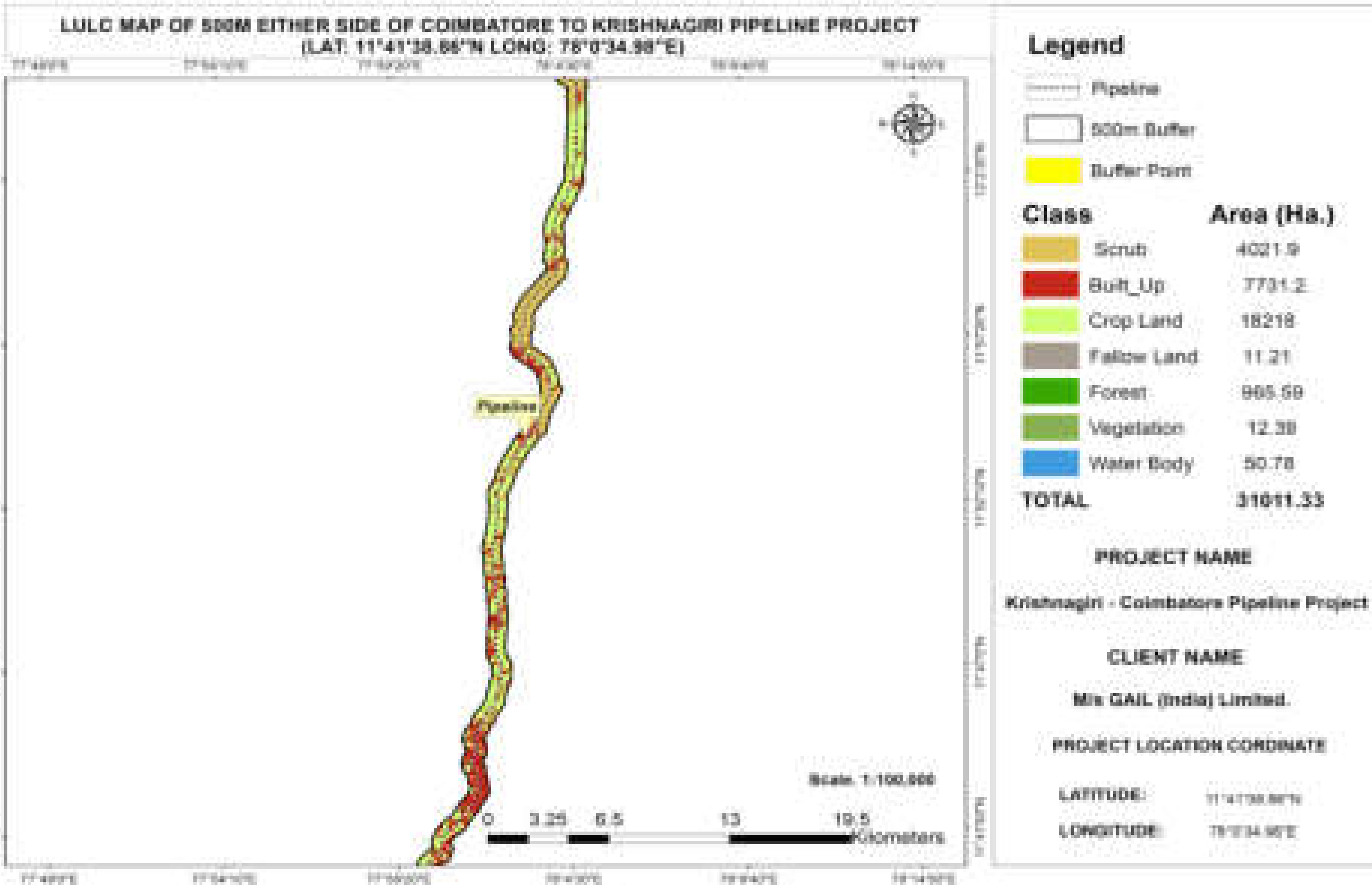


Figure-3.9: LULC map of 500 meter either side of Coimbatore to Krishnagiri pipeline project

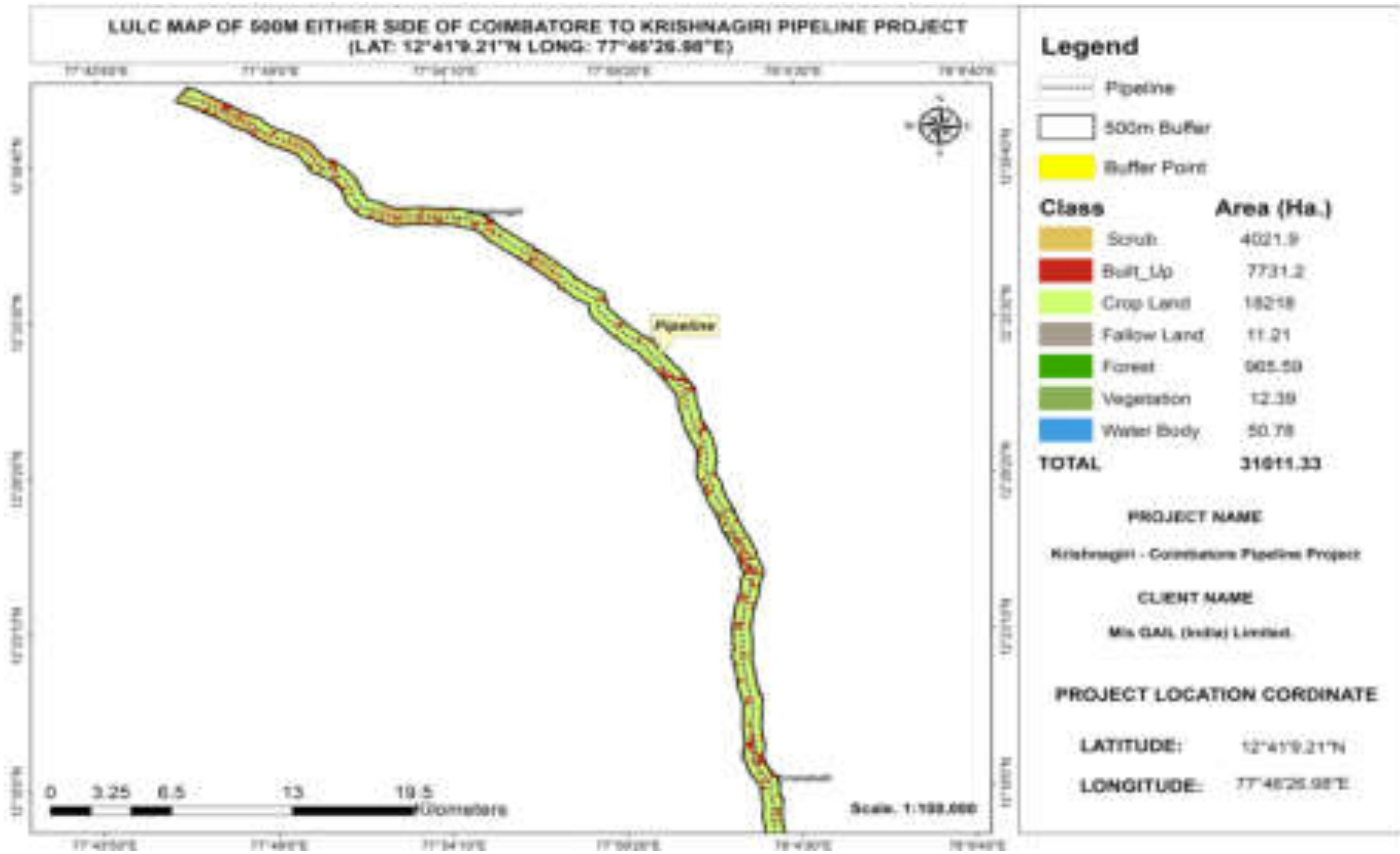


Figure-3.10: LULC map of 500 meter either side of Coimbatore to Krishnagiri pipeline project

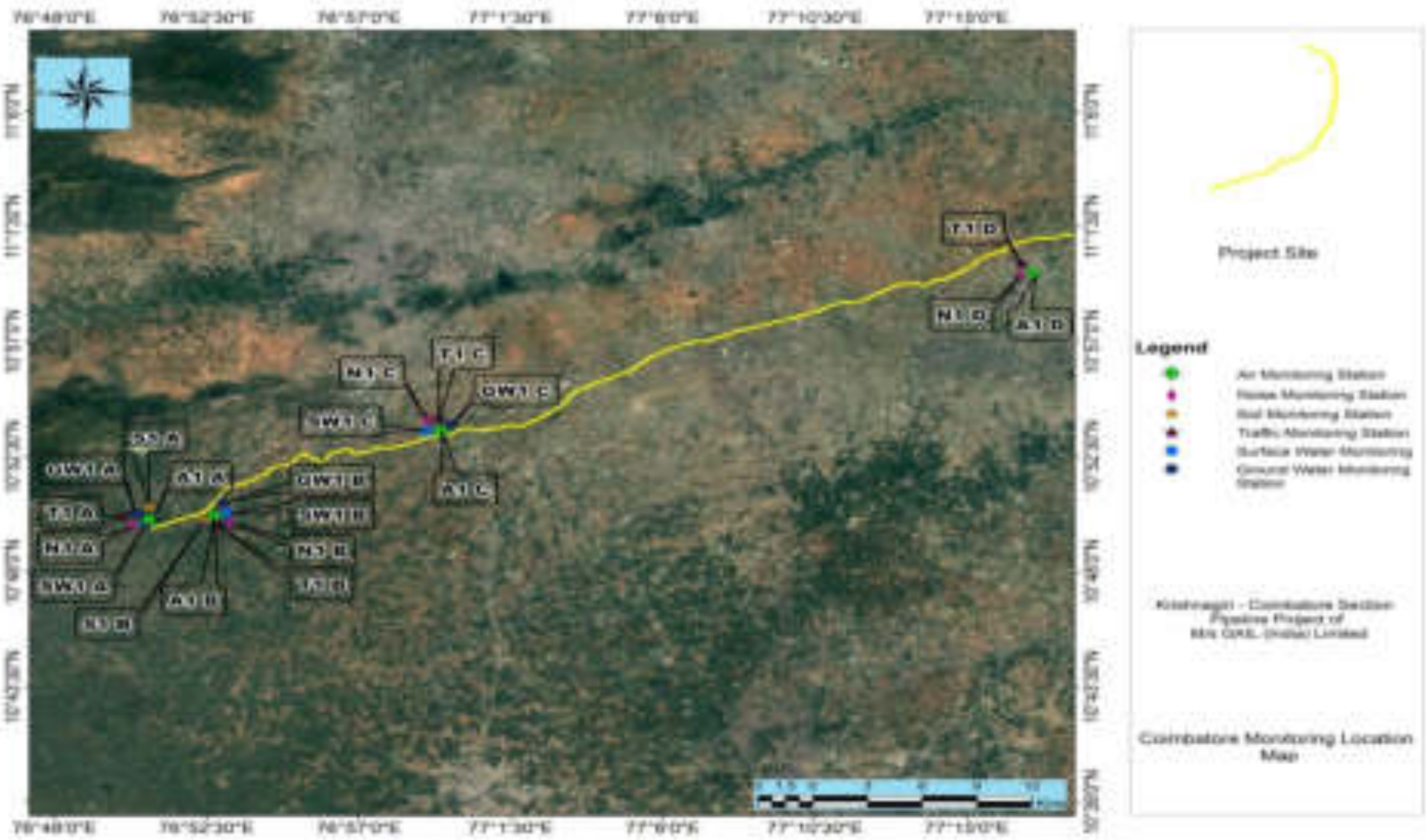


Figure-3.11: Air, Noise, Ground Water, Surface Water, Noise and Traffic Monitoring Locations map of Pipeline starting point at Coimbatore within 10 km radius

Figure-3.12: Air, Noise, Ground Water, Surface Water, Noise and Traffic Monitoring Locations map near IPS-3 within 10 km radius

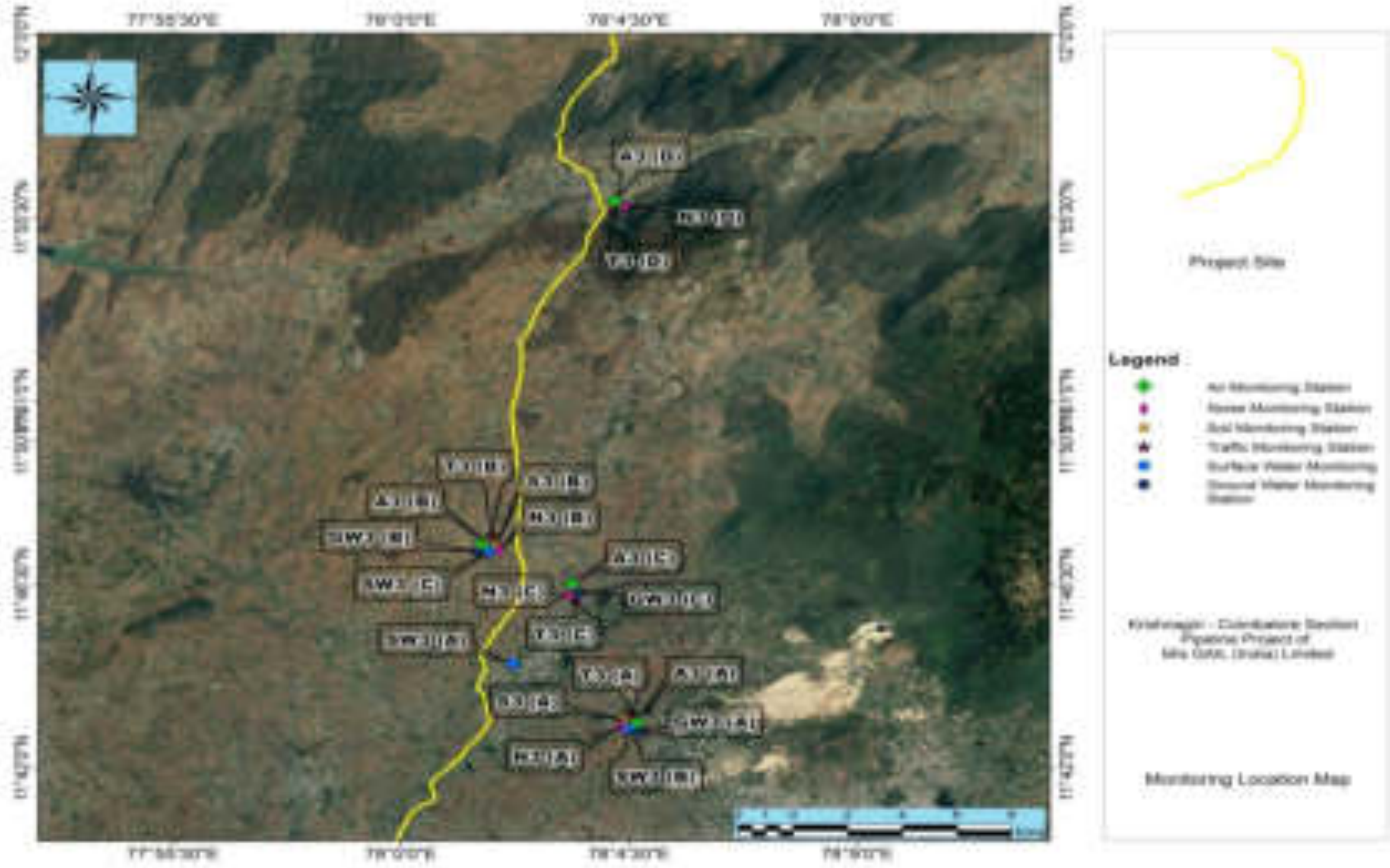


Figure-3.13: Air, Noise, Ground Water, Surface Water, Noise and Traffic Monitoring Locations map near SV-18 Chainage within 10 km radius

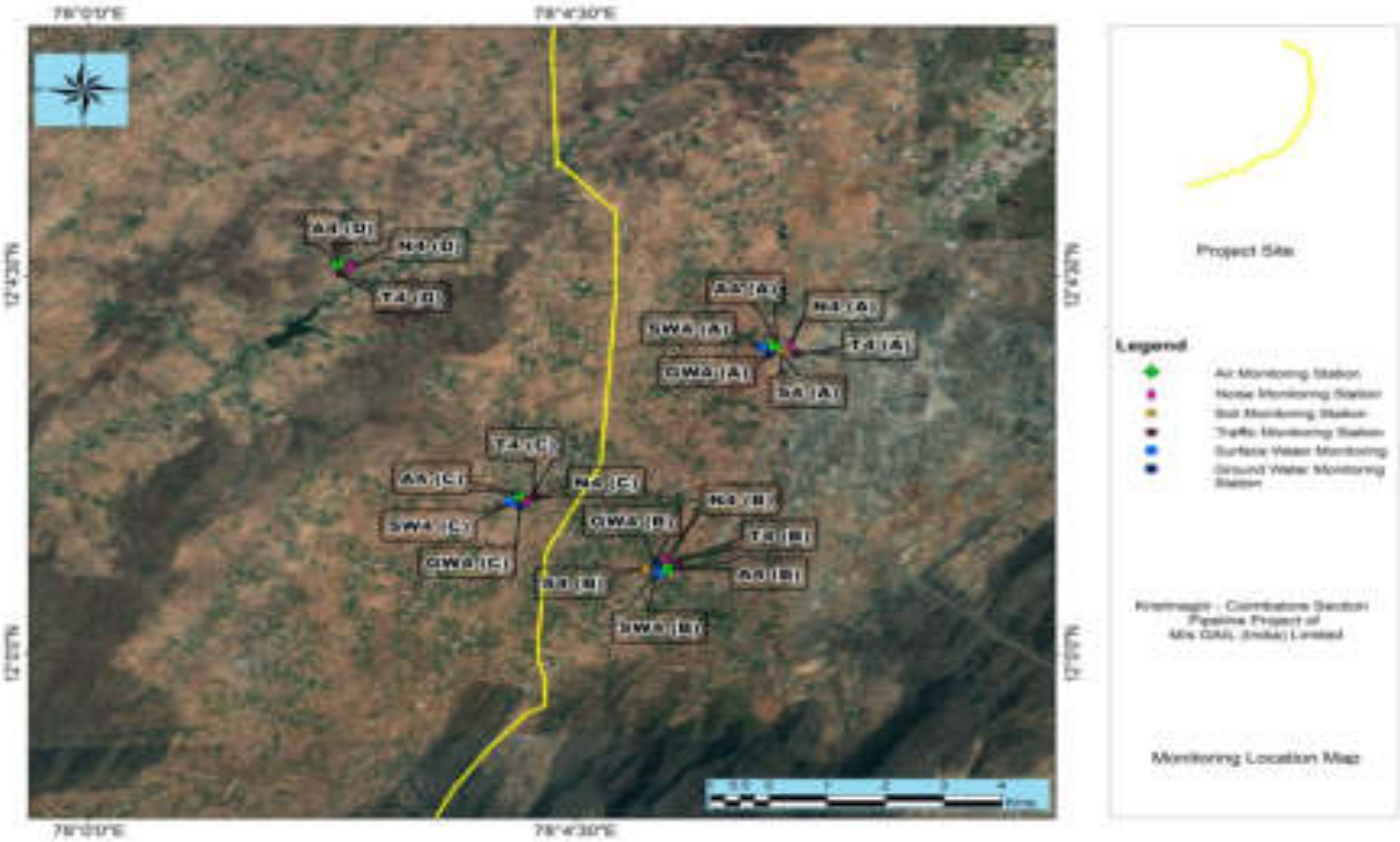


Figure-3.14: Air, Noise, Ground Water, Surface Water, Noise and Traffic Monitoring Locations map near IPS-4 Chainage within 10 km radius

Figure-3.15: Air, Noise, Ground Water, Surface Water, Noise and Traffic Monitoring Locations map of pipeline end point at krishnagiri within 10 km radius

3.2 AIR ENVIRONMENT

District wise Profile, Climate & Rainfall of Tamil Nadu

The climate, rainfall and other meteorological characteristics of the districts in the study area are given below:

(i) Krishnagiri

Krishnagiri district is located approximately between 11‟12N and 12‟49N of the North Latitude and between 77‟27E and 78‟38E of east longitude. The total geographical area of the district is 5143 Sq. Km. Krishnagiri district is elevated from 300m to 1400m above the mean sea level. The district is surrounded by Vellore and Tiruvannamalai districts in the East, Karnataka in the West, Andhra Pradesh in the North, Dharmapuri district in the South.

(a) Climate

The climate of Krishnagiri district is comparatively more pleasant than that of the surrounding districts due to general dryness of atmosphere and appreciable drop in temperature in the monsoon season. The year may be divided into four season namely dry season from January to March, summer season April and May, southwest monsoon season from June to Sept. and northeast monsoon season from October to December. During summer season (April to May) the maximum temperature is about 37°C, and the mean daily minimum temperature of about 25°C in the plains. There is a gradual decrease of both day and night temperatures from June onwards till December, when the mean daily maximum temperature is about 30°C and the mean daily min. is about 19°C in plains. The day temperature increases gradually from January onwards. The lowest temperature is reached in January when the mean daily minimum is about 19°C. However, in higher areas i.e., Hosur, Thally and Krishnagiri taluks day and night temperature are lower by about 2 to 3°C. In these areas weather is comparatively pleasant round the year.

(b) Rainfall

The district receives the rain under the influence of both southwest and northeast monsoons. The normal annual rainfall over the district varies from about 750 to about 900 mm. It is the minimum around Hosur (767.7 mm) and Rayakottai (768.0 mm) in the northern and central parts of the district. It gradually increases towards west and east and is the maximum around Denkanikotai (910.7 mm) in the western part.

(ii) Dharmapuri

Dharmapuri is one of the 38 districts in the state of Tamil Nadu in India. It is the first district created in Tamil Nadu after the independence of India by splitting it from then-Salem district on 2 October 1965. The other major towns in the district are Harur, Palacode, Karimangalam, Nallampalli, Pennagaram and Pappireddipatti.

Dharmapuri District is one of the major producers of mango in the state, fine quality granite is found in the district. It is also one of the main sericulture belts in the state. Around 30 percent of the district's area is under forest cover. Kaveri enters Tamil Nadu through this district. Dharmapuri district had the lowest literacy rate of 74.23% in Tamilnadu during the 2011 census.

(a) Climate

The district temperature is a gradual decrease of both day and night temperatures from June onwards till December, when the mean daily maximum is about 30°C and the mean daily minimum about 19°C in the plains. The day temperatures increase gradually from January onwards. The lowest temperature is reached in January when the mean daily minimum is about 19°C. April and May are the hottest months in the year with the mean daily maximum temperature of about 37°C and the mean daily minimum temperature of about 25°C in the plains. However, in the higher areas in Hosur, Thally and Krishnagiri taluks day and night temperatures are lower by about 2°C to 3°C. In these areas weather is comparatively pleasant round the year. In the lower plains weather is also pleasant except on individual days in May, June and July when weather becomes occasionally oppressive and sultry due to high temperatures (about 42°C). The climate of the district on the whole is slightly humid. The driest months are February and March with average relative humidity of about 30% in the afternoons. During the rainy months the average humidity is appreciably below the saturation level. Skies are generally clear or lightly clouded during the period January to about the middle of April. The cloudiness increases from the later half of April and from middle of June onwards when the skies are generally clouded till about the middle of November.

(b) Rainfall

The normal annual rainfall over the district varies from about 760mm to about 910mm. It is lowest around Rayakota (766.5mm) in the northern part of the district. It gradually increases towards south, west and east and attains a maximum around Denkanikota (912.0mm) in the northwestern part small area the northwestern part around Thally. It increases towards the north and reaches a maximum in the northern part around Rayakota

(iii)Salem

Salem District is one of the 38 districts of Tamil Nadu state in southern India. The district is now divided into Dharmapuri, Krishnagiri, Namakkal as individual districts. Salem is the district headquarters and other major towns in the district include Mettur, Thammampatti, Attur, Omalur, Sankagiri and Edappadi. That Salem dates to at least two thousand years ago is evident from the discovery of silver coins from the Roman Emperor Nero Claudius Caesar Augustus Germanicus (37–68 CE) found by Koneripatti of Salem in 1987. It was ruled by Mazhavar King Kolli Mazhavan and kings Adhiyaman and Valvil Ori of Sangam age. It is part of Kongu Nadu and Mazhanadu, a vast region that dates to the 2nd century BCE. Salem was the largest district of Tamil Nadu. It was bifurcated into Salem and Dharmapuri districts in 1965 and Namakkal district in 1997. Now Salem has been developed a lot by building many bridges and is considered to be the smart city. Salem is famous for cultivating mangoes.

(a) Climate

The district enjoys a tropical climate. The weather is pleasant during the period from November to January. Mornings in general are more humid than the afternoons, with the humidity exceeding 75% on an average. In the period June to November the afternoon humidity exceeds 60% on an average. In the rest of the year the afternoons are drier, the summer afternoons being the driest. The hot weather begins early in March, the highest temperature being reached in April and May. Weather cools down progressively from about the middle of June and by December, the mean daily maximum temperature drops to 30.2°C, while the mean daily minimum drops to 19.2°C and 19.6°C in January in Salem and Mettur Dam respectively.

(b)Rainfall

The district receives the rain under the influence of both southwest and northeast monsoons. The northeast monsoon chiefly contributes to the rainfall in the district. Rainfall data from six stations over the period 1901-2003 were utilized and a perusal of the analysis shows that the normal annual rainfall over the district varies from about 800 mm to 1600 mm. It is the minimum around Sankari (800 mm) in the southwestern part of the district. It gradually increases towards north, northeast and east and attains a maximum around Yercaud (1594.3 mm) in the northern part.

(iv) Erode

Erode District is one of the 38 districts in the state of Tamil Nadu in India. It was the largest district by area in the state before the formation of Tirupur District in 2009. The headquarters of the district is Erode. It is divided into two revenue divisions, Erode and Gobichettipalayam, and is further subdivided into 10 taluks. Erode District was a part of Coimbatore District before its division into two on 17 September 1979. It covers an area of 5,722 square kilometres (2,209 sq mi), and as of 2011, had a population of 2,251,744.

(a) Climate

The western part of the Erode district enjoys a salubrious climate because of the hilly region, whereas the central and eastern parts of the district are hot and humid. The cooler and pleasant climate prevails in the hilly regions. The weather is extremely pleasant during the period from November to February both in the plains and on the hills. Mornings in general are more humid than the afternoons. The relative humidity varies from 65 to 87 percent during the northeast monsoon period between October and November. The hot weather begins early in March, the highest temperature being reached in April and May. Highest temperatures are recorded during the months of April and May with temperatures reaching 40°C. The weather in the plains during the summer i.e., from April to June is generally dry and hot. Weather cools down progressively from about the middle of June and by December. The night temperatures are the lowest in the hills.

(b)Rainfall

The district receives the rain under the influence of both southwest and northeast monsoons. The northeast monsoon chiefly contributes to the rainfall in the district. The southwest monsoon is also reasonable. During the winter and hot seasons, the rainfall is scanty. The normal annual rainfall over the district varies from about 575 mm to about 833 mm. It is the minimum in the southern and southeastern parts of the district around Kodumudi (575.3 mm) Mulanur (581.0 mm) and Dharapuram (593.0 mm. It gradually increases towards north and northwest and reaches a maximum around Talavadi (833 mm).

(vi)Coimbatore

Coimbatore district is one of the 38 districts in the state of Tamil Nadu in India. Coimbatore is the administrative headquarters of the district. It is one of the most industrialized districts and a major textile, industrial, commercial, educational, information technology, healthcare and manufacturing hub of Tamil Nadu. The region is bounded by Tiruppur district in the east, Nilgiris district in the north, Erode district in the north-east, Palakkad district, Idukki district and small parts of Thrissur district and Ernakulam district of neighboring state of Kerala in the west and south respectively. As of 2011, Coimbatore district had a population of 3,458,045 with a sex-ratio of 1,000 and literacy rate of 84%.

(a) Climate

The district enjoys a tropical climate. The weather is pleasant during the period from November to January. Mornings in general are more humid than the afternoons, with the humidity exceeding 78% on an average. In the period June to November the afternoon humidity exceeds 66% on an average. In the rest of the year the afternoons are drier, the summer afternoons being the driest. The period from April to June is generally hot and dry. The temperature recorded varies from 11.7°C to 42.6°C.

(b)Rainfall

The district receives the rain under the influence of both southwest and northeast monsoons. The northeast monsoon chiefly contributes to the rainfall in the district and summer rains are negligible. Rainfall data from six stations over the period 1901-2000 were utilized and a perusal of the analysis shows that the normal annual rainfall over the district varies from about 550mm to 900mm. It is the minimum around Sulur (550 mm) in the eastern part of the district. It gradually increases towards south and attains a maximum around Anamalai hills.

3.2.1 Meteorological Data

Meteorology plays a vital role in affecting the dispersion of pollutants, which once discharged into the atmosphere cannot be controlled. Since meteorological factors show wide fluctuations with time, meaningful interpretation can be drawn only from long-term reliable data. Such source of data is the India Meteorological Department (IMD), which maintains a network of meteorological stations at several important locations. Meterological station was installed at the project site to record the data. The Meteorological parameters obtained from this station are temperature, humidity, rainfall, wind speed and wind direction. (Table no 3.3).

3.2.2 Meteorological Status at the Project Site

Meteorological station was set-up at site (Near Salem Junction - Railway station, Nehru St Subramani Nagar, Azad Nagar, Old Suramangalam, Salem, Fig no-3.17) to record surface meteorological parameter during study period; **December 2021 to March 2022**. Wherein maximum and minimum temperature, percentage relative humidity, wind speed and direction were recorded simultaneously and the summary of the same is given in the Table no-3.3. Table. 3.1 and Table no. 3.2 depicts the location, GPS coordinates of the meteorological station and Secondary meteorological data of Salem district from 1980 to 2010 respectively.

Table-3.1: Meteorological Stations

S.No.	Location	State	Lattitude	Longitude
1	Near Salem Junction - Railway station, Nehru St Subramani Nagar, Azad Nagar, Old Suramangalam, Salem	Tamil Nadu	11˚40'15.312" N	78˚06'55.344"

Table-3.2: Meteorological data of Salem

Month	Temperature ˚C		Relative Humidity %		Wind Speed (m/s)	Rainfall (mm)
	Max	Min	Max	Min	Mean	Monthly Total
December	33.2	16.4	76	56	3.5	35
January	34.6	16.3	74	45	4.3	4.4
February	37.2	16.9	71	36	4.7	3.4
March	39.3	18.9	67	33	4.5	17.3

Source: IMD data 1980-2010

Table-3.3: Meteorological Conditions at Near Salem Junction - Railway station, Nehru St SubramaniNagar, Azad Nagar, Old Suramangalam, Salem (December 2021 to March 2022)

Month	Temperature ˚C		Relative Humidity %		Wind Speed (m/s)		Rainfall (mm)		Predominant Wind Direction
	Max	Min	Max	Min	Max	Min	Max	Min	
16 December 2021	28.31	13.61	106.59	50.79	6.77	1.47	0.455	0	ENE
January 2022	32.65	15.65	104.04	34.53	6.68	0.06	0.464	0	
February 2022	36.04	14.5	105.02	15.32	6.34	0.06	0.073	0	
15 March 2022	37.46	18.01	97.27	11.19	6.31	0.16	0.027	0	

3.2.3 Wind Speed / Wind Rose Diagram

Wind speed and wind direction data recorded during the study period is useful in identifying the influence of meteorology on the air quality of the area. Based on the collected meteorological data, relative percentage frequencies of different wind directions were calculated and plotted as wind roses of Sixteen directions *viz*., N, NNE, NE, ENE, E, ESE, SE, SSE, S, SSW, SW, WSW, W, WNW, NW and NNW for twenty four hour duration, respectively which is given below:

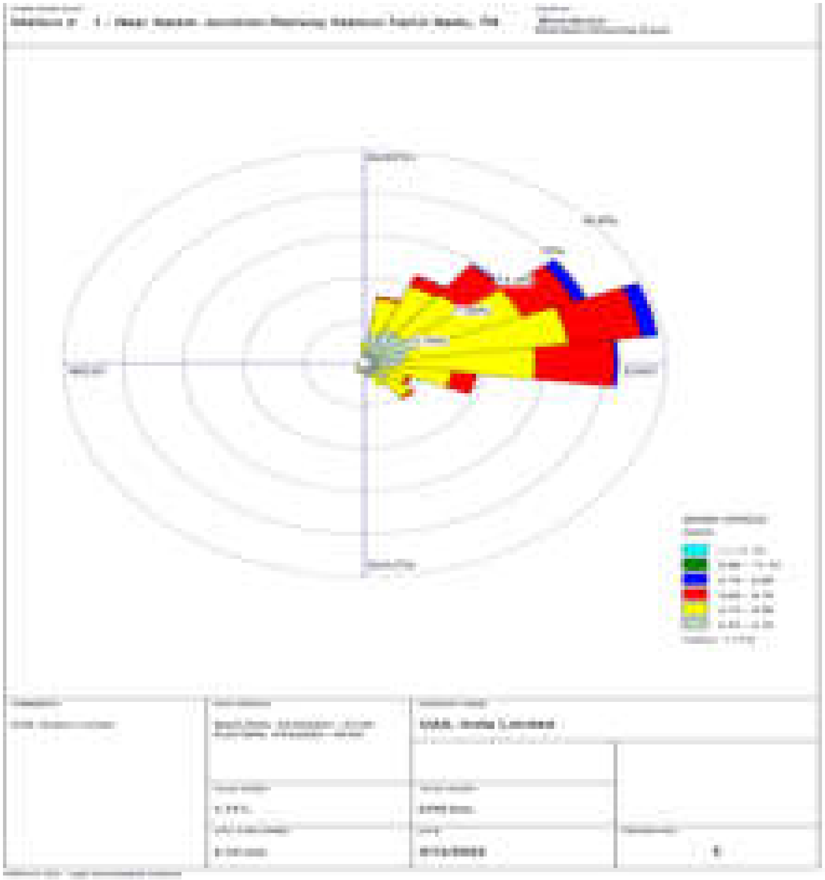
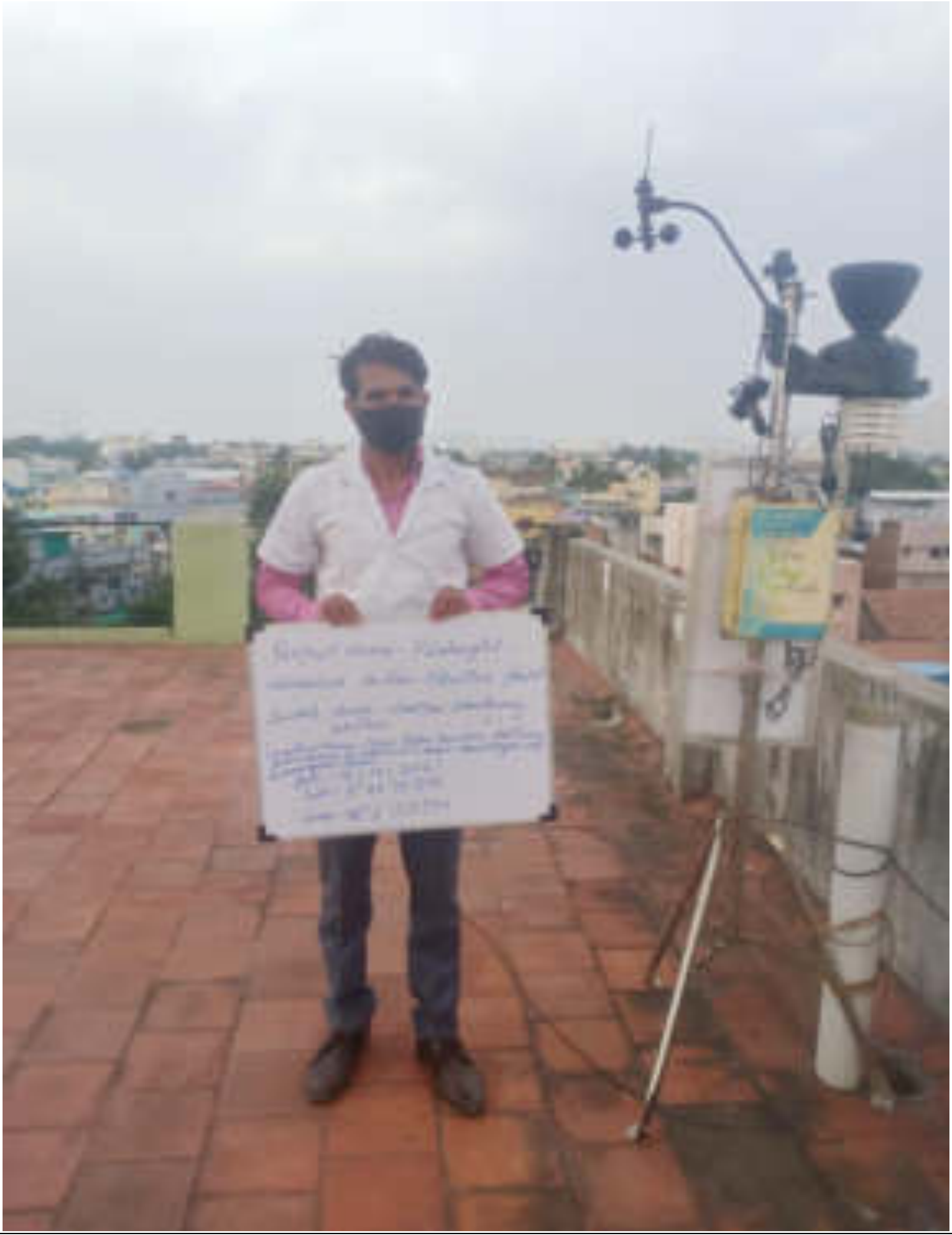


Figure-3.16: Wind Rose Diagram from December 2021 to March 2022 at project site

In the wind rose diagram drawn from the monitored data, the average wind speed recorded during the Monitoring period was 2.70 m/s. The wind rose diagram further shows that the Predominant wind direction during the study period was mainly from ENE.



Near Salem Junction - Railway station, Nehru St Subramani Nagar, Azad Nagar, Old Suramangalam, Salem

Figure-3.17: Meteorology Monitoring Photographs

3.2.4 AMBIENT AIR QUALITY

The baseline air quality study was done to assess the existing air quality of the proposed pipeline area. This will also be useful for assessing the conformity to standards of the ambient air quality during the operation after the proposed pipline.

The ambient air quality along the study area of approx. 293.7 km project length forms the baseline information. The various sources of air pollution in the region are dust rising from unpaved roads, domestic fuel burning, vehicular traffic, agricultural activities, etc. The prime objective of baseline air quality monitoring is to assess existing air quality of the area. This will also be useful in assessing the conformity to standards of the ambient air quality during the operations.

3.2.4.1 Selection of Sampling Station

The baseline status of the ambient air quality has been assessed through scientifically designed Ambient Air Quality Network. The design of monitoring network in the air quality surveillance program has been based on the following considerations:

a) Representation of project area.
b) Representation of the downwind direction and cross-sectional distribution.
c) Representation of residential areas.
d) Representation of regional background levels.
e) Representation of sensitive receptor.
f) Meteorological conditions (predominant wind direction and wind speed).
g) Topography of the study area.
h) Influence of the existing sources if any, are to be kept at minimum.

Total 20 Ambient Air Quality Monitoring Stations were established within the study area depicted in Table no-3.4, while the results are summarised in Tables-3.6 to 3.12.

Table-3.4: Ambient Air Quality Monitoring, Sampling Stations

Stations	Locations	Sampling Locations	Coordinates	
			Latitude	Longitude
A1	**Pipeline starting point at Coimbatore**	Coimbatore (Tamil Nadu)		
A	Parade Ground SFTI Walayar near Village Chandrapuram		10˚50'4.8" N	76˚50'45.2" E
B	JCT College of Engineering and Technology near Pichanur - Bus stop		10˚50'16.5" N	76˚52'45.9" E
C	Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore		10˚53'22.8" N	76˚59'44.4" E

D	Palladam Bus Stand, Coimbatore Road		10˚59'37.5" N	76˚16'55.1" E
A2	**Near IPS-3 location**	Erode (Tamil Nadu)		
A	Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam		11˚15'48" N	77˚43'40" E
B	Erode Junction Railway Station		11˚19'49" N	77˚43'31" E
C	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai		11˚14'08" N	77˚43'08" E
D	Erode East RTO Office - Transportation authority office on SH 84,Nanjailakkapuram		11˚17'53" N	77˚46'21" E
A3	**Near SV-18 at Chainage 371.035.**	Salem (Tamil Nadu)		
A	Periyar University, Periyar, Palkalai Nagar - Salem		11˚37'50" N	78˚08'54" E
B	Semmandappatti - Railway station, Semmandapatti		11˚47'25" N	78˚01'34" E
C	Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur		11˚46'32" N	78˚03'23" E
D	Toppur - Railway station, Sekkarapatti		11˚56'04" N	78˚04'17" E
A4	**Near IPS-4**	Dharmapuri (Tamil Nadu)		
A	Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli		12˚03'38" N	78˚06'07" E
B	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur		12˚00'57" N	78˚05'19" E
C	Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti		12˚01'57" N	78˚04'01" E
D	Indian Bank, GS Complex, Housing Board Bus Stop, Royakottah Main Road, Mullai Nagar, Hosur		12˚43'18" N	77˚50'20" E
A5	**Pipeline end point at Krishnagiri**	Krishnagiri (Tamil Nadu)		
A	Hosur Airport, Taneja Aerospace Road, Belagondanahalli		12˚40'11" N	77˚45'42" E
B	Rams Farm - Resort hotel, Hosur		12˚38'35" N	77˚49'56" E

C	Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur		12˚41'33" N	77˚50'36" E
D	Sub Registrar Office - Government office, Hosur Main Road, Attibele-Rayakottai Road, Kelamangalam		12˚36'33" N	77˚51'47" E

3.2.4.2 Baseline Data

Ambient air monitoring at 20 locations were carried out during **December 2021 to March 2022** in the study area to assess the ambient air quality at the source. Major air quality parameters *viz.*Particulate Matter (PM_{10}), Particulate Matter ($PM_{2.5}$), Sulphur Dioxide (SO_2), Nitrogen Dioxide (NO_2),Ozone (O3) Carbon Monoxide (CO), Ammonia (NH3), Benzene(C_6H_6), HC (Methane & Non-Methane) representing the basic air quality in the region were analysed in Ambient Air Quality Monitoring (AAQM).

Parameters, Frequency and Monitoring Methodology

PM_{10}, $PM_{2.5}$, SO_2, NO_2, O_3, CO, NH_3, C_6H_6 and HC were parameters analysed for the baseline study. Parameters like PM_{10}, $PM_{2.5}$, SO_2 and NO_2 were analyzed on 24 hourly basis, whereas CO & Ozone were on 8 hourly basis. The sampling equipment was placed at a height of 3 to 3.5 meters above ground level at each monitoring station, thus negating the effects of wind blow ground dust. The equipment was placed at open space free from trees and vegetation which otherwise act as a sink of pollutants resulting in lower levels in monitoring results. At locations close to internal roads, the equipment was placed at least 10 m away from such roads to avoid influence of traffic exhaust emissions. The methodology used for analysis of various parameters shall be a s specified in NAAQS 2009.

Table 3.5: National Ambient Air Quality Standards, 2009

S.no.	Pollutant	Time Weighted Average	Concentration in ambient air	
			Industrial, Residential, Rural and other areas	Ecologically sensitive Area (Notified by Central Government)
1	Sulphur Dioxide (SO_2), µg/m^3	Annual	50	20
		24 hours	80	80
2	Nitrogen dioxide (NO_2), µg/m^3	Annual	40	30
		24 hours	80	80
3	Particulate Matter PM_{10} µg/m^3	Annual	60	60
		24 hours	100	100
4	Particulate Matter $PM_{2.5}$ µg/m^3	Annual	40	40
		24 hours	60	60
5	Ozone	8 hours	100	100
		1 hours	180	180
6	Lead (Pb), µg/m^3	Annual	0.50	0.50
		24 hours	1.0	1.0
7		8 hours	02	02

	Carbon Monoxide (CO), mg/m^3	1 hour	04	04
8	Ammonia (NH3), µg/m3	Annual	100	100
		24 hours	400	400
9	Benzene (C6H6) , µg/m3	Annual	05	05
10	Benzo(a)Pyrene (BaP) - particulate phase only, ng/m3	Annual	01	01
11	Arsenic (As), ng/m3	Annual	06	06
12	Nickel (Ni), ng/m3	Annual	20	20

*NAAQS –National Ambient Air Quality Standards, Schedule-VII, [Rule 3(3B)], [Part-II-sec (i)] 18.11.2009.

3.2.4.3 Results and Discussions

Various statistical parameters like minimum, maximum, Average and 98 percentiles concentrations have been computed from the results generated during sampling at all the monitoring stations. Results are summarised in Tables 3.6 to 3.12 and are discussed below.

3.2.4.3.1 PM_{10} (Particulate Matter)

The 98th percentile concentrations of PM_{10} range from **71.9 to 84.9 µg/m^3** (Table 3.6). Minimum concentration **68 µg/m^3** is recorded at A1(a) i.e. Parade Ground SFTI walayar near village Chandrapuram, A2 (c) Sarasu Mahal Avalpoondurai (Festival Hall) on Erode Dharapuram Road, A3(a) Periyar University, Periyar Palkalai Nagar Salem, A4(c) Samichettipatti Velaan Kadan Sangam-Central Government Office Samichettipatti, A5(b) Rams Farm-Resort Hotel Hosur. Maximum concentration is **85 µg/m^3** found at A1(d) Palladam Bus Stand, Coimbatore Road and A3(b) Semmandappatti Railway Station. Fig: 3.18 gives the graphical representaion of the Particulate Matter concentration at different monitoring stations. The concentration of PM_{10} is found to be well within the NAAQS limits at all locations.

Table-3.6: Particulate Matter (PM_{10}) Results
(Min, Max, Average & 98th Percentile concentrations)

S.No.	Location code	Min.	Max.	Avg	98th Percentile	Test Method
A1	A1(a)	68	72	70	71.9	NAAQMS/36/2012
	A1(b)	75	78	76.6	77.5	NAAQMS/36/2012
	A1(c)	72	79	75.3	78.8	NAAQMS/36/2012
	A1(d)	80	85	83.1	84.3	NAAQMS/36/2012
A2	A2(a)	72	79	76	78.9	NAAQMS/36/2012
	A2(b)	81	84	82.5	83.9	NAAQMS/36/2012
	A2(c)	68	72	70.3	71.9	NAAQMS/36/2012
	A2(d)	73	77	75	76.9	NAAQMS/36/2012

A3	A3(a)	68	73	70.3	72.9	NAAQMS/36/2012
	A3(b)	81	85	82.6	84.9	NAAQMS/36/2012
	A3(c)	70	75	73.1	74.9	NAAQMS/36/2012
	A3(d)	77	83	80	82.9	NAAQMS/36/2012
A4	A4(a)	76	81	78.6	80.9	NAAQMS/36/2012
	A4(b)	78	83	80.3	82.9	NAAQMS/36/2012
	A4(c)	68	73	70.5	72.9	NAAQMS/36/2012
	A4(d)	70	75	72.8	74.9	NAAQMS/36/2012
A5	A5(a)	76	80	78.5	79.5	NAAQMS/36/2012
	A5(b)	68	75	71	74.7	NAAQMS/36/2012
	A5(c)	72	78	74.1	77.7	NAAQMS/36/2012
	A5(d)	74	78	75.8	77.9	NAAQMS/36/2012

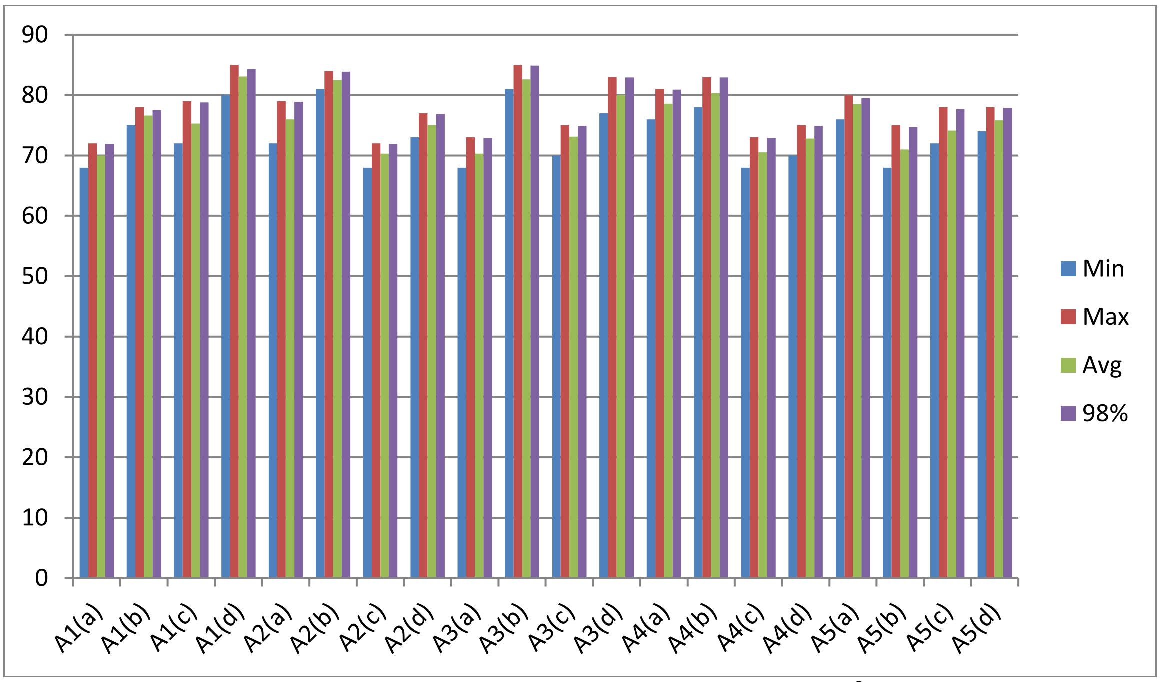


Figure-3.18: PM_{10} Concentration in µg/m^3

3.2.4.3.1 $PM_{2.5}$ (Particulate Matter)

The 98th percentile concentrations of $PM_{2.5}$ ranging from **34.6** to **47.9 µg/m^3** (Table 3.7) The maximum concentration found is **48 µg/m^3** at A1(d) Palladam Bus Stand, Coimbatore Road and A3(b) Semmandappatti Railway station where as minimum concentration found is **30 µg/m^3** at A1(a) Parade Ground SFTI Walayar near Village Chandrapuram. Fig: 3.19 gives the graphical representaion of the Particulate Matter concentration at different monitoring stations. The concentration of $PM_{2.5}$ is found to be well within the NAAQS limits at all locations.

Table-3.7: Particulate Matter ($PM_{2.5}$) Results
(Min, Max, Average & 98th Percentile concentrations)

S.No.	Location code	Min.	Max.	Avg	98th Percentile	Test Method
A1	A1(a)	30	35	32.3	34.9	NAAQMS/36/2012

	A1(b)	37	40	38.5	39.9	NAAQMS/36/2012
	A1(c)	40	44	42	43.9	NAAQMS/36/2012
	A1(d)	43	48	45.8	47.9	NAAQMS/36/2012
A2	A2(a)	38	43	40.5	42.9	NAAQMS/36/2012
	A2(b)	43	46	45.1	45.6	NAAQMS/36/2012
	A2(c)	37	42	38.6	41.8	NAAQMS/36/2012
	A2(d)	34	40	36.6	39.9	NAAQMS/36/2012
A3	A3(a)	31	35	33.3	34.6	NAAQMS/36/2012
	A3(b)	43	48	46	47.9	NAAQMS/36/2012
	A3(c)	35	39	36.8	38.9	NAAQMS/36/2012
	A3(d)	39	46	42.5	45.9	NAAQMS/36/2012
A4	A4(a)	39	45	41.6	44.9	NAAQMS/36/2012
	A4(b)	38	44	40.8	43.8	NAAQMS/36/2012
	A4(c)	32	38	35.1	37.9	NAAQMS/36/2012
	A4(d)	35	38	36.3	37.9	NAAQMS/36/2012
A5	A5(a)	36	40	38.3	39.9	NAAQMS/36/2012
	A5(b)	32	39	36	38.9	NAAQMS/36/2012
	A5(c)	37	42	39.5	41.9	NAAQMS/36/2012
	A5(d)	38	43	41.1	42.6	NAAQMS/36/2012

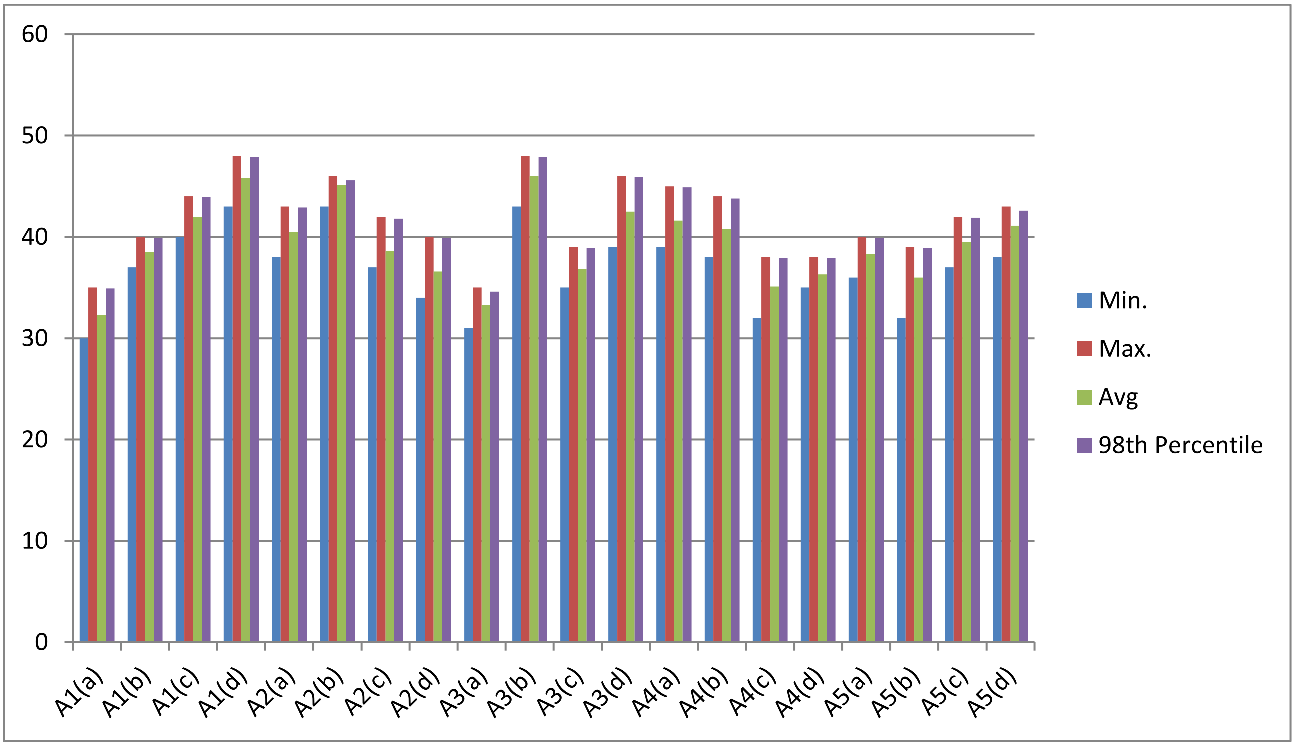


Figure-3.19: $PM_{2.5}$ Concentration in µg/m^3

3.2.4.3.3 Sulphur Dioxide

The 98th percentile concentrations are ranging from **18.0 to 23.4 µg/m^3** (Table 3.8). The maximum concentration found at A1(d) Palladam Bus Stand, Coimbatore Road **(23.5 µg/m^3)** where as minimum concentration found at A5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli **(14.9 µg/m³).** Fig: 3.20 gives the graphical representaion of the Sulphur Dioxide concentration at different monitoring stations. The concentration of SO_2 is found to be well within the NAAQS limits at all locations.

Table-3.8: Sulphur Dioxide (SO_2) Results
(Min, Max, Average & 98th Percentile concentrations)

S.No.	Location code	Min.	Max.	Avg	98th Percentile	Test Method
A1	A1(a)	15.3	18.1	16.8	18.0	NAAQMS/36/2012
	A1(b)	18.3	21.4	19.3	21.2	NAAQMS/36/2012
	A1(c)	18.5	20.9	19.5	20.8	NAAQMS/36/2012
	A1(d)	19.8	23.5	21.5	23.4	NAAQMS/36/2012
A2	A2(a)	15.3	19.5	17.4	19.4	NAAQMS/36/2012
	A2(b)	18.9	21.5	20.2	21.4	NAAQMS/36/2012
	A2(c)	18.4	21.8	20.3	21.7	NAAQMS/36/2012
	A2(d)	17.5	21.6	19.4	21.4	NAAQMS/36/2012
A3	A3(a)	18.3	21.2	19.9	21.1	NAAQMS/36/2012
	A3(b)	18.7	22.3	20.1	22.1	NAAQMS/36/2012
	A3(c)	18.5	22.8	20.4	22.6	NAAQMS/36/2012
	A3(d)	19.2	22.9	20.7	22.7	NAAQMS/36/2012
A4	A4(a)	19.4	22.7	21.2	22.6	NAAQMS/36/2012
	A4(b)	16.8	20.5	18.6	20.4	NAAQMS/36/2012
	A4(c)	15.1	19.5	17.7	19.4	NAAQMS/36/2012
	A4(d)	15.6	19.4	17.6	19.3	NAAQMS/36/2012
A5	A5(a)	14.9	18.1	16.5	18.0	NAAQMS/36/2012
	A5(b)	18.5	20.9	19.8	20.8	NAAQMS/36/2012
	A5(c)	17.3	20.5	19.1	20.4	NAAQMS/36/2012
	A5(d)	15.3	22.8	17.2	22.2	NAAQMS/36/2012

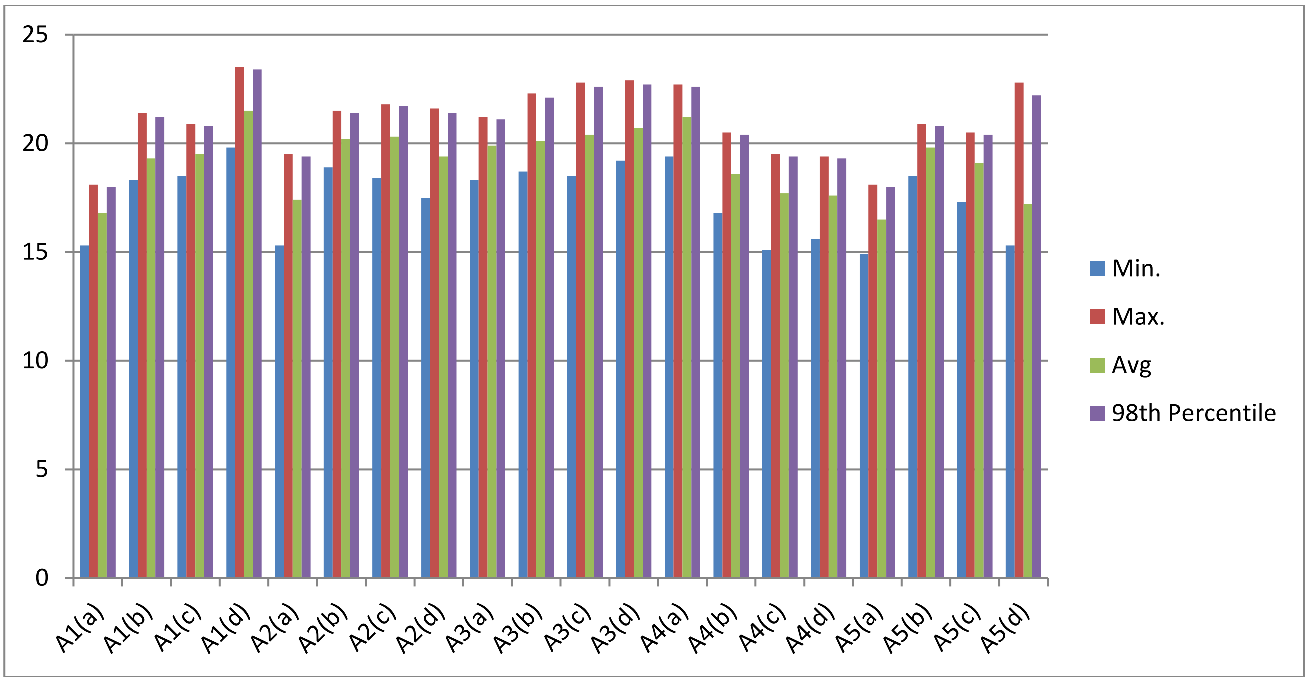


Figure-3.20: SO_2 Concentration in µg/m^3

3.2.4.3.4 Oxides of Nitrogen

The 98th percentile concentrations are ranging from **23.4 to 34.1 µg/m^3** (Table 3.9). The maximum concentration found at A3(d) Toppur - Railway station, Sekkarapatti **(34.2 µg/m^3)** where as minimum concentration found at A2(a) Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam **(19.2 µg/m^3).** Fig: 3.21 gives the graphical representaion of the Nitrogen Dioxide concentration at different monitoring stations. The concentration of NO_2 is found to be well within the NAAQS limits at all locations.

Table-3.9: Nitrogen Dioxide (NO_2) Results
(Min, Max, Average & 98th Percentile concentrations)

S.No.	Location code	Min.	Max.	Avg	98th Percentile	Test Method
A1	A1(a)	21.8	24.1	22.7	24	NAAQMS/36/2012
	A1(b)	27.2	29.5	28.4	29.4	NAAQMS/36/2012
	A1(c)	20.2	24.3	22.4	24.2	NAAQMS/36/2012
	A1(d)	26.5	29.2	27.7	29.1	NAAQMS/36/2012
A2	A2(a)	19.2	23.9	21.3	23.7	NAAQMS/36/2012
	A2(b)	26.3	30	28.2	29.9	NAAQMS/36/2012
	A2(c)	20.8	23.9	22.5	23.8	NAAQMS/36/2012
	A2(d)	20.3	24.8	22.6	24.6	NAAQMS/36/2012
A3	A3(a)	21.6	24.8	23.1	24.7	NAAQMS/36/2012
	A3(b)	25.5	28.3	26.6	28.2	NAAQMS/36/2012
	A3(c)	22.8	25.9	24.3	25.8	NAAQMS/36/2012
	A3(d)	28.5	34.2	31.8	34.1	NAAQMS/36/2012

A4	A4(a)	24.2	29.5	27.2	29.4	NAAQMS/36/2012
	A4(b)	25.3	30.2	28.2	30.1	NAAQMS/36/2012
	A4(c)	20.1	24.5	22.2	24.3	NAAQMS/36/2012
	A4(d)	20.7	23.5	22.2	23.4	NAAQMS/36/2012
A5	A5(a)	19.8	24.6	21.8	24.4	NAAQMS/36/2012
	A5(b)	20.2	24.3	22.1	24.2	NAAQMS/36/2012
	A5(c)	24.3	27.9	26.1	27.8	NAAQMS/36/2012
	A5(d)	22.4	25.8	23.9	25.7	NAAQMS/36/2012

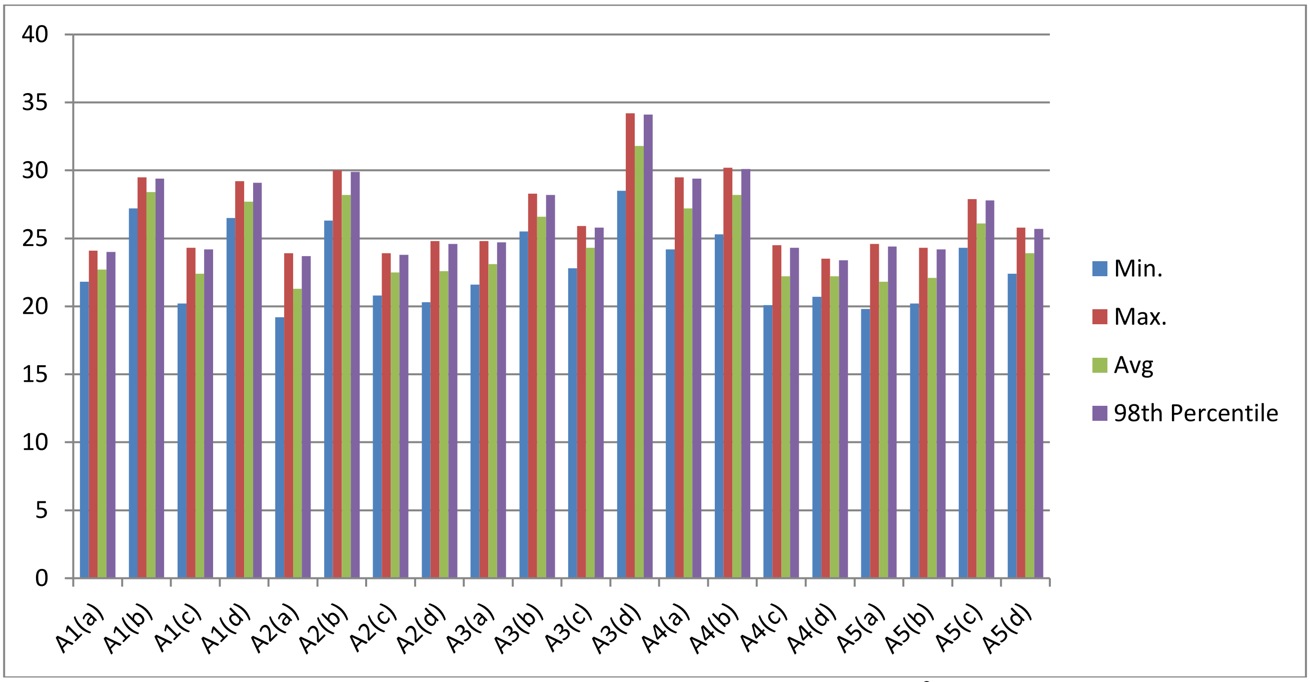


Figure-3.21: NO_2 Concentration in µg/m^3

3.3.4.3.5 Carbon Monoxide

The 98th percentile concentrations are ranging from **0.35 to 0.64 mg/m^3** (Table 3.10). Maximum concentration of CO found at A1(d) Palladam Bus Stand Coimbatore Road and A3(d) and Toppur - Railway station, Sekkarapatti **0.65 mg/ m^3.** Minimum Concentration with **0.17 mg/ m^3** recorded at A5(c) Carmel International School, Onnalavadi P.O Karapalli Jonnabonda Road, R K Road, Hosur. Fig: 3.22 gives the graphical representaion of the Carbon Monoxide concentration at different monitoring stations. All the results are found to be below the NAAQ limits.

Table-3.10: Carbon Monoxide (CO mg/m^3) Results
(Min, Max, Average & 98th Percentile concentrations)

S.No.	Location code	Min.	Max.	Avg	98th Percentile	Test Method
A1	A1(a)	0.25	0.40	0.32	0.39	NAAQMS/36/2012
	A1(b)	0.23	0.49	0.36	0.48	NAAQMS/36/2012
	A1(c)	0.22	0.42	0.31	0.41	NAAQMS/36/2012
	A1(d)	0.32	0.65	0.50	0.64	NAAQMS/36/2012
A2	A2(a)	0.23	0.53	0.37	0.51	NAAQMS/36/2012

	A2(b)	0.36	0.62	0.46	0.61	NAAQMS/36/2012
	A2(c)	0.22	0.45	0.33	0.44	NAAQMS/36/2012
	A2(d)	0.22	0.39	0.30	0.38	NAAQMS/36/2012
A3	A3(a)	0.24	0.39	0.30	0.38	NAAQMS/36/2012
	A3(b)	0.26	0.56	0.41	0.55	NAAQMS/36/2012
	A3(c)	0.26	0.46	0.37	0.45	NAAQMS/36/2012
	A3(d)	0.32	0.65	0.50	0.64	NAAQMS/36/2012
A4	A4(a)	0.23	0.42	0.31	0.41	NAAQMS/36/2012
	A4(b)	0.42	0.64	0.53	0.63	NAAQMS/36/2012
	A4(c)	0.23	0.36	0.30	0.35	NAAQMS/36/2012
	A4(d)	0.27	0.46	0.37	0.45	NAAQMS/36/2012
A5	A5(a)	0.32	0.63	0.49	0.62	NAAQMS/36/2012
	A5(b)	0.25	0.48	0.33	0.46	NAAQMS/36/2012
	A5(c)	0.17	0.45	0.30	0.44	NAAQMS/36/2012
	A5(d)	0.26	0.58	0.40	0.56	NAAQMS/36/2012

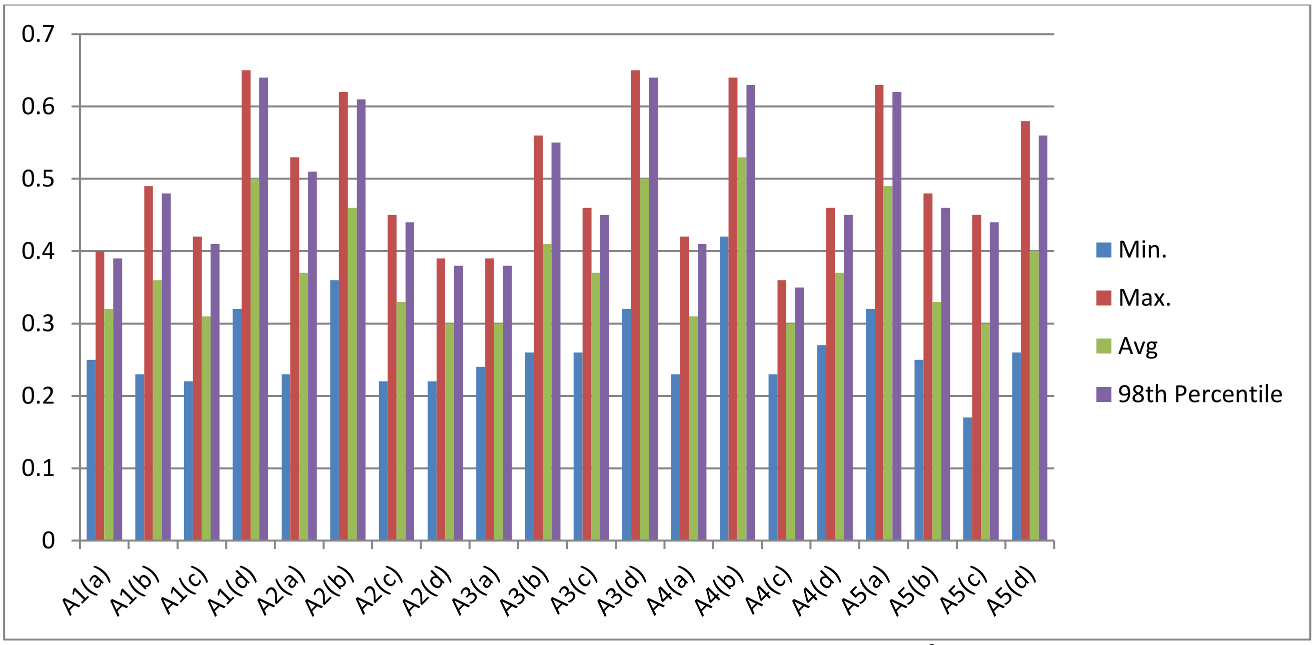


Figure-3.22 : CO Concentration in mg/m³

3.2.4.3.6 Ammonia as NH3

The 98th percentile concentrations are ranging from **25.7 to 38.9 µg/m³** (Table 3.11). Maximum concentration of NH3 found at A3(d) Toppur - Railway station, Sekkarapatti **39 µg/m³.** Minimum Concentration with **23 µg/m³** recorded at A2(a) Sri Palani Murugan Spinning Mill - Cotton mill Erode-Dharapuram Road Modavandi Sathyamangalam. Fig: 3.23 gives the graphical representaion of the Ammonia concentration at different monitoring stations. All the results are found to be below the NAAQ limits.

Table-3.11: Ammonia (NH3 µg/m³) Results
(Min, Max, Average & 98th Percentile concentrations)

S.No.	Location code	Min.	Max.	Avg	98th Percentile	Test Method
A1	A1(a)	30	32	31	31.9	NAAQMS/36/2012
	A1(b)	30	33	31.5	32.9	NAAQMS/36/2012
	A1(c)	25	29	26.5	28.9	NAAQMS/36/2012
	A1(d)	28	33	30.3	32.9	NAAQMS/36/2012
A2	A2(a)	23	26	24.8	25.7	NAAQMS/36/2012
	A2(b)	30	35	32.5	34.9	NAAQMS/36/2012
	A2(c)	24	28	25.8	27.9	NAAQMS/36/2012
	A2(d)	25	30	27	27.9	NAAQMS/36/2012
A3	A3(a)	25	27	26	26.8	NAAQMS/36/2012
	A3(b)	29	34	31.8	33.9	NAAQMS/36/2012
	A3(c)	28	33	30.6	32.9	NAAQMS/36/2012
	A3(d)	34	39	36.1	38.9	NAAQMS/36/2012
A4	A4(a)	28	32	29.8	31.9	NAAQMS/36/2012
	A4(b)	30	34	32	33.9	NAAQMS/36/2012
	A4(c)	29	35	31.8	34.9	NAAQMS/36/2012
	A4(d)	28	34	31	33.8	NAAQMS/36/2012
A5	A5(a)	32	35	33.5	34.7	NAAQMS/36/2012
	A5(b)	27	31	29.3	30.5	NAAQMS/36/2012
	A5(c)	25	30	27	29.9	NAAQMS/36/2012
	A5(d)	26	30	28	29.9	NAAQMS/36/2012

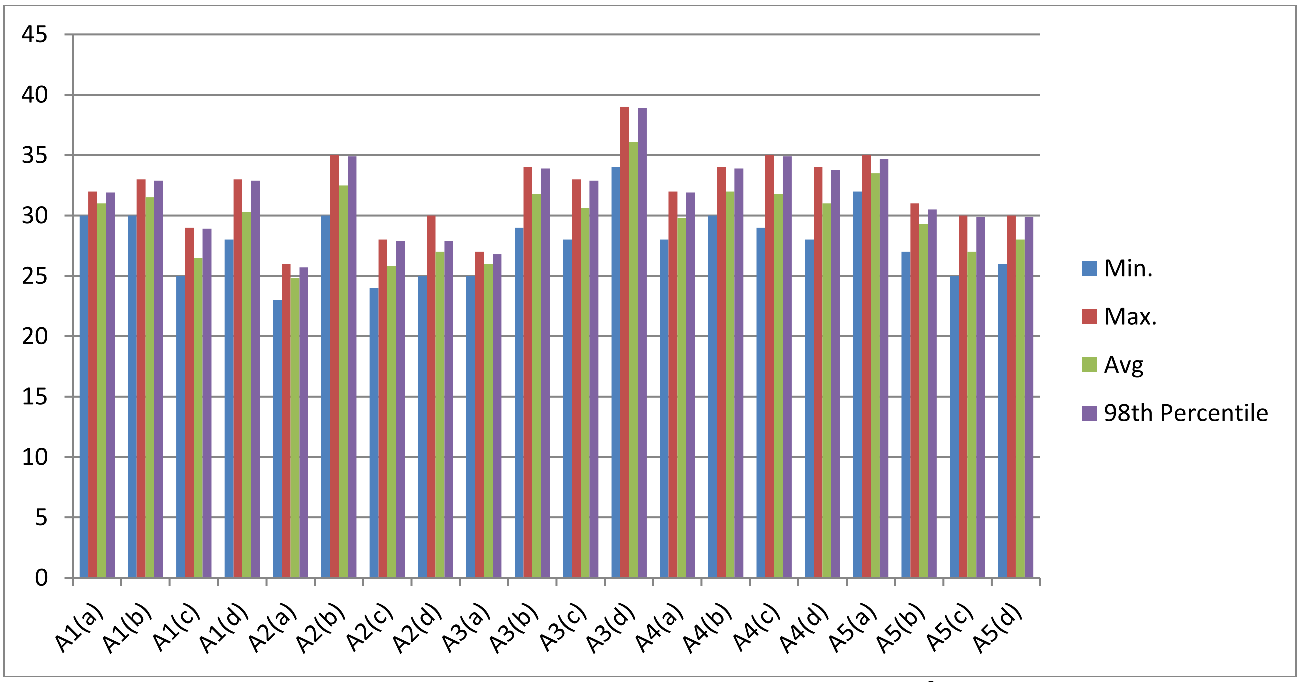


Figure-3.23 : NH_3 Concentration in µg/m³

3.2.4.3.7 Ozone

The 98th percentile concentrations are ranging from **20.8 to 24.9 µg/m3** (Table 3.12). Maximum concentration of O_3 found at A2(a) Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam, A2(b) Erode Junction Railway Station, A3(b) Semmandappatti Railway station, Semmandapatti and A5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli **25 µg/m3.** Minimum Concentration with **17 µg/m3** recorded at A1(b) JCT College of Engineering and Technology near Pichanur - Bus stop, A2(c) Sarasu Mahal, Avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai, A2(d) Erode East RTO Office - Transportation authority office on SH 84,Nanjailakkapuram, A3(a) Periyar University, Periyar, Palkalai Nagar - Salem, A4(c) Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti, A5(c) Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur and A5(d) Sub Registrar Office - Government office, Hosur Main Road, Attibele-Rayakottai Road, Kelamangalam. Fig: 3.24 gives the graphical representaion of the Ozone concentration at different monitoring stations. All the results are found to be below the NAAQ limits.

Table-3.12: Ozone (O_3 µg/m3) Results
(Min, Max, Average & 98th Percentile concentrations)

S.No.	Location code	Min.	Max.	Avg	98th Percentile	Test Method
A1	A1(a)	18	21	19.6	20.8	NAAQMS/36/2012
	A1(b)	17	22	19.7	21.6	NAAQMS/36/2012
	A1(c)	18	23	20.3	22.6	NAAQMS/36/2012
	A1(d)	18	24	20.6	23.6	NAAQMS/36/2012
A2	A2(a)	18	25	21	24.3	NAAQMS/36/2012
	A2(b)	19	25	21.3	24.6	NAAQMS/36/2012
	A2(c)	17	24	20.3	23.6	NAAQMS/36/2012
	A2(d)	17	23	20.5	22.9	NAAQMS/36/2012
A3	A3(a)	17	23	19.7	22.6	NAAQMS/36/2012
	A3(b)	21	25	23.1	24.8	NAAQMS/36/2012
	A3(c)	18	23	20.8	22.9	NAAQMS/36/2012
	A3(d)	18	24	21.5	23.6	NAAQMS/36/2012
A4	A4(a)	18	23	20.8	22.9	NAAQMS/36/2012
	A4(b)	18	24	21.1	23.6	NAAQMS/36/2012
	A4(c)	17	22	19.4	22.9	NAAQMS/36/2012
	A4(d)	19	23	21	22.8	NAAQMS/36/2012
A5	A5(a)	20	25	22.8	24.9	NAAQMS/36/2012
	A5(b)	19	24	21.7	24.6	NAAQMS/36/2012
	A5(c)	17	21	19.2	21.6	NAAQMS/36/2012
	A5(d)	17	23	19.3	22.3	NAAQMS/36/2012

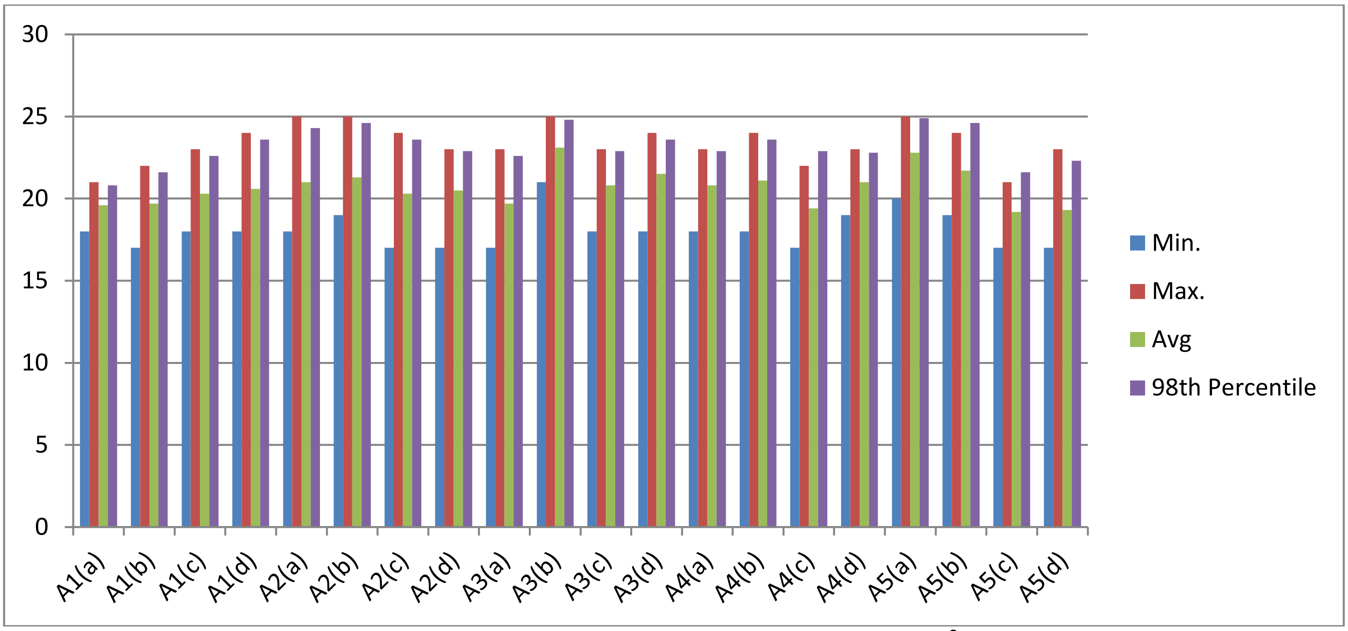


Figure-3.24 : Ozone Concentration in µg/m^3

3.2.4.3.8 Benzene

The concentration of Benzene was found to be **<0.5 µg/m^3** at A1(a) Parade Ground SFTI Walayar near Village Chandrapuram, A2(c) Sarasu mahal, avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai, A3(a) Periyar University, Periyar, Palkalai Nagar - Salem, A4(c) Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti and A5(b) Rams Farm - Resort hotel, Hosur.

The maximum concentration of Benzene was found to be **0.82 µg/m^3** at A2(b) Erode Junction Railway Station, A3(b) Railway station Semmandappatti and A3(d) Toppur - Railway station, Sekkarapatti.

Hydrocarbons (Methane and Non Methane): Non-Methane Hydrocarbons were found below detection level at all the monitoring locations.

From the above study and discussions, it can be concluded that air quality of the area is good as the levels are well within the prescribed limits as prescribed by CPCB.

	
Parade Ground SFTI Walayar near Village Chandrapuram	JCT College of Engineering and Technology near Pichanur - Bus stop
	
Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore	Palladam Bus Stand, Coimbatore Road

	
Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam	Erode Junction Railway Station
	
SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai	Erode East RTO Office - Transportation authority office on SH 84,Nanjailakkapuram

	
Periyar University, Periyar, Palkalai Nagar - Salem	Semmandappatti - Railway station, Semmandapatti
	
Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur	Toppur - Railway station, Sekkarapatti

	
Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur
	
Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti	Indian Bank, GS Complex, Housing Board Bus Stop, Royakottah Main Road, Mullai Nagar, Hosur

Hosur Airport, Taneja Aerospace Road, Belagondanahalli

Rams Farm - Resort hotel, Hosur

Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur

Sub Registrar Office - Government office, Hosur Main Road, Attibele-Rayakottai Road, Kelamangalam

Figure-3.25: Ambient Air Quality Monitoring Photographs

3.2.4.4. Interpretation of Results

- The minimum & maximum concentrations of PM_{10} were found to be 68 μg/m^3 (at A1(a) i.e. Parade Ground SFTI walayar near village Chandrapuram, A2 (c) Sarasu Mahal Avalpoondurai (Festival Hall) on Erode Dharapuram Road , A3(a) Periyar University,Periyar Palkalai Nagar Salem, A4(c) Samichettipatti Velaan Kadan Sangam-Central Government Office Samichettipatti, A5(b) Rams Farm-Resort Hotel Hosur) and 85 µg/m^3 (at A1(d) Palladam Bus Stand, Coimbatore Road and A3(b) Semmandappatti Railway Station) respectively.
- Minimum and maximum concentrations of $PM_{2.5}$ were found between 30 µg/m^3 (at A1(a) Parade Ground SFTI Walayar near Village Chandrapuram) and 48 µg/m^3 (at A1(d) Palladam Bus Stand, Coimbatore Road and A3(b) Semmandappatti Railway station) respectively.
- Ranges of SO_2 concentration were found between 14.9 µg/m^3 at A5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 23.5 µg/m^3 at A1(d) Palladam Bus Stand, Coimbatore Road.
- The range of NO_2 concentrations was found to be 19.2 µg/m^3 at at A2(a) Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam to 34.2 µg/m^3 at A3(d) Toppur - Railway station, Sekkarapatti . The prescribed CPCB limit of SO_2 and NO_2 is 80 μg/m^3 for residential and rural areas are well within prescribed norms at all monitoring stations.
- The Range of Carbon Monoxide (CO) was found to be 0.17 mg/ m^3 recorded at A5(c) Carmel International School, Onnalavadi P.O Karapalli Jonnabonda Road, R K Road, Hosur to 0.65 mg/ m^3 at A1(d) Palladam Bus Stand Coimbatore Road and A3(d) and Toppur - Railway station, Sekkarapatti.
- The Range of Ammonia (NH_3) was found to be 23 µg/m^3 recorded at A2(a) Sri Palani Murugan Spinning Mill - Cotton mill Erode-Dharapuram Road Modavandi Sathyamangalam to 39 µg/m^3 at A3(d) Toppur - Railway station, Sekkarapatti
- Range of Ozone concentration were found between 17 µg/m^3 (at A1(b) JCT College of Engineering and Technology near Pichanur - Bus stop, A2(c) Sarasu Mahal, Avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai, A2(d) Erode East RTO Office - Transportation authority office on SH 84,Nanjailakkapuram, A3(a) Periyar University, Periyar, Palkalai Nagar - Salem, A4(c) Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti, A5(c) Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur and A5(d) Sub Registrar Office - Government office, Hosur Main Road, Attibele- Rayakottai Road, Kelamangalam) to 25 µg/m3 (at A2(a) Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam, A2(b) Erode Junction Railway Station, A3(b) Semmandappatti Railway station, Semmandapatti and A5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli).
- Minimum and maximum concentrations of Benzene were found between 0.51µg/m3 (at A1(b) JCT College of Engineering and Technology near Pichanur - Bus stop) and 0.82 µg/m3 (at A2(b) Erode Junction Railway Station, A3(b) Railway station Semmandappatti and A3(d) Toppur - Railway station, Sekkarapatti) respectively.
- Non-Methane Hydrocarbons were found below detection level at all the monitoring locations.
- From the above study and discussions, it can be concluded that air quality of the area is good as the levels are well within the prescribed limits as prescribed by CPCB.

3.3 NOISE ENVIRONMENT

Noise in general is sound, which is composed of many frequency components of various loudness distributed over the audible frequency range. Various noise scales have been introduced to describe, in a single number, the response of an average human being to a complex sound made up various frequencies at different loudness levels. The most common and heavily favored of those scales is the A weighted decibel (dBA). This is more suitable for audible range of 20 to 20,000 Hertz. The scale has been designed to weigh various components of noise according to the response of a human ear.

The main objective of the noise level monitoring is to assess the background noise levels in different zones *viz*., industrial, commercial, residential and silence zones within the study area. Noise levels were measured in residential areas, bus stands and other settlements located within 10 Km radius around the site.

3.3.1 Noise Analysis within the Study Area

The noise level within the study area was recorded. The instrument was calibrated with a Standard Acoustic Calibrator before using in the field. The measurements were carried out continuously for the 24-hour period to obtain hourly Equivalent sound pressure level, 1 hour Leq. From these values, day and night time as well as 24-hour Leq values were also calculated. The Leq value is the equivalent continuous sound level, which is equivalent to the same sound energy as the fluctuating sound measured in the same period.

3.3.2 Methodology adopted for Selection of Sampling Station

Noise levels are more annoying in the night time, particularly in the residential areas. The environmental impact of noise can have several effects varying from annoyance to hearing loss depending on the loudness of noise levels. The monitoring of noise levels were done in 20 locations, keeping considering the population and traffic in the area. The locations are depicted in **Table-3.13** and levels recorded stated in **Table-3.15.**

Table-3.13: Noise Monitoring Sampling Stations

Stations	Locations	Sampling Locations	Coordinates	
			Latitude	Longitude
N1	**Pipeline starting point at Coimbatore**	Coimbatore (Tamil Nadu		
A	Parade Ground SFTI Walayar near Village Chandrapuram		10˚50'5.1" N	76˚50'44.8" E
B	JCT College of Engineering and Technology near Pichanur - Bus stop		10˚50'15.2" N	76˚52'44.6" E

C	Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore		10°53'21.1" N	76°59'42.5" E
D	Palladam Bus Stand, Coimbatore Road		10°59'36.2" N	76°16'54.2" E
N2	**Near IPS-3 location**	Erode (Tamil Nadu)		
A	Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam		11°15'50.4" N	77°43'41.9" E
B	Erode Junction Railway Station		11°19'46" N	77°43'32" E
C	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai		11°14'12" N	77°43'09" E
D	Erode East RTO Office - Transportation authority office on SH 84,Nanjailakkapuram		11°17'51" N	77°46'22" E
N3	**Near SV-18 at Chainage 371.035.**	Salem (Tamil Nadu)		
A	Periyar University, Periyar, Palkalai Nagar - Salem		11°37'49" N	78°08'56" E
B	Semmandappatti - Railway station, Semmandapatti		11°47'26" N	78°01'34" E
C	Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur		11°46'33" N	78°03'24" E
D	Toppur - Railway station, Sekkarapatti		11°56'05" N	78°04'18" E
N4	**Near IPS-4**	Dharmapuri (Tamil Nadu)		
A	Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli		12°03'39" N	78°06'08" E
B	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur		12°00'58" N	78°05'20" E
C	Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti		12°01'58" N	78°04'02" E
D	Indian Bank, GS Complex, Housing Board Bus Stop, Royakottah Main Road, Mullai Nagar, Hosur		12°43'19" N	77°50'21" E

N5	**Pipeline end point at Krishnagiri**			
A	Hosur Airport, Taneja Aerospace Road, Belagondanahalli	Krishnagiri (Tamil Nadu)	12°40'12" N	77°45'42" E
B	Rams Farm - Resort hotel, Hosur		12°38'36" N	77°49'57" E
C	Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur		12°41'34" N	77°50'37" E
D	Sub Registrar Office - Government office, Hosur Main Road, Attibele-Rayakottai Road, Kelamangalam		12°36'34" N	77°51'48" E

Methodology of Noise Measurement

For Noise levels measured over a given period of time interval, it is possible to describe important features of noise using statistical quantities. This is calculated using the percent of the time as certain noise levels are exceeding the time interval. The notations for the statistical quantities of noise level are given below:

- L_{10} is the noise level exceeded 10% of the time
- L_{50} is the noise level exceeded 50% of the time and
- L_{90} is the noise level exceeded 90% of the time
- Equivalent sound pressure level (L_{eq})

The L_{eq} is the equivalent continuous sound level, which is equivalent to the same sound energy as the actual fluctuating sound measured in the same period. This is necessary because sound from noise source often fluctuates widely during a given period of time.
This is calculated from the following equation:

$$L_{eq} = L_{50} + (L_{10} – L_{90})^2/60$$

L_{day} is defined as the equivalent noise level measured over a period of time during day (6 am to 10 pm). L_{night} is defined as the equivalent noise level measured over a period of time during night (10 pm to 6 am). A noise rating developed by environment protection agency, usepa for specification of community noise from all the sources is day-night sound level, (L_{dn}).

Hourly noise recorded data and L_{day} values (16 hours) L_{night} (8 hours) and L_{dn} (24 hours) are computed and tabulated.

Day–night sound levels (L_{dn}):

The noise rating developed for community noise from all sources is the Day-Night Sound Level (L_{dn}). It is similar to a 24 hr equivalent sound level except that during night time period (10 pm to 6 am) A 10 dB (A) weighting penalty is added to the instantaneous sound level before computing the 24 hraverage.This is time penalty is added to account for the fact that noise during night when people usually sleep is judged as more annoying than the same noise during the daytime.

The L_{dn} for a given location in a community may be calculated from the hourly L_{eq} by the following equation.

$L_{dn} = 10 \log \{1/24 [16(10^{Ld/10}) + 8 (10^{(Ln + 10)/10})]\}$

Where L_d is the equivalent sound level during the day time (6 am to 10 pm) and L_n is the equivalent sound level during the night time (10 pm to 6 am).

Table 3.14: Standard Noise Limits

Area Code	Category of Area/Zone	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

Table-3.15: Noise Levels in Study Area

S. No.	Average Day Time (6:00 a.m. to 10:00 p.m.) Noise Level Leq. dB (A)	Max	Min	Average Night Time (10:00 p.m. to 6:00 a.m.) Noise Level Leq. dB (A)	Max	Min	CPCB limits in dB(A) Leq (Industrial: Day – 75.00, Night-70.00) (Residential: Day - 55.00 Night-45.00)
N1 (A)	51.5	55	46.7	42.6	44.8	41.3	Residential Area
(B)	52.7	54.8	50.8	42.7	44.8	41.6	Commercial Area
(C)	51.9	55.1	41.7	42.6	44	41	Commercial Area
(D)	52.5	58.6	47	42.5	44	41.6	Commercial Area
N2 (A)	52.7	55.8	50.1	42.3	44.2	38.7	Industrial Area
(B)	52.8	54.9	50.9	42.2	44.3	39.1	Commercial Area
(C)	52.8	54.8	51.1	39.9	43.2	35.9	Residential Area
(D)	52.7	54.8	51.1	41.9	44.6	36.9	Commercial Area
N3 (A)	52.8	54.7	51.2	40.3	44.7	36.9	Residential Area
(B)	52.7	54.5	51.1	38.7	43.1	36.2	Commercial Area
(C)	52.6	54.9	51.1	40.0	43.4	36.4	Commercial Area
(D)	52.5	54.7	51.1	39.6	42.2	36.1	Commercial Area
N4 (A)	52.3	54.2	51	41.4	42.9	38.9	Commercial Area
(B)	52.3	55.8	51	41.8	44	40.2	Commercial Area
(C)	52.1	54	50.1	41.9	44	40.1	Commercial Area
(D)	52.6	56	50.8	41.8	44.2	40.3	Commercial Area

N5 **(A)**	51.7	53.9	41.6	41.4	42.8	40.2	Commercial Area
(B)	51.9	54	50.2	41.8	42.9	40.2	Commercial Area
(C)	52.3	54.2	50.2	41.7	42.9	40	Commercial Area
(D)	52.3	56.8	51.3	41.5	43.8	40.2	Commercial Area

3.3.3 Interpretation of Noise Monitoring Results

Ambient noise levels were measured at 20 locations around the pipeline project. The average values of noise levels recorded during the day time were from **52.8 L_{eq}dB** at N2(b) Erode Junction Railway Station, N2(c) Sarasu mahal, avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai and N3(a) Periyar University, Periyar, Palkalai Nagar - Salem to **51.5 L_{eq} dB (A)** at N1(a) Parade Ground SFTI Walayar near Village Chandrapuram. The maximum noise level was recorded at N1(d) Palladam Bus Stand, Coimbatore Road **58.6 L_{eq} dB (A)** whereas minimum was recorded at N5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli **41.6 L_{eq} dB (A).**
The average values of noise levels recorded during the night time were from **42.7 L_{eq}dB** at N1(b) JCT College of Engineering and Technology near Pichanur - Bus stop to **38.7 L_{eq} dB (A)** at N3(b) Railway station Semmandappatti, Semmandapatti . The maximum noise level during night was recorded at N1(a) Parade Ground SFTI Walayar near Village Chandrapuram and N1(b) JCT College of Engineering and Technology near Pichanur - Bus stop **44.8 L_{eq} dB (A)** whereas minimum was recorded was **35.9 L_{eq} dB (A)** at N2(c) Sarasu mahal, avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai. Thus noise levels at all the locations were observed to be within the tolerance limits as prescribed by CPCB.

Parade Ground SFTI Walayar near Village Chandrapuram

JCT College of Engineering and Technology near Pichanur - Bus stop

	
Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore	Palladam Bus Stand, Coimbatore Road
	
Erode Junction Railway Station	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai

Periyar University, Periyar, Palkalai Nagar - Salem

Semmandappatti - Railway station, Semmandapatti

Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur

Toppur - Railway station, Sekkarapatti

	
Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur
	
Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti	Indian Bank, GS Complex, Housing Board Bus Stop, Royakottah Main Road, Mullai Nagar, Hosur

Hosur Airport, Taneja Aerospace Road, Belagondanahalli


Rams Farm - Resort hotel, Hosur

Sub Registrar Office - Government office, Hosur Main Road, Attibele-Rayakottai Road, Kelamangalam

Figure-3.26: Noise Quality Monitoring Photographs

3.4 TRAFFIC STUDY

Traffic study measurements were performed near Pipeline starting point at Coimbatore, Near IPS-3 Near SV-18, Near IPS-4 and Pipeline end point at Krishnagiri road near project site to assess impact on the Local Transport Infrastructure due to this pipeline project. The traffic study has been conducted between **December 2021 to March 2022.**

Table: 3.16 Traffic Monitoring Locations

Stations	Locations	Sampling Locations	Coordinates	
			Latitude	Longitude
T1	**Pipeline starting point at Coimbatore**	Coimbatore (Tamil Nadu)		
A	Parade Ground SFTI Walayar near Village Chandrapuram		10˚50'12" N	76˚50'48" E
B	JCT College of Engineering and Technology near Pichanur - Bus stop		10˚50'16" N	76˚52'45" E
C	Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore		10˚53'25" N	76˚59'32" E
D	Palladam Bus Stand, Coimbatore Road		10˚59'37" N	76˚17'00" E
T2	**Near IPS-3 location**	Erode (Tamil Nadu)		
A	Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam		11˚15'51" N	77˚43'36" E
B	Erode Junction Railway Station		11˚19'51" N	77˚43'37" E
C	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai		11˚14'09" N	77˚43'10" E
D	Erode East RTO Office - Transportation authority office on SH 84,Nanjailakkapuram		11˚18'00" N	77˚46'25" E
T3	**Near SV-18 at Chainage 371.035.**	Salem (Tamil Nadu)		
A	Periyar University, Periyar, Palkalai Nagar - Salem		11˚37'48" N	78˚08'55" E
B	Semmandappatti - Railway station, Semmandapatti		11˚47'23" N	78˚01'34" E
C	Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur		11˚46'22" N	78˚03'17" E
D	Toppur - Railway station, Sekkarapatti		11˚56'05" N	78˚04'18" E
T4	**Near IPS-4**	Dharmapuri (Tamil Nadu)		
A	Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli		12˚03'33" N	78˚06'20" E

B	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur		12˚00'57" N	78˚05'20" E
C	Samichettipatti Velaan Kadan Sangam - Central Government Office, Samichettipatti		12˚01'54" N	78˚04'00" E
D	Indian Bank, GS Complex, Housing Board Bus Stop, Royakottah Main Road, Mullai Nagar, Hosur		12˚43'10" N	77˚50'08" E
T5	**Pipeline end point at Krishnagiri**	Krishnagiri (Tamil Nadu)		
A	Hosur Airport, Taneja Aerospace Road, Belagondanahalli		12˚40'08" N	77˚45'39" E
B	Rams Farm - Resort hotel, Hosur		12˚39'02" N	77˚49'43" E
C	Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur		12˚41'31" N	77˚50'41" E
D	Sub Registrar Office - Government office, Hosur Main Road, Attibele-Rayakottai Road, Kelamangalam		12˚36'23" N	77˚51'36" E

Table: 3.17 Hourly Data of Traffic Study

	2/3 Wheelers				LMV				HMV			
	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1	T1
Time	A	B	C	D	A	B	C	D	A	B	C	D
9:00AM-10:00AM	31	27	26	35	31	30	37	31	24	28	19	22
10:00AM-11:00AM	32	25	29	33	36	34	40	23	14	27	26	21
11:00AM-12:00PM	32	30	33	36	33	26	30	37	14	29	24	29
12:00PM-13:00 PM	28	21	26	41	26	33	34	27	24	30	24	26
13:00PM-14:00 PM	35	29	29	31	28	30	28	28	21	26	25	26
14:00PM-15:00 PM	34	27	31	34	32	32	26	25	16	28	23	29
15:00PM-16:00 PM	34	29	25	32	25	36	28	30	20	33	28	27
16:00PM-17:00 PM	20	27	30	35	26	31	28	26	25	30	26	30
17:00PM-18:00 PM	27	29	31	35	23	30	32	29	16	30	26	37
18:00PM-19:00 PM	18	22	22	22	19	27	23	22	11	18	14	13
19:00PM-20:00 PM	20	22	27	26	20	23	19	22	13	20	19	18
20:00PM-21:00 PM	18	27	23	20	18	21	22	24	11	19	15	19
21:00PM-22:00 PM	19	18	20	20	13	15	17	19	8	19	10	17
22:00PM-23:00 PM	20	15	21	22	15	17	15	17	7	10	9	13
23:00PM-00:00 AM	18	18	13	17	9	15	15	14	9	11	10	14
00:00AM-1:00 AM	14	12	13	16	10	13	13	16	8	11	5	13
1:00AM-2:00 AM	9	10	10	12	8	18	9	12	5	13	7	8
2:00AM-3:00 AM	8	10	7	13	10	13	12	9	6	16	5	9
3:00AM-4:00 AM	8	9	9	5	5	9	10	7	7	9	10	5
4:00AM-5:00 AM	8	11	13	9	10	14	13	11	8	19	10	8
5:00AM-6:00 AM	11	15	18	14	13	17	18	11	14	20	15	13
6:00AM-7:00AM	16	18	22	18	17	23	26	21	15	22	18	21
7:00AM-8:00AM	18	22	26	18	22	26	25	28	25	23	20	24
8:00AM-9:00AM	24	27	32	23	20	30	33	31	25	26	22	30
Total	**495**	**493**	**527**	**561**	**464**	**558**	**547**	**513**	**341**	**512**	**405**	**467**

Table: 3.18 Hourly Data of Traffic Study

	2/3 Wheelers				LMV				HMV			
	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2	T2
Time	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
9:00AM-10:00AM	32	34	30	31	28	26	27	24	16	16	20	18
10:00AM-11:00AM	29	33	33	31	25	29	30	28	16	16	15	18
11:00AM-12:00PM	31	39	38	34	30	29	26	27	22	19	18	21
12:00PM-13:00 PM	31	28	29	33	27	32	29	28	25	24	23	26
13:00PM-14:00 PM	33	33	33	31	25	27	32	31	25	27	22	22
14:00PM-15:00 PM	27	35	38	34	27	27	32	31	27	22	19	22
15:00PM-16:00 PM	31	25	32	33	27	30	35	33	29	23	19	24
16:00PM-17:00 PM	35	27	33	33	29	29	36	34	30	27	24	23
17:00PM-18:00 PM	35	34	32	38	32	29	35	36	31	25	23	28
18:00PM-19:00 PM	22	21	21	21	21	16	16	17	11	10	9	9
19:00PM-20:00 PM	25	25	24	24	19	21	16	17	11	12	12	9
20:00PM-21:00 PM	18	18	19	20	21	21	17	21	16	12	12	10
21:00PM-22:00 PM	18	15	15	17	14	15	16	18	18	12	12	14
22:00PM-23:00 PM	18	16	20	17	17	16	16	17	16	8	9	10
23:00PM-00:00 AM	14	10	13	16	15	16	16	13	12	7	10	12
00:00AM-1:00 AM	10	7	11	12	11	10	9	11	9	7	6	7
1:00AM-2:00 AM	8	6	8	12	7	10	11	9	8	5	5	4
2:00AM-3:00 AM	5	3	5	12	4	6	7	8	6	7	4	4
3:00AM-4:00 AM	4	4	5	16	4	4	4	4	3	4	6	5
4:00AM-5:00 AM	4	7	7	6	7	6	7	7	5	6	7	7
5:00AM-6:00 AM	7	10	14	8	8	8	10	7	8	9	12	10
6:00AM-7:00AM	11	13	16	13	13	11	13	11	12	15	17	10
7:00AM-8:00AM	15	18	19	16	18	20	21	18	15	19	21	16
8:00AM-9:00AM	21	24	24	21	22	26	27	24	18	25	21	17
Total	**478**	**480**	**515**	**524**	**446**	**458**	**483**	**468**	**384**	**351**	**342**	**339**

Table: 3.19 Hourly Data of Traffic Study

	2/3 Wheelers				LMV				HMV			
	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3	T3
Time	A	B	C	D	A	B	C	D	A	B	C	D
9:00AM-10:00AM	32	34	36	29	24	26	24	24	16	17	16	14
10:00AM-11:00AM	34	31	28	31	29	30	32	26	16	14	16	18
11:00AM-12:00PM	38	37	37	33	29	29	29	30	20	17	19	22
12:00PM-13:00 PM	32	31	25	28	24	27	29	27	24	22	24	20
13:00PM-14:00 PM	31	30	29	31	29	31	30	30	25	27	25	25
14:00PM-15:00 PM	37	29	34	27	29	32	34	23	23	20	21	27
15:00PM-16:00 PM	34	34	36	25	28	27	30	28	27	23	27	26
16:00PM-17:00 PM	34	35	28	33	27	32	34	25	25	23	32	29
17:00PM-18:00 PM	33	35	32	36	28	26	33	31	26	22	23	31
18:00PM-19:00 PM	22	25	19	24	16	18	15	23	10	9	9	11
19:00PM-20:00 PM	27	25	25	24	16	17	15	26	12	13	11	12
20:00PM-21:00 PM	19	19	17	19	20	23	20	20	10	13	10	13
21:00PM-22:00 PM	19	17	14	21	14	16	13	17	12	13	7	17
22:00PM-23:00 PM	16	15	18	16	12	12	10	14	8	8	6	20
23:00PM-00:00 AM	14	11	12	14	9	8	10	11	10	7	6	15
00:00AM-1:00 AM	10	11	10	7	7	10	11	9	5	7	6	13
1:00AM-2:00 AM	6	8	7	5	5	6	8	6	6	7	7	8
2:00AM-3:00 AM	3	4	4	3	3	4	6	4	4	3	7	6
3:00AM-4:00 AM	4	6	6	5	4	5	5	5	4	3	5	5
4:00AM-5:00 AM	7	9	7	5	4	8	8	5	7	5	7	5
5:00AM-6:00 AM	10	11	10	7	9	10	11	5	9	8	12	7
6:00AM-7:00AM	14	16	14	9	13	14	16	11	13	8	16	12
7:00AM-8:00AM	18	21	18	12	21	18	18	17	18	13	19	14
8:00AM-9:00AM	28	26	25	21	26	22	22	20	22	17	17	17
Total	**516**	**514**	**486**	**455**	**422**	**447**	**458**	**428**	**345**	**314**	**341**	**378**

Table: 3.20 Hourly Data of Traffic Study

	2/3 Wheelers				LMV				HMV			
	T4	T4	T4	T4	T4	T4	T4	T4	T4	T4	T4	T4
Time	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
9:00AM-10:00AM	30	28	31	29	24	25	25	30	16	20	18	26
10:00AM-11:00AM	30	34	33	35	26	30	31	32	20	16	17	24
11:00AM-12:00PM	33	38	38	33	29	27	28	31	24	19	22	21
12:00PM-13:00 PM	32	28	32	30	26	28	27	36	22	22	25	23
13:00PM-14:00 PM	30	37	31	32	28	30	33	34	23	23	25	27
14:00PM-15:00 PM	29	40	38	34	26	30	34	39	27	22	22	29
15:00PM-16:00 PM	27	37	38	37	31	31	29	28	27	22	26	31
16:00PM-17:00 PM	33	35	39	35	25	34	34	26	30	22	25	30
17:00PM-18:00 PM	37	37	41	39	32	31	35	33	32	25	28	31
18:00PM-19:00 PM	23	28	28	36	21	21	17	30	10	12	12	9
19:00PM-20:00 PM	25	27	28	34	21	17	20	28	12	15	14	12
20:00PM-21:00 PM	20	23	19	30	19	20	23	31	12	14	13	17
21:00PM-22:00 PM	22	19	20	27	16	17	18	31	16	14	10	13
22:00PM-23:00 PM	18	20	20	20	14	16	16	27	15	11	14	16
23:00PM-00:00 AM	15	11	13	15	11	12	18	24	14	8	11	8
00:00AM-1:00 AM	10	8	9	8	8	10	11	12	9	9	13	9
1:00AM-2:00 AM	6	5	9	3	5	8	9	8	8	6	9	9
2:00AM-3:00 AM	3	3	4	3	3	4	9	8	5	5	8	5
3:00AM-4:00 AM	4	5	4	6	5	5	5	4	5	7	5	6
4:00AM-5:00 AM	5	7	8	8	7	8	8	8	7	10	7	9
5:00AM-6:00 AM	9	11	12	14	9	13	12	10	6	12	10	11
6:00AM-7:00AM	12	15	15	16	12	16	14	13	12	17	14	13
7:00AM-8:00AM	16	19	20	21	19	22	23	18	15	21	19	16
8:00AM-9:00AM	25	24	29	26	23	22	26	26	20	20	23	19
Total	**488**	**535**	**551**	**561**	**434**	**471**	**500**	**557**	**380**	**368**	**384**	**405**

Table: 3.21 Hourly Data of Traffic Study

	2/3 Wheelers				LMV				HMV			
	T5	T5	T5	T5	T5	T5	T5	T5	T5	T5	T5	T5
Time	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**	**A**	**B**	**C**	**D**
9:00AM-10:00AM	29	29	30	34	24	26	29	26	19	22	18	20
10:00AM-11:00AM	29	33	36	36	28	30	27	27	24	23	21	27
11:00AM-12:00PM	30	29	27	31	27	30	22	24	23	21	25	25
12:00PM-13:00 PM	34	32	27	29	33	33	21	25	26	25	30	30
13:00PM-14:00 PM	31	34	34	37	27	29	25	26	24	23	32	34
14:00PM-15:00 PM	32	35	30	31	30	27	32	33	24	26	29	21
15:00PM-16:00 PM	33	36	32	31	33	30	35	32	26	24	27	25
16:00PM-17:00 PM	34	34	35	36	33	35	31	31	26	27	28	29
17:00PM-18:00 PM	37	37	39	40	36	35	36	34	29	30	18	31
18:00PM-19:00 PM	27	33	23	23	21	26	18	20	12	16	16	17
19:00PM-20:00 PM	29	35	25	23	24	25	21	24	14	19	11	13
20:00PM-21:00 PM	25	29	21	22	28	29	25	27	13	18	13	13
21:00PM-22:00 PM	22	29	15	19	23	30	17	25	16	15	15	18
22:00PM-23:00 PM	19	20	10	13	19	28	13	22	12	20	10	18
23:00PM-00:00 AM	12	19	13	9	18	19	11	18	9	11	12	17
00:00AM-1:00 AM	10	12	9	5	12	16	9	12	8	11	8	9
1:00AM-2:00 AM	7	6	12	2	8	8	9	6	5	19	3	7
2:00AM-3:00 AM	4	3	6	2	4	4	6	6	5	8	7	4
3:00AM-4:00 AM	3	3	3	3	7	4	10	4	7	6	9	5
4:00AM-5:00 AM	6	7	8	7	10	8	12	8	9	7	7	5
5:00AM-6:00 AM	10	7	11	11	14	12	15	10	9	6	14	9
6:00AM-7:00AM	13	11	15	9	18	14	20	11	14	10	18	14
7:00AM-8:00AM	16	14	18	15	18	18	16	20	18	13	23	18
8:00AM-9:00AM	22	20	22	23	24	21	26	20	18	16	20	15
Total	**510**	**543**	**494**	**485**	**515**	**531**	**481**	**485**	**385**	**411**	**407**	**417**

Table: 3.22 Values of PCU

2/3 wheelers	0.5
LMV (Car, Van etc.)	1.0
HMV (Truck, Bus etc.)	3.0

Total number of vehicles per hour under the three categories was determined. From the Table 3.17, 3.18,3.19,3.20 and 3.21 it was observed that the traffic density of 2/3 wheelers was maximum between 9 am to 1 pm while minimum between 1 am to 4 am, Traffic density for LMV was observed maximum between 2pm to 4pm and minimum 1 am to 4am while maximum traffic density for HMV was observed from 1pm tp 3pm & minimum at 1 am to 4 am.

The above data was converted to PCU following the IRC Code 64-1990 & IRC Code 106-1990 as shown below in Table 3.23,3.24,3.25,3.26 and 3.27.

Table-3.23: No. of Vehicles per Day at T1

S.No.	Vehicles Distribution	Passenger Car Unit (PCU)					Total Number of Vehicle in PCU				Total Number of Vehicle (PCU) / 24Hour			
		A	B	C	D		A	B	C	D	A	B	C	D
1.	2/3 Wheelers	495	493	527	561	**0.5**	247	248	264	280	10	10	11	12
2.	LMV (Car, Van etc.)	464	558	547	513	**1.0**	464	558	547	513	19	23	23	22
3.	HMV (Trucks, Buses etc.)	341	512	405	467	**3.0**	1023	1536	1215	1401	43	64	51	58
	Total	**1300**	**1563**	**1479**	**1541**		**1734**	**2342**	**2026**	**2194**	**72**	**97**	**85**	**92**

Table-3.24: No. of Vehicles per Day at T2

S.No.	Vehicles Distribution	Passenger Car Unit (PCU)					Total Number of Vehicle in PCU				Total Number of Vehicle (PCU)/ 24 Hour			
		A	B	C	D		A	B	C	D	A	B	C	D
1.	2/3 Wheelers	478	480	515	524	**0.5**	239	240	257	262	10	10	11	11
2.	LMV (Car, Van etc.)	446	458	483	468	**1.0**	446	458	483	468	19	19	20	20
3.	HMV (Trucks, Buses etc.)	384	351	351	339	**3.0**	1152	1053	1053	1017	48	44	44	43
	Total	**1308**	**1289**	**1349**	**1331**		**1837**	**1751**	**1793**	**1747**	**77**	**73**	**75**	**74**

Table-3.25: No. of Vehicles per Day at T3

S.No.	Vehicles Distribution	Passenger Car Unit (PCU)					Total Number of Vehicle in PCU				Total Number of Vehicle (PCU)/ 24 Hour			
		A	B	C	D		A	B	C	D	A	B	C	D
1.	2/3 Wheelers	516	514	486	455	**0.5**	258	257	243	227	11	25	10	9
2.	LMV (Car, Van etc.)	422	447	458	428	**1.0**	422	447	458	428	18	19	19	18
3.	HMV (Trucks, Buses etc.)	345	314	341	378	**3.0**	1035	942	1023	1134	43	39	43	47
	Total	**1283**	**1275**	**1285**	**1261**		**1715**	**1646**	**1724**	**1789**	**72**	**83**	**72**	**74**

Table-3.26: No. of Vehicles per Day at T4

S.No.	Vehicles Distribution	Passenger Car Unit (PCU)					Total Number of Vehicle in PCU				Total Number of Vehicle (PCU)/ 24 Hour			
		A	B	C	D		A	B	C	D	A	B	C	D
1.	2/3 Wheelers	488	535	551	561	**0.5**	244	267	275	280	10	11	12	12
2.	LMV (Car, Van etc.)	434	471	500	557	**1.0**	434	471	500	557	18	20	21	23

3.	HMV (Trucks, Buses etc.)	380	368	384	405	**3.0**	1140	1104	1152	1215	48	46	48	51
	Total	**1302**	**1374**	**1435**	**1523**		**1818**	**1842**	**1927**	**2052**	**76**	**77**	**81**	**86**

Table-3.27: No. of Vehicles per Day at T5

S.No.	Vehicles Distribution	Passenger Car Unit (PCU)					Total Number of Vehicle in PCU				Total Number of Vehicle (PCU)/ 24Hour			
		A	B	C	D		A	B	C	D	A	B	C	D
1.	2/3 Wheelers	510	543	494	485	**0.5**	255	271	247	242	10	11	10	10
2.	LMV (Car, Van etc.)	515	531	481	485	**1.0**	515	531	481	485	21	22	20	20
3.	HMV (Trucks, Buses etc.)	385	411	407	417	**3.0**	1155	1233	1221	1251	48	52	51	52
	Total	**1410**	**1485**	**1382**	**1387**		**1925**	**2035**	**1949**	**1978**	**79**	**85**	**81**	**82**

Table-3.28: Existing Traffic Scenario and LOS (Level of Service)

Location	Road	V (Volume in PCU/hr)	C (Capacity in PCU/hr)	Existing V/C Ratio	LOS
T1	**Pipeline starting point at Coimbatore**				
A	Parade Ground SFTI Walayar near Village Chandrapuram	72	2000	0.03	**A**
B	JCT College of Engineering and Technology near Pichanur - Bus stop	97	2000	0.04	**A**
C	Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore	85	2000	0.04	**A**
D	Palladam Bus Stand, Coimbatore Road	92	1900	0.04	**A**
T2	**Near IPS-3 location**				
A	Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam	77	2000	0.03	**A**
B	Erode Junction Railway Station	73	1900	0.03	**A**
C	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai	75	2000	0.03	**A**

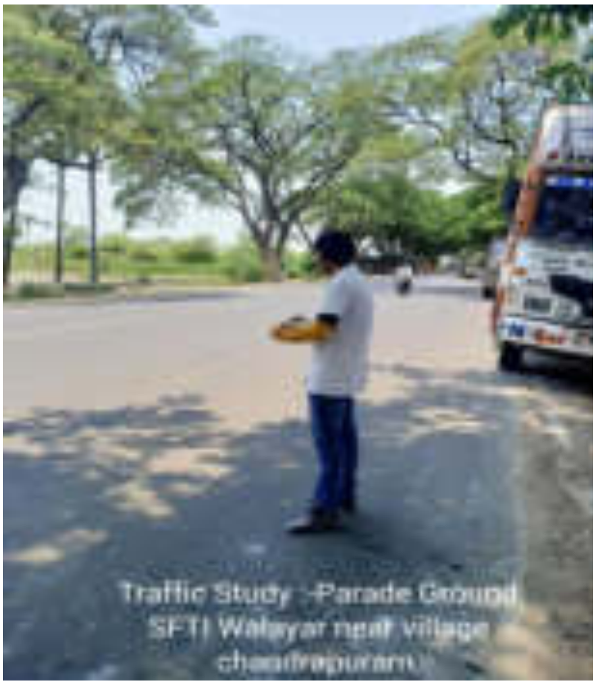
D	Erode East RTO Office - Transportation authority office on SH 84,Nanjailakkapuram	74	1900	0.03	**A**
T3	**Near SV-18 at Chainage 371.035.**				
A	Periyar University, Periyar, Palkalai Nagar - Salem	72	1900	0.03	**A**
B	Semmandappatti - Railway station, Semmandapatti	83	2000	0.04	**A**
C	Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur	72	2000	0.03	**A**
D	Toppur - Railway station, Sekkarapatti	74	2000	0.03	**A**
T4	**Near IPS-4**				
A	Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli	76	2000	0.03	**A**
B	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur	77	1900	0.04	**A**
C	Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti	81	1900	0.04	**A**
D	Indian Bank, GS Complex, Housing Board Bus Stop, Royakottah Main Road, Mullai Nagar, Hosur	86	1900	0.04	**A**
T5	**Pipeline end point at Krishnagiri**				
A	Hosur Airport, Taneja Aerospace Road, Belagondanahalli	79	1900	0.04	**A**
B	Rams Farm - Resort hotel, Hosur	85	2000	0.04	**A**
C	Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur	81	1900	0.04	**A**
D	Sub Registrar Office - Government office, Hosur Main Road, Attibele- Rayakottai Road, Kelamangalam	82	1900	0.04	**A**

Table: 3.29 Level of service with respect to vehicle to capacity ratio

V/C	LOS	Performance
0.0-0.2	A	Excellent
0.2-0.4	B	Very Good
0.4-0.6	C	Good/ Average/ Fair
0.6-0.8	D	Poor
0.8-1.0	E	Very Poor

3.4.1 Interpretation of Results

Total number of vehicles in PCU were found maximum at T1(b) JCT College of Engineering and Technology near Pichanur - Bus stop while the minimium at T1(a) Parade Ground SFTI Walayar near Village Chandrapuram, T3(a) Periyar University, Periyar, Palkalai Nagar – Salem and T3(c) Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur. The hourly study of traffic density of Krishnagiri to Coimbatore pipeline was found between 0.02 to 0.04 at all the monitoring locations.
The passenger car unit conversion of above data shows that the level of service at both the roads is excellent and falls in **"Category A".**

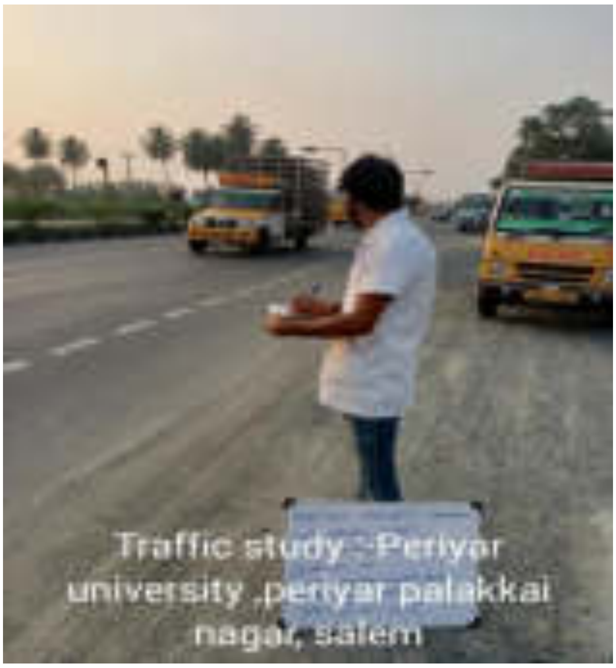


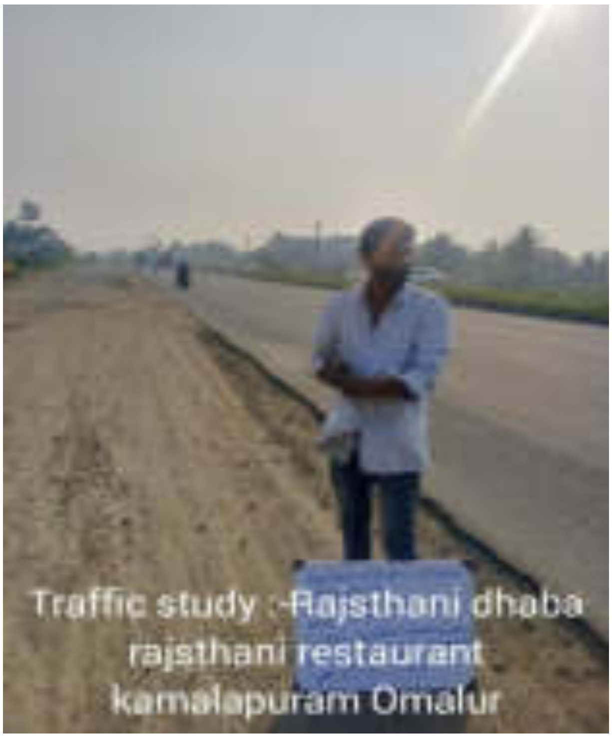
Parade Ground SFTI Walayar near Village Chandrapuram

JCT College of Engineering and Technology near Pichanur - Bus stop

Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore	Palladam Bus Stand, Coimbatore Road

Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam	Erode Junction Railway Station

	
SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai	Erode East RTO Office - Transportation authority office on SH 84,Nanjailakkapuram
	
Periyar University, Periyar, Palkalai Nagar - Salem	Semmandappatti - Railway station, Semmandapatti

<table>
<tr><td>
</td><td>
</td></tr>
<tr><td>Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur</td><td>Toppur - Railway station, Sekkarapatti</td></tr>
<tr><td></td><td>
</td></tr>
<tr><td>Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli</td><td>Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur</td></tr>
</table>

Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti

Indian Bank, GS Complex, Housing Board Bus Stop, Royakottah Main Road, Mullai Nagar, Hosur

Hosur Airport, Taneja Aerospace Road, Belagondanahalli

Rams Farm - Resort hotel, Hosur

	
Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur	Sub Registrar Office - Government office, Hosur Main Road, Attibele-Rayakottai Road, Kelamangalam

Figure-3.27: Traffic Study Photographs

3.5 WATER ENVIRONMENT

Water of high quality is essential to human life, and water of acceptable quality is essential for agricultural, industrial, domestic and commercial uses; in addition, most recreation is water based; therefore, major activities having potential effects on surface water are certain to be of appreciable concern to the consumers.

Studies on water environment aspects of ecosystem is important for Environmental Impact Assessment to identify sensitive issues and take appropriate action by maintaining ‘ecological homeostasis’ in the early stages of development of the project. The objective of this report is to define the present environment in which the proposed action is to occur, to evaluate all possible eventualities, to ensure that all negative impacts are minimized, and to demonstrate that proposed project has been appropriately announced to all interested parties so that their concerns can be considered.

3.5.1 Methodology Adopted for Selection of Sampling Station

The water resource in the study area may be classified into two major categories. viz. surface and groundwater sources. The sampling was done both for surface water and underground water by grab sampling method. The samples were taken from the identified monitoring locations within the 10 Km radius of the study area. The samples was taken from 15 locations (15 for ground water and 15 for surface water).

All the samples were analyzed for parameters such as hardness, alkalinity, salts, conductivity, inorganic substance, heavy metals, coliforms etc. Parameters like pH, conductivity, temperature and DO were analyzed at the time of collection in the field.

These parameters were analyzed as per the procedures specified in ‘Standard Methods for Examination of Water and Wastewater’ published by American Public Health Association (APHA). Ground water samples results were compared with IS: 10500 specification and surface water samples results were compared with CPCB Water Quality Criteria.

Method of Water Sampling

The following precautions were taken while sampling:

- Washing the bottles/cans with distilled water prior to the sampling.
- Before collection of water the bottles/cans are again washed 2-3 times with the same water.
- For surface water, Bottles were lowered to a minimum depth of 30 cm below water surface.
- At each point Different sets of water samples were collected so as to cover all the parameters.
- Meticulous attention is taken in proper numbering at the site.
- Sterilized bottles were used for the samples that are to be analyzed for bacteria.
- Civil supply water pipeline taps are sterilized before collection for bacteriological analysis.
- Parameters like pH, conductivity and temperature were analyzed in the field conditions. There are specific instruments for measuring EC and pH in the field. These are portable. These instruments will be calibrated at laboratory before use.
- The results were reconfirmed after getting to the laboratory. DO is fixed and titrated in the field itself:
- Appropriate preservatives are added, depending upon the elements to be analyzed and marked accordingly (IS-10500-2012, APHA).
- All the water samples collected in the ice box, were immediately transported to the laboratory and freezed at <5ºC analysis.
- Field observations were noted in the field notebook.

Table-3.30 : Ground Water Sampling Stations

Stations	Locations	Sampling Locations	Coordinates	
			Latitude	Longitude
GW1	**Pipeline starting point at Coimbatore**	Coimbatore (Tamil Nadu		
A	Parade Ground SFTI Walayar near Village Chandrapuram		10˚50'5.8" N	76˚50'45.7" E
B	JCT College of Engineering and Technology near Pichanur - Bus stop		10˚50'17.2" N	76˚52'45.5" E
C	Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore		10˚53'22.1" N	76˚59'44.1" E
GW2	**Near IPS-3 location**	Erode (Tamil Nadu)		
A	Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam		11˚15'52" N	77˚43'41" E

B	Erode Junction Railway Station		11˚19'51''' N	77˚43'35''E
C	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai		11˚14'09'' N	77˚43'09'' E
GW3	**Near SV-18 at Chainage 371.035.**	Salem (Tamil Nadu)		
A	Periyar University, Periyar, Palkalai Nagar - Salem		11˚37'53'' N	78˚08'57'' E
B	Semmandappatti - Railway station, Semmandapatti		11˚47'28'' N	78˚01'37'' E
C	Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur		11˚46'35'' N	78˚03'25'' E
GW4	**Near IPS-4**	Dharmapuri (Tamil Nadu)		
A	Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli		12˚03'35'' N	78˚06'09'' E
B	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur		12˚00'55'' N	78˚05'17'' E
C	Samichettipatti Velaan Kadan Sangam - Central Government Office, Samichettipatti		12˚01'59'' N	78˚04'03'' E
GW5	**Pipeline end point at Krishnagiri**	Krishnagiri (Tamilnadu)		
A	Hosur Airport, Taneja Aerospace Road, Belagondanahalli		12˚40'13'' N	77˚45'44'' E
B	Rams Farm - Resort hotel, Hosur		12˚38'37'' N	77˚49'58'' E
C	Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur		12˚41'35'' N	77˚50'38'' E

Table-3.31: Ground Water Analysis Result

S. NO.	PARAMETER	GW1			GW2			GW3			GW4			GW5			IS 10500:2012 AD-1		
																	DESIRABLE LIMIT	PERMISSIBLE LIMIT	TEST METHOD
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
1	pH (at 25 °C)	7.38	7.58	7.44	7.51	7.66	7.69	7.60	7.45	7.53	7.34	7.63	7.32	7.56	7.37	7.26	6.5 to 8.5	No Relaxation	APHA 4500H+B 23rd Edition,2017
2	Temperature	24.70	24.73	24.77	25.10	24.80	25.03	25.0	25.0	24.9	24.9	25.0	25.0	24.9	25.1	25.1	-	-	APHA 2550 B 23rd Edition, 2017
3	Colour (HU)	2.67	3.03	4.53	4.0	3.37	2.83	3.47	2.87	2.37	2.30	2.90	3.20	3.0	3.77	2.47	5 Max	15 Max	APHA 2120 B&C 23rd Edition, 2017
4	Odour	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	Agree-able	APHA 2150 B 23rd Edition, 2017
5	Salinity	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-	-	Lab SOP
6	Total Dissolved Solids (mg/l)	378	410	389	443	485	390	362	488	412	352	314	357	291	344	391	500 Max	2000 Max	APHA 2540 C 23rd Edition,2017

S. NO.	PARAMETER	GW1			GW2			GW3			GW4			GW5			IS 10500:2012 AD-1		
																	DESIRABLE LIMIT	PERMISSIBLE LIMIT	TEST METHOD
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
7	Total Suspended Solids (mg/l)	7.33	9	10.33	9.83	9.33	9.67	6.33	10.6	8.67	9.33	8.67	9.67	10	10	7.67	-	-	APHA 2540 D 23rd Edition, 2017
8	Total Alkalinity (mg/l)	193	215	197	218	266	214	210	259	228	186	175	187	161	207	232	200 Max	600 Max	APHA 2320 B 23rd Edition, 2017
9	Total Hardness (mg/l)	169	189	178	180	230	189	175	202	191	162	157	162	136	176	199	200 Max	600 Max	APHA 2340 C 23rd Edition, 2017
10	Calcium Hardness (mg/l)	107	122	128	134	151	133	115	153	134	125	115	117	106	116	122	-	-	APHA 3500-Ca B 23rd Edition, 2017
11	Magnesium Hardness (mg/l)	15	16	12	11	19	13	14	11	13	8	10	10	7	14	18	-	-	APHA 3520-Mg B 23rd Edition, 2017
12	Chloride (mg/l)	33	28	35	21	41	31	22	46	20	20	21	23	16	25	39	250 Max	1000 Max	APHA 4500 Cl-B 23rd Edition, 2017
13	Fluoride	0.74	0.79	0.87	0.74	0.87	0.69	0.79	0.86	0.64	0.67	0.76	0.60	0.58	0.79	0.92	1.0 Max	1.5 Max	CPCB Guide

S. NO.	PARAMETER	GW1			GW2			GW3			GW4			GW5			IS 10500:2012 AD-1		
																	DESIR-ABLE LIMIT	PERMIS-SIBLE LIMIT	TEST METHOD
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
	(mg/l)																		Manual: Water & waste water Analysis
14	Arsenic (mg/l)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	0.05 Max	1.5 Max	APHA 3125 B 23rd Edition, 2017
15	Sulphate (mg/l)	16.4	21.1	15.8	18.3	28.4	20.7	20.8	30.0	17.3	14.6	17.7	21.0	15.5	27.8	34.3	200 Max	400 Max	APHA 4500-SO^{2}-4E 23rd Edition, 2017
16	Sodium (mg/l)	11	13	14	14	18	15	15	18	14	12	13	12	12	16	24	-	-	APHA 3125 B 23rd Edition, 2017
17	Lead (mg/l)	BLQ(LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ(LOQ-0.002)	BLQ(LOQ-0.002)	BLQ(LOQ-0.002)	BLQ(LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ(LOQ-0.002)	BLQ(LOQ-0.002)	BLQ (LOQ-0.002)	BLQ(LOQ-0.002)	BLQ (LOQ-0.002)	0.3 Max	No Relaxat-ion	APHA 3125 B 23rd Edition, 2017
18	Potassium (mg/l)	4.0	4.9	4.0	6.0	8.1	4.7	4.2	6.9	5.6	4.9	4.8	3.4	4.9	5.7	8.8	-	-	APHA 3125 B 23rd Edition, 2017

S. NO.	PARAMETER	GW1			GW2			GW3			GW4			GW5			IS 10500:2012 AD-1		
																	DESIRABLE LIMIT	PERMISSIBLE LIMIT	TEST METHOD
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
19	Nitrates (mg/l)	1.31	2.97	1.90	1.13	2.65	1.88	1.50	2.59	1.48	1.16	1.32	1.48	1.84	2.01	2.74	45	No Relaxation	APHA 4500 NO-3B 23rd Edition, 2017
20	Total Phosphate (mg/l)	0.65	0.59	0.71	0.56	0.72	0.54	0.53	0.69	0.65	0.58	0.48	0.54	0.61	0.84	0.56	-	-	APHA4500-P D23rd Edition 2017
21	DO (mg/l)	7.40	7.17	7.0	7.17	7.0	7.10	6.73	7.63	7.63	7.37	7.27	7.37	6.80	7.47	7.0	-	-	CPCB Guide Manual: Water & waste water Analysis
22	BOD (mg/l)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	-	-	CPCB Guide Manual: Water & Waste Water Analysis
23	COD (mg/l)	4.3	4.6	4.6	4.2	4.2	4.1	4.2	4.0	4.0	4.0	4.2	4.7	4.8	4.4	4.4	-	-	CPCB Guide Manual: Water & Waste

S. NO.	PARAMETER	GW1			GW2			GW3			GW4			GW5			IS 10500:2012 AD-1		
																	DESIRABLE LIMIT	PERMISSIBLE LIMIT	TEST METHOD
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C			
																			Water Analysis
24	Total Nitrogen (mg/l)	1.0	1.5	1.2	1.5	1.5	1.7	1.3	0.95	1.15	0.99	0.75	1.15	0.88	0.93	0.86	-	-	APHA 4500NO^-3 B 23rd Edition, 2017
25	Total Phosphorous (mg/l)	0.34	0.49	0.63	0.65	0.58	0.57	0.71	0.56	0.64	0.70	0.65	0.55	0.76	0.57	0.77	-	-	APHA4500-P D23rd Edition 2017
26	Total Coliform Bacteria (MPN/ 100ml)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	Shall Not be Detected in 100ml sample	Shall Not be Detected in 100ml sample	IS 1622 :1981
27	Faecal Coliform (MPN/ 100ml)	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	-		IS 1622 :1981

3.5.2 Interpretation of Results

Analysis results of Ground water reveal the following;

The pH values of the ground water samples were found to be in the range of 7.26 to 7.69 at all the monitoring locations. The total dissolved solids (TDS) of the ground water samples were found to be in the range of 291 mg/L at GW5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 488 mg/L at GW3(b) Semmandappatti - Railway station, Semmandapatti. The total hardness value of the ground water samples were found to be in the range of 136 mg/L at GW5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 230 mg/L at GW2(b) Erode Junction Railway Station. Fluoride content varies from 0.58 mg/L at GW5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 0.92 mg/L at GW5(c) Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur. The concentrations of chloride were found between 16 mg/L at GW5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 46 mg/L at GW3(b) Semmandappatti - Railway station, Semmandapatti.

A review of the above chemical analysis reveals that there is some variation in chemical composition of water tapped from different sources but the ground water from all sources remains suitable for drinking purposes with proper disinfection as all the constituents are within the limits prescribed for drinking water standards promulgated by Indian Standards (IS: 10500).

	
Parade Ground SFTI Walayar near Village Chandrapuram	JCT College of Engineering and Technology near Pichanur - Bus stop

	
Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore	Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam
	
Erode Junction Railway Station	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai

	
Periyar University, Periyar, Palkalai Nagar - Salem	Semmandappatti - Railway station, Semmandapatti
	
Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur	Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli

Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur,

Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti

Hosur Airport, Taneja Aerospace Road, Belagondanahalli

Rams Farm - Resort hotel, Hosur

Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur

Figure-3.28: Ground Water Quality Monitoring Photographs

Table-3.32: Surface Water Sampling Stations

Stations	Locations	Sampling Locations	Coordinates	
			Latitude	Longitude
SW1	**Pipeline starting point at Coimbatore**	Coimbatore (Tamil Nadu		
A	Parade Ground SFTI Walayar near Village Chandrapuram		10˚50'32" N	76˚50'50" E
B	JCT College of Engineering and Technology near Pichanur - Bus stop		10˚50'05" N	76˚52'43" E
C	Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore		10˚54'10" N	76˚59'28" E
SW2	**Near IPS-3 location**	Erode (Tamil Nadu)		
A	Kaveri river near shree chamundeeshwari temple		11˚17'58" N	77˚47'00" E
B	Erode Junction Railway Station (Erodai river)		11˚19'40" N	77˚43'09" E
C	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai		11˚14'14" N	77˚43'29" E
SW3	**Near SV-18 at Chainage 371.035.**	Salem		
A	Periyar University, Periyar, Palkalai Nagar - Salem		11˚43'20" N	78˚04'53" E

B	Semmandappatti - Railway station, Semmandapatti	(Tamil Nadu)	11˚47'07" N	78˚01'59" E
C	Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur		11˚45'59" N	78˚03'39" E
SW4	**Near IPS-4**	Dharmapuri (Tamil Nadu)		
A	Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli		12˚4'19" N	78˚06'23" E
B	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur		12˚01'00" N	78˚05'14" E
C	Samichettipatti Velaan Kadan Sangam - Central Government Office, Samichettipatti		12˚01'59" N	78˚04'08" E
SW5	**Pipeline end point at Krishnagiri**	Krishnagiri (Tamil Nadu)		
A	Hosur Airport, Taneja Aerospace Road, Belagondanahalli		12˚39'49" N	77˚46'56" E
B	Rams Farm - Resort hotel, Hosur		12˚39'49" N	77˚48'18" E
C	Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur		12˚41'33" N	77˚50'45" E

Table-3.33: Surface Water Analysis Result

S. NO.	PARAMETER	SW1			SW2			SW3			SW4			SW5			TEST METHOD
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
1	pH (at 25 °C)	7.82	7.78	7.65	7.75	7.49	7.97	7.60	7.79	7.59	7.69	7.59	7.74	7.63	7.42	7.56	APHA 4500H+B 23rd Edition,2017
2	Temperature	24.67	24.73	24.70	25.20	24.77	24.97	24.83	24.57	24.70	25.20	25	24.93	25.07	24.77	25.00	APHA 2550 B 23rd Edition, 2017
3	Colour (HU)	4.03	4.77	3.37	3.80	4.23	4.80	3.90	3.97	3.50	4.23	4.08	2.97	4.63	3.23	3.83	APHA 2120 B&C 23rd Edition, 2017
4	Odour	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	APHA 2150 B 23rd Edition, 2017
5	Salinity	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	<2	Lab SOP
6	Total Dissolved Solids (mg/l)	295	366	502	320	293	322	403	336	444	385	303	277	304	318	272	APHA 2540 C 23rd Edition,2017
7	Total Suspended Solids (mg/l)	15.00	16.33	18.00	12.00	16.67	17.67	17.67	18.33	16.33	18.33	14.33	18.00	15.67	18.67	15.00	APHA 2540 D 23rd Edition, 2017
8	Total Alkalinity (mg/l)	179	200	253	216	187	234	259	257	274	266	211	197	208	221	186	APHA 2320 B 23rd Edition,2017
9	Total Hardness (mg/l)	141	165	184	179	152	177	190	201	207	188	174	172	180	179	161	APHA 2340 C 23rd Edition, 2017
10	Calcium Hardness (mg/l)	95.0	105.0	132.9	105.6	100.2	104.0	117.6	122.1	121.3	123.2	106.0	111.3	108.3	103.3	97.1	APHA 3500-Ca B 23rd Edition,2017

S. NO.	PARAMETER	SW1			SW2			SW3			SW4			SW5			TEST METHOD
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
11	Magnesium Hardness (mg/l)	11.18	14.66	12.42	17.82	12.59	17.74	17.58	19.24	20.90	15.82	16.61	14.74	17.58	18.39	15.59	APHA 3520-Mg B 23rd Edition,2017
12	Chloride (mg/l)	38.00	41.67	49.00	39.33	35.67	44.00	40.00	40.00	52.33	39.00	36.00	25.00	38.00	40.00	25.67	APHA 4500 Cl-B 23rd Edition,2017
13	Fluoride (mg/l)	0.93	1.11	1.28	0.85	0.87	1.13	0.99	1.24	1.48	0.75	0.77	1.22	1.33	0.99	0.97	CPCB Guide Manual:Water & waste water Analysis
14	Arsenic (mg/l)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	APHA 3125 B 23rd Edition,2017
15	Sulphate (mg/l)	32.57	30.93	38.17	38.40	28.47	23.20	30.47	31.70	34.77	27.93	23.17	27.73	33.03	27.30	21.47	APHA 4500-SO^{2-} 4E 23rd Edition,2017
16	Sodium (mg/l)	17.80	16.47	23.23	15.87	17.70	13.73	15.07	15.13	24.17	15.50	13.27	18.83	17.80	17.03	16.40	APHA 3125 B 23rd Edition,2017
17	Lead (mg/l)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	BLQ (LOQ-0.002)	APHA 3125 B 23rd Edition,2017
18	Potassium (mg/l)	7.23	7.10	12.10	9.80	9.07	8.07	7.23	8.93	11.27	8.58	7.43	10.20	9.50	8.73	9.30	APHA 3125 B 23rd Edition,2017
19	Nitrates (mg/l)	3.15	3.06	3.93	2.62	2.09	4.07	2.78	3.92	3.14	4.01	3.15	4.45	3.05	2.20	3.51	APHA 4500 NO-3B 23rd Edition,2017
20	Total Phosphate (mg/l)	0.57	0.68	0.86	0.85	0.48	0.94	0.58	0.56	0.77	0.89	0.63	0.73	1.12	0.88	0.72	APHA4500-P D23rd Edition 2017

S. NO.	PARAMETER	SW1			SW2			SW3			SW4			SW5			TEST METHOD
		A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	
21	DO (mg/l)	7.10	7.07	6.90	7.17	7.07	6.87	7.00	6.93	6.93	7.10	6.97	6.97	7.07	7.00	6.93	CPCB Guide Manual:Water & waste water Analysis
22	BOD (mg/l)	1.83	1.93	2.26	1.76	1.26	1.4	1.63	1.63	1.9	1.4	1.43	1.56	1.73	1.26	1.3	CPCB Guide Manual: Water & Waste Water Analysis
23	COD (mg/l)	11.33	12.00	15.33	13.33	14.17	12.43	13.27	12.40	18.00	14.47	14.13	13.47	18.27	10.67	14.20	CPCB Guide Manual: Water & Waste Water Analysis
24	Total Nitrogen (mg/l)	1.37	1.36	1.77	1.19	1.53	0.87	1.12	1.01	1.32	1.51	1.69	0.91	1.34	1.47	1.00	APHA 4500NO^{-}3 B 23rd Edition, 2017
25	Total Phosphorous (mg/l)	0.66	0.55	0.82	0.72	0.82	0.65	0.46	0.58	0.49	0.72	1.02	0.75	1.41	0.81	1.15	APHA4500-P D23rd Edition 2017
26	Total Coliform Bacteria (MPN/ 100ml)	180	175	290	290	360	310	180	280	380	170	320	280	250	150	250	IS 1622 :1981
27	Faecal Coliform (MPN/100ml)	60	40	30	120	110	150	60	130	40	50	190	120	30	70	170	IS 1622 :1981

*Water quality has been defined as per the IS: 3025 and APHA Method.

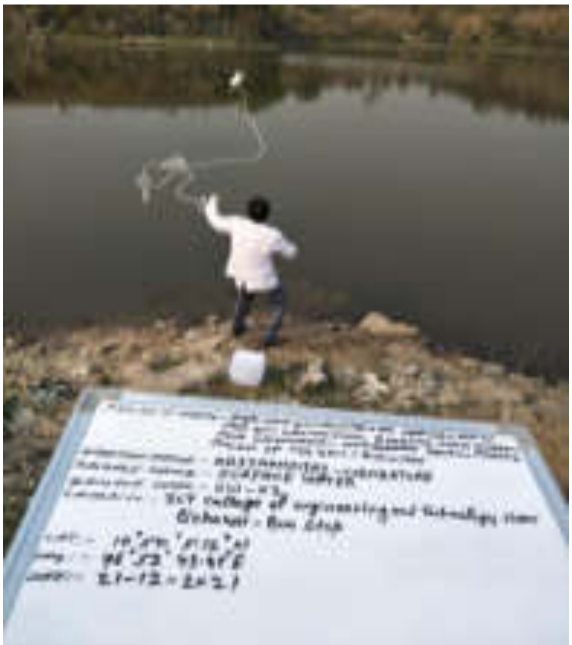
3.5.3 Interpretation of Results

Analysis results of Surface water reveal the following;

Observations made on the analytical results pertaining to all locations reveal that the pH values of the surface water samples were found to be in the range of 7.42 at SW5(b) Rams Farm - Resort hotel, Hosur to 7.97 at SW2(c) Sarasu Mahal, Avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai. The total dissolved solids (TDS) of the surface water samples were found to be in the range of 272 mg/L at SW5(c) Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur to 444 mg/L at SW3(c) Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur. The total hardness value of the surface water samples were found to be in the range of 141 mg/L at SW1(a) Parade Ground SFTI Walayar near Village Chandrapuram to 207 mg/L at SW3(c) Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur. Dissolved oxygen ranges from 6.87 mg/L at SW2(c) Sarasu Mahal, Avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai to 7.17 mg/L at SW2(a) Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam. Chemical Oxygen Demand of the surface water samples ranges between 10.6 mg/L at SW5(b)Rams Farm - Resort hotel, Hosur to 18 mg/L at SW3(c) Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur. Biological Oxygen Demand of the samples were found in the range of 1.26 at SW2(b) Erode Junction Railway Station and SW5(b) Rams Farm - Resort hotel, Hosur to 2.26 mg/L at SW1(c) Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore at all the monitoring locations.

From the results of all the samples analysed (Table no-3.33), it is observed that :

The surface waters falls in category B or D i.e. Outdoor bathing and propagation of wildlife fisheries when compared with the water quality standards for Inland surface water prescribed by Central Pollution Control Board.
(*Source: cpcb.nic.in*)

	
Parade Ground SFTI Walayar near Village Chandrapuram	JCT College of Engineering and Technology near Pichanur - Bus stop
	
Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore	Kaveri River near Shri Chamundeeshwari Temple

	
West sarabanga river Dam, Omalur - Salem	Periyar University, Periyar, Palkalai Nagar - Salem
	
Semmandappatti - Railway station, Semmandapatti	Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli

	
Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur	Samichettipatti Velaan Kadan Sangam - Central Government Office, Samichettipatti
	
Hosur Airport, Taneja Aerospace Road, Belagondanahalli	Rams Farm - Resort hotel, Hosur

	
Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai

Figure-3.29 : Surface Water Quality Monitoring Photographs

3.6 SOIL ENVIRONMENT

Soil Profile of Districts falling under the study areas of Tamil Nadu

(1) Krishnagiri

Soils have been classified into Black soil, mixed soil, red loamy soil, gravelly and sandy soils. Red loamy and sandy soils are predominant in Hosur taluk. Vast stretches of loam soils and black soils occur in Krishnagiri district.

(2) Dharmapuri

The soils of Dharmapuri district can be classified into i) Red Soil, ii) Red lateritic soil, (iii) Brown soil and iv) alluvial soil The soils are mostly in-situ in nature, lateritic, earthy and pale reddish in colour. They are derived from laterisation of gneisses. The soils derived from gneisses are mostly brownish. The thickness of soils in the mounts is almost negligible whereas in the valleys it is around 2 m.

(3) Salem

The soils can be broadly classified into 6 major soils types viz., Red insitu, Red Colluvial Soil, Black Soil, Brown Soil, Alluvial and Mixed Soil. Major part of the district is covered by Red insitu and Red Colluvial soils. Block soils are mostly seen in Salem, Attur, Omallur and sankari taluks. Brown Soil occupies major portion of Yercaud and parts of Salem and Omallur taluks and the Alluvial Soil is seen along the river courses in Omallur and Sankari taluks. Mixed soil is occurring only in Attur taluk.

(4) Erode

The soils of Erode district can be broadly classified into 6 major soils types viz., Red calcareous soil, Red non calcareous soil, Black Soil, Alluvial and Colluvial soils, Brown soil and Forest soil.

Major part of the district covered by red calcareous soils. They are mostly sandy to loamy and characterised by the hard and compact layer of lime. The red non-calcareous soils are seen in Erode, Perunthurai and Gopichettioalayam taluks. The black soils are occurring as patches in four taluks. Brown soil occupies only a small portion of Bhavani, Kangayam and Gopichettipalayam taluks. Alluvial soils are fund in small patches along the Noyil and Bhavani rivers and the Colluvial soils are found in the foothills of Western Ghats. Forest soil is confined to the reserve forest area in northwestern part of the district, where a surface layer of organic matter is present.

(5) Coimbatore

The soils of Coimbatore district can be broadly classified into 6 major soils types viz., Red calcareous Soil, Black Soil, Red non-calcareous, Alluvial and Colluvial Soil, Brown Soil, and Forest Soil. About 60 per cent of the district is covered by red soils, of which red calcareous soil is predominant. They occupy most parts of Palladam, Coimbatore, Mettupalayam and Udumalpet taluks. Medium to deep red calcareous soils are found mainly in Pollachi and Udumalpet taluks. Parts of Palladam, Avinashi and Udumalpet taluks are occupied by red non-calcareous soils. The highlands in Coimbatore, Palladam and Avinashi taluks are mostly occupied by the black soils, which are dark gray to grayish brown in co lour. The Alluvial soils are found in small patches along the Noyil river mainly in the upper reaches. The Colluvial soils are found mainly in Chinnathadagam and Chitrachavadi sub-basins and as scattered patches at the foothills of the Anaimalai. The Forest soils are confined to the reserve forest area and have a surface layer of organic matter.

3.6.1 Soil Quality

Assessment of soil quality is an important aspect with reference to tree plantations, percolation of water, ground water impact, etc. The information on soils has been collected from various secondary sources and also through primary soil sampling analysis of which is described in this section.

3.6.2 Methodology adopted for Selection of Sampling Station

Random soil samples were collected up to a depth of 15 cm and homogenized samples were then sent to the laboratory for analysis. The physical and chemical characteristics of the soil of the study area have been assessed by analyzing various parameters as per the methods described in “Soil Chemical Analysis” IS 2720, APHA & USDA.The soil quality of the study area has been assessed by collecting samples from 15 different locations.

Soil Quality

The sampling locations have been finalized with the following objectives:

- To determine the base line characteristics
- To determine the soil characteristics of proposed project site.
- To determine the impact of industrialization/urbanization on soil characteristics
- To determine the impacts on soils from agricultural productivity point of view.

Table-3.34: Soil Monitoring Station Details

Stations	Locations	Sampling Locations	Coordinates	
			Latitude	Longitude
S1	**Pipeline starting point at Coimbatore**	Coimbatore (Tamil Nadu)		
A	Parade Ground SFTI Walayar near Village Chandrapuram		10˚50'5.1" N	76˚50'46.1" E
B	JCT College of Engineering and Technology near Pichanur - Bus stop		10˚50'17.1" N	76˚52'46.2" E
S2	**Near IPS-3 location**	Erode (Tamil Nadu)		
A	Erode Junction Railway Station		11˚19'51" N	77˚43'33" E
B	SARASU MAHAL, AVALPOONDURAI (Festival hall)on Erode - Dharapuram Road, Avalpoondurai		11˚14'10" N	77˚43'11" E
S3	**Near SV-18 at Chainage 371.035.**	Salem (Tamil Nadu)		
A	Periyar University, Periyar, Palkalai Nagar - Salem		11˚37'52" N	78˚08'56" E
B	Semmandappatti - Railway station, Semmandapatti		11˚47'27" N	78˚01'36" E
S4	**Near IPS-4**	Dharmapuri (Tamil Nadu)		
A	Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli		12˚03'41" N	78˚06'09" E
B	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur		12˚00'55" N	78˚05'17" E
S5	**Pipeline end point at Krishnagiri**	Krishnagiri (Tamil Nadu)		
A	Hosur Airport, Taneja Aerospace Road, Belagondanahalli		12˚40'14" N	77˚45'45" E
B	Rams Farm - Resort hotel, Hosur		12˚38'37" N	77˚49'58" E

3.6.3 Soil Classification

Source: https://www.ternaryplot.com/

Figure-3.30: Soil Texture Diagram

Table: 3.35 Colour Coding of soil texture

Location	Colour Indication	Soil Texture
S1(a)	Purple	**Loamy Clay**
S1(b)	Deep Pink	**Loamy Clay**
S2(a)	Blue	**Loamy Clay**
S2(b)	Indigo	**Loamy Clay**
S3(a)	Greenyellow	**Loamy Clay**
S3(b)	Red	**Loamy Clay**
S4(a)	Orange	**Loamy Clay**
S4(b)	Green	**Loamy Clay**
S5(a)	Magenta	**Loamy Clay**
S5(b)	Brown	**Loamy Clay**

Table 3.36 Standards of soil classification

Chemical Parameters	Ranking				
	Very Low	**Low**	**Moderate**	**High**	**Very High**
pH	<4, Very Strongly Acidic	4-5, Strongly Acidic	5-8, Ideal for Plant Growth	8-9 Strongly Basic	>9 Very Strongly Basic
Electrical conductivity (µS/cm)	<2000, Non-Saline	2000-4000 Saline	4000-8000 Moderately Saline	8000-16000 Highly Saline	>16000 Extremely Saline
Total Nitrogen (%)	<0.05 Very Low	0.05-0.15 Low	0.15-0.25 Moderate	0.25-0.5 High	>0.5 Very High
Total Phosphorous (mg/kg)	<5 Very Low	5-10 Low	10-30 Moderate	30-60 High	>60 Very High
Sodium (mg/kg)	-	<200 Non Sodic	200-500 Moderate	>500 Sodic	
Potassium (mg/kg)	-	<150 Low	150-250 Moderate	250-800 High	>800 Very High
Calcium (mg/kg)	-	<1000 Low	1000-2000 Moderate	>2000 High	-
Magnesium (mg/kg)	<40 Very Low	40-100 Low	100-300 Moderate	>300 High	-
% Organic Matter	0.5-1.0 Very Low	1.0-2.0 Low	2.0-3.0 Moderate	3.0-5.0 High	>5 Very High

Table-3.37: Soil Analysis Result

S. No	Parameter	S1		S2		S3		S4		S5		Test Method
		A	B	A	B	A	B	A	B	A	B	
1.	Type of Soil	Lumps & Powder	Lumps & Powder	Lumps & Powder	Lumps & Powder	Lumps & Powder	Lumps & Powder	Lumps & Powder	Lumps & Powder	Lumps & Powder	Lumps & Powder	Manual for Soil Testing , Govt. of India, Jan.2011
2.	pH (at 25 °C)	7.66	7.56	7.79	7.71	7.80	7.66	7.74	7.60	7.79	7.67	USEPA 1998, 9045D
3.	Electrical Conductivity (µS/ cm)	136.5	115.5	98	115	159	168.5	87.5	109	80	102	USDA
4.	Soil Texture	Loamy Clay	Loamy Clay	Loamy Clay	Loamy Clay	Loamy Clay	Loamy Clay	Loamy Clay	Loamy Clay	Loamy Clay	Loamy Clay	USDA
5.	Porosity	0.60	0.64	0.64	0.69	0.62	0.68	0.60	0.64	0.65	0.60	USDA
6.	Bulk Density	1.50	1.48	1.45	1.51	1.47	1.50	1.48	1.52	1.49	1.51	EPA Soil screening guidance manual
7.	Sand%	18.05	17.9	18.15	17.9	18	18.3	18.05	17.90	18.35	18.10	EPA Soil screening guidance manual
8.	Silt% & Clay%	52.75& 29.2	53&29.1	52.9&2 8.95	53.1&29	52.95& 29.05	52.95& 28.75	52.85&2 9.1	52.95&2 9.15	52.8&29. 05	53.1& 28.75	EPA Soil screening guidance manual
9.	Organic Matter (%)	0.46	0.50	0.52	0.49	0.50	0.50	0.48	0.49	0.49	0.49	APHA2540 G23rd Edition, 2017
10.	Sodium Adsorption Ratio	1.33	1.31	1.44	1.43	1.50	1.40	1.44	1.38	1.51	1.42	USDA
11.	Specific Gravity	1.49	1.49	1.45	1.50	1.48	1.50	1.48	1.52	1.49	1.51	EPA Method 830.7300
12.	NPK Ratio	5.84:1.6 0:1	5.31:1.44: 1	4.47:1.4 3:1	5.46:1.61: 1	5.30:1.6 6:1	5.08:1.26: 1	5.02:1.44: 1	4.73:1.25: 1	4.90:1.50: 1	4.86:1.56: 1	Manual for Soil Testing , Govt. of India, Jan.2011

3.6.4 Interpretation of Results

The analysis results shows that pH value ranges from **7.56 at S1(b)** JCT College of Engineering and Technology near Pichanur - Bus stop **to 7.80 at S3(a)** Periyar University, Periyar, Palkalai Nagar – Salem. The organic matter varies between **0.46% at S1(a)** Parade Ground SFTI Walayar near Village Chandrapuram **to 0.52 % at S2(a)** Erode Junction Railway Station**.** The Concentration of Nitrogen, Phosphorus and Potassium has been found to be in good amount in the Soil Samples. Soil texture is Loamy Clay at all the locations and is good for agricultural purposes.

	
Parade Ground SFTI Walayar near Village Chandrapuram	JCT College of Engineering and Technology near Pichanur - Bus stop
	
Erode Junction Railway Station	SARASU MAHAL, AVALPOONDURAI (Festival hall) on Erode - Dharapuram Road, Avalpoondurai

	
Periyar University, Periyar, Palkalai Nagar - Salem	Semmandappatti - Railway station, Semmandapatti
	
Sri Vijay Vidyalaya College of Arts and Science – University Nallampalli Papparapatty Road (via) Nagarkoodal, Balajangamanhalli	Adyar Ananda Bhavan Veg Restaurant, on NH 47, near BPCL petrol pump, Thombarambakkam Village, Thoppur
	
Hosur Airport, Taneja Aerospace Road, Belagondanahalli	Rams Farm - Resort hotel, Hosur

Figure-3.31: Soil Quality Monitoring Photographs

3.7 BIOLOGICAL ENVIRONMENT

Biological studies are one of the important aspects of Environmental Impact Assessment with a view to understand the ecosystems and biodiversity in the study area and assess the need for conservation actions. Generally, biological communities are good indicators of climatic and edaphic factors.

3.7.1 Methodology

Flora

To achieve above objectives a detailed study of the area was undertaken in along the pipeline route. 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.

Fauna

Random walk and opportunistic observations were used for documenting the birds. However, point count methods were used in mudflat and wetland areas. Birds were identified with the help of binocular and standard field identification guides during morning (06:00 to 10:00 hrs) and evening (17:00 to 19:00 hrs) hours. Both direct (visual encounter survey) and indirect methods (tracks &signs) were used to document mammals. Visual encounter survey method was followed to identify herpetofauna (amphibians and reptiles).

3.7.2 National Parks and Sanctuaries

There are no Wildlife Sanctuaries and Naional Parks present in 10 km surrounding of Krishnagiri-Coimbatore pipeline project.

3.7.3 Field Survey Results

Different ecosystems such as wasteland, agricultural fields, scrub land, surface water bodies (ponds and rivers) were surveyed in the study area.

3.7.4 Floral diversity

A total of 134 species of plants (including wild, ornamental and cultivated plants) belonging to 108 genera and spreading over 53 plant families were documented and identified in the 10 km radial distance from the proposed project site of the study area.

The distribution of plants have been categorized into different habitat and mentioned below in **Table 3.38**. The list of plant species are given in **Table-3.39.**

Table 3.38 - Habitat wise distribution of plants in the study area

Habit	Number of species
Climber	10
Herb	34
Shrub	24
Tree	66
Grand Total	**134**

Table 3.39 - List of plants in the study area

S. No	Scientific Name	Family	Habit
1	*Abutilon indicum* (L.)Sweet	Sterculiaceae	Shrub
2	*Acacia auriculiformis*A.Cunn.ex Benth.	Mimosaceae	Tree
3	*Acacia nilotica* (L.) Delile	Mimosaceae	Tree
4	*Acanthus ilicifolius* L.	Acanthaceae	Shrub
5	*Aegle marmelos* (L.) Correa ex Roxb.	Rutaceae	Tree
6	*Aeluropuslagopoides* (L.) Trin. Ex Thw.	Poaceae	Herb
7	*Alstoniascholaris* (L.) R.Br.	Apocynaceae	Tree
8	*Alternanthera polygonoides* (L.) H.B. & K. ex Roem and Schult	Amaranthaceae	Herb
9	*Alternanthera pungens*Kunth	Amaranthaceae	Herb
10	*Alternanthera sessilis* (L.) R.Br.ex DC.	Amaranthaceae	Herb
11	*Amaranthus spinosus* L.	Amaranthaceae	Herb
12	*Amaranthus viridis* L.	Amaranthaceae	Herb
13	*Anthocephalus chinensis* (Lam.) A.Rich.ex Walp.	Rubiaceae	Tree
14	*Antigononleptopus* Hook. & Arn.	Polygonaceae	Climber
15	*Argemone mexicana* L.	Papaveraceae	Herb
16	*Artocarpus heterophyllus* Lam.	Moraceae	Tree
17	*Avicennia marina* (Forssk.) Vierh.	Verbenaceae	Shrub
18	*Avicenniaofficinallis* L.	Verbenaceae	Tree
19	*Avicenniaofficinallis* L. var. acutissima	Verbenaceae	Tree
20	*Azadirachta indica* A. Juss.	Meliaceae	Tree
21	*Barringtonia acutangula* (L.) Gaertn.	Barringtoniaceae	Tree
22	*Bauhinia purpurea* L.	Caesalpiniaceae	Tree
23	*Boerhaviadiffusa* L.	Nyctaginaceae	Herb
24	*Bombax ceiba* L.	Bombacaceae	Tree
25	*Borassus flabellifer* L.	Arecaceae	Tree
26	*Bougainvillea spectabilis* Willd.	Nyctaginaceae	Shrub
27	*Bruguiera cylindrica* (L.) Blume	Rhizophoraceae	Tree
28	*Bruguieragymnorrhiza* (L.) Savigny	Rhizophoraceae	Tree
29	*Callistemon citrinus* (Curtis) Stapf	Myrtaceae	Tree

S. No	Scientific Name	Family	Habit
30	*Capparis sepiaria* L.	Capparaceae	Shrub
31	*Capparis zeylanica* L.	Capparaceae	Shrub
32	*Caryotaurens* L.	Arecaceae	Tree
33	*Cassia fistula* L.	Caesalpiniaceae	Tree
34	*Cassia siamea* Lam.	Caesalpiniaceae	Tree
35	*Cassia tora* L.	Caesalpiniaceae	Shrub
36	*Cassia trifolia*	Caesalpiniaceae	Herb
37	*Casuarina equisetifolia* L.	Casurinaceae	Tree
38	*Catharanthus roseus* (L.) G.Don	Apocynaceae	Herb
39	*Ceiba pentandra* (L.) Gaertn.	Bombacaceae	Tree
40	*Celosia argentea* L. var. argentea	Amaranthaceae	Herb
41	*Clerodenduminerme* (L.) Gaertn.	Verbenaceae	Shrub
42	*Clerodendrumviscosum* Vent.	Verbenaceae	Shrub
43	*Clitoriaternatea* L.	Papilionaceae	Climber
44	*Cocos nucifera* L.	Arecaceae	Tree
45	*Commelinabenghalensis* L.	Commelinaceae	Herb
46	*Commelinadiffusa*Burm.f.	Commelinaceae	Herb
47	*Cordia macleodii* (Griff.) Hook.f. & Thoms.	Ehretiaceae	Tree
48	*Cordia sebestena* L.	Ehretiaceae	Tree
49	*Couroupitaguianensis*Aubl.	Lecythidaceae	Tree
50	*Croton bonplandianum*Baill.	Euphorbiaceae	Shrub
51	*Cycas revoluta* Thunb.	Cycadaceae	Herb
52	*Cyperus difformis* L.	Cyperaceae	Herb
53	*Cyperus distans*L.f.	Cyperaceae	Herb
54	*Cyperus iria* L.	Cyperaceae	Herb
55	*Cyperus rotundus* L.	Cyperaceae	Herb
56	*Dalbergia sisoo*Roxb.	Papilionaceae	Tree
57	*Delonixelata* (L.) Gamble	Caesalpiniaceae	Tree
58	*Delonix regia* (Boj.ex Hook.) Raf.	Caesalpiniaceae	Tree
59	*Dendrophthoe falcata* (L.f.) Etting	Loranthaceae	Shrub
60	*Derris trifoliata*Lour.	Caesalpiniaceae	Shrub
61	*Erythrina indica*	Caesalpiniaceae	Tree
62	*Euphorbia thymifolia* L.	Euphorbiaceae	Herb
63	*Excoecariaagallocha* L.	Euphorbiaceae	Tree
64	*Ficsubenghalensis* L. var. benghalensis	Moraceae	Tree
65	*Ficus elastica*Roxb.exHornem	Moraceae	Shrub
66	*Ficus hispida*L.f.	Moraceae	Tree
67	*Ficus racemosa* L.	Moraceae	Tree
68	*Ficus religiosa* L.	Moraceae	Tree
69	*Fimbristylisferruginea* (L.) Vahl	Cyperaceae	Herb
70	*Gliricidiasepium* (Jacq.) Kunth ex Walp.	Papilionaceae	Tree
71	*Grangeamaderaspatana* (L.) Poir.	Asteraceae	Herb

S. No	Scientific Name	Family	Habit
72	*Grevillea robusta*A.Cunn.ex R.Br.	Proteaceae	Tree
73	*Hamelia patens* Jacq.	Rubiaceae	Shrub
74	*Heliotropium indicum* L.	Boraginaceae	Herb
75	*Holarrhenapubescens* (Buch.-Ham.) Wall. ex G.Don	Apocynaceae	Shrub
76	*Indigofera linnaei* Ali	Papilionaceae	Herb
77	*Ipomoea carnea* Jacq.	Convolvulaceae	Shrub
78	*Ipomoea obscura* Ker-Gawl.	Convolvulaceae	Climber
79	*Ipomoea pes-tigridis* L.	Convolvulaceae	Climber
80	*Ipomoea quamoclit* L.	Convolvulaceae	Climber
81	*Jasminum sambac* (L.) Ait.	Oleaceae	Shrub
82	*Jatropha podagrica* Hook.	Euphorbiaceae	Shrub
83	*Kigeliaafricana* (Lam.) Benth.	Bignoniaceae	Tree
84	*Lageraaurita*	Asteraceae	Herb
85	*Lagerstroemia reginae*Roxb.	Lythraceae	Tree
86	*Lantana camara* L. var. aculeata (L.) Mold.	Verbenaceae	Shrub
87	*Lawsoniainermis* L.	Lythraceae	Shrub
88	*Leucaena leucocephala* (Lam.) de Wit	Mimosaceae	Tree
89	*Malachra capitata* (L.) L.syst	Malvaceae	Herb
90	*Mangifera indica* L.	Anacardiaceae	Tree
91	*Melia azedarach* L.	Meliaceae	Tree
92	*Merremiaturpethum* (L.) Shah & Bhat	Convolvulaceae	Climber
93	*Millingtonia hortensis*L.f.	Bignoniaceae	Tree
94	*Mimusopselengi* L.	Sapotaceae	Tree
95	*Mirabilis jalapa* L.	Nyctaginaceae	Herb
96	*Momordica dioica* Roxb.	Cucurbitaceae	Climber
97	*Moringa oleifera* Lam.	Moringaceae	Tree
98	*Murrayakoenigii*(L.) Spreng.	Rutaceae	Tree
99	*Mussendafrondosa*L.	Rubiaceae	Shrub
100	*Nyctanthes arbor-tristis* L.	Oleaceae	Tree
101	*Peltophorumpterocarpum*(DC.) Backer	Caesalpiniaceae	Tree
102	*Pentatropis capensis* (L.f.) Bullock	Ascelpiadaceae	Climber
103	*Phoenix sylvestris* (L.) Roxb.	Arecaceae	Tree
104	*Pithecellobium dulce* (Roxb.) Benth.	Mimosaceae	Tree
105	*Pluchia arguta*	Asteraceae	Herb
106	*Plumeria rubra* L.	Apocynaceae	Tree
107	*Polyalthia longifolia* (Sonn.) Thw	Annonaceae	Tree
108	*Pongamia pinnata* (L.) Pierre	Caesalpiniaceae	Tree
109	*Rhizophora mucronata*Poir.	Rhizophoraceae	Tree
110	*Ricinus communis* L.	Euphorbiaceae	Herb
111	*Rivea ornate* Choisy	Convolvulaceae	Climber
112	*Roystonea regia* (Kunth) O.F. Cook	Arecaceae	Tree

S. No	Scientific Name	Family	Habit
113	*Salvadora persica* L. var. wighitiana (Planch. Ex thw.) Verdc.	Salvadoraceae	Shrub
114	*Samanea saman* (Jacq.) Merr.	Mimosaceae	Tree
115	*Sesuviumportulacastrum* (L.) L.	Aizoaceae	Herb
116	*Sida acuta*Burm.f.	Malvaceae	Herb
117	*Sonneratia apetala* Buch.- Ham.	Sonneratiaceae	Tree
118	*Sonneratiacaseolaris* (L.) Engl.	Sonneratiaceae	Tree
119	*Spathodeacampanulata*P.Beauv.	Bignoniaceae	Tree
120	*Suaeda fruticosa*	Chenopodiaceae	Herb
121	*Syzygiumcumini* (L.) Skeels	Myrtaceae	Tree
122	*Taberneamontanadivaricata* (L.) Burkill	Apocynaceae	Tree
123	*Tamarindus indica* L.	Caesalpiniaceae	Tree
124	*Tecoma stans* (L.) Kunth	Bignoniaceae	Tree
125	*Terminalia arjuna* (Roxb.ex DC.) Wight & Arn.	Combretaceae	Tree
126	*Thespesia populnea* (L.) Sol.ex Corr.	Malvaceae	Tree
127	*Thevetia peruviana* (pers.) Merrill	Apocynaceae	Shrub
128	*Trichosanthescucumerina* L.	Cucurbitaceae	Climber
129	*Tridax procumbens* L.	Asteraceae	Herb
130	*Triumfettarhomboidea* Jacq.	Tiliaceae	Herb
131	*Typha angustata* Bory &Chaub.	Typhaceae	Herb
132	*Urena lobata* L.	Malvaceae	Shrub
133	*Wrightia tinctoria* (Roxb,) R.Br.	Apocynaceae	Tree
134	*Zizyphusmauritiana* Lam.	Rhamnaceae	Tree

3.7.5 Threatened Plant Species

There are no threatened plant species as per the Red Data Book published by Botanical Survey of India in the proposed study area.

Familial Composition

Among the 53 families reported in the study area, the family Caesalpiniaceae is the dominant one and is represented with 10 species. The other notable dominant plant families recorded in the study area include Apocynaceae 8 species, Moraceae 7 species, 6 species each of Amaranthaceae, Convulvulaceae and Verbenaceae. The distribution of families is given in **Table 3.40**.

Table 3.40 - Dominant plant families of the study area

S. No.	Family	No of Species
1	Caesalpiniaceae	12
2	Apocynaceae	7
3	Amaranthaceae	6
4	Convolvulaceae	6
5	Moraceae	6

S. No.	Family	No of Species
6	Verbenaceae	6
7	Arecaceae	5
8	Cyperaceae	5
9	Euphorbiaceae	5
10	Mimosaceae	5
11	Asteraceae	4
12	Bignoniaceae	4
13	Malvaceae	4
14	Papilionaceae	4
15	Nyctaginaceae	3
16	Rhizophoraceae	3
17	Rubiaceae	3
18	Bombacaceae	2
19	Capparaceae	2
20	Commelinaceae	2
21	Cucurbitaceae	2
22	Ehretiaceae	2
23	Lythraceae	2
24	Myrtaceae	2
25	Oleaceae	2
26	Rutaceae	2
27	Sonneratiaceae	2
28	Acanthaceae	1
29	Aizoaceae	1
30	Anacardiaceae	1
31	Annonaceae	1
32	Ascelpiadaceae	1
33	Barringtoniaceae	1
34	Boraginaceae	1
35	Casurinaceae	1
36	Chenopodiaceae	1
37	Combretaceae	1
38	Cycadaceae	1
39	Lecythidaceae	1
40	Loranthaceae	1
41	Meliaceae	1
42	Meliaceae	1
43	Moringaceae	1
44	Papaveraceae	1
45	Poaceae	1
46	Polygonaceae	1
47	Proteaceae	1

S. No.	Family	No of Species
48	Rhamnaceae	1
49	Salvadoraceae	1
50	Sapotaceae	1
51	Sterculiaceae	1
52	Tiliaceae	1
53	Typhaceae	1
Grand Total		**134**

3.7.6 Fauna Diversity Analysis

Avifauna

A total of 30 bird species belonging to 18 families are recorded in the study area. The common birds recorded were Indian Pond Heron *Ardeolagrayii*, Little Egret *Egrettagarzetta,* Black-winged Stilt *Himantopus himantopus,* Common Sandpiper *Actitis hypoleucos,* House Crow *Corvus splendens,* Red-wattled Lapwing *Vanellus indicus* etc. Oriental White Ibis (*Threskiornismalanocephalus*) is a near threatened bird which sighted in the study site. The total list of birds is given in below mentioned **Table 3.41**.

Table 3.41 - List of avifauna recorded in the study area

S. No	Common Name	Scientific Name	Family	Distribution	Status
1	Ashy Prinia	*Priniasocialis*	Muscicapidae	R	C
2	Asian Palm Swift	*Cypsiurusbalasiensis*	Apodidae	LM	C
3	Baya Weaver	*Ploceusphilippinus*	Ploceidae	R	C
4	Black-winged Stilt	*Himantopus himantopus*	Recurvirostridae	R	C
5	Cattle Egret	*Bubulcus ibis*	Ardeidae	R	A
6	Common Babbler	*Turdoidescaudatus*	Muscicapidae	R	A
7	Common Myna	*Acridotheres tristis*	Sturnidae	R	A
8	Common Sandpiper	*Actitis hypoleucos*	Glareolidae	W	C
9	Green Sandpiper	*Tringaochropus*	Glareolidae	W	R
10	House Crow	*Corvus splendens*	Curvidae	R	A
11	Median Egret	*Mesophoyx intermedia*	Ardeidae	LM	O
12	Large Egret	*Casmerodius albus*	Ardeidae	LM	O
13	Little Egret	*Egrettagarzetta*	Ardeidae	R	A
14	Little Ringed-Plover	*Charadrius dubius*	Glareolidae	W	C
15	Oriental White Ibis	*Threskiornismalanocephalus*	Threskiornithidae	LM	C
16	Indian Pond Heron	*Ardeolagrayii*	Ardeidae	R	C
17	Red-vented Bulbul	*Pycnonotuscafer*	Pycnonotidae	R	A
18	Red-wattled Lapwing	*Vanellus indicus*	Glareolidae	R	A
19	Rufousbacked Shrike	*Lanius schach*	Laniidae	R	C
20	Small Bee-eater	*Meropsorientalis*	Meropidae	LM	C
21	Spotted Munia	*Lonchurapunctulata*	Ploceidae	R	R

S. No	Common Name	Scientific Name	Family	Distribution	Status
22	Whiskered Tern	*Chidonias hybridus*	Laridae	R	C
23	Grey Heron	*Ardea cinerea*	Ardeidae	R	C
24	Black Kite	*Milvus migransgovinda*	Accipitridae	R	C
25	Gull-billed Tern	*Gelochelidonnilotica*	Laridae	LM	C
26	Blue Rock Piegon	*Columba livia*	Columbidae	R	C
27	Rose-ringed Parakeet	*Psittaculakrameri*	Psittacidae	R	C
28	Asian Koel	*Eudynamysscolopacea*	Cuculidae	R	C
29	Small Blue Kingfisher	*Alcedo atthis*	Alcedinidae	R	C
30	Oriental Magpie-Robin	*Copsychussaularis*	Muscicapidae	R	C

Note: R: Resident; LM: Local Migrant; C: Common; O: Occasional; WM: Winter migrant; A: Abundant

Among the families, Ardeidae has 6 numbers of species followed by Glareolidae (4), Muscicapidae (3), Laridae and Ploceidae each with two species. The distribution of avifauna among families is given below in **Table 3.42**.

Table 3.42 - Family-wise distribution of avifauna in the study area

Family	No. of species
Ardeidae	6
Glareolidae	4
Muscicapidae	3
Laridae	2
Ploceidae	2
Accipitridae	1
Alcedinidae	1
Apodidae	1
Columbidae	1
Cuculidae	1
Curvidae	1
Laniidae	1
Meropidae	1
Psittacidae	1
Pycnonotidae	1
Recurvirostridae	1
Sturnidae	1
Threskiornithidae	1
Grand Total	**30**

Butterflies

There are 14 butterfly species belonging to 5 families which were identified in a random survey around the study area. Grey Pansy *Junoniaatlites* is sighted in study area. The list of butterflies recorded from the study area is provided in **Table 3.43**.

Table 3.43 - List of butterflies in the study area

S. No.	Common Name	Scientific Name	Family
1	Common Rose	*Pachlioptaaristolochiae*	Papilionidae
2	Crimson Rose	*Pachliopta hector*	Papilionidae
3	Common Mormon	*Papilio polytes*	Papilionidae
4	Common Grass yellow	*Euremahecabe*	Pieridae
5	Small Grass Yellow	*Euremabrigitta*	Pieridae
6	Common Emigrant	*Catopsiliapomona*	Pieridae
7	Common Jezebell	*Delias eucharis*	Pieridae
8	Peacock Pansy	*Junoniaalmana*	Nymphalidae
9	Striped Tiger	*Danaus genutia*	Nymphalidae
10	Plain Tiger	*Danaus chrysippus*	Nymphalidae
11	Common Crow	*Euploea core*	Nymphalidae
12	Grey Pansy	*Junoniaatlites*	Nymphalidae
13	Stripped Pierrot	*Tarucusnara*	Lycaenidae
14	Plain Banded Owl	*Hasora vitta*	Hesperiidae

Fish

Several species of fishes are available in the river water and collected by local fisherman. Some of them are Indian Tarpon *Megalops* sp., Guppy *Guppypoecila*, Catfish *Clarius* sp., Tilapia *Oreochronismossambicus*, Mullet *Mugil cephulus*, Mud-skipper *Periophthalmus* sp., and Eel *Anguilla* sp. are common in the mudflat areas.

Reptiles

The survey of study area was carried out. We have recorded 5 species of snakes, one species of lizards and 2 types of skinks. Snake species recorded were Common Kukri *Oligodonarnensis*, Dog faced water snake *Cerberus rhyncops*, Common Indian Cobra *Naja Naja*, Russel's Viper *Daboia russelii* and Common Rat Snake *Ptyasmucosus*. Only one species of lizard is found i.e. Common Garden Lizard *Calotes versicolor*. Two species of skinks recorded were Forest Skink *Mabuyamacularia* and Common Skink *Mabuyacarinata*.Common Kukri snake is recorded in salt pan areas.

Mammals

The Jackal (Canis aureus), Common Mongoose (Herpestesedwardsi), Bandicoot Rat (Bandicota indica and Indian Mole-Rat (Bandicota bengalensis) are recorded species in the surrounding areas which was mentioned in literature.

3.8 SOCIO-ECONOMIC ENVIRONMENT

Any developmental activity exerts a direct impact on the socio-economic environment of the region. Usually, the beneficial impacts such as better job opportunities, improved education, communication, energy, housing, health, transportation facilities etc. outweighs the adverse impacts, if any.

The study of socio-economic component of environment is incorporating various facets, viz. demographic structure, availability of basic amenities such as housing, education, health and medical services, occupation, water supply, sanitation, communication and power supply, prevailing diseases in the region as well as features such as places of tourist attraction and monuments of archaeological importance. The study of these parameters helps in identifying, predicting and evaluating the likely impacts due to project activity in the surrounding region.

The main objective of baseline study is to identify & evaluate impact on environment from the proposed project of 293.7 km. The pipeline will originate from Coimbatore, Tamil Nadu and ends at Krishnagiri, Tamil Nadu.

Baseline data for demographic pattern, occupational status, educational, health and other amenities as existing in the study area have been studied and compiled from the secondary source i.e. Census of India 2011.

3.8.1 Baseline Status

The latest available data has been complied to generate the existing socio-economic scenario of the study area. Information on socio-economic profile was collected from the Census of India 2011 and other government wesites.

3.8.1.1 Village

The basic unit for rural areas is the revenue village which has definite surveyed boundaries. The revenue village may comprise of one or more hamlets but the entire village is treated as one unit for presentation of data.

3.8.1.2 Study Area

The total stretch of Pipeline is 293.7 km from Coimbatore, Tamil Nadu to Krishnagiri, Tamil Nadu. The study area defined for baseline study defined is an area within 10 km radius around the project (Pipeline starting point at Coimbatore, Near IPS-3 location, Near SV-18 at Chainage 371.035, Near IPS-4 and Pipeline end point at Krishnagiri) as shown in figures 3.1, 3.2, 3.3, 3.4 and 3.5. All the five stations fall in districts Coimbatore, Erode, Salem, Dharmapuri and Krishnagiri of Tamil Nadu.

Hence for socio-economic data, characteristics like demographic profile, male/female ratio, occupational pattern etc. for villages falling in the district have been identified and respective parameters for census data have been taken and compiled. It is observed that 13 number of villages fall in Pipeline starting point at Coimbatore (T1), and 12 number in Near IPS-3 location (T2) & 20 number in Near SV-18 at Chainage 371.035 (T3), 16 number in Near IPS-4 (T4) & 20 number in Pipeline end point at Krishnagiri (T5). A total of 81 villages have been taken for the study.

3.8.2 Demographic profile of the 10km radius study area around the terminals and intermediate pigging stations

3.8.2.1 Pipeline starting point at Coimbatore (Area within 10 kms of the project site)

A total 13 villages were taken up for study within the 10 km radial area around the Pipeline starting point at Coimbatore, which lies in Tamil Nadu. The area is mainly rural type.

- Total number of households is about 12249.

- Total population of the villages in study area around T1 is 42872 out of which 21574 are males and 21298 are females contributing 50.32% & 49.67% respectively.
- The Sex ratio (No. of females per 1000 males) is 987 which indicates that females are less in number than their male counterpart in the study area
- Out of the total population, the population of children within the age of 0-6 age-group is about 3497 (8.15%), of which male - 1746 (4.07%) and female - 1751(4.08%)
- Child Sex ratio is 1002 i.e no.of female children per 1000 male child.
- Scheduled caste population is 10898 (25.41%) while Scheduled tribes population is 1891 (4.41%) in the area.
- Out of the total population in the region, 28328 (66%) are literates. Among them 15770 (36.78%) are male literates and only 12558 (29.29 %) are female literates.

It can be inferred from the data collected for above that the study area is densely populated and the adult female population is lower but female child ratio is higher as compared to the male child population. Scheduled tribe population is 4.41% in the region while the scheduled caste population comprises of 25.41% of the total population of the study area. Literacy level is low, only about 66%.

3.8.2.2 Near IPS-3 location (Area within 10 kms of the project site)

A total 12 villages are coming within the study area. Which are from Erode District of Tamil Nadu. The area is mainly rural.

- Total number of households is about 20154.
- Total population of the villages in study area around T2 is 66946 out of which 33376 are males and 33570 are females contributing 49.85 % & 50.14 % respectively.
- The Sex ratio (No. of females per 1000 males) is 100 which indicates that females to male ratio is 100% in the study area
- Out of the total population, the population of children within the age of 0-6 age-group is about 5563 (8.30%), male 2896 (4.3%) and female 2667 (3.98%).
- Child Sex ratio is 920 i.e no.of female child per 1000 male child
- Scheduled caste population is 14096 (21.05%) while Scheduled tribes population is about 60 (0.08%) in the area.
- Out of the total population in the region, 44206 (66.03%) are literates. Among them 24626 (36.78%) are male literates and only 19580 (29.24 %) are female literates.

It can be inferred from the data collected for above that the study area is densely populated and the adult female population is 100% but female child is lower as compared to the adult male population. Scheduled tribe population is less in the region 0.08% as compared to the scheduled caste population comprises of 29.24% of the total population of the study area. Literacy rate is low, only about 66.03%.

3.8.2.3 Near SV-18 at Chainage 371.035 (Area within 10 kms of the project site)

A total 20 villages are coming within the 10 km radius of the study area. The villages are from Salem District of Tamil Nadu. The area is mainly rural.

- Total number of households is about 23991.

- Total population of the villages in study area around T3 is 94381 out of which 49417 are males and 44964 are females contributing 52.35% & 47.64% respectively.
- The Sex ratio (No. of females per 1000 males) is 909 which indicates that females are less in number than their male counterpart in the study area.
- Out of the total population, the population of children within the age of 0-6 age-group is about 9857 (10.44%), male 5130 (5.43%) and female 4727 (5.00%) .
- Child Sex ratio is 921 i.e no.of female child per 1000 male child
- Scheduled caste population is 23033 (24.40%) while Scheduled tribes population is only 1293 (1.36%) in the study area.
- Out of the total population in the region, 56161 (59.50%) are literates. Among them 33153 (35.12%) are male literates and only 23008 (24.37%) are female literates.

It can be inferred from the data collected for above that in the study area, the adult and female child is lower as compared to the adult male and male child population. Scheduled tribe population is less in the region as compared to the scheduled caste population comprises of 1.36% of the total population of the study area. Literacy rate is low, only about 59.50%.

3.8.2.4 Near IPS-4 (Area within 10 kms of the project site)

A total 16 villages are coming within the 10 km radius of the study area. The villages are from Dharmapuri District of Tamil Nadu. The area is mainly rural.

- Total number of households is about 23759.
- Total population of the villages in study area around T4 are 96583 out of which 49533 are males and 47050 are females, contributing 51.28% & 48.71% respectively.
- The Sex ratio (No. of females per 1000 males) is 949 which indicates that females are less in number than their male counterpart in the study area
- Out of the total population, the population of children within the age of 0-6 age-group is about 10912 (11.29%), male 5614 (5.81%) and female 5298 (5.48%).
- Child Sex ratio is 943 i.e no.of female child per 1000 male child
- Scheduled caste population is 12359 (12.79%) while Scheduled tribes population is only 960 (0.99%) in the study area.
- Out of the total population in the region, 58862 (60.94%) are literates. Among them 34046 (35.25%) are male literates and only 24816 (25.69%) are female literates.

It can be inferred from the data collected for above that the study area is densely populated and the adult female population both adult and female child is lower as compared to the adult male and male child population. Scheduled tribe population is less i.e. 0.99% in the region as compared to the scheduled caste population comprises of 12.79 % of the total population of the study area. Literacy rate is low, only about 60.94%.

3.8.2.5 Pipeline end point at Krishnagiri (Area within 10 kms of the project site)

A total 20 villages are coming within the 10 km radius of the study area. The villages are from Krishnagiri district of Tamil Nadu.

- Total number of households is about 16955.

- Total population of the villages in study area around T5 are 74289 out of which 38366 are males and 35923 are females, contributing 51.64% & 48.35% respectively.
- The Sex ratio (No. of females per 1000 males) is 936 which indicates that females are less in number than their male counterpart in the study area
- Out of the total population, the population of children within the age of 0-6 age-group is about 8440 (11.36%), male 4306 (5.79%) and female 4134 (5.56%).
- Child Sex ratio is 960 i.e no.of female child per 1000 male child.
- Scheduled caste population is 15324 (20.62%) while Scheduled tribes population is only 281 (0.37%) in the study area.
- Out of the total population in the region, 46585 (62.70%) are literates. Among them 26492 (35.66%) are male literates and only 20093 (26.38%) are female literates.

It can be inferred from the data collected for above that the study area is densely populated and both adult and female child is lower as compared to the adult male and male child population. Scheduled tribe population is very less i.e. 0.37% only in the region while the scheduled caste population comprises of 20.62% of the total population of the study area. Literacy rate of the the region is low i.e. 62.70%.

The figure below represents the ratio of Adult Male-Female and Child Sex Ratio in the study area of all the stations.

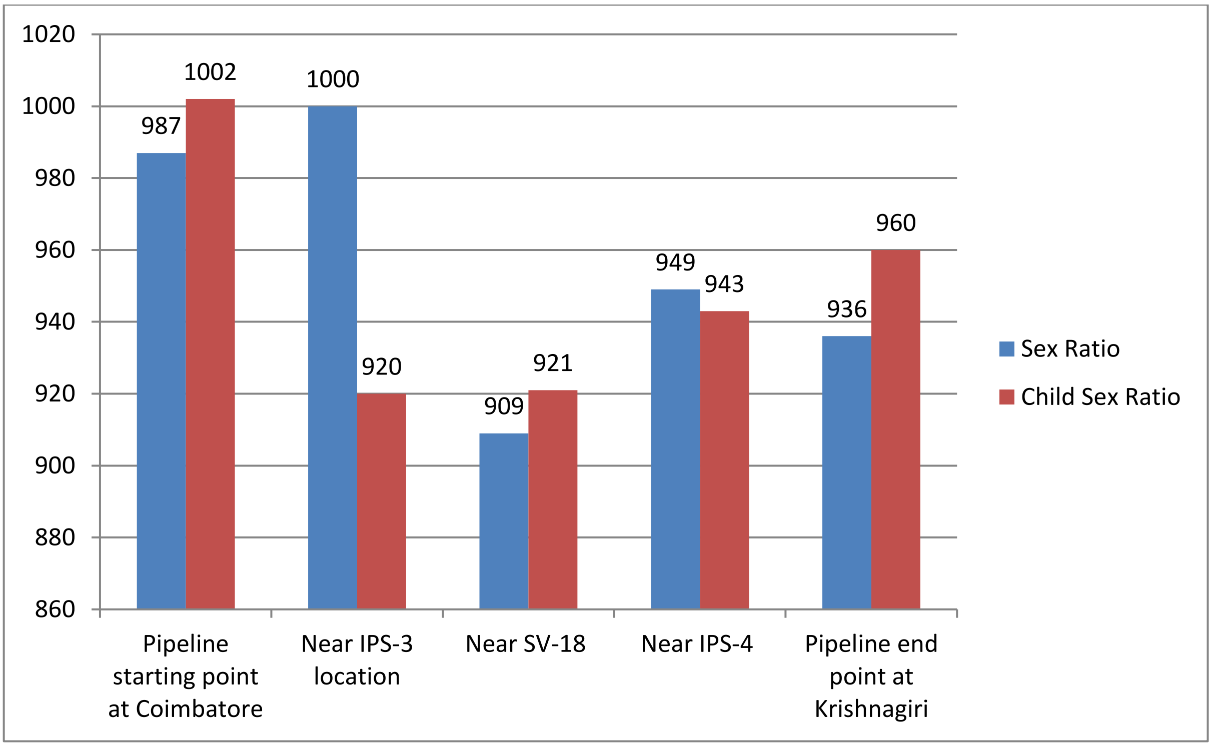


Figure- 3.32: Graphical representation of Sex Ratio and Child Sex Ratio in the study area

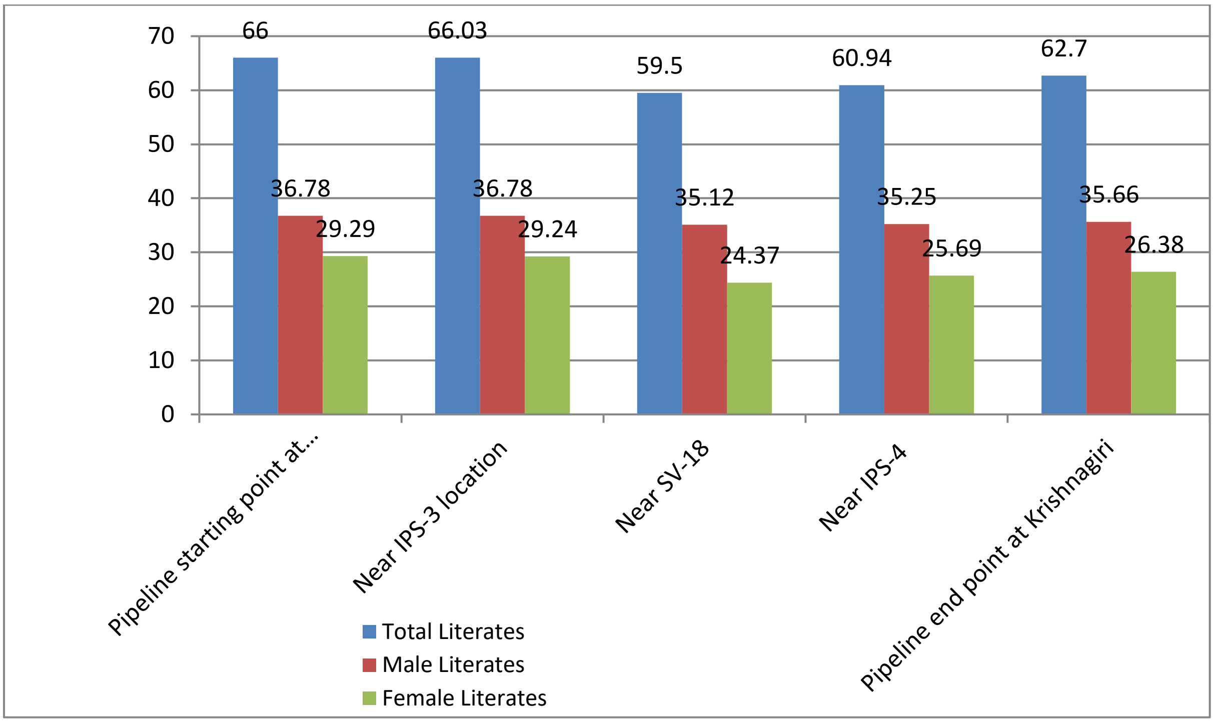


Figure-3.33 : Graphical representation of Literacy rate in the study area

3.8.3 Occupational Pattern/ Economic Resource Base

'Work' has been defined as participation in any economically productive activity. Such participation may be physical or mental. Persons on leave and under training are also treated as workers. However, rent receivers and pensioners are not treated as workers.

3.8.3.1 Total Workers

Total workers of the villages in study area of T1 is 23335 i.e 54.42% of the total population, in T2 is 37809 (56.47%), T3 is 46006 (48.74%), T4 is 46204 (47.83%) and in T5 is about 31851 (42.87%).Occupational pattern of any region mainly depends upon its economically active group i.e. the working populations involved in different economically productive activities. The total workers are further categorized as main workers, marginal and the non-working population.

3.8.3.2 Main Workers

Main workers are those who have worked for a major part of the year (i.e. at least six months or 183 days). Main activity of a person who was engaged in more than one activity was reckoned in terms of time disposition.

Main Workers in the study area of T1 21254 i.e 49.57% of the total population, in T2 is 35172 (52.53%), T3 is 42020 (44.52%), T4 are about 37665 (38.99%) and in T5 is about 26691 (35.92%).

The figure below shows the graphical representation of the total workers, Main Workers, Marginal Workers and Non-workers in the study area.

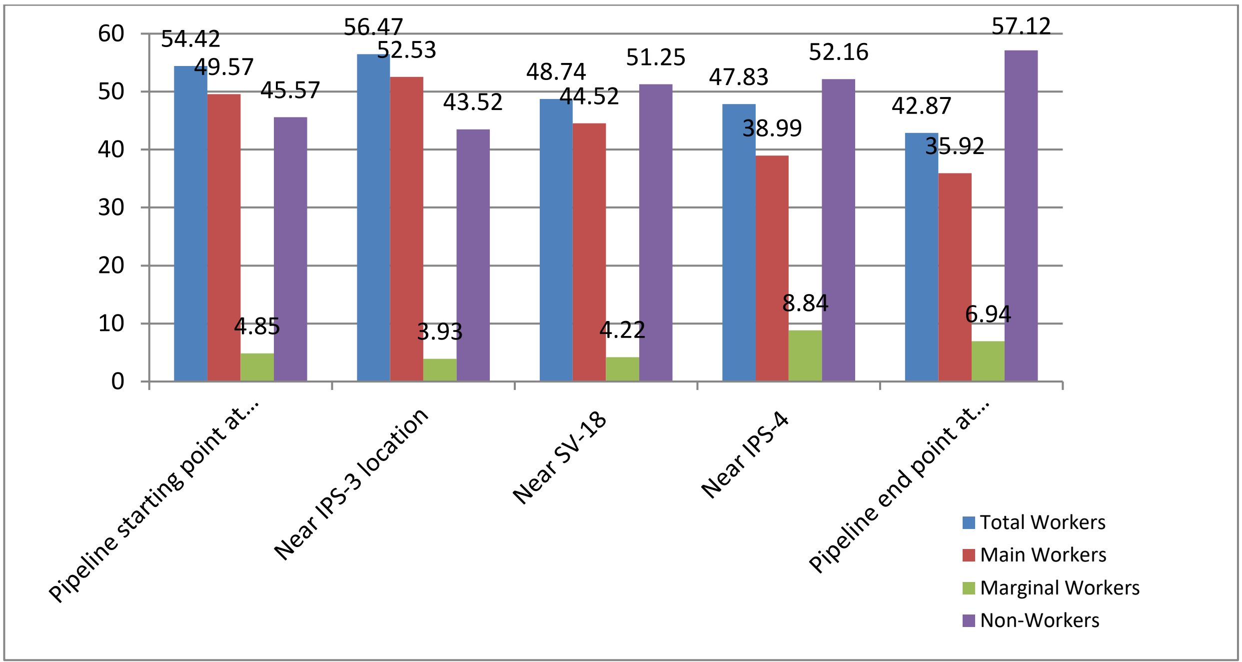


Figure-3.34 : Graphical representation of Total Workers and Non-Workers in the study area

From the figure 3.34 it is evident that of total workers, main workers are highest at T2 i.e. Near IPS-3 while the minimum at T5 i.e. Pipeline end point at Krishnagiri and marginal workers are highest at T4 i.e. near IPS-4 but lowest at T2 i.e. near IPS-3.

Main workers are further classified into 4 categories viz., cultivators, agricultural laborers and household workers and other main workers.

3.8.3.3 Cultivators

For purposes of the Census a person is classified as cultivator if he or she is engaged in cultivation on land owned or held from government or held from private persons or for payment in money, kind or share. The person who is engaged either as employer, single worker or family worker in cultivation of land is recognized as a cultivator. Cultivation involves ploughing, sowing, harvesting and production of cereals and millet crops such as wheat, paddy, jowar, bajra, chana, joun, soyabean, mung, urad, arhar, peas, til, masur, mungphali, barley etc., and other crops such as Potato, sugarcane, mustard etc.

Maximum population in the study area is dependent on agriculture. The cultivator population within the study area of Pipeline starting point at Coimbatore are about 3730 i.e 8.70% of the total population, in Near IPS-3 location are about 7212 (10.77%), Near SV-18 at Chainage 371.035 are about 7097 (7.5%), Near IPS-4 are about 11635 (12.04%) and in Pipeline end point at Krishnagiri is about 8104(10.90%).

3.8.3.4 Agricultural Laborers

Persons working on land owned by others for wages or share in the yield have been treated as agricultural laborers. Out of the total main worker category, the agricultural labour population in study area of:

- Pipeline starting point at Coimbatore is 9404 (21.9%)
- Near IPS-3 location is 13906 (20.7%)

- Near SV-18 at Chainage 371.035 is 13621 (14.43%)
- Near IPS-4 is 9135 (9.45%)
- Pipeline end point at Krishnagiri is 7288 (9.81%).

From the above it is clear that maximum population of coimbatore is engaged as Agriculture Labourers and minimum at IPS-4 in Dharmapuri.

3.8.3.5 Laborers in Household Industry

The laborers engaged in household activity are quite low at all the study area. Among the total main workers very few population are engaged in household activity, Pipeline starting point at coimbatore is 397 i.e 0.92% of the total population, in IPS-3 location are about 585 (0.87%), Near SV-18 at chainage is 2910 (3.08%), Near IPS-4 is 609 (0.63%) and at pipeline end pint at krishnagiri is about 452 (0.60%). The laborers engaged in household activity are highest at SV-18 in Salem and lowest at pipeline end pint at krishnagiri in Tamil Nadu.

3.8.3.6 Other Workers

All main workers i.e. those who are engaged in some economic activity during the last one year and are neither cultivators nor agricultural laborers or household industry workers are classified as other main workers. Type of workers that come under this category factory workers, plantation workers, those in trade, commerce, business, transport, construction, political or social works, all government servants, municipal employees, teachers, priests, entertainers, artists etc. The population of the study area engaged in other activity at T1 is 7723 i.e 18.01% of the total population, in T2 is 13469 (20.11%), T3 is 18392(19.48%), T4 is 16286 (16.86%) and in T5 is about 10847 (14.60%).respectively.

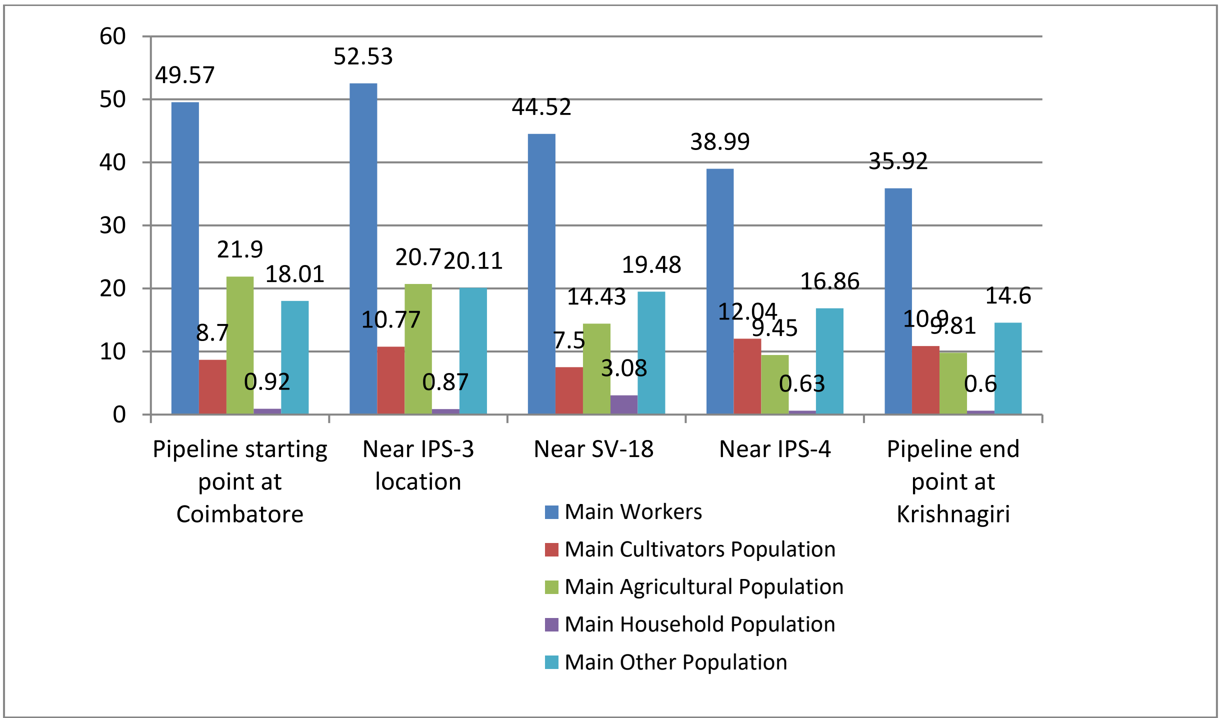


Figure-3.35 : Graphical representation of Occupational Pattern in the study area

3.8.3.7 Marginal Workers

Marginal workers are those who have worked any time in the year for less than six months or 183 days but have not worked for a major part of the year. Population of marginal workers in the study area of Pipeline starting point at Coimbatore is 2081 i.e 4.85% of the total population, in Near IPS-3 location is 2637 (3.93%), Near SV-18 at Chainage 371.035 is 3986 (4.22%), Near IPS-4 is 8539 (8.84%) and in Pipeline end point at Krishnagiri is 5160 (6.94%).

As per census data 2011, marginal workers are highest in T4 (8.84%) lowest in T2 (3.93%).

3.8.3.8 Non-Workers

Non-Workers are those who have not worked any time at all in a year. Non-workers constitute householders, students, dependents, retired persons etc.

From the census data 2011, it is observed that population unemployed in villges of T1 is 19537 i.e 45.57% of the total population, in Near IPS-3 location is 29137 (43.52%), Near SV-18 at Chainage 371.035 is 48375 (51.25%), Near IPS-4 is 50379 (52.16%) and in Pipeline end point at Krishnagiri is about 42438 (57.12%).

3.8.4 Infrastructure Resource Base

The details of infrastructure resources with reference to education, medical facilities, water supply, power supply, transport, police station and fire station etc within the 10 km radius of the project area are discussed below:

3.8.4.1 Medical Facilities

The details of medical facilities within the districts of Coimbatore, Erode, Salem, Dharmapuri and Krishnagiri in Tamil Nadu State.

At T1 Primary health centers, Maternity & Child Welfare centres, Dispensaries are available only in 3 villages Arisippalayam, Kaliyapuram and Sokkanur. At T2 14 primary health sub centres, 5 Maternity & Child Welfare centres are available. There are 3 dispensaries in village Thuyyampondurai, 2 in Nanjaiuthukuli, 1 in Punjai Kalamangal and 1 in Elumathur. No community health centre is available at T2. At T3 two primary health centres and two dispensaries are available in village Vellalapatti and Tholasampatti. 25 Primary Health Sub centres and 4 Maternity & Child Welfare centres are available at T3. At T4 a total of 17 villages 7 Primary Health Centres, Maternity & Child Welfare centres, Dispensaries and 20 Primary Health Sub Centres are available. At T5 no community Health Centres,primary health centres, Maternity & Child Welfare centres and dispensaries are available. 19 Primary Health Sub centres are available in the study area.

If not present are available at 5-10 km distance from the villages. The medical health facilities are quite good in the area.

3.8.4.2 Educational Facilities

As per census data 2011, the overall literacy rate is about 66% in study areas of Pipeline starting point at Coimbatore, 66.03% in Near IPS-3, 59.5% in Near SV-18, 60.94% in Near IPS-4 and 62.70% in Pipeline end point at Krishnagiri.

(a) Pipeline starting point at Coimbatore

A total of 30 govt. & 1 private primary schools, 13 govt. & 1private middle schools , 5 govt. & 1 Pvt. secondary schools at T1. There is 2 govt. senior secondary schools at village Arisippalayam and Kaliyapuram, 1 pvt. senior secondary school at Okkilipalayam. There is no Govt. Engineering college at T1, but 6 Pvt engineering collegees are available.

(b) Near IPS-3

A total of 40 govt. & 1 private primary schools, 15 govt. & 3 private middle schools , 3 govt.& 1 private secondary schools at T2. There is 3 govt. senior secondary schools and no pvt. senior secondary school. There is no Govt. but 2 Pvt. Engineering colleges at T2.

(c) Near SV-18

A total of 51 govt. & no private primary schools, 21 govt. middle school & 1 private middle school , 10 govt. & 5 private secondary schools at T3. There is 10 govt. senior secondary schools and 2 pvt. senior secondary school at Thuyyampoondurai. There is no Govt. and only 1 Pvt. Engineering college in village Poosaripatti at T3.

(d) Near IPS-4

A total of 64 govt. & 10 private primary schools, 27 govt. & 4 private middle schools , 9 govt. & 3 private secondary schools at T4. There is 6 govt. senior secondary schools and 2 pvt. senior secondary schools. There is no Govt. and Pvt. Engineering college at T4.

(e) Pipeline end point at Krishnagiri

A total of 53 govt. & 4 private primary schools, 18 govt. & 3 private middle schools , 1 govt. & 1 private secondary schools, 1 govt. senior secondary schools,1 pvt. senior secondary schools in village Kundumaranapalli at T5. There is no Govt. Engineering college but 1 Pvt. Engineering college in village Chenathur at T5.

3.8.4.3 Water Resources

At T1 tap water is available in every village. Hand pumps, Tube wells/Borewells are availablein most of the village. River/Canal water is available in three village i.e. Serrappalayam, Arisippalayam and Kaliyapuram. At T2 water resources like tap water, handpumps, Tube well/Borewells are available in almost every village, River/Canal are available only in 5 villages. At T3 tap water, handpumps, Tube well/Borewells are available in almost every village, River/Canal is available only in Pannapatti village.

At T4 tap water, handpumps, Tube well/Borewells are available,but river/canal is availbe only in two villages i.e. Nathathahalli and Arakasanahalli. At T5 tap water (treated, un-treated) is available in every village. Handpumps, Tube well/Borewells are available in most of the villages, but there is no river/canal water is available in the study area.

The water supply in the region is mostly through wells and handpumps. For drinking purpose people are using only ground water supply.

3.8.4.4 Power Supply

Power supply is available for all users like domestic, agriculture and commercial is available in every village from 10 to 22 hours in summers (April-September) & 10 to 24 hours winters (October-March) at T1, power supply is available almost in every village from 15 to 24 hours in summers (April-September) & 10 to 24 hours winters (October-March) at T2 and from 10 to 22 hours in summers (April-September) & 8 to 20 hours winters (October-March) at T3, from 4 to 24 hours in summers (April-September) & 8 to 24 hours winters (October-March) at T4, from 8 to 21 hours in summers (April-September) & 8 to 20 hours winters (October-March) at T5.

The power is sourced from State Electricity Board.

3.8.4.5 Transport

Transportation facilities like Public bus services, private bus services are available, but there is no Railway station, Auto, Taxi and Rickshaw service is available in very few villages in the study. Villages are connected with roads and SH at T1 and T2. At T3 Public bus services, private bus services are available, railway station is availabe in three villages T. maramangalam, Omalur and Semmandapatti. At T4 Public bus services, private bus services are available in some of the villages, taxi service is available n some villages, railway station available in village Sivadi. Some villages are well connected with NH and SH. At T5 Public bus services, private bus services are available in most of the villages, railwaystation is available at Bodichipalli, taxi service is available in Kothapalli. Kothapalli, Thorapalli Agraharam are coonected with NH and Kothagondapalli, Chenathur & Thorapalli Agraharam are connected with SH.

If not available people have to travel 5-10 kms for the service transport. Villages are well connected with the roads and quite far away from the State Highway and National Highway.

3.8.4.6 Police & Fire Stations

Police stations and Fire stations are also available within 10 km radius of the project area.

3.8.5 Economic Resource Base

3.8.5.1 Agriculture (Cropping pattern)

Agriculture is the main occupation of the people of the study area and it has an important role in the economy. It provides direct employment to the total workers of the state mainly agriculture and cultivators. The scenario of the cropping pattern reveals that most of the food grain crops. Agricultural produce of the districts of Tamilnadu is taken to the market for sale.

1. Pipeline Start point at Coimbatore (T1) - Coconut, Tomato, Banana, Maize, Paddy, Ground Nut, Bitter guard etc.

2. Near IPS-3 location (T2) - Paddy, Coconut, Tumeric, Sugarcane and Banana etc.

3. Near SV-18 at Chainage 371.035 (T3) - Paddy, Samai, Tomato, Sugarcane, Ground Nut, Ragi, Coconut, Flowers etc.

4. Near IPS-4 (T4) - Turmeric, Paddy, Ground Nut, Ragi, Sugarcane etc.

5. Pipeline end point at Krishnagiri (T5) - Vegetables, Flowers, Ragi, Paddy, Onion, Ground Nut, Beans, Maize, Pulses, Fruits, Mulberry etc.

3.8.5.2 Industries, Trade & Commerce

(a) Coimbatore District-Pipeline starting point at Coimbatore

In Coimbatore houses a large number of small and medium texitle mills. It also has textile research institutes like the Central Institute for Cotton Research (CICR) - Southern Regional station, South Indian Textiles Research Association (SITRA) and the Sardar Vallabhai Patel International School of Textiles and Management.

The city is the second largest software producer in Tamil nadu, next only to Chennai. The software development is set to take an upswing with the launch of TIDEL park and other private IT parks around the city. The IT industry in Coimbatore is nascent compared to its textile and manufacturing industries, with Tata Consultancy Services, Cognizant Technology Solutions, Robert Bosch DELL, KGISL and CSS Corp Pvt Ltd to name a few. Coimbatore is also emerging as an IT and BPO city. Coimbatore is ranked at 17th place among the global outsourcing cities.

Manufacturing Research and Development Organisations like South India Textile Research Association, PSG and Sakthi group of Industries. Larsen and Toubro (L&T) commissioned its Casting Manufacturing Unit (CMU) near Malumichampatti. Some of the other major industries are Lakshmi Machine Works Ltd (LMW), Premier Instruments and Control Limited (PRICOL), Premier Evolvics, ELGI Equipments, Shanti Gears, Roots Industries, Indoshell are one among the major employers in the city. Coimbatore is also called as the Pump City. The first in-house car was designed and developed in 1960s.Successfully manufactured India's first indigenously developed diesel engines in 1972 for cars and their own CNC lathes in 1982 at Coimbatore. Tamil Nadu Government owned SIDCO industrial unit is located at Kurichi in Coimbatore. The term "Coimbatore Wet Grinder" was given a Geographical indication for wet grinders manufactured in Coimbatore and Erode.Coimbatore is also home to a common facility for the manufacturers of wet grinders. Pump manufacturing It is also called as the Pump City of India.The city also houses numerous jewellers engaged in jewellery exports. Major Wind Energy Company's are located in and around Coimbatore.

The City houses large number of small scale engineering companies. The motor and pump industry supplies two thirds of India's requirements, while its wet-grinder industry has a near monopoly. Agriculture is still the major occupation in the district as in any other part of the Country. General trade attracts people from all over the state including the neighbouring Kerala. The Major Pump industries Suguna pumps, Sharp Industries, CRI Pumps, Texmo Industries, Deccan Pumps & KSB Pumps are renowned world wide. Coimbatore also has a 160,000 square feet trade fair ground, built in 1999. It was named COINTEC due to its hosting of INTEC (Small Industries Exhibition). This Trade Fair complex is one of the country's largest and is owned by CODISSIA (Coimbatore District Small Industries Association). It is also the country's largest pillar-free hall according to the Limca Book of Records.Many Industrial and Commericial Exhibitions is held through out the year.
Source: **https://coimbatore.nic.in**
Major Exportable Items: 1. Textiles & Garments 2. Software products 3. Motors and Pumps 4. Granite 5. Gold Jewellery 6. Wet Grinders 7. Electronic Products

Source: ***http://dcmsme.gov.in/***

(b) Erode District- Near IPS-3

Large Scale Industries / Public Sector undertakings List of the units in Erode District

1. Bannari Amman Sugars Ltd., Periapuliyur Po, Sathy Tk
2. Agni Steels Private Ltd, Ingur, Perundurai Tk
3. Rajalakshmi Textile Processor, Ramanathapurampudur Po, Erode TK
4. Vinayaka Electro Alloys (I) Pvt. Ltd. Ingur, Perundurai TK
5. GMB Textiles Mills India Limited, Elumathur Po, Erode TK
6. Sakthi Sugars, Poondurai Po, Erode TK
7. Naveen Cotton Mill Private Limited, Pungampalli, Sathy
8. Sakthi Sugars Limited, Appakoodal, Bhavani TK
9. Krishna Poultry Tex Mill (India) Pvt. Ltd, Vijayamangalam, Perundurai TK
10. Ranjeer Cotton Mills (India) Private Limited, Gettiseviyur Po, Gobi TK

Major Exportable Items: Egg Powder, Sugar, Reclaimed Rubber, Paper, Cotton Yarn, Iron & Steel, Motor Vehicle Parts.

Source: dcmsme.gov.in

(c) Salem District- Near SV-18

Large Scale Industries / Public Sector undertakings
LIST OF THE UNITS IN SALEM & NEAR BY AREA

1) S.P.SUPER FINE COTTON MILLS P LTD. CUDDALUR MAIN ROAD, ATTUR
2) RASU TEXTUKES P LTD., CYDDAKIRE MAIN ROAD, ATTUR
3) FIDELITY TEXTILE P LTD., UDAYAPATTI, ATTUR MAIN ROAD, SALEM
4) S.P.SPINNING MILLS P.LTD., CUDDALUR MAIN ROAD, ATTUR
5) SAMBANDAM SPINNING MILLS .LTD., ATTUR MAIN ROAD, UDAYAPATTI
6) KANDAGIRI SPINNING MILLS LTD., UNIT.1 UDAYAPATTI, SALEM
7) DHARANIDARA SPINNERS P LTD., ATTAYAMPATTI ROAD, KAKAPALAYAM
8) PARAGAN POLYMER PRODUCTS P LTD., KAKAPALAYAM, SALEM
9) CHIRANJILAI SPINNERS P LTD., ATTAYAMPATTI, SALEM DIST.
10) JSW LTD., POTTANERI, MECERI VIA, METTUR TALUK
11) THERMAL POWER STATION, METTUR DAM, SALEM DIST.
12) MADRAS ALUMINIUM CO LTD., KARUMALAIKOODAL, METTUR R.S.
13) CHEMPLAST SANMAR LTD., PLANT.1 PUDUCHAMPALLI
14) CHEMPLAST SANMAR LTD., PLANT II, PUDUCHAMPALLI
15) CHEMPLAST SANMAR LTD., PLANT III & IV, RAMAN NAGAR, METTUR DAM
16) CABOT SANMAR LTD., RAMAN NAGAR, METTUR DAM,
17) HITECH MINERALS COVAL P LTD., KOTTAGOUNDAMPATTI, OMALUR TK
18) TAMIL NADU MAGNESITE LTD., OMALUR MAIN ROAD, AMMAPALAYAM, SALEM
19) DALMIA MAGNESITE LTD., VELLAKKALPATTI, OMALUR TALUK
20) PALLIPALAYAM SPINNERS P LTD., NILAVARAPATTI, SALEM
21) SRI MALINI SPINNING MILLS LTD, SANTHIYUR, SALEM
22) THAMBI MODERN SPINNING MILLS LTD., JAGIR AMMAPALAYAM, SALEM
23) BURN STANDARD CO.LTD., OMALUR MAIN ROAD, SALEM
24) NARASUS COFFEE CO., JOHNSONPET, SALEM
25) SALEM DIST. COOP. MILK PRODUCERS UNION LTD., STEEL PLANT ROAD, SALEM

26) PALLAVA TEXTILES LTD., MANGARANKAMPALAYAM, VEERACHIPALAYAM POST, SANKARI
27) THE INDIA CEMENTS LTD., SANKARI WEST, SANKARI, SALEM DIST.
28) PERUMAL SPINNING MILLS P LTD., SESHANCHAVADI, VALAPADI TK, SALEM
29) KANDAGIRI SPINNING MILLS P LTD., SESHANCHAVADI, SALEM DIST.
30) SALEM STEEL PLANT, ALAGUSAMUDRAM, THARAMANGALAM MAIN ROAD, SALEM.
31) SAMBANDAM SIVA TETILES LTD., KATTUVEPPILLAIPATTI, SESHANCHAVADI PO.

Major Exportable Items:
1) GRANITES 2) FABRICS 3) READYMADE GARMENTS 4) EGG. 5) FOOD PRODUCTS
Source: dcmsme.gov.in

(d) Dharmapuri District- Near IPS-4

Large Scale Industries

1 M/s. Senthilnathan Spining Mills (P) Ltd, Nallampalli (Block), Dharmapuri (Tk)
2 M/s. Madev Marbles and Granites, Nallampalli (Block)Thoppur, Dharmapuri.(Tk)
3 Subramanya Siva Co-operative Sugar Mills , Gopalapuram, Pappireddipatty(Block & Tk)
4 M/s.Varalakshmi SagoFactory, Salem Main Road, Pappireddipatty(Block &Tk)
5 M/s. Devi Spinning Mills, Sogathur, Dharmapuri (Block & Tk)
6 M/s. PMP Spinning Mills, Palayam Pudur, Nallampalli Block Dharmapuri (Tk)
7 M/s. Kumaragiri Textile Ltd, Thokkampatti, Nallampalli (Block) Dharmapuri (Tk)
8 Dharmapuri Roller Flour Mill, Pennagaram Road, Dharmapuri.
9 The Dharmapuri District Co-op Sugar Mills, Jerthalav, Palacode (Block & Tk)
10 M/s. Indigra Exports (P) Ltd, Kattumariamman Kovil , Adagapadi, Dharmapuri Block & Tk
11 M/s. Hatsun Agro Products Ltd, Kolasanahalli , Palacode (Block & Tk)
12 M/s. Gowri Spinning Mills, Thokkampaptti Nallampalli Block, Dharmapuri –Tk
13 M/s. Sivamani Spinning Mills, Krishnagiri Main Road, Bysuhalli, Karimangalam Block, Palacode Tk
14 M/s. Thangavelu Spinning Mills Ltd, Dharmapuri Main Road, Bommidi, Pappireddipatty Block & Tk
15 M/s. Amman Granites, Harur
16 M/s.Sri PKP Spintex Mills Pvt Ltd., Gundalapatty, Dharmapuri.
17 M/s.Thangavelu Spinning Mills Ltd, Bommidi, Dharmapuri Dt

Major Exportable Items: i) Granite Slab & Monuments. ii) Modified Tapioca starch.

Source: dcmsme.gov.in

(e) Krishnagiri District- Pipeline end point at Krishnagiri

In jalaun the major industries falling are given below:

1. Ashok Leyland Ltd.,

2 TVS Motors Ltd.,

3 TITAN Industries

4 Sundaram Clayton

5 Taneja Aerospace and Aviation Ltd.,

6 AV Tech Ltd.,

7 Carborandum Universal Ltd.,

8 TTK Prestige Ltd.,

9 India Pistons Ltd.,

10 Global Calcium Pvt., Ltd

Major Exportable Items: Auto Components/Tools Vehicles Watches Jewellery Polished Granite Slabs Mango Pulp Cut Flowers.

Source: dcmsme.gov.in

3.8.6 Forest

As per the Census data 2011, no forest area falls under at T1 and T2, 0.21 hectare (T3), 5178.31 hectare (T4) and 312.26 hectare (T5) area is falling under forest area in Tamil Nadu.

3.8.7 Health Status (morbidity pattern with reference to prominent and epidemic diseases)

Malaria: In 2006 out of 28219 cases, no deaths were reported, in 2007 out of 22389, 1 death was reported and in 2008 out of 27373 cases, no deaths were reportd, also in 2009 out of 3678 cases no deaths were reported.

Japanese Encephalitis: Japanese Encephalitis cases have been reported regularly from Tamil Nadu. Districts Villupuram, Virudhnagar and Cuddalore were taken up for JE vaccination during 2007.during 2008 Madurai, Parambulur, Tanjavurur, Tiruchirapalli, Thiruvarur.

In 2006 out of 18 cases, 1 death was reported, in 2007 out of 42, 1 death was reported and in 2008 out of 144 cases,no death was reportd.

Dengue: Epidemiological data for last four years are- In 2006 out of 477 cases, 2 deaths were reported, in 2007 out of 707, 2 deaths were reported and n 2008 out of 530 cases, 3 deaths were reportd, in 2009 out of 148 cases no death was reported.

Chikungunya: Total of 64802 suspected Chikungunya fever cases and no death were reported during 2006.

Source: https://www.nhm.gov.in/

The details of medical facilities within the districts of Coimbatore, Erode, Salem, Dharmapuri and Krishnagiri in Tamil Nadu State.

At T1 Primary health centers, Maternity & Child Welfare centres, Dispensaries are available only in 3 villages Arisippalayam, Kaliyapuram and Sokkanur. At T2 14 primary health sub centres, 5 Maternity & Child Welfare centres are available. There are 3 dispensaries in village Thuyyampondurai, 2 in Nanjaiuthukuli, 1 in Punjai Kalamangal and 1 in Elumathur. No community health centre is available at T2. At T3 two primary health centres and two dispensaries are available in village Vellalapatti and Tholasampatti. 25 Primary Health Sub centres and 4 Maternity & Child Welfare centres are available at T3. At T4 a total of 17 villages 7 Primary Health Centres, Maternity & Child Welfare centres, Dispensaries and 20 Primary

Health Sub Centres are available. At T5, no community Health Centres, primary health centres, Maternity & Child Welfare centres and dispensaries are available. 19 Primary Health Sub centres are available in the study area.

If not present are available at 5 - 10km distance from the villages.

3.8.8 Cultural and Aesthetic Attributes

(a) Coimbatore:

1. Valparai Hill station is located above 3500 feet height from the sea level on the Anamalai mountain range of the Western Ghats and is also one of the best tourist places in Tamilnadu. At a distance of 64 km from Pollachi and 102 kms distance from Coimbatore. Valparai Hill station is pollution free heavenly land surrounded with full of tea estates. It stands majestically with Green Spread Mountains and picturesque forest all around. Travelling between Pollachi to Valparai is itself an exotic experience. This place has number of tea and coffee estates surrounded by thick forest. The climate of Valparai is most suitable for tea, coffee, cardamom and cincona trees. According to the earlier records, in 1846, Mr. Ramaswamy Mudaliyar started cultivating coffee in his private estate.

2. Aliyar Dam is a charming location surrounded by Annamali Hills with wonderful natural views. It is located between Pollachi and Valparai.At a distance of 64 Kms from Coimbatore, 24 Kms from Pollachi & 545 Kms from Chennai.Built across Aliyar River between 1959 and 1969, the primary purpose of the dam is to support irrigation for Pollachi and near by places for Agriculture purpose. The height of the dam is 81 meters. There is a well maintained park built at bottom of the Dam. The view of the Anamalai range around the reservoir is a feast for the eyes and the view of the coconut groves from top of the dam is amazing. Boating is available here.

3. Kovai Kutralam is a scenic spot with a gentle waterfall originating on the Siruvani hill ranges. It is located on the western ghat mountain range that lies to the west of this city at a distance of about 32 kms from Coimbatore. The siruvani dam is just above this water fall and this place is under the control of state forest department. Permission has to be sought from them to visit this Kovai Kutralam Falls. Limited bus service is available from the city and this area is out of bounds after 5 pm. This is the only place near Coimbatore where you find a nice enchanting waterfall.

Source:http://coimbatore.nic.in

(b) Erode:

1. Erode Government Museum will appeal to culture buffs and history lovers. The museum is a rich repository of objects related to art, anthropology and archeology, being one of the largest storehouses of art and culture in Tamil Nadu. The museum was established in 1987 and is open on Sundays too.

Government Museum is the prominent gallery that exhibits regional art and traditions. The museum was opened for public in 1987, displaying inscriptions belonging to the Kongu Chola Kingdom. Artifacts, handicrafts and stones from Bargur are some of the major attractions at

the gallery. Furthermore, there are separate sections to display Thanjore paintings, manuscripts and other pre-history items.
Besides, the museum is known for housing botanical and zoological specimens along with an extensive collection of palm-leaf manuscripts.

2. Birds Sanctuary, Vellode is about 15 kms from Erode. It is at a large lake surrounded with semi-dark bushes near Vellode. This .772 km^2 (0.298 sq mi) sanctuary is home to many foreign birds. The sanctuary features thousands of birds coming from various countries, some of which can be easily identified. Some easily found bird species include cormorants, teals, pintail ducks, pelicans, and darters.

3. Bhavanisagar Dam is about 16 kms. from Sathyamangalam across the river Bhavani.Kodiveri Dam is about 10 kms from Gobichettipalayam and 55 kms from Erode.

4. Bannari Amman Temple is 75 kms away from Erode and 10 kms distance from Sathyamangalam. It is the famous temple in Erode District and situated at the bottom of the Western Ghats on the way to Mysore.

5. Chennimalai – is about 30 kms. from Erode and 12 kms from Perundurai.

6. Sangameshwarar Temple, Bhavani is about 15 kms. from Erode. Confluence of three rivers by name Cauvery, Bhavani and invisible Amudha at this pilgrimage place and termed as Mukkoodal.

Source:http://erode.nic.in

(c) Salem:

1. The Muttal Village is situated about 15km away from Attur in the Attur-Mullaivadi road, the waterfalls situated in the spot called Aaniavari in the Forest area about 3km away from the village.The heavy flow of water in the Aanaivari water falls in Muttal village in Attur forest range and the special arrangements made by the Forest Department has been attracting a large number of tourists from across the Western districts.

2. Sankagiri Fort is a historical fort maintained by the Archaeological Survey of India. It is located 22 km from the city of Erode and 38 km from Salem. Fort was built in the 15th Century by the Vijayanagar Empire. It has 12 fort walls built on and built by the British. The fort served as a British tax storage facility for Kongu Nadu. It was an important military base for Tippu Sultan and later for the British army. This is because only one side of the hill is climbable, as all the others are too steep to climb. This has a death well, granary, two masjiths, 2 Varadhraja Perumal temples, former British Army administrative buildings, and cemeteries formerly used by armies that were stationed at the fort. Dheeran Chinnamalai was hanged by British in this fort.

3. Yercaud is a hill station near Salem, in the Servarayan range of hills (anglicized as Shevaroys) in the Eastern Ghats. It is at an altitude of 1515 metres (4969 feet) above the see level. The total extent of Yercaud Taluk is 382.67 Sq.kms. including Reserve Forest. The entire Taluk is a Township. Yercaud has also a Panchayat Union with its Head Quarters at Yercaud

and its Jurisdiction is the same as for Yercaud Taluk. Popular as the "Poor man's Ooty". Yercaud is one of the low cost hill station destination in India.

4. 12 km from Salem Bus stand. There is one a small zoological park with natural beautiful environmental circumstance.

5. Temples- Kandhasamy Kovil, Kumaragiri Murugan Temple, Lingam (1008) Temple, Kottai Mariamman Temple, Kandhashramam, Udaiyapatti, Oothumalai – Sathya Narayana Sithar Peedam, Siddhar Temple, Alagirinathar Temple etc.

Source:http://salem.nic.in

(d) Dharmapuri:

1. Theerthamalai is an important scacred place in Harur taluk of Dharmapuri District. Shri Theerthagirishwarar Temple is located at the top of a hillock. Chola and Vijayanagara Kings donated liberally to this temple. A lot of devotees throng the temple during the Mahashivarathiri. The Department of Tourism has a Guest Houses for the benefit of the devotees. Theerthamalai is declared as an important tourist spot in Dharmapuri District.

2. Hogenakal is situated at the borders of Karnataka at 46 kms from Dharmapuri. In Hogenakal the river Cauvery enters into Tamil Nadu as a big river with gushing water presentably as a natural falls. The name Hogenakal is derived from Kannada means 'Smoky Rocks'. The river when falls on the rock below, the gushing force of water resembles like smoke emanating from the rocks. At Hogenakal the water spreads for miles around and on these waters cruising on country made dinghies (PARISAL) is possible. Parisal ride will give an enthralling experience. Surrounding by hills at various heights Hogenakal offers the visitors a different ambience and refreshing relaxations. One could also take bath in the falls. Oil massaging by local people is a different experience. As the river flows throughout the year Hogenakal can be visited all days through the year. There are enough transport facility available from Dharmapuri & Krishnagiri.

Source:http://dharmapuri.nic.in

(e) Krishnagiri:

1. Kattuveera Anjaneya Temple is located at Krishnagiri in Tamil Nadu is said to be 2500 years old.

2. SHREE PARSHWA PADMAVATHE SHAKTIPEET TIRTH DHAM (Jain temple)- Jain dharma consists of 24 theerthankars, In these 24 theerthankars the 23rd theerthankar is considered to be swami parshwanathbhagwan. Today shaktipeet is the world's highest (365 ft height).

3. Thally garden and lake is located 25 kms from hosur 77 kms from krishnagiri. Thally village is fully surrounded by number of hill stations in Denkannikottai thaluk this place is located 1000ft above the sea level salubrious weather is remembering England climate therefore during the British regime onwards this place we call it as "Little England".

4. Chandra choodeswarar temple (lord siva temple) is famous for its hill temple where presiding deity lord Siva is Arul migu maragathambal samadha (Sreee Chandra Choodeswarar) it is located 40kms from Bangalore 52 kms from Krishnagiri in National High ways NH-7 Daily 500-1000 Devotees are visiting this temple most of them from hosur, Bangalore, Krishnagri, and neibouring states like Karnataka, and Anthrapradesh. it is very famous temple like Mysore Samundeeswari temple.
5. Krishnagiri Museum is located near Apsara Theatre on Gandhi Road. It was opened as 12th District Museum in the year 1993. This Museum exhibits objects of Art and Archaeology, Anthropology, Geology, Botany and Zoology disciplines. Most important exhibits of this Museum are the Hero Stones, which were collected from different parts of this district.

Source:http://krishnagiri.nic.in

Almost all villages have temples at every monitoring station. All people celebrate hindu festivals in the study area. Proposed project will not disturb any cultural and aesthetic environment in study area.

The salient observations recorded during socio economic survey in the study areas are depicted below:

- Agriculture is the main activity in the project area. It was been observed that majority of workers are working as Agriculture labourers.
- The main crops grown are wheat, paddy, jowar, bajra, chana, joun, soyabean, mung, urad, arhar, peas, til, masur, mungphali, barley.
- The main problem in the area is water scarcity during the summer months.
- Most of the study area villages are equipped with primary school and Middle school.
- Most of the study area villages connected with district major roads.
- Post offices are available in the survey villages few have sub post offices and banking facilities is available within the villages.
- Government Medical facilities are available in the study area. Mostly villagers avail the medical benefits from the nearest towns.
- Majority of surveyed population opted positive response regarding the proposed project activity as most of the local population will be given preference in employment and the activity will help in development of auxiliary as well as ancillary jobs in the region.

CHAPTER-4

ANTICIPATED ENVIRONMENTAL IMPACTS & MITIGATION MEASURES

4.1 METHODOLOGY

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

Step 1: 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 described in Chapter - 2.0. The potential positive and negative environmental impacts from these releases and other activities of the project have been identified.

Step 2: 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 number 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). Matrix for evaluating spatial criteria is given in **Table 4.1.**

Table 4.1: Matrix for Evaluating Spatial Criteria

<table>
<tr><th colspan="2" rowspan="2">Impact evaluation as per SPATIAL CRITERIA (Is)</th><th colspan="4">Impact Spatial extension (Sp)</th></tr>
<tr><th>HIGH</th><th>MEDIUM</th><th>LOW</th><th>NEGLIGIBLE</th></tr>
<tr><td rowspan="4">Impact Intensity (I)</td><td>HIGH</td><td>H</td><td>H</td><td>H</td><td>H</td></tr>
<tr><td>MEDIUM</td><td>H</td><td>M</td><td>M</td><td>M</td></tr>
<tr><td>LOW</td><td>M</td><td>L</td><td>L</td><td>L</td></tr>
<tr><td>NEGLIGIBLE</td><td>N</td><td>N</td><td>N</td><td>N</td></tr>
</table>

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). Matrix for evaluating Temporal Criteria is given in **Table 4.2.**

Table 4.2: 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. Matrix for evaluating Significance is given in **Table 4.3.**

Table 4.3: 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.

4.2 IDENTIFICATION OF ENVIRONMENTAL IMPACTS

The environmental impacts associated with the proposed Krishnagiri-Coimbatore Pipeline Section of Kochi – KKBMPL-II project with a total pipeline length of 293.7 km are identified in the below sections of the chapter.

On various environmental components such as air, water, noise, soil, flora, fauna, land, socioeconomic, etc. has been identified using Impact Identification Matrix **(Table 4.4).**

Table 4.4: Impact Identification Matrix

	Physical				Biological		Socio-economic	
Activities	**Ambient air quality**	**Ground / surface water (quantity / quality)**	**Ambient noise**	**Land (land use, topography & drainage, soil)**	**Flora**	**Fauna**	**Livelihood & occupation**	**Infrastructure**
CONSTRUCTION PHASE								
Site preparation	*		*	*	*	*	*	
Civil works	*		*			*		
Heavy equipment operations			*					
Disposal of construction wastes				*				
Generation/disposal of sewerage		*		*				
Transportation of materials	*		*			*		
OPERATION PHASE								
Commissioning of Pipeline								
Product handling and storage	*							

Emission & Waste management – Air, liquid and solid waste	*	*		*				

4.3 IMPACT EVALUATION AND MITIGATION MEASURES

The following mitigation measures related to Air Environment, Water Environment, Noise Environment, Land Environment, Biological Environment and Socio-economic Environment for the entire Pipeline/facility shall be implemented during Construction and Operation stages of the project as per the applicability.

4.3.1 AIR ENVIRONMENT

4.3.1.1 Construction Phase

a. Impact Evaluation

Construction activities are anticipated to take place over a period of at least 36 months from Zero date of Construction. Following mechanical completion, Commissioning and production ramp-up leading to 100% capacity utilization will be achieved in last six months.

Potential emissions sources during construction phase include the following:

- Site preparation and civil works
- Storage and handling of construction material (e,g. sand, cement) at proposed project site.
- 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, NOx, & SO_2 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 4.5**.

Table 4.5: 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 4.1
Impact(I_t)	Low	By combining I_s and temporal factors as per methodology given in Section 4.1
Overall Significance Value of Impact (S)	**Low**	By combining I_t and Vulnerability factors as per methodology given in Section 4.1

b. 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 of DG sets with sufficient height for dispersion as per CPCB guidelines.
- Vehicles carrying dusty materials for construction should be covered
- Maintenance programme for construction vehicles to ensure optimum performance thus reducing emissions

4.3.1.2 Operation Phase

a. Impact Evaluation

The potential emissions sources during operation phase include the following:

- Operation of pumps driven by fuel.
- Operation of diesel generator sets.
- Movement of vehicles.

The impacts are described below:

- PM, CO, NOx, & SOx generation from operation of diesel generator sets and engines of vehicles;

There will be DG stacks in the SV Stations and DT/RT terminals. Only DG sets will be there in case of emergency power failure and to run fire water engines in case of fire. Fugitive HC emissions of hydrocarbons are anticipated from valves, flanges, and seals. Hence, air quality modeling is not required for the proposed project.

The significance of the impacts of air emissions on ambient air quality during operation phase is summarized in **Table 4.6.**

Table 4.6: Impact of Air Emissions (Operation Phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	No gaseous emissions envisaged except some fugitive emissions
Spatial	Low	Negligible
Temporal	Medium	There shall be no gaseous emission during initial period after commissioning. But after long run of the pipeline, there shall be impact on air environment which has an important long-term effect i.e 1 week to 1 year
Vulnerability	Low	Open area
Evaluation of factors		
Impact(I_s)	Low	By combining intensity and spatial factors as per methodology given in Section 4.1
Impact(I_t)	Low	By combining I_s and temporal factors as per methodology given in Section 4.1
Overall	**Low**	By combining I_t and Vulnerability factors as

Factors of assessment	Value of assessment	Justification
Significance Value of Impact(S)		per methodology given in Section 4.1

b. Mitigation measures

- 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 (PUC) certificates are used.

4.3.2 WATER ENVIRONMENT

4.3.2.1 Construction Phase

a. Impact Evaluation

During this phase, raw water will be required for the following purposes:

- Civil works (such as cement preparation, curing)
- Hydro-testing (tanks and piping)
- Domestic use (such as bathing, washing, laundry etc.)
- Water sprinkling on site for dust abatement

Requirement of water during laying of pipeline and construction of SV stations are not envisaged. All potable water requirements will be met with packaged drinking water or local water supply.

The significance of the impact of raw water consumption on local water resources during construction phase is summarized in **Table 4.7.**

Table 4.7: Impact of Water Consumption (Construction Phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Moderate consumption of raw water
Spatial	Low	the impact extends inside battery limit
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)	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

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.
- Hydro-testing water discharge

The sewage and grey water will be treated on-site using biodigesters. The hydro-test water will be disposed in lined pits after ensuring that it contains no significant pollutants.

The significance of the impact of effluent generation during construction phase is summarized in **Table 4.8.**

Table 4.8: 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 inside the site
Temporal	Low	The impact has a temporary and short term effect
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

a. Mitigation Measures

- Monitoring water usage at construction camps to prevent wastage.

4.3.2.2 Operation Phase

a. Impact Evaluation

During operation phase, 45 - 50 liters/day a fresh water demand per capita shall be required and met through local domestic water source for IPS and SV stations.

The impact of water consumption on local resources during operation phase is summarized in **Table 4.9.**

Table 4.9: Impact of Water Consumption (Operation Phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Low consumption of raw water at each site
Spatial	Low	the impact extends in a restricted area outside the site (< 10 km)
Temporal	Low	The impact has an important short-term effect
Vulnerability	Low	Designated Industrial 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

No ETP is envisaged for this proposed pipeline project. Only Bio-digestor is adopted for treatment of sewage generated in IPS.

The impact of effluent generation during operation phase is summarized in **Table 4.10.**

Table 4.10: 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
Vulnerability	Low	No ETP & STP are envisaged
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

b. Mitigation Measures

- Tracking of consumption and installing water meter at any water abstraction source.
- Installation of rainwater harvesting structures to collect and use rainwater, thereby reducing abstraction.

4.3.3 LAND ENVIRONMENT

4.3.3.1 Construction Phase

a. Impact Evaluation

There is land requirement for SV and IPS Stations. The land will be purchased by GAIL for SV and IPS stations. Laying of pipeline is a temporary activity and land will be returned to the landowners for their original use immediately after the construction period is over. The land will be restored to near original conditions before handing over to the landowner. This includes grading, replacing the original top-soil, sloping and restoration of bunds.

The impact on land use and topography during construction phase is summarized in **Table 4.11.**

Table 4.11: Impact on land use & topography (construction phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	No additional land required.
Spatial	Low	The impact extends inside the site.
Temporal	Low	The impact has a short-term effect
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	**Low**	By combining I_t and Vulnerability factors

Factors of assessment	Value of assessment	Justification
Significance Value of Impact (S)		

There is potential for impact on soil quality due to project-related leaks and chemicals and uncontrolled disposal of wastes and wastewater. Care will be taken to avoid 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 4.12.**

Table 4.12: Impact on Soil Quality (Construction Phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Releases of low quantity
Spatial	Low	The impact extends inside the site.
Temporal	Low	The impact has a short-term effect
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

b. Mitigation Measures

- Avoiding rainy season for construction so as to avoid soil erosion.
- Ensuring the top-soil soil stock pile is not contaminated with any 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.
- Restoring the ROU as soon as possible after construction.
- Restoration of construction camp sites before abandonment.
- Ensuring side slopes and beds of water body crossings are restored as close as possible to the original conditions including replacement of original type and density of vegetation, slopes, drainage pattern and adoption of slope stabilization techniques wherever necessary.
- Ensuring all temporary facilities are removed from project sites, unless requested by the landowner and after maintaining requisite documentation of the same.
- After final site grading is complete, ensuring that the excess excavated material is not dumped indiscriminately but used for filling low lying areas.
- 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.
- Ensuring housekeeping teams are available at all sites including pipeline ROU.
- Developing and maintaining dedicated waste storage areas, with secondary containment for hazardous wastes.

- Disposal of wastes to vendors authorized by the regulatory agency after inspection.

4.3.3.2 Operation Phase

a. Impact Evaluation

There is a potential for impact on soil quality due to activities such as cleaning and maintenance (e.g. pigging of pipelines) and handling and storage of hazardous waste and chemicals (e.g. waste oil, oil contaminated filters). However, all activities having potential for soil contamination will be planned properly and the hazardous materials will be collected in impermeable containers or areas. Pigging waste at pig receiver area will be collected in closed tank and transported to the authorized vendors.

The impacts on soil quality during operation phase are summarized in **Table 4.13.**

Table 4.13: 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	Low	The impact has a short-term effect
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

b. Mitigation Measures

- Developing and maintaining dedicated waste storage areas,
- Proper collection, transportation and temporary storage of pigging wastes.
- Ensuring waste storage areas are provided while pigging.

4.3.4 NOISE ENVIRONMENT

4.3.4.1 Construction Phase

a. Impact Evaluation

The main sources of noise emissions during construction phase are operation of heavy equipment and machinery, operation of DG 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 4.14.**

Table 4.14: Sound Pressure (noise) levels of Construction Machinery

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

The impact of noise emission on ambient noise levels are summarized in **Table 4.15.**

Table 4.15: Impact on Ambient noise (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
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

b. 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.

4.3.4.2 Operation Phase

a. Impact Evaluation

The sources of noise emissions include operation of pumps, DGs, and movement of vehicles. The DG sets will have acoustic enclosures and exhaust mufflers by design. Project related heavy vehicle movement (for carrying materials and consumables) will be very low.

The impact of these noise emissions during operation is summarized in **Table 4.16.**

Table 4.16: 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	Low	The impact has an important and short term effect
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

b. 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.

4.3.5 BIOLOGICAL ENVIRONMENT

4.3.5.1 Construction Phase

a. Impact Evaluation

The land use at the proposed project sites is predominantly agricultural land and built up area, followed by scrub and forest land.

Cuttings of trees, if required will be carried out during laying of pipeline with prior approval from Forest Department. Open pipeline trench and un-barricaded waste/waste water pits may lead to injury of animals which fall in them.

The proposed pipeline is not passing through any Wildlife Sanctuary/National Park/Eco-sensitive areas/Coastal Regulation Zones/Coral reefs. Therefore, the temporal or short term impact will be occurred on fauna during laying of pipeline or construction activities.

The contractors are obliged to provide cooking gas at the construction camps as use of firewood is not allowed in GAIL projects. However, all contractual labourers will be instructed not to use firewood.

The impacts on flora and fauna during construction phase are summarized in **Table 4.17.**

Table 4.17: Impact on Biological Environment (Construction Phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Construction and laying will be done within a ROW of pipeline.
Spatial	Low	Impact extends in a restricted area outside the site (< 1 km)
Temporal	Low	The impact has an important and short term effect
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

b. Mitigation measures

- Keeping a tally of trees cut – viz. no., species taluka-wise.
- Avoid cutting of tress wherever possible, especially the endangered species observed in the study area.
- Exploring opportunities for conservation of endangered species.
- Closing of trenches as soon as possible of construction.
- Prevent littering of work sites with wastes, especially plastic and hazardous waste.
- Training of drivers to maintain speed limits and avoid road accidents.

4.3.5.2 Operation Phase

a. Impact Evaluation

The impacts due to proposed project activities during operation phase shall be limited. Impacts on Flora & Fauna during operation phase are summarized in **Table 4.18**.

Table 4.18: Impact on Biological Environment (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	Impact has an important and long term effect
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

b. Mitigation Measures

- Avoid cutting of tress wherever possible.
- Training of drivers to maintain speed limits and avoid road accidents.

4.3.6 SOCIO-ECONOMIC ENVIRONMENT

4.3.6.1 Construction Phase

a. Impact Evaluation

The landowners along the pipeline ROU will be compensated for loss of crops and property in accordance with applicable legal provisions under Petroleum and Minerals Pipelines (Acquisition of Right of User in Land) Act, 1962. The RoU will be restored immediately after the laying of the pipeline and handed back to the landowners in a condition as close as possible to the original. Permanent acquisition will be done based on willing buyer–willing seller as per prevailing market rates. There will be no economic or physical displacement. However, there may be discontent among landowners in case of delayed payment of compensation.

The issues need to be addressed during the construction phase of the project include the effect of employment generation and additional transport requirements on local infrastructural facilities. These are only short term impacts lasting during the construction phase of the project.

During the construction phase, local skilled and unskilled labour will get temporary employment based on required skill sets. However, as the development will be phase-wise, the total number of locals employed at any one time may not be more than 50-100. GAIL has a philosophy of preferring local skilled and unskilled workers and service providers (e.g. transportation, material supply) during its projects in order to boost local employment generation.

There will be movement of heavy vehicles (e.g. trucks, trailers, cargo vans) on local roads. These vehicles will be involved in supply of construction material, construction equipment pipes, raw water etc. to project sites. Heavy machineries (such as cranes, dozers, excavators etc.) will also be brought to the sites for earth-moving works, trenching, material movement pipe laying and backfilling. There will also be movement of car vehicles transporting staff and contracted construction labour from the nearby residential areas to the sites. On an average, movement 10 heavy vehicles and 15 passenger vehicles per day is expected. Vehicular movement in roads approaching remote project sites can potentially cause inconvenience to local road users and lead to road accidents. Company has a policy for road safety which sets speed limits and routes for vehicles operating for the company.

Movement of heavy vehicles and machinery may cause damage to local roads, impede local traffic and create general disturbance to local people.

Though preference will be given to local employment, some skilled and unskilled labour will be brought in by the EPC companies. Construction camps will be set up for housing the migrant workers and some may stay at nearby residential areas. There will be a general flow of truck drivers throughout the duration of the construction phase. There will be an impact on basic necessities like shelter, food, water, sanitation and medical facilities for the truck drivers. So there will be a short-term stress on housing, food supply, sanitation and medical facilities. There may also be chances of disputes between migrant work force and local community, though no such incidents have been reported in earlier projects. Indiscriminate disposal of wastes and wastewater may lead to community concern.

The construction camps will be run based on very high standards of safety and hygiene. This includes proper ventilation and lighting arrangements in living quarters, hygienic kitchen and mess, potable drinking water, adequate number of toilets and washrooms, drainage and waste collection, and waste water treatment facilities. The impact of construction activities on socio-economic environment during construction phase is summarized in **Table 4.19.**

Table 4.19: 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	Low	Impact extends in a restricted area outside the site (< 1 km)
Temporal	Low	The impact has a short term effect
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

b. Mitigation Measures

- Avoid cutting of tress wherever possible.
- 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.
- 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
- 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
- Conducting awareness programmes for workers.
- 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.
- Providing prior notice to affected parties when their access will be blocked, even temporarily.

4.3.6.2 Operation Phase

a. Impact Evaluation

Operational phase of the terminal, pipeline routes, SV Stations and IPSs covers the entire life span of the plant. Hence, the impacts of the operational phase extend over a long period of time. These impacts include employment generation, effects on transport and other basic infrastructure.

The manpower requirement during for operation of the pipeline would be around 33 consisting of 6 officers and 27 temporary persons (17 for 17 SV stations and 10 Line Patrolmen). GAIL staffs will hold the position at both terminals.
Vehicle movements will be relatively lower during the operation phase. Approx. 5-10 personnel including staff and contractors will be travelling from nearby residential areas to the project site every day. Additional traffic of approx. 5 passenger vehicles and 1-2 heavy vehicles per day is expected. Road safety is an important agenda in GAIL's HSE management system and travel of staff and contracted worker is very well regulated through tools such as journey management plan, defensive driving training, use of seat belts and vehicle tracking systems.

The impact of these activities on socio-economic environment during operation phase is summarized in **Table 4.20.**

Table 4.20: Impact on Socio-Economic Environment (Operation Phase)

Factors of assessment	Value of assessment	Justification
Intensity	Low	Involvement of labour, infrastructure and other utilities in marginal quantities/Nos.
Spatial	Low	Impact extends in a restricted area outside the site (< 1 km)
Temporal	Low	The impact has an short term effect
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

b. Mitigation Measures

- Extending reach of Corporate Social Responsibility programs to project areas.
- Extending pipeline safety awareness campaigns in project areas
- Monitoring speed and route of project-related vehicles

4.4 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 4.21.**

Table 4.21: Summary of Impact Evaluation in terms of Significance Value

Environmental component		Construction	Operation
Air		Low	Low
Water	**Consumption of Raw Water**	Low	Low

	Generation of Effluent	Low	Low
Land	**Land use & Topography**	Low	-
	Soil Quality	Low	Low
Noise		Low	Low
Biological		Low	Low
Socio-Economic		Low	Low

CHAPTER 5

ANALYSIS OF ALTERNATIVES

5.1 ANALYSIS OF ALTERNATIVE SITE

New proposed pipeline section is from Coimbatore to Krishnagiri of Tamil Nadu of KKBMPL pipeline Project within their ROW of pipeline route section. Total length of Natural Gas Pipeline is about 293.7 Kms.

Laying of pipeline is a temporary activity and land will be returned to the landowners for their original use immediately after the construction period is over. The land will be restored to near original conditions before handing over to the landowner. This includes grading, replacing the original top-soil, sloping and restoration of bunds.

The pipeline will be buried 1.5 m down the soil and proper compensation will be given to land owners as per GAIL policy.

Based on the above, the site was selected for establishment of proposed project and the site is in accordance with the MoEFCC guidelines.

In consideration of the requirements of environmental parameters, construction methodology to be adopted for different terrain encountered en-route, design and engineering factors, availability of logistic support during construction, operation and maintenance of Pipelines and specific geographical condition to lay the pipeline along most feasible route was identified based on the detailed study of relevant topographic maps and as per the guidelines to follow the route as suggested and inspected by M/s GAIL (India) Limited. Relevant topographic maps along the various sections of Pipeline route were identified. After conducting a detailed desktop study of the proposed alternative route, proposed Pipeline route was marked on the topographic sheet.

This was subsequently supplemented with route reconnaissance and data collection along the feasible route for arriving at the optimum route. While identifying the route alternatives for the selection of optimum route following factors were considered:

- ✓ Compliances with environmental regulation.
- ✓ Safety of people and property as far as possible.
- ✓ Shortest possible length as far as possible.
- ✓ Minimum number of bends as far as possible.
- ✓ Favorable ground profile for Pipeline.
- ✓ Accessibility to Pipeline route during construction, maintenance and operation as far as possible.
- ✓ Location of Pipeline facilities and access thereto.
- ✓ Avoidance of Mining protected and reserved forest, archeological and other sensitive areas including flora and fauna as far as possible.
- ✓ Avoidance of unstable ground feature as far as possible.
- ✓ Minimizing road, canal, river and flood prone and tidally affected areas.
- ✓ Avoidance of Rocky stretches as far as possible.
- ✓ Avoidance of Areas reserved for planned and future development as far as possible.
- ✓ Flexibility for future expansion.
- ✓ Avoiding entire stretch of wild life sanctuaries en-route.

Hence, no alternative sites are considered.

5.2 ALTERNATIVE TECHNOLOGY

There are no alternative technology options for laying the natural gas pipeline.

However, construction method to opt for Laying of natural gas Pipelines:

A pipeline is a system of pipes designed to carry fluids such as oil, natural gas, or other petroleum-based products over long distances, often underground.

It is a very important part of the modern civilization that has now been used for millennia for the movement of water or gas or oil.

Pipelines typically cost more than roads or open channels. It takes years and requires many surveys and studies and plans to be completed to develop a comprehensive plan that addresses the societal, developmental, environmental and safety considerations necessary to build the pipeline.

However, they can offer reductions in cost based on shorter and more direct routes than roads or open channels.

Constructions of pipelines, especially for large scale water-supply, gas or petroleum projects, are large multi-disciplinary activities which involve the investment of large amounts of cash and other resources.

There are different types of pipelines classified on the basis of manufacturing material, transported substance, and function of the pipes.

CHAPTER – 6

ENVIRONMENTAL MONITORING PROGRAM

6.1 INTRODUCTION

This effectiveness of mitigation measures described in Chapter- 4 will be monitored through a well-defined environmental monitoring programme. This will be done by direct measurement of parameters related to environmental quality, emissions, discharges etc.

6.2 ENVIRONMENTAL MONITORING AND REPORTING PROCEDURE

Development of the programme during the planning process shall be conducted or supported by environmental specialists. However, the implementation responsibility rests with working managers of GAIL, who should, therefore, ensure they fully understand and subscribe to the commitments being made. These commitments will include the legal and statutory controls imposed on the operation as well as other corporate commitment to responsible environment management.

GAIL had already an Engineering Group to review the effectiveness of environment management system during construction and operational phase of existing and proposed project expansion. The Environmental Monitoring Cell (EMC) is a part of Engineering Group who works for monitoring and meet regularly to review the effectiveness of the EMP implementation. The data collected on various EMP measures would be reviewed by EMC and if needed corrective action will be formulated for implementation.

The typical Organogram of GAIL EMC/HSE Cell is given below in **Figure 6.1.**

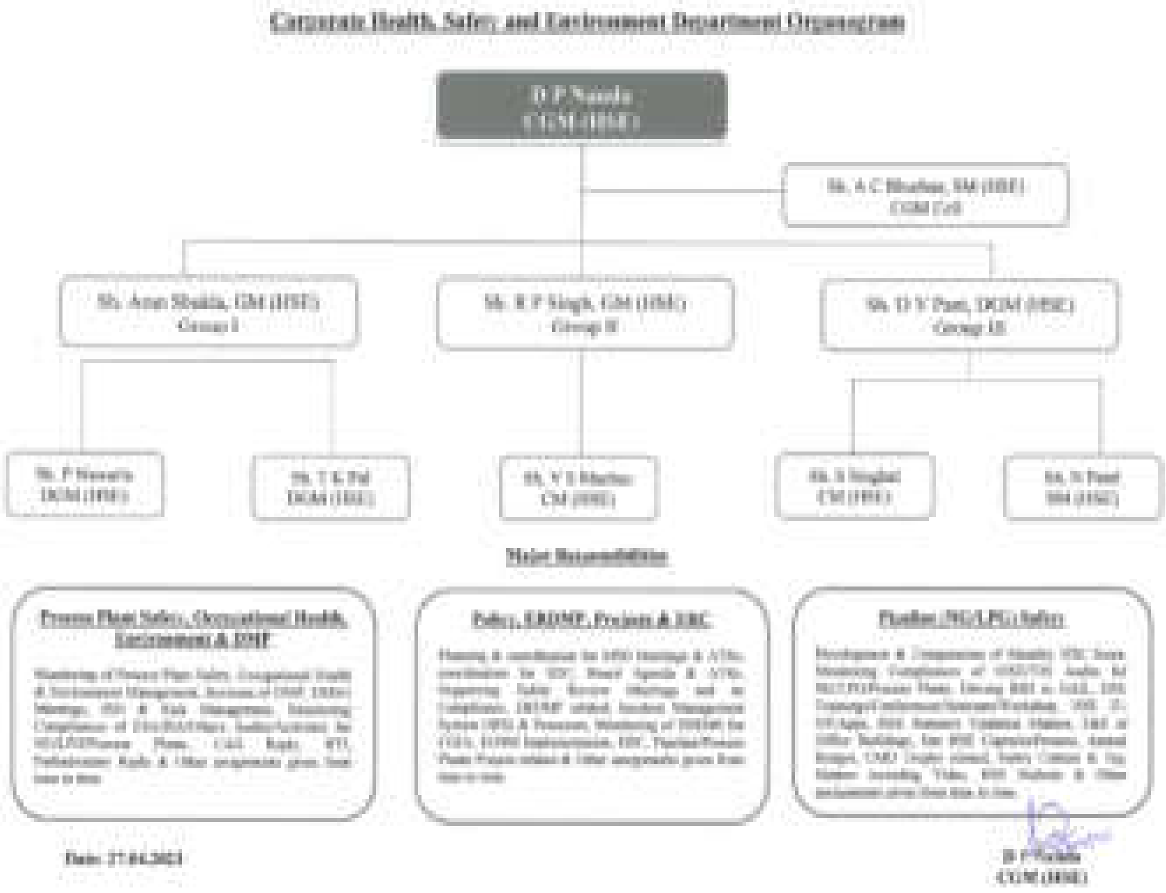


Figure 6.1 Typical Organogram of GAIL EMC/HSE Cell

Monitoring shall confirm that commitments are being met. This may take the form of direct measurement and recording of quantitative information, such as amounts and concentrations of discharges, emissions and wastes, for measurement against corporate or statutory standards, consent limits or targets. It may also require measurement of ambient environmental quality in the vicinity of a site using ecological / biological, physical and chemical indicators. Monitoring may include socio-economic interaction, through local liaison activities or even assessment of complaints.

6.3 OBJECTIVES OF MONITORING

The objectives of monitoring are:

- To check effectiveness of mitigation measures to evaluate the adequacy of Environmental Impact Assessment.
- To assess status of compliance to legal requirements.
- To assess if the Environmental Management Plan needs revisions/ updation.

6.4 MONITORING SCHEDULE

The proposed environmental monitoring program during both construction and operation phases of the project are given in **Table 6.1** and **Table 6.2** below:

Table 6.1: Environmental Monitoring Program (Construction Phase)

Sl. No.	Component	Description of Location	Parameters	Frequency
1.	Stack emission characteristics	Stacks attached to emission sources (e.g. DG sets)	Stack monitoring for PM, SO_x, NO_x and HC	Once in a month
2.	Ambient air quality	Boundary of construction sites and camps	Ambient air quality parameters as per NAAQS viz. PM_{10}, $PM_{2.5}$, SO_x, NO_x, CO	Once in a month
3.	Ground water quality (used as source of domestic water)	Point of abstraction	Parameters listed in ISO:10500	Once in a month
4.	Water consumption	Construction sites and camps	Consumption by volume	Once in a day
5.	Effluent quality	Discharge header of hydro-tested pipeline/ tank	According to general discharge standards	As per requirement
6.	Solid Waste (including hazardous)	Construction sites and camps	Quantity/ volume generated and disposed	Once in a month
7.	Equipment noise levels	1 m from DG set	dB(A)	Once in a month
8.	Ambient noise levels	Boundary of construction sites and camps	Ambient noise levels ($L_{eq\ day}$ & $L_{eq\ night}$)	Once in a month

Table 6.2: Environmental Monitoring Program (Operation Phase)

Sl. No.	Component	Description of Location	Parameters	Frequency
1.	Stack emission characteristics	PM, SOx, NOx and HC for DG stacks.	Monitoring at each DG stacks for PM, SOx, NOx and HC	Once in a month
2.	Ambient air quality	Parameters viz. PM_{10}, $PM_{2.5}$, SOx, NOx, VOC and HC at fence-line of all terminals and SV/IPS stations	Monitoring around pump station associated with pipeline for PM_{10}, $PM_{2.5}$, SOx, NOx, VOC and HC	Once in a month
3.	Ground water quality (Borewell)	Monitoring at source for parameters listed in ISO:10500, except pesticides and radioactive materials	Water quality monitoring at each new bore well, if any, for all the parameters listed in ISO:10500, except pesticides and radioactive materials	Once in a month
		Measurement of flow at each bore well through water meters	Measurement of flow at each new bore well, if any, through water meters	As per requirement
4.	Solid Waste	Quantity/ volume generated and disposed at terminal and SV/IPS Stations	Quantity/ volume generated and disposed at new surface facilities in all terminals and SV/IP stations	Once in 3 months
5.	Source noise emissions	Noise level monitoring in dB(A) near pumps	Noise level monitoring in dB(A) near pumps and DGs installed as part of the proposed project	Once in a month
6.	Ambient noise levels	Ambient noise levels (Leq day & Leq night) at fence-line of all terminals and SV/IPS Stations	Ambient noise levels (Leq day & Leq night) at new surface facilities in all SV/IPS Stations	Once in a month
7.	Greenbelt development	Plant density, health, growth and survival rate at SV/IPS stations	Plant density, health, growth and survival rate in additional greenbelt	Once in 6 months

CHAPTER – 7
ADDITIONAL STUDIES

7.0 ADDITIONAL STUDIES

Rapid Risk Assessment (RRA) study have been carried out as part of EIA report. The report is attached separately as ***Annexure V***.

7.1 EMERGENCY RESPONSE PLAN

The Emergency Response Plan is formulated with the broad objective of safeguarding human life and minimizing human suffering & property loss by localizing the emergency and to eliminate it as far as possible as per Codes of Practices for Emergency Response and Disaster Management Plan (ERDMP)) Regulations. Elimination of impacts of a foreseeable accident requires prompt action by operators and emergency staff using, e.g., fire-fighting equipment, shut-off valves and water sprays. Minimizing the effects include rescue, first aid, evacuation, rehabilitation and giving information promptly to people in nearby area.

7.2 IDENTIFICATION OF HAZARDS

Natural gas has a risk of a flash fire or major explosion. Natural gas is highly inflammable and can ignite if it comes into contact with an ignition source.

Decreased level of oxygen: Leaking natural gas can replace oxygen in ambient air, resulting in a range of symptoms including headache, dizziness, nausea, eye and throat irritation, and inability to breathe.

7.3 HAZARDOUS MATERIAL HANDLING & TRANSPORTATION

The transportation system for natural gas consists of a complex network of pipelines, designed to quickly and efficiently transport natural gas from its origin, to areas of high natural gas demand. Natural gas that is transported through interstate pipelines travels at high pressure in the pipeline, at pressures. This reduces the volume of the natural gas being transported (by up to 600 times), as well as propelling natural gas through the pipeline. The distribution system delivers natural gas from the interstate pipeline system to consumers.

7.4 EMERGENCY TEAM

In case of any emergency each individual in the terminal has to act in proper co-ordination to execute specific tasks under the designated team leader. This avoids overlapping of responsibilities & possible chaos at the time of emergency.

7.4.1 Declaration of Emergency

Incidents/scenarios like fires, explosions, natural calamities, sabotage, and act of war or negligence may lead to an accident or disaster at the terminal.

As soon as any untoward incident is observed which has potential to lead to any emergency situation, it is the responsibility of the observer to rush to the spot of fire (depending on the amount of fire) with the nearest portable extinguisher available to him by shouting FIRE, FIRE, FIRE till he himself (or someone hears and rushes for help and arrange to) sound the siren. The person will break the glass of MCP immediately which makes alarm in the control room. Actuation of siren would mean declaration of emergency. A red colored flag would be used to indicate the site of fire. First observer must make sure that Incident Controller or Fire In-charge (Site Controller) is informed about the incident and takes overall charge of the situation. Fire in-charge will issue suitable instruction after quickly assessing the situation. The emergency will continue until all fire has been extinguished with no risk of re-ignition. On ensuring normal conditions Site Controller will declare normalcy.

7.4.2 Emergency Reporting Procedure and Organizational Structure

The emergency message is communicated in the following manner:

- Call Emergency message to Shift Supervisor Operation Manager on Radio.
- Local nearest telephone if Radio is unavailable.
- Inform shift Console operator in Shift Supervisor at main control room / Fire Station, through emergency telephone number or through automated process by breaking glass of MCP that gives alarm and shows the region where fire has occurred.
- Wait for acknowledgement from Fire & Safety department personnel.
- Caller to confirm the accuracy of the message (location of emergency) as repeated by F&S personnel.
- Reporting by Walkie Talkies (high range).
- Providing an early warning/alarm system.
- Immediate response procedures/measures: As per OISD GDN-206 (Guidelines on Safety Management System in Petroleum Industry), a list of immediate actions to be taken in case of an emergency, should be provided along with the people/positions to perform the initial tasks.
- Mutual aid arrangements with neighbouring industries to be worked out in the plan to facilitate additional help in the event of fire fighting or in rescue operations.
- List of Do's and Don'ts to be carried out during emergency.
- Mock drills should be conducted periodically (Planned and Unannounced).

GAIL shall prepare "Emergency Response and Disaster Management Plan (ERDMP)" for Natural gas pipeline in operation phase.

7.5 SAFETY, HEALTH & ENVIORNMENT

GAIL has always accorded high priority to Health, Safety and Environment (HSE). Safety management is an integral part of overall management system of GAIL right from the inception. GAIL is committed to safety and demonstrated leadership in the field of HSE. The Health, Safety and Environment policy of GAIL is attached as **Annexure - VI.**

7.5.1 Safety & Fire Protection Measures

GAIL has a well defined HSE policy approved by the Board, which gives direction for various safety, occupational health and environmental protection related activities. Adequate resources are allocated for effective implementation of HSE policy to achieve high standards of safety. Safety Committees play vital role in this regard. Representatives of the workmen and officers work together in the safety committees.

It is the endeavour of the management to involve all the employees and others related personnel in the safety matters. Safety is a key element reviewed in the local management committee meetings chaired by Unit Head/Installation Head. Management Safety Committee Meeting is held every quarter under the convenership of Unit Head/Installation Head to review all aspects of safety. Respective Executive Director reviews safety performance in their monthly performance review meetings of the division.

Major incidents and corrective actions taken are also appraised to the Board. Executive Committee of the Board is apprised on safety issue of the corporation on periodically basis.

Standard operating procedures ensure correct operation and will be updated periodically. GAIL will ensure safe operation with train manpower. GAIL train all concerned including employees, contract labourers, truck drivers and security personnel etc. Considering the socio-economic conditions and high turnover of contractor personnel, major thrust is given for training of contractor personnel.

Mechanical integrity of equipment/ system is ensured through condition monitoring, periodic inspection and preventive/predictive maintenance for reliable and safe operation. All incidents will be investigated with the objective of learning and to avoid repetitive mistakes. Recommendations will be implemented in time bound manner.

All jobs in the plants will be carried out through a systematic work permit system to ensure that safety precautions are taken in line with the norms/ guidelines of OISD. Use of proper Personal Protective Equipment (PPE) will be enforced. Strict supervision will be maintained by Fire & Safety Personnel/ site supervisors regarding compliance of permit conditions and use of PPE.

To ensure effectiveness of all the component of safety system and activities, the following audit systems need to be carried out regularly.

a) Internal Safety Audit by multi disciplinary teams,
b) External Safety Audit by third party agency.

7.6 RAPID RISK ASSESSMENT (RRA) STUDY

A Rapid Risk Assessment study has been carried out by EIL for generation of important baseline data / specific information required for the subject EIA study. The details of the same are presented below:

Rapid Risk Analysis study identifies the various hazards related to loss of containment events associated with the proposed facility, analyses their potential consequences draws suitable conclusions and provides necessary recommendations/mitigation measures to limit the risk up to an acceptable level.

7.6.1 Approach Methodology

RRA study evaluates the consequences of potential failure scenarios, assess extent of damages based on damage criteria's and suggest suitable measures for mitigating the Hazard. RRA involves identification of various potential hazards & credible failure scenarios for various systems based on their frequency of occurrence & resulting consequence. Basically two types of scenarios are identified spanning across various process facilities; Cases with high chance of Occurrence but having low consequence, e.g., Instrument Tapping Failure and cases with low Chance of occurrence but having high consequence, e.g. Full-Bore Rupture of pipeline, Catastrophic Rupture of Pressure Vessels / Large Hole on the outlet of Pressure Vessels. Effect zones for various outcomes of failure scenarios (Flash Fire, Jet Fire, Blast overpressure etc.) are studied and identified in terms of distances on plot plan of each facility of the Pipeline. Based on effect zones, measures for mitigation of the hazard are suggested.

7.6.2 Major Observations & Recommendations of the Study

The detailed consequence due to release of hydrocarbon gas in case of various credible failure scenarios modelled in terms of release rate, dispersion, flammability and characteristics etc., as applicable have been discussed in detail in this report at various locations.

Based on the assessment of the software output for consequence analysis, major findings and recommendations arising out of this study are summarized in sections below.

Analysis & recommendations based on consequence modelling:

1. Typical SV (Refer Annexure I in RRA report attached at Annexure V of EIA report): Jet fire radiation intensity of 12.5 kW/m2 is realized up to ~9 m and may impact on eastern side of SV station for u/g leak case. Jet fire radiation intensity of 37.5 kW/m2 is realized up to ~16 m and may impact on eastern side of SV station for a/g leak case. Overpressure explosion distance for 5 psi is reaching upto 22 25 m in case of 20 mm A/G case. Results for large leak i.e. 50 mm A/G case may be utilized for emergency response plan preparation

   It is recommended to:

   - Ensure that entry & exit of guard room are outside of the 12.5 kW/m2 contour of jet fire zone (i.e. 11 meter from SV leak source) to protect the guard room occupant from injury due to fire radiation.
   - Ensure safe escape and evacuation plan is in place for guard room occupants in this scenario.
   - Provide flammable gas detectors near Sectionalizing Valve (SV). Procedures to be developed for remote closure of Sectionalizing valves in case of leak detection to prevent further escalation of hazardous consequences.
   - SV Stations remains unmanned hence no major hazard considered.

2. IPS-1 & IPS-2 The 50 mm leak(large) and pipeline full bore rupture failure frequency is very low so it is suggested to consider all these failure cases hazardous distances as provided in “Annexure-II” for emergency response plan and same shall be included in ERDMP of this pipeline facility.

   It is recommended to:

   - Ensure that entry & exit of guard room are outside of the 12.5 kW/m2 contour of jet fire zone to protect the guard room occupant from injury due to fire radiation.
   - Ensure safe escape and evacuation plan is in place for guard room occupants in this scenario.
   - Provide flammable gas detectors at each IPS.
   - IPS remains unmanned hence no major hazard considered.
   - Large leak/breach case probability is very less; hence results may be utilized for ERDMP.
   - Regular mock drills to be conducted for remaining alert and ready to handle any unforeseen case.

3. General Recommendations for pipeline facilities:

Preventive Measures

In order to reduce the leakage scenario from pipeline, the following preventive measures are recommended:

- Suitable measures shall be considered to prevent the leakage of the pipeline during the design engineering stage (i.e. pipeline thickness, material selection, corrosion allowance, cathodic protection for buried pipeline, corrosion monitoring system etc. should be considered suitably)
- Periodic health check of instruments and maintenance of piping are required to be ensured. Periodic calibration of instruments and testing of alarms, trips & interlocks should be given due attention.
- Pipeline section passing through seismic zone (if required) to be suitably designed for earthquake resistance.

Mitigating Measures:

Mitigating measures are those measures in place to minimize the damage due to loss of containment event and hazards arising out of Loss of containment. These include:

- Rapid detection of an uncommon event (HC, Flame etc.) and alarm arrangement at all stations along the pipeline route and development of subsequent quick isolation mechanism for major inventory
- Measures for controlling / minimization of Ignition sources inside the operating area.
- Active and Passive Fire Protection for critical equipment's and major structures as per the standard/code.
- Effective emergency response plan shall be in place for the pipeline facilities.

The Complete Risk Assessment Study Report is attached as **Annexure-V.**

CHAPTER – 8

PROJECT BENEFITS

8.0 CONTRIBUTION TO NATIONAL ENERGY SECURITY

GAIL (India) Limited envisage laying of Natural gas Pipeline from Coimbatore to Krishnagiri section of its KKBMPL project in the State of Tamilnadu.

India has been witnessing rapid urban and industrial growth in the past two decades, and with the country's current liberalization policy, this growth is expected to accelerate and need additional energy for development.

GAIL (India) Limited is continuously taking measures to improve sustainability activities to ensure staying on track and in balance with the three sustainability dimensions of economic, environmental and social impact at all times. The triple bottom line i.e. people, profit, planet approach is the cornerstone of all our social interventions which have been designed to schematically meet all three goals.

8.1 REDUCED RISKS & COSTS

Overland transport of fuels by trucks is uneconomical, unsafe, and contributes to environmental degradation due to fuel consumption and air pollutants caused by vehicles in transit. It causes a potential for road accidents and spillages (common in India). Pipelines are internationally recognized as the preferred alternative for transport of fuels from the point of view of safety, economy and relative environmentally friendliness.

The important factors affecting the operating economics of pipeline transportation are capital cost, and expenses towards maintenance under supervision. However, these costs outweigh the expenses of any other mode of transportation on a long run. Hence this is an economical option particularly to provide reliable supply.

Major advantages of pipelines over other modes of transportation are briefly indicated below:

- Pipelines are a safe and dependable mode for transportation of inflammable products. Products reach the destination with minimum chances of interruption in the supply.
- Environmental impact of a pipeline system is negligible.
- Energy requirements are lower in the case of pipeline transportation.
- Transportation losses in the pipeline mode are considerably lower as compared to other mode of transportation.
- The operating cost of a pipeline system is very low, resulting in overall economy in transportation over a period of time.
- In the pipeline option, the container remains static while the cargo is moved. In the case of transportation by other modes, the container itself moves. This results in wasteful utilization of the available transportation capacity due to return of empty containers to the loading point, as well as wastage of energy consumed for return journey of empty containers.
- In the pipeline mode of transportation, it is possible to significantly augment the pipeline to a higher capacity as low cost.
- Pipelines are normally not affected by natural calamities like floods, breaches etc., which

disturb the surface transport systems. This is due to almost the entire pipeline being laid underground.

- The pipeline mode reduces/eliminate problems connected with large scale despatch of products by rail from one loading base.

8.2 ENVIRONMENT BENEFIT

- The project will provide a cleaner and more efficient fuel source to the region, thereby reducing the carbon footprint and promoting sustainable development.

- The project aims to improve the air quality of the region by reducing the use of polluting fossil fuels.

8.3 SOCIO-ECONOMIC DEVELOPMENT

- Natural gas is a cost-effective fuel source compared to other fossil fuels. This will help in reducing the energy bills of households and industries.

- The project aims to increase the energy security of the region by providing a reliable and uninterrupted supply of natural gas to various industries, commercial entities, and households thereby improving the business of individuals and industries.

- The project aims to reduce the dependence of the region on imported fuel sources by providing a domestic and abundant fuel source.

- The project aims to promote industrial growth in the region by providing a reliable and cost-effective fuel source to various industries

CHAPTER 9

ENVIRONMENTAL COST BENEFIT ANALYSIS

9.1 ENVIRONMENTAL COST BENEFIT ANALYSIS

Environmental Cost-Benefit Analysis, or CBA, refers to the economic appraisal of policies and projects that have the deliberate aim of improving the provision of environmental services or actions that might affect (sometimes adversely) the environment as an indirect consequence.

Vital advances have arisen in response to the challenges that environmental problems and environmental policy pose for CBA. It also compares the monetary value of benefits with the monetary value of costs in order to evaluate and prioritize issues.

The effect of time (i.e. the time it takes for the benefits of a change to repay its costs) is taken into consideration by calculating a payback period. In its simple form, CBA uses only financial costs and financial benefits.

As per EIA notification, dated: 14th September, 2006, Environmental cost benefit analysis is applicable only when recommended at the scoping stage.

However as per EIA notification; Environmental cost benefit analysis is not recommended at this scoping stage, and has therefore not been carried out.

CHAPTER – 10

ENVIRONMENTAL MANAGEMENT PLAN

10.1 ENVIRONMENT MANAGEMENT PLAN

An Environmental Management Plan (EMP) has been prepared for the proposed project to describe the responsibility and resource requirements for implementing the mitigation measures identified in Chapter-4 and monitoring program described in Chapter-6.

10.2 EXISTING ENVIRONMENTAL MANAGEMENT SYSTEM

GAIL has a well-established Health, Safety and Environment (HSE) management system. The system is driven by a robust HSE policy and the plans and procedures developed to achieve the policy are implemented by an experienced corporate team based in GAIL office/site and a site-based team. The Corporate Health, Safety and Environment policy of GAIL is attached in **Annexure VI.**

10.3 ENVIRONMENTAL MANAGEMENT BY GAIL

Environmental Management is a priority area for GAIL by continuously striving to minimize adverse environmental impacts from company activities, products and services by using processes, practices, materials and products that avoid, reduce or control pollution. Following measures are taken for control and abetment of pollution.

10.3.1 Waste Water Management

There is only transportation of Natural gas during normal operation of the pipeline and hence there shall be no process effluent generation. But there shall be 2.4 KLD sewage generation which will be treated through bio-digestor.

10.3.2 Water Conservation

During operation phase, Water consumption is limited to only 3 KLD and hence to conservation measures are adopted.

10.3.3 Prevention of Air Pollution

All vehicles under contract are required to have PUC certificates and these are checked routinely and during inspections. The same will be continued for the proposed pipeline project also.

10.3.4 Tree Plantation/Greenbelt Development

Since land are returned to the owners, no greenbelt development is envisaged.

10.4 IMPACT ANALYSIS & MITIGATION MEASURES

The mitigation measures for the potential negative impacts anticipated from the proposed project described in Chapter-4 is elaborated below. The environmental monitoring schedule is described in Chapter-6.

10.4.1 Air Environment

<u>Construction phase (Impact significance: Low)</u>

- 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 of DG sets with sufficient height for dispersion as per CPCB guidelines.
- Vehicles carrying dusty materials for construction should be covered
- Maintenance programme for construction vehicles to ensure optimum performance thus reducing emissions

<u>Operation phase (Impact significance: Low)</u>

- 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 (PUC) certificates are used.

10.4.2 Water Environment

<u>Construction phase (Impact significance: Consumption of water - Medium, Generation of effluent - Low)</u>

- Monitoring water usage at construction camps to prevent wastage.

<u>Operation phase (Impact significance: Consumption of water - Medium, Generation of effluent - Low)</u>

- 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.

10.4.3 Land Environment

<u>Construction phase (Impact significance: Land use & topography - Low, Soil quality - Low)</u>

- Avoiding rainy season for construction so as to avoid soil erosion.
- Ensuring the top-soil soil stock pile is not contaminated with any spills.
- Ensuring any material resulting from clearing and grading is not deposited on approach roads, streams or ditches, which may hinder the passage and/or natural water drainage.
- Ensuring minimal soil erosion during discharge of used hydro test water by placing non-erodible materials on the ground at the point of discharge to prevent erosion.
- Restoration of construction camp sites before abandonment.
- Restoring the ROU as soon as possible after construction.
- Ensuring side slopes and beds of water body crossings are restored as close as possible to the original conditions including replacement of original type and density of vegetation, slopes, drainage pattern and adoption of slope stabilization techniques wherever necessary.
- Ensuring all temporary facilities are removed from project sites, unless requested by the landowner and after maintaining requisite documentation of the same.

- After final site grading is complete, ensuring that the excess excavated material is not dumped indiscriminately but used for filling low lying areas.
- 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.
- Ensuring housekeeping teams are available at all sites including pipeline ROU.
- Developing and maintaining dedicated waste storage areas, with secondary containment for hazardous wastes.
- Disposal of wastes to vendors authorized by the regulatory agency after inspection.

Operation phase (Impact significance: Soil quality - Low)

- Developing and maintaining dedicated waste storage areas,
- Proper collection, transportation and temporary storage of pigging wastes.
- Ensuring waste storage areas are provided while pigging.

10.4.4 Noise Environment

Construction phase (Impact significance: Low)

- 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 at night and close to sensitive receptors (such as schools, hospitals, places of worship.

Operation phase (Impact significance: Low)

- 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.

10.4.5 Biological environment

Construction phase (Impact significance: Low)

- Keeping a tally of trees cut – viz. no., species taluka-wise.
- Avoid cutting of tress wherever possible, especially the endangered species observed in the study area.
- Exploring opportunities for conservation of endangered species.
- Closing of trenches as soon as possible of construction.
- Prevent littering of work sites with wastes, especially plastic and hazardous waste.
- Training of drivers to maintain speed limits and avoid road accidents.

Operation phase (Impact significance: Low)

- Training of drivers to maintain speed limits and avoid road accidents.

10.4.6 Socio-economic environment

Construction phase (Impact significance: Low)

- Avoid cutting of tress wherever possible.
- 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.
- 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
- 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
- Conducting awareness programmes for workers.
- 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.
- Providing prior notice to affected parties when their access will be blocked, even temporarily.

Operation phase (Impact significance: Low)

- Extending reach of Corporate Social Responsibility programs to project areas.
- Extending pipeline safety awareness campaigns in project areas
- Monitoring speed and route of project-related vehicles

10.5 IMPLEMENTATION OF ENVIRONMENT MANAGEMENT (CONSTRUCTION PHASE)

GAIL will engage EPC contractors for the proposed project. All such contractors will be obliged, as part of contract, to ensure best standards in environment management and meet all commitments of GAIL in this regard.

All the mitigation measures planned during construction phase and described in section 10.4 of this Chapter will be controlled and managed by the Project Manager of the EPC Contractor through a dedicated Project HSE Team. The EPC Contractor will develop site/project specific HSE Plan for complete EPC phase of the project, which will be authorized by GAIL.

The HSE Plan will describe the environmental management and monitoring plans to be implemented by the EPC Contractor and will be in line with the EIA-EMP commitments and the relevant regulations. The Project HSE team will be supervised by GAIL HSE Team.

The following procedures for environmental management will be developed by the EPC Contractor as part of the HSE Plan.

- Procedure for waste and waste water management
- Procedure for handling & storage of HSD at site for DG & construction machineries.
- Procedure for cleaning of oil spill during filling of HSD in DG.

The following records will be maintained by the EPC Contractor as part of the HSE Plan.

- Inventory of waste generated and disposed.
- Inventory of water consumption and chemical use.
- Inventory of trees cut.

The budget for air and noise pollution control by design, provision of waste water handling and treatment, preventive maintenance and restoration is considered in project cost, an estimated budget for implementation of environmental management plan and monitoring schedule for construction phase is given in **Table 10.1.**

Table 10.1: Budget for EMP Implementation (Construction Phase)

Sl. No.	Activity	Capital Cost (INR lakhs)
1.1	Ambient air quality monitoring	4.0
1.2	Noise Monitoring (source monitoring and fence noise levels)	2.0
1.3	Effluent monitoring	1.0
1.4	Waste management	2.0
	Total Amount	**9.0**

10.6 IMPLEMENTATION OF ENVIRONMENT MANAGEMENT (OPERATION PHASE)

All the mitigation measures planned during operation phase and described in section 10.4 of this Chapter will be controlled and managed by the GAIL Team. An estimated budget for implementation of environmental management plan and monitoring schedule for operation phase is given in **Table 10.2.**

Table 10.2: Budget for EMP Implementation (Operation Phase)

Sl. No.	Activity	Recurring Cost (INR lakhs/annum)
1.1	Ambient air quality monitoring	2.0
1.2	Noise Monitoring	1.0
1.3	Effluent monitoring	1.0
1.4	Waste management	2.0
	Total Amount	**6.0**

10.7 BIOLOGICAL ENVIRONMENT IMPROVEMENT

Since land are returned to the owners, no greenbelt development is envisaged.

10.8 CORPORATE SOCIAL RESPONSIBILITY (CSR) ACTIVITIES OF GAIL (INDIA) LIMITED

GAIL (India) Limited Redefining Corporate Social Responsibility to resonate with people by rejuvenating commitment to ‘Social Good’.

In last 03 years, GAIL has invested exhaustively in generating goodness across the country. Company devoutly believes in inherent goodness of all the creatures of the world and has made honest efforts towards proliferation of this virtue through its Corporate Social Responsibility activities and programmes.

Commitment and accountability towards all stakeholders, especially the communities surrounding our present operations/upcoming business areas is in the very fabric of GAIL. GAIL remains committed to its CSR vision of conducting business to promote social good and integrate economic, environmental and social objectives with the GAIL’s operations and growth.

GAIL is committed to ensure increased commitment at all levels in the organization to operate business in an economically, socially & environmentally sustainable manner, while recognising the interests of all its stakeholders. GAIL remains invested in taking up CSR projects that benefit the communities in & around its work centres and results, over a period of time, in enhancing the quality of life & economic well-being of the local populace.

CSR Policy of GAIL is available on Company website at https://gailonline.com/CSR_Ploicy.html and the composition of the CSR Committee of the Board is hosted on Company’s website www.gailonline.com. As enshrined in the CSR Policy, GAIL adopts a multi-stakeholder approach, collaborating with communities, governmental and nongovernmental organisations, academic institutions and others, in an effort to identify emerging issues, develop projects and effectively respond to challenges. GAIL endeavours to follow best practices in identifying, implementing, sustaining and monitoring its CSR interventions to maximize sustainability, scalability and transparency.

GAIL’s CSR policy with expenditure in various projects/fields revised in march 2015 is given in **Annexure VII** with this EIA Report.

CHAPTER – 11

SUMMARY & CONCLUSION

11.0 SUMMARY

This Summary covers the following topics in brief:

1. Project Description
2. Description of Environment
3. Baseline data collection
4. Anticipated Environmental Impacts and Mitigation measures
5. Environmental Monitoring Programme
6. Environment Management Plan
7. Additional studies
8. Project Benefits

11.1 PROJECT DESCRIPTION

GAIL (India) Limited, India's principal Gas Transmission and Marketing Company, was set up by the Government of India in August 1984 to create gas sector infrastructure for sustained development of the Natural gas sector in the country.

GAIL (India) Limited, is India's flagship Natural Gas company, integrating all aspects of the Natural Gas value chain (including Exploration & Production, Processing, Transmission, Distribution and Marketing) and its related services. In a rapidly changing scenario, GAIL is spearheading the move to a new era of clean fuel industrialization, creating a quadrilateral of green energy corridors that connect major consumption centre in India with major Gas Fields, LNG terminals and other cross border gas sourcing points. GAIL is also expanding its business to become a player in the International Market.

GAIL (India) Limited intends to carry out Environmental Impact Assessment (EIA) study for proposed Krishnagiri - Coimbatore Pipeline Section of KKBMPL-II in accordance with the relevant Gazette Notification of Ministry of Environment, Forest and Climate Change (MoEFCC).

The KKBMPL project is having a total main pipeline length of approx. 890 km excluding spur lines (which includes approx. 450 km of Kochi-Mangalore section and approx. 440 km of Koottanad-Bangalore).

This study is for Krishnagiri – Coimbatore Pipeline (KCPL) section which is a part of Koottanad-Bangalore pipeline of KKBMPL-II in the state of Tamilnadu. The pipeline will be traversing through the states of Kerala, Karnataka and Tamil Nadu.

Project Name:	Krishnagiri - Coimbatore Pipeline Section of KKBMPL-II
Service:	Regasified LNG
Size (OD):	610 mm (24”)
From:	Krishnagiri, Tamilnadu
To:	Coimbatore, Tamilnadu

GAIL (India) Limited has entrusted M/s Engineers India Limited (EIL) to carry out environment impact assessment study and preparation of environmental management plan for various environmental components of the proposed project. EIL is an accredited consultant for carrying out EIA studies by Quality Council of India (QCI) in 6 (a) category i.e. Oil & gas transportation pipeline (crude and refinery/petrochemical products).

The pipeline is not passing through any wildlife sanctuary, National Park and Eco-sensitive zones. Hence, Environmental Clearance (EC) for the proposed pipeline is not required.

Project Cost and Schedule

The estimated capital cost for the proposed project is **Rs. 2175.97 Crores.**

The proposed project is expected to be completed in **36 months from the start date by 28-02-2026.**

The detailed description of proposed pipeline routes as given below:

- ❖ This entire section of the proposed cross country pipeline is coming in the Tamil Nadu State. The total length of the pipeline is 293.7 km.
- ❖ The Proposed Pipeline section takes off at Coimbatore.
- ❖ The proposed pipelines section terminate at Krishnagiri.
- ❖ No wildlife sanctuary, CRZ, Coral Reef, Ecologically sensitive areas including LNG terminals & National Park are coming in this proposed pipeline route section.
- ❖ The proposed pipelines crossing Reserved Forest & total length of Reserved Forest 7.144 Km. Forest Clearance for 7.144 Km diversion of forest areas is applied separately.
- ❖ Proposed pipeline section does not pass through Critically polluted area as per MoEF notification dated 15/03/2012.

11.2 EMISSIONS/DISCHARGE FROM THE PROPOSED PROJECT

In order to minimize the impact of the project on the environment, due attention is given for implementing effective pollution control measures.

Air Environment

There will be DG stacks in the SV Stations and IP stations. Only DG sets will be there in case of emergency power failure and to run fire water engines in case of fire. Fugitive HC emissions of hydrocarbons are anticipated from valves, flanges, and seals. Hence, air quality modeling is not required for the proposed project.

Water Environment

During operation phase, 45 liters/day a fresh water demand per capita/person shall be required and met through local domestic water source for SV and IP stations.

No ETP is envisaged for this proposed pipeline project. Only Bio-digestor is adopted for treatment of sewage generated in IPS.

Solid / Hazardous Waste Management

Routine generation of hazardous wastes are not envisaged during construction and operation phase.

11.3 BASELINE DATA COLLECTION

The baseline data forms the basis for predicting/assessing the environmental impacts of the proposed project. The data has been collected around Study Area of Project site during the period of December 2021 to March, 2022 by M/s Idma Laboratories Limited, Panchkula, Haryana, which is accredited by NABL and recognized by MoEFCC. The baseline data for various environmental components related Ambient Air Quality, Water Quality, Noise Level, traffic; Soil, Meteorology and Socio-economic data were monitored and collected in an area of 10 km radius around proposed IP stations and 500m for the pipelines.

(a) Air Environment

After analyzing all the parameters, the results were represented into various statistical parameters. Minimum, maximum, 98th percentile and average concentrations have been computed from the data generated during baseline studies. The AAQ results for the selected parameters at the selected sites are given in Table 3.6 to 3.12 of Chapter-3.

Interpretation

- The minimum & maximum concentrations of PM_{10} were found to be 68 $\mu g/m^3$ (at A1(a) i.e. Parade Ground SFTI walayar near village Chandrapuram, A2 (c) Sarasu Mahal Avalpoondurai (Festival Hall) on Erode Dharapuram Road , A3(a) Periyar University,Periyar Palkalai Nagar Salem, A4(c) Samichettipatti Velaan Kadan Sangam-Central Government Office Samichettipatti, A5(b) Rams Farm-Resort Hotel Hosur) and 85 $\mu g/m^3$ (at A1(d) Palladam Bus Stand, Coimbatore Road and A3(b) Semmandappatti Railway Station) respectively.
- Minimum and maximum concentrations of $PM_{2.5}$ were found between 30 $\mu g/m^3$ (at A1(a) Parade Ground SFTI Walayar near Village Chandrapuram) and 48 $\mu g/m^3$ (at A1(d) Palladam Bus Stand, Coimbatore Road and A3(b) Semmandappatti Railway station) respectively.
- Ranges of SO_2 concentration were found between 14.9 $\mu g/m^3$ at A5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 23.5 $\mu g/m^3$ at A1(d) Palladam Bus Stand, Coimbatore Road.
- The range of NO_2 concentrations was found to be 19.2 $\mu g/m^3$ at at A2(a) Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam to 34.2 $\mu g/m^3$ at A3(d) Toppur - Railway station, Sekkarapatti . The prescribed CPCB limit of SO_2 and NO_2 is 80 $\mu g/m^3$ for residential and rural areas are well within prescribed norms at all monitoring stations.
- The Range of Carbon Monoxide (CO) was found to be 0.17 mg/ m^3 recorded at A5(c) Carmel International School, Onnalavadi P.O Karapalli Jonnabonda Road, R K Road, Hosur to 0.65 mg/ m^3 at A1(d) Palladam Bus Stand Coimbatore Road and A3(d) and Toppur - Railway station, Sekkarapatti.

- The Range of Ammonia (NH_3) was found to be 23 µg/m^3 recorded at A2(a) Sri Palani Murugan Spinning Mill - Cotton mill Erode-Dharapuram Road Modavandi Sathyamangalam to 39 µg/m^3 at A3(d) Toppur - Railway station, Sekkarapatti
- Range of Ozone concentration were found between 17 µg/m^3 (at A1(b) JCT College of Engineering and Technology near Pichanur - Bus stop, A2(c) Sarasu Mahal, Avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai, A2(d) Erode East RTO Office - Transportation authority office on SH 84,Nanjailakkapuram, A3(a) Periyar University, Periyar, Palkalai Nagar - Salem, A4(c) Samichettipatti Velaan Kadan Sangam - Central Government Office,Samichettipatti, A5(c) Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur and A5(d) Sub Registrar Office - Government office, Hosur Main Road, Attibele- Rayakottai Road, Kelamangalam) to 25 µg/m3 (at A2(a) Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam, A2(b) Erode Junction Railway Station, A3(b) Semmandappatti Railway station, Semmandapatti and A5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli).
- Minimum and maximum concentrations of Benzene were found between 0.51µg/m^3 (at A1(b) JCT College of Engineering and Technology near Pichanur - Bus stop) and 0.82 µg/m^3 (at A2(b) Erode Junction Railway Station, A3(b) Railway station Semmandappatti and A3(d) Toppur - Railway station, Sekkarapatti) respectively.
- Non-Methane Hydrocarbons were found below detection level at all the monitoring locations.
- From the above study and discussions, it can be concluded that air quality of the area is good as the levels are well within the prescribed limits as prescribed by CPCB NAAQS limits.

(b) Water environment

Ground water:

Based on the analysis of ground water samples collected, the pH values were found to be in the range of 7.26 to 7.69 at all the monitoring locations. The total dissolved solids (TDS) of the ground water samples were found to be in the range of 291 mg/L at GW5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 488 mg/L at GW3(b) Semmandappatti - Railway station, Semmandapatti. The total hardness value of the ground water samples were found to be in the range of 136 mg/L at GW5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 230 mg/L at GW2(b) Erode Junction Railway Station. Fluoride content varies from 0.58 mg/L at GW5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 0.92 mg/L at GW5(c) Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur. The concentrations of chloride were found between 16 mg/L at GW5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli to 46 mg/L at GW3(b) Semmandappatti - Railway station, Semmandapatti.
Review of the chemical analysis reveals that there is some variation in chemical composition of water tapped from different sources but the ground water from all sources remains suitable for drinking purposes with proper disinfection as all the constituents are within the limits prescribed for drinking water standards promulgated by Indian Standards (IS: 10500).

Surface Water:

Observations made on the analytical results pertaining to all locations reveal that the pH values of the surface water samples were found to be in the range of 7.42 at SW5(b) Rams Farm - Resort hotel, Hosur to 7.97 at SW2(c) Sarasu Mahal, Avalpoondurai (Festival hall) on Erode -

Dharapuram Road, Avalpoondurai. The total dissolved solids (TDS) of the surface water samples were found to be in the range of 272 mg/L at SW5(c) Carmel International School, Onnalavadi P.O, Karapalli to Jonnabonda Road, R K Road, Hosur to 444 mg/L at SW3(c) Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur. The total hardness value of the surface water samples were found to be in the range of 141 mg/L at SW1(a) Parade Ground SFTI Walayar near Village Chandrapuram to 207 mg/L at SW3(c) Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur. Dissolved oxygen ranges from 6.87 mg/L at SW2(c) Sarasu Mahal, Avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai to 7.17 mg/L at SW2(a) Sri Palani Murugan Spinning Mill - Cotton mill, Erode-Dharapuram Road Modavandi Sathyamangalam. Chemical Oxygen Demand of the surface water samples ranges between 10.6 mg/L at SW5(b)Rams Farm - Resort hotel, Hosur to 18 mg/L at SW3(c) Rajasthani Dhaba - Rajasthani Restaurant, Kamlapuram ,Opp. AVM Petrol Pump NH-7 Bangalore To Salem Bye Pass, Omalur. Biological Oxygen Demand of the samples were found in the range of 1.26 at SW2(b) Erode Junction Railway Station and SW5(b) Rams Farm - Resort hotel, Hosur to 2.26 mg/L at SW1(c) Hindusthan College of Engineering and Technology – on Pollachi Main Road, Coimbatore at all the monitoring locations.

From the results of all the samples analysed (Table no-3.33), it is observed that, the surface waters falls in category B or D i.e. Outdoor bathing and propagation of wildlife fisheries when compared with the water quality standards for Inland surface water prescribed by Central Pollution Control Board.

(c) Noise environment

Ambient noise levels were measured at 20 locations around the pipeline project. The average values of noise levels recorded during the day time were from **52.8 L_{eq}dB** at N2(b) Erode Junction Railway Station, N2(c) Sarasu mahal, avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai and N3(a) Periyar University, Periyar, Palkalai Nagar - Salem to **51.5 L_{eq} dB (A)** at N1(a) Parade Ground SFTI Walayar near Village Chandrapuram. The maximum noise level was recorded at N1(d) Palladam Bus Stand, Coimbatore Road **58.6 L_{eq} dB (A)** whereas minimum was recorded at N5(a) Hosur Airport, Taneja Aerospace Road, Belagondanahalli **41.6 L_{eq} dB (A).**

The average values of noise levels recorded during the night time were from **42.7 L_{eq}dB** at N1(b) JCT College of Engineering and Technology near Pichanur - Bus stop to **38.7 L_{eq} dB (A) at** N3(b) Railway station Semmandappatti, Semmandapatti . The maximum noise level during night was recorded at N1(a) Parade Ground SFTI Walayar near Village Chandrapuram and N1(b) JCT College of Engineering and Technology near Pichanur - Bus stop **44.8 L_{eq} dB (A)** whereas minimum was recorded was **35.9 L_{eq} dB (A)** at N2(c) Sarasu mahal, avalpoondurai (Festival hall) on Erode - Dharapuram Road, Avalpoondurai. Thus noise levels at all the locations were observed to be within the tolerance limits as prescribed by CPCB.

(d) Traffic Density Study

Total number of vehicles in PCU were found maximum at T1(b) JCT College of Engineering and Technology near Pichanur - Bus stop while the minimium at T3(a) Periyar University,

Periyar, Palkalai Nagar – Salem. The hourly study of traffic density of Krishnagiri to Coimbatore pipeline was found between 0.02 to 0.04 at all the monitoring locations.
The passenger car unit conversion of above data shows that the level of service at both the roads is excellent and falls in **“Category A”.**

(e) Land Environment

The analysis results shows that pH value ranges from 7.56 at S1(b) JCT College of Engineering and Technology near Pichanur - Bus stop to 7.80 at S3(a) Periyar University, Periyar, Palkalai Nagar – Salem. The organic matter varies between 0.46% at S1(a) Parade Ground SFTI Walayar near Village Chandrapuram to 0.52 % at S2(a) Erode Junction Railway Station**.** The Concentration of Nitrogen, Phosphorus and Potassium has been found to be in good amount in the Soil Samples. Soil texture is Loamy Clay at all the locations and is good for agricultural purposes.

Land Use Land Cover (LULC) Maps for SV & IPS & Land use Map of 500 m around the Pipeline are given in chapter -3 represented under figures no. 3.1 to 3.10.

11.4 ANTICIPATED ENVIRONMENTAL IMPACTS AND MANAGEMENT PLAN

11.4.1 Air Environment

Construction Phase

a. Impact Evaluation

Potential emissions sources during construction phase include the following:

- Dust will be generated from earth-moving, grading and civil works, and movement of vehicles on unpaved roads.
- PM, CO, NOx, & SO2 will be generated from operation of diesel sets and diesel engines of machineries and vehicles.

b. 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 of DG sets with sufficient height for dispersion as per CPCB guidelines.
- Vehicles carrying dusty materials for construction should be covered
- Maintenance programme for construction vehicles to ensure optimum performance thus reducing emissions

Operation Phase

a. Impact Evaluation

The potential emissions sources during operation phase include the following:

- Operation of pumps driven by fuel.
- Operation of diesel generator sets.
- Movement of vehicles.

b. Mitigation Measures

- 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 (PUC) certificates are used.

11.4.2 Noise Environment

The main sources of noise during construction will be:

- Site preparation.
- Civil works.
- Heavy equipment operations.

Mitigation Measures (construction phase)

- Ensuring preventive maintenance of equipments and vehicles.
- Avoiding unnecessary engine operations (e.g. equipments with intermitted use are Switched off when not working).
- Ensuring DG sets are provided with acoustic enclosures and exhaust mufflers.

During operational phase of the proposed project, the noise shall be caused due to various rotating equipment viz. Pumps etc.

Mitigation Measures (operation phase)

- Avoiding continuous (more than 8 hrs) exposure of workers to high noise areas.
- Provision of adequate PPE's like ear muffs at the high noise areas.
- Ensuring preventive maintenance of equipment.
- Ensuring DG sets have acoustic enclosures and exhaust mufflers as per design.

11.4.3 Water Environment

Construction Phase

a. Impact Evaluation

During this construction phase, raw water will be required for the following purposes:

- Civil works (such as cement preparation, curing)
- Hydro-testing (tanks and piping)
- Domestic use (such as bathing, washing, laundry etc.)
- Water sprinkling on site for dust abatement.

b. Mitigation Measures

- Monitoring water usage at construction camps to prevent wastage.

Operation Phase

a. Impact Evaluation

- During operation phase, 45 - 50 liters/day a fresh water demand per capita/person shall be required and met through local domestic water source for IPS and SV stations.

b. Mitigation Measures

- No ETP is envisaged for this proposed pipeline project. Only Bio-digestor is adopted for treatment of sewage generated in IPS.

11.4.4 Land Environment

There is land requirement for SV and IPS Stations. The land will be purchased by GAIL for SV and IPS stations. Laying of pipeline is a temporary activity and land will be returned to the landowners for their original use immediately after the construction period is over. The land will be restored to near original conditions before handing over to the landowner. This includes grading, replacing the original top-soil, sloping and restoration of bunds.

Mitigation Measures (construction phase)

- Avoiding rainy season for construction so as to avoid soil erosion.
- Ensuring the top-soil soil stock pile is not contaminated with any 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.
- Restoring the ROU as soon as possible after construction.
- Restoration of construction camp sites before abandonment.
- Ensuring side slopes and beds of water body crossings are restored as close as possible to the original conditions including replacement of original type and density of vegetation, slopes, drainage pattern and adoption of slope stabilization techniques wherever necessary.
- Ensuring all temporary facilities are removed from project sites, unless requested by the landowner and after maintaining requisite documentation of the same.
- After final site grading is complete, ensuring that the excess excavated material is not dumped indiscriminately but used for filling low lying areas.
- Developing project specific waste management plan and hazardous material handling plan for the construction phase.

Mitigation Measures (Operation phase)

There is a potential for impact on soil quality due to activities such as cleaning and maintenance (e.g. pigging of pipelines) and handling and storage of hazardous waste and chemicals (e.g. waste oil, oil contaminated filters). However, all activities having potential for soil contamination will be planned properly and the hazardous materials will be collected in impermeable containers or areas. Pigging waste at pig receiver area will be collected in closed tank and transported to the authorized vendors.

- Developing and maintaining dedicated waste storage areas,
- Proper collection, transportation and temporary storage of pigging wastes.
- Ensuring waste storage areas are provided while pigging.

11.4.5 Biological Environment

The land use at the proposed project sites is predominantly agricultural land and buildup area followed by Scrub & Forest land.

Mitigation Measures (construction phase)

- Keeping a tally of trees cut – viz. no., species taluka-wise.
- Avoid cutting of tress wherever possible, especially the endangered species observed in the study area.
- Exploring opportunities for conservation of endangered species.
- Closing of trenches as soon as possible of construction.
- Prevent littering of work sites with wastes, especially plastic and hazardous waste.
- Training of drivers to maintain speed limits and avoid road accidents.

The impacts due to proposed project activities during operation phase shall be limited to long run impact of emissions and traffic movement.

Mitigation measures (Operation phase)

- Avoid cutting of tress wherever possible.
- Training of drivers to maintain speed limits and avoid road accidents.

11.4.6 Socio-economic Environment

The landowners along the pipeline ROU will be compensated for loss of crops and property in accordance with applicable legal provisions under Petroleum and Minerals Pipelines (Acquisition of Right of User in Land) Act, 1962. The RoU will be restored immediately after the laying of the pipeline and handed back to the landowners in a condition as close as possible to the original. Permanent acquisition will be done based on willing buyer–willing seller as per prevailing market rates. There will be no economic or physical displacement. However, there may be discontent among landowners in case of delayed payment of compensation.

The issues need to be addressed during the construction phase of the project include the effect of employment generation and additional transport requirements on local infrastructural facilities. These are only short term impacts lasting during the construction phase of the project.

During the construction phase, local skilled and unskilled labour will get temporary employment based on required skill sets. However, as the development will be phase-wise, the total number of locals employed at any one time may not be more than 50-100. GAIL has a philosophy of preferring local skilled and unskilled workers and service providers (e.g. transportation, material supply) during its projects in order to boost local employment generation.

There will be movement of heavy vehicles (e.g. trucks, trailers, cargo vans) on local roads. These vehicles will be involved in supply of construction material, construction equipment pipes, raw water etc. to project sites. Heavy machineries (such as cranes, dozers, excavators etc.) will also be brought to the sites for earth-moving works, trenching, material movement pipe laying and backfilling. There will also be movement of car vehicles transporting staff and contracted construction labour from the nearby residential areas to the sites. On an average, movement 10 heavy vehicles and 15 passenger vehicles per day is expected. Vehicular movement in roads approaching remote project sites can potentially cause inconvenience to local road users and lead to road accidents. Company has a policy for road safety which sets speed limits and routes for vehicles operating for the company.

Movement of heavy vehicles and machinery may cause damage to local roads, impede local traffic and create general disturbance to local people.

Though preference will be given to local employment, some skilled and unskilled labour will be brought in by the EPC companies. Construction camps will be set up for housing the migrant workers and some may stay at nearby residential areas. There will be a general flow of truck drivers throughout the duration of the construction phase. There will be an impact on basic necessities like shelter, food, water, sanitation and medical facilities for the truck drivers. So there will be a short-term stress on housing, food supply, sanitation and medical facilities. There may also be chances of disputes between migrant work force and local community, though no such incidents have been reported in earlier projects. Indiscriminate disposal of wastes and wastewater may lead to community concern.

The construction camps will be run based on very high standards of safety and hygiene. This includes proper ventilation and lighting arrangements in living quarters, hygienic kitchen and mess, potable drinking water, adequate number of toilets and washrooms, drainage and waste collection, and waste water treatment facilities.

Mitigation Measures (construction phase)

- Avoid cutting of tress wherever possible.
- 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.
- 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
- 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
- Conducting awareness programmes for workers.
- 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.
- Providing prior notice to affected parties when their access will be blocked, even temporarily.

Mitigation Measures (operation phase)

- Extending pipeline safety awareness campaigns in project areas.
- Monitoring speed and route of project-related vehicles.

11.5 ENVIRONMENTAL MONITORING PROGRAMME (EMP)

The proposed environmental monitoring program during both construction and operation phases of the project are given in Table 11.1 and Table 11.2 below:

Table 11.1: Environmental Monitoring Program (Construction Phase)

Sl. No.	Component	Description of Location	Parameters	Frequency
1.	Stack emission characteristics	Stacks attached to emission sources (e.g. DG sets)	Stack monitoring for PM, SO_x, NO_x and HC	Once in a month
2.	Ambient air quality	Boundary of construction sites and camps	Ambient air quality parameters as per NAAQS viz. PM_{10}, $PM_{2.5}$,SO_x, NO_x, CO	Once in a month
3.	Ground water quality (used as source of domestic water)	Point of abstraction	Parameters listed in ISO:10500	Once in a month
4.	Water consumption	Construction sites and camps	Consumption by volume	Once in a day
5.	Effluent quality	Discharge header of hydro-tested pipeline/ tank	According to general discharge standards	As per requirement
6.	Solid Waste (including hazardous)	Construction sites and camps	Quantity/ volume generated and disposed	Once in a month
7.	Equipment noise levels	1 m from DG set	dB(A)	Once in a month
8.	Ambient noise levels	Boundary of construction sites and camps	Ambient noise levels ($L_{eq\ day}$ & $L_{eq\ night}$)	Once in a month

Table 11.2: Environmental Monitoring Program (Operation Phase)

Sl. No.	Component	Description of Location	Parameters	Frequency
1.	Stack emission characteristics	PM, SOx, NOx and HC for DG stacks.	Monitoring at each DG stacks for PM, SOx, NOx and HC	Once in a month
2.	Ambient air quality	Parameters viz. PM10, $PM_{2.5}$,SOx, NOx, VOC and HC at fence-line of all terminals and SV/IPS stations	Monitoring around pump station associated with pipeline for PM_{10}, $PM_{2.5}$, SOx, NOx, VOC and HC	Once in a month
3.	Ground water quality (Borewell)	Monitoring at source for parameters listed in ISO:10500, except pesticides and radioactive materials	Water quality monitoring at each new bore well, if any, for all the parameters listed in ISO:10500, except pesticides and radioactive materials	Once in a month

Sl. No.	Component	Description of Location	Parameters	Frequency
		Measurement of flow at each bore well through water meters	Measurement of flow at each new bore well, if any, through water meters	As per requirement
4.	Solid Waste	Quantity/ volume generated and disposed at terminal and SV/IPS Stations	Quantity/ volume generated and disposed at new surface facilities in all terminals and SV/IP stations	Once in 3 months
5.	Source noise emissions	Noise level monitoring in dB(A) near pumps	Noise level monitoring in dB(A) near pumps and DGs installed as part of the proposed project	Once in a month
6.	Ambient noise levels	Ambient noise levels (Leq day & Leq night) at fence-line of all terminals and SV/IPS Stations	Ambient noise levels (Leq day & Leq night) at new surface facilities in all SV/IPS Stations	Once in a month
7.	Greenbelt development	Plant density, health, growth and survival rate at SV/IPS stations	Plant density, health, growth and survival rate in additional greenbelt	Once in 6 months

11.6 IMPLEMENTATION OF ENVIRONMENT MANAGEMENT (CONSTRUCTION PHASE)

GAIL will engage EPC contractors for the proposed project. All such contractors will be obliged, as part of contract, to ensure best standards in environment management and meet all commitments of GAIL in this regard. All the mitigation measures planned during construction phase and described in section 10.4 of Chapter 10 will be controlled and managed by the Project Manager of the EPC Contractor through a dedicated Project HSE Team. The EPC Contractor will develop site/project specific HSE Plan for complete EPC phase of the project, which will be reviewed and authorized by GAIL.

The HSE Plan will describe the environmental management and monitoring plans to be implemented by the EPC Contractor and will be in line with the EIA-EMP commitments and the relevant regulations. The Project HSE team will be supervised by GAIL HSE Team.

The following procedures for environmental management will be developed by the EPC Contractor as part of the HSE Plan.

- Procedure for waste and waste water management
- Procedure for handling & storage of HSD at site for DG & construction machineries.
- Procedure for cleaning of oil spill during filling of HSD in DG.

The following records will be maintained by the EPC Contractor as part of the HSE Plan.

- Inventory of waste generated and disposed.
- Inventory of water consumption and chemical use.
- Inventory of trees cut.

The budget for air and noise pollution control by design, provision of waste water handling and treatment, preventive maintenance and restoration is considered in project cost, an estimated budget for implementation of environmental management plan and monitoring schedule for construction phase is given in Table 11.3.

Table 11.3: Budget for EMP Implementation (Construction Phase)

Sl. No.	Activity	Capital Cost (INR lakhs)
1.1	Ambient air quality monitoring	4.0
1.2	Noise Monitoring (source monitoring and fence noise levels)	2.0
1.3	Effluent monitoring	1.0
1.4	Waste management	2.0
	Total Amount	**9.0**

11.7 IMPLEMENTATION OF ENVIRONMENT MANAGEMENT (OPERATION PHASE)

All the mitigation measures planned during operation phase and described in EMP chapter -10 of this EIA study report will be controlled and managed by the GAIL HSE Team.

An estimated budget for implementation of environmental management plan and monitoring schedule for operation phase is given in Table 11.4.

Table 11.4: Budget for EMP Implementation (Operation Phase)

Sl. No.	Activity	Recurring Cost (INR lakhs/annum)
1.1	Ambient air quality monitoring	2.0
1.2	Noise Monitoring	1.0
1.3	Effluent monitoring	1.0
1.4	Waste management	2.0
	Total Amount	**6.0**

11.8 RAPID RISK ASSESSMENT (RRA) STUDY

A Rapid Risk Assessment study has been carried out by EIL for generation of important baseline data / specific information required for the subject EIA study. Rapid Risk Analysis study identifies the various hazards related to loss of containment events associated with the proposed facility, analyses their potential consequences draws suitable conclusions and provides necessary recommendations/mitigation measures to limit the risk up to an acceptable level or ALARP zone with certain recommendations to minimize the risk.

MAJOR OBSERVATIONS & RECOMMENDATIONS OF THE STUDY

The detailed consequence due to release of hydrocarbon gas in case of various credible failure scenarios modelled in terms of release rate, dispersion, flammability and characteristics etc., as applicable have been discussed in detail in this report at various locations.

Based on the assessment of the software output for consequence analysis, major findings and recommendations arising out of this study are summarized in sections below.

Analysis & recommendations based on consequence modelling:

1. Typical SV (Refer Annexure I in RRA report attached at Annexure V of EIA report): Jet fire **radiation** intensity of 12.5 kW/m2 is realized up to ~9 m and may impact on eastern side of SV station for u/g leak case. Jet fire radiation intensity of 37.5 kW/m2 is realized up to ~16 m and may impact on eastern side of SV station for a/g leak case. Overpressure explosion distance for 5 psi is reaching upto 22 25 m in case of 20 mm A/G case. Results for large leak i.e. 50 mm A/G case may be utilized for emergency response plan preparation

It is recommended to:

- Ensure that entry & exit of guard room are outside of the 12.5 kW/m2 contour of jet fire zone (i.e. 11 meter from SV leak source) to protect the guard room occupant from injury due to fire radiation.

- Ensure safe escape and evacuation plan is in place for guard room occupants in this scenario.

- Provide flammable gas detectors near Sectionalizing Valve (SV). Procedures to be developed for remote closure of Sectionalizing valves in case of leak detection to prevent further escalation of hazardous consequences.

- SV Stations remains unmanned hence no major hazard considered.

2. IPS-1 & IPS-2 The 50 mm leak(large) and pipeline full bore rupture failure frequency is very low so it is suggested to consider all these failure cases hazardous distances as provided in “Annexure-II” for emergency response plan and same shall be included in ERDMP of this pipeline facility.

It is recommended to:

- Ensure that entry & exit of guard room are outside of the 12.5 kW/m2 contour of jet fire zone to protect the guard room occupant from injury due to fire radiation.
- Ensure safe escape and evacuation plan is in place for guard room occupants in this scenario.
- Provide flammable gas detectors at each IPS.
- IPS remains unmanned hence no major hazard considered.
- Large leak/breach case probability is very less; hence results may be utilized for ERDMP.
- Regular mock drills to be conducted for remaining alert and ready to handle any unforeseen case.

3. General Recommendations for pipeline facilities:

Preventive Measures

In order to reduce the leakage scenario from pipeline, the following preventive measures are recommended:

- Suitable measures shall be considered to prevent the leakage of the pipeline during the design engineering stage (i.e. pipeline thickness, material selection, corrosion allowance, cathodic protection for buried pipeline, corrosion monitoring system etc. should be considered suitably)
- Periodic health check of instruments and maintenance of piping are required to be ensured. Periodic calibration of instruments and testing of alarms, trips & interlocks should be given due attention.
- Pipeline section passing through seismic zone (if required) to be suitably designed for earthquake resistance.

Mitigating Measures:

Mitigating measures are those measures in place to minimize the damage due to loss of containment event and hazards arising out of Loss of containment. These include:

- Rapid detection of an uncommon event (HC, Flame etc.) and alarm arrangement at all stations along the pipeline route and development of subsequent quick isolation mechanism for major inventory
- Measures for controlling / minimization of Ignition sources inside the operating area.
- Active and Passive Fire Protection for critical equipment's and major structures as per the standard/code.
- Effective emergency response plan shall be in place for the pipeline facilities.

The Complete Risk Assessment Study Report is attached as **Annexure-V.**

11.9 CORPORATE SOCIAL RESPONSIBILITY (CSR) ACTIVITIES OF GAIL (INDIA) LIMITED

GAIL (India) Limited Redefining Corporate Social Responsibility to resonate with people by rejuvenating commitment to 'Social Good'.

In last 03 years, GAIL has invested exhaustively in generating goodness across the country. Company devoutly believes in inherent goodness of all the creatures of the world and has made honest efforts towards proliferation of this virtue through its Corporate Social Responsibility activities and programmes.

Commitment and accountability towards all stakeholders, especially the communities surrounding our present operations/upcoming business areas is in the very fabric of GAIL. GAIL remains committed to its CSR vision of conducting business to promote social good and integrate economic, environmental and social objectives with the GAIL's operations and growth.

GAIL is committed to ensure increased commitment at all levels in the organization to operate business in an economically, socially & environmentally sustainable manner, while recognising the interests of all its stakeholders. GAIL remains invested in taking up CSR projects that benefit the communities in & around its work centres and results, over a period of time, in enhancing the quality of life & economic well-being of the local populace.

CSR Policy of GAIL is available on Company website at https://gailonline.com/CSR_Ploicy.html and the composition of the CSR Committee of the Board is hosted on Company's website www.gailonline.com. As enshrined in the CSR Policy, GAIL adopts a multi-stakeholder approach, collaborating with communities, governmental and nongovernmental organisations, academic institutions and others, in an effort to identify emerging issues, develop projects and effectively respond to challenges. GAIL endeavours to follow best practices in identifying, implementing, sustaining and monitoring its CSR interventions to maximize sustainability, scalability and transparency.

GAIL's CSR policy with expenditure in various projects/fields revised in march 2015 is given in **Annexure VII** with this EIA Report.

CHAPTER – 12

DISCLOSURE OF CONSULTANTS

12.1 GENERAL INFORMATION

Name of Organization: Engineers India Limited (EIL)

Address: Head - Environment, Water & Safety Division (EWS),
Tower-I, Ground floor,
Engineers India Limited, Office Complex Gurugram,
(On NH-8), Haryana-122001

Email: pk.goel@eil.co.in

12.2 ESTABLISHMENT

Engineers India Limited (EIL) was established in 1965 to provide engineering and related services for Petroleum Refineries and other industrial projects. Over the years, it has diversified into and excelled in various fields. EIL has emerged as Asia's leading design, engineering and turnkey contracting company in Petroleum Refining, Petrochemicals, Pipelines, Onshore Oil & Gas, Mining & Metallurgy, Offshore Oil & Gas, Terminals & Storages and Infrastructure. EIL provides a wide range of design, engineering, procurement, construction supervision, commissioning assistance and project management as well as EPC services.

It also provides specialist services such as heat & mass transfer equipment design, environment engineering, information technology, specialist materials and maintenance, plant operations & safety including HAZOPS & Risk Analysis, refinery optimization studies and yield & energy optimization studies.

Engineers India has earned recognition for jobs executed in India and several countries of West Asia, North Africa, Europe and South East Asia including Algeria, Bahrain, Kuwait, Korea, Malaysia, Norway, Qatar, Saudi Arabia, Sri Lanka, UAE and Vietnam. EIL is diversifying into the areas of Water & Waste Management, Nuclear Power, Thermal and Solar Power and City Gas Distribution.

EIL has its head office in New Delhi, regional engineering offices in Gurugram, Chennai, Kolkata and Vadodara and a branch office in Mumbai. It has inspection offices at all major equipment manufacturing locations in India and a wholly owned subsidiary

Certification Engineers International Ltd. (CEIL) for undertaking independent certification & third party inspection assignments. Outside India, EIL has offices in Abu Dhabi (UAE), London, Milan and Shanghai and a wholly owned subsidiary, EIL Asia Pacific Sdn. Bhd. (EILAP) in Malaysia. EIL has also formed a joint venture Jabal EILIOT with IOTL & Jabal Dhahran for tapping business opportunities in Saudi Arabia.

Backed by its unmatched experience, EIL enjoys a high professional standing in the market and is known as a versatile and competent engineering company that can be relied upon for meeting the clients' requirements. Quality Management System with respect to EIL's services conforms to ISO 9001:2008 The Design Offices are equipped with state-of-the-art computing systems, design tools and infrastructure.

12.3 EIL'S VISION

To be a world-class globally competitive EPC and total solutions consultancy organization.

12.4 EIL'S MISSION

- Achieve 'Customer delight' through innovative, cost effective and value added consulting and EPC services.
- To maximize creation of wealth, value and satisfaction for stakeholders with high standards of business ethics and aligned with national policies.

12.5 CORE VALUES OF EIL

- Benchmark to learn from superior role models.
- Nurture the essence of Customer Relationship and bonding.
- Foster Innovation with emphasis on value addition.
- Integrity and Trust as fundamental to functioning.
- Thrive upon constant Knowledge updation as a Learning organization.
- Passion in pursuit of excellence.
- Quality as a way of life.
- Collaboration in synergy through cross-functional team efforts.
- Sense of ownership in what we do.

12.6 QUALITY POLICY OF EIL

- Enhance customer satisfaction through continuous improvement of our technologies, work processes, and systems and total compliance with established quality management system.
- Consistently improve the quality of products /services with active participation of committed and motivated employees and feedback from stakeholders.
- Provide added value to customers through timely and cost effective services/deliverables.
- Ensure total compliance with applicable health, safety and environment requirements during design and delivery of products to enrich quality of life.

12.7 HSE POLICY OF EIL

- Ensure compliance with requirements of health, safety and environment, during design and delivery of products/ services as per applicable National and International codes, standards, procedures, engineering practices, and statutory requirements including customer's requirements.
- Ensure safety and health of employees, personnel of clients and associates.
- Create awareness on health, safety and environment aspects for all employees and associates.

12.8 RISK MANAGEMENT POLICY OF EIL

- EIL is committed to effective management of risks across the organization by aligning its risk management strategy to its business objectives through
- Instituting a risk management structure for timely identification, assessment, mitigating, monitoring and reporting of risks.
- Risk management at EIL is the responsibility of every employee both individually as well as collectively.

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.

12.9 DETAIL’S OF ACCREDITATION

National Accreditation Board for Education and Training (NABET) - under the Accreditation Scheme for EIA Consultant Organizations has accredited EIL as EIA consultant for 13 EIA Sectors, vide NABET notification dated 18.12.23 and certification No.-NABET/EIA/21-24/SA 0214 valid till 22.05.2024.

The list of sectors for which the accreditation has been accorded by NABET is given in **Figure - 12.1**. The same can be referred from the NABET website https://nabet.qci.org.in/eia.php, by following the link - EIA Accreditation Scheme – Accreditation Register – Accredited Consultant.

QUALITY COUNCIL OF INDIA

NABET

National Accreditation Board for Education and Training

Certificate of Accreditation

Engineers India Limited, Gurugram

EIL Office Complex, Sector-16, On NH-8, Gurugram- 122001, Haryana

The organization is accredited as ***Category-A*** *under the QCI-NABET* ***Scheme for Accreditation of EIA Consultant Organization, Version 3*** *for preparing EIA/EMP reports in the following Sectors*

S. No	Sector Description	Sector (as per)		Cat.
		NABET	MoEFCC	
1.	Offshore and onshore oil and gas exploration, development & production	2	1 (b)	A
2.	Thermal power plants	4	1 (d)	B
3.	Metallurgical industries (Non ferrous only)	8	3 (a)	A
4.	Petroleum refining industry	10	4 (a)	A
5.	Chemical fertilizers	16	5 (a)	A
6.	Petro-chemical complexes (industries based on processing of petroleum fractions & natural gas and/or reforming to aromatics)	18	5 (c)	A
7.	Distilleries	22	5 (g)	A
8.	Oil & gas transportation pipeline (crude and refinery/ petrochemical products), passing through national parks/ sanctuaries/coral reefs / ecologically sensitive areas including LNG terminal	27	6 (a)	A
9.	Isolated storage & handling of hazardous chemicals (As per threshold planning quantity indicated in column 3 of schedule 2 & 3 of MSIHC Rules 1989 amended 2000)	28	-	B
10.	Air ports	29	7 (a)	A
11.	Common hazardous waste treatment, storage and disposal facilities (TSDFs)	32	7 (d)	A
12.	Ports, harbours, break waters and dredging	33	7 (e)	A
13.	Townships and Area development projects	39	8 (b)	B

Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in SAAC minutes dated [illegible] posted on QCI-NABET website.

This Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in QCI-NABET's letter of accreditation bearing no. [illegible] dated Dec. 18, 2023. The accreditation needs to be renewed before the expiry date by Engineers India Limited, Gurugram following due process of assessment.

Issue Date
Dec. 18, 2023

Valid up to:
May 22, 2024

Mr. Ajay Kumar Jha
Sr. Director - NABET

Certificate No.
NABET/EIA/[illegible]

Prof (Dr) Varinder S Kanwar
CEO - NABET

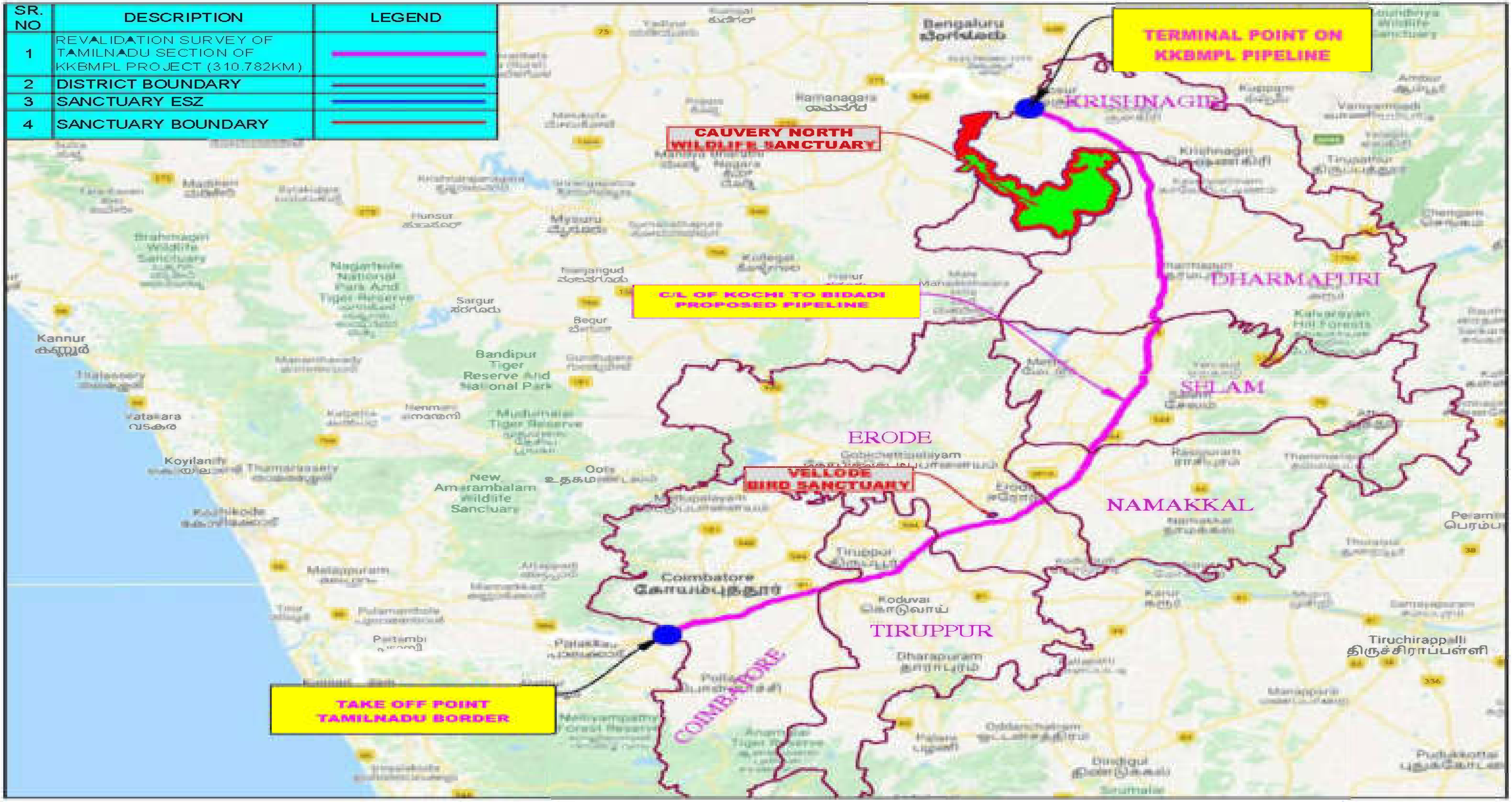
For the updated List of Accredited EIA Consultant Organizations with approved Sectors please refer to QCI-NABET website.

Figure-12.1: EIL Accreditation Certificate by NABET

ANNEXURE – I

SURVEY ROUTE OF PROPOSED

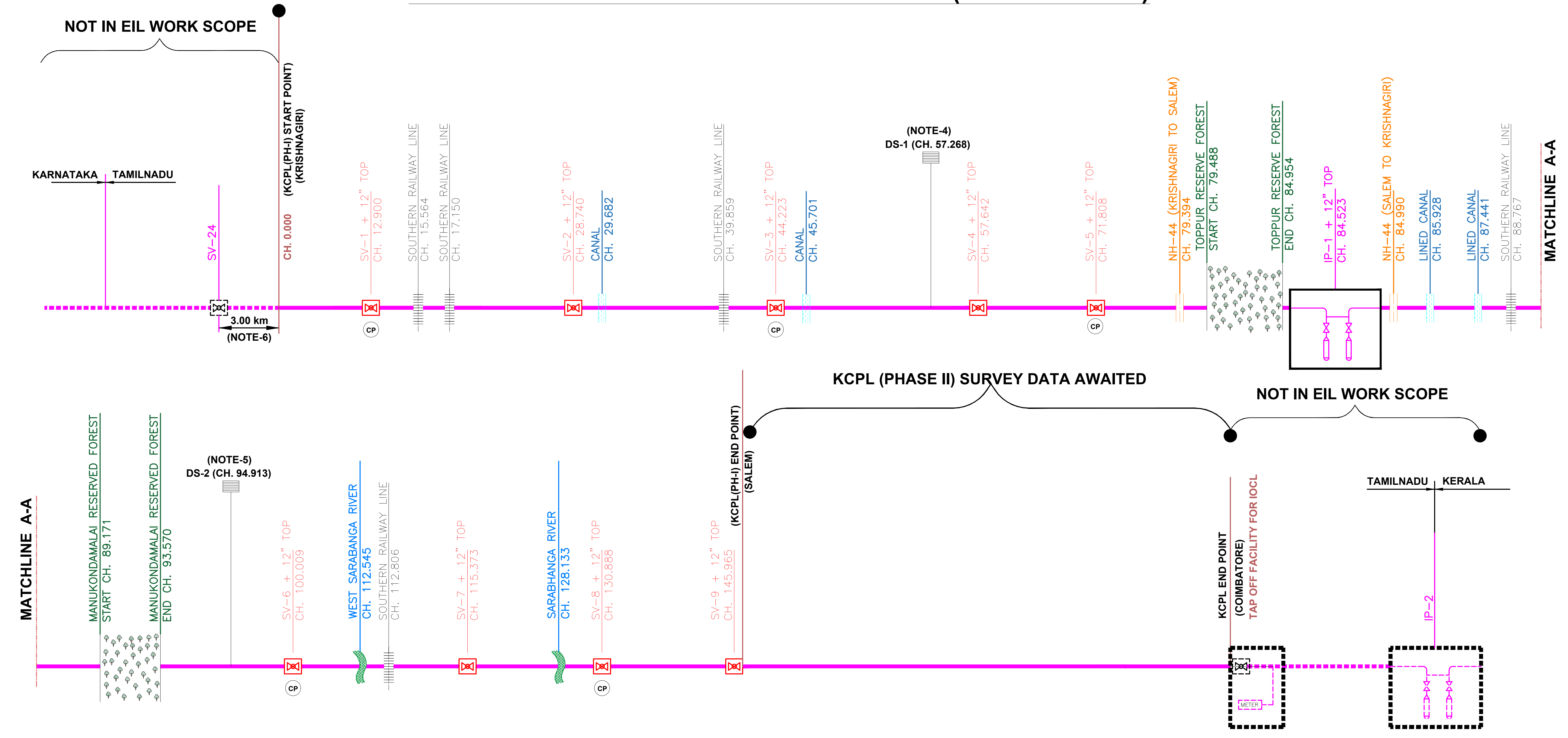
KRISHNAGIRI - COIMBATORE PIPELINE SECTIONS


SR. NO
DESCRIPTION
LEGEND
1
REVALIDATION SURVEY OF TAMILNADU SECTION OF KKBMPL PROJECT (310.782KM)
2
DISTRICT BOUNDARY
3
SANCTUARY ESZ
4
SANCTUARY BOUNDARY
TERMINAL POINT ON KKBMPL PIPELINE
CAUVERY NORTH WILDLIFE SANCTUARY
C/L OF KOCHI TO BIDADI PROPOSED PIPELINE
VELLODE BIRD SANCTUARY
TAKE OFF POINT TAMILNADU BORDER
KRISHNAGIRI
DHARMAPURI
SALEM
ERODE
NAMAKKAL
TIRUPPUR
COIMBATORE
Bengaluru
Mysuru
Kannur
Coimbatore
Tiruppur
Tiruchirappalli
Bandipur Tiger Reserve And National Park

ANNEXURE – II

SCHEMATIC ARRANGEMENT OF PIPELINE FACILITIES FOR KCPL PHASE- I (KRISHNAGIRI TO SALEM)

KRISHNAGIRI - SALEM PIPELINE PROJECT (KCPL PHASE-I)



LEGEND:-

IP	INTERMEDIATE PIGGING STATION		24" KRISHNAGIRI - COIMBATORE PIPELINE
	SV - SECTIONALIZING VALVE		24" EXISTING PIPELINE
	SV - SECTIONALIZING VALVE (EXISTING)		EXISTING FACILITIES
	RIVER CROSSING	CP	CATHODIC PROTECTION SYSTEM
	RAILWAY CROSSING		FOREST
	NH - NATIONAL HIGHWAY CROSSING	KCPL	KRISHNAGIRI - COIMBATORE PIPELINE
	DS - DUMP SITE	KKBMPL	KOCHI - KOOTTANAD - BANGALURU-MANGALORE PIPELINE
	PIG LAUNCHER/ RECEIVER	TOP	TAP-OFF POINT
	LINED CANAL CROSSING		

NOTES:

1. ALL CHAINAGES INDICATED ARE IN KM AND ARE AS PER THE DETAILED ROUTE SURVEY PROVIDED BY M/s GAIL VIDE EMAIL DATED 21.10.2022.
2. LOCATIONS OF IP & SV STATIONS ARE INDICATIVE ONLY & EXACT LOCATIONS SHALL BE FINALISED DEPENDING ON AVAILABILITY OF PLOTS.
3. ALL SVs ON THE MAIN PIPELINE SHALL BE REMOTE OPERATED WITH GAS OVER OIL ACTUATORS.
4. EXISTING DUMP SITE FOR LINE PIPE STORAGE AT CH. 57.268 IS FOR LINEPIPES DIRECTLY PROCURED BY GAIL (INDIA) LIMITED. AS PER COMMUNICATION DATED 28.09.2021, CLIENT HAS ALREADY PLACED ORDER FOR PROCUREMENT AND SUPPLY OF 24", 12.4 mm THK., API 5L GR. X70 PSL2 LINEPIPE OF LENGTH 106.838 KM LINEPIPE FOR THIS PROJECT.
5. THIS PROPOSED DUMP SITE IS FOR QTY. OF LINE PIPE TO BE PROCURED BY EIL UNDER KCPL PH-I PROJECT.
6. EIL WORK SCOPE STARTS FROM 3 KM DOWNSTREAM OF EXISTING SV-24, AS PER MOM DATED 04.08.2022.

DETAILS OF PIPELINE (KCPL PH-I)

DESIGN PRESSURE (kg/cm²(g))	92.0		DESIGN TEMPERATURE	-29°C to 65°C
PIPE OD (INCH)	24"		SERVICE	REGASSIFIED LNG
MATERIAL GRADE	API 5L GR. X70, PSL-2			
CORROSION ALLOWANCE (mm)	1.0			
WALL THICKNESS (mm)	CLASS-1&2	CLASS-3		CLASS-4
	10.8	12.4 (NOTE-5)	12.7	15.5
COATING	EXTERNAL : 3 LPE , INTERNAL : EPOXY			
PIPELINE LENGTH (Km)	145.965 (Approx.)			

ENGINEERS INDIA LIMITED
NEW DELHI

GAIL

PROJECT: KRISHNAGIRI - SALEM PIPELINE PROJECT (KCPL PH-I)
CLIENT : M/s GAIL (INDIA) LIMITED
JOB NO : B411

REV.	DATE	REVISION	BY	CHK	APPROVED
C	27.10.2022	REVISED & RE-ISSUED FOR COMMENTS	MKM	AG/TT	RK
B	19.09.2022	REVISED & RE-ISSUED FOR COMMENTS	MKM	AG/TT	RK
A	07.09.2022	ISSUED FOR COMMENTS	MKM	AG/TT	RK

SCHEMATIC ARRANGEMENT OF PIPELINE FACILITIES

DRAWING NO. B411-000-83-41-30001

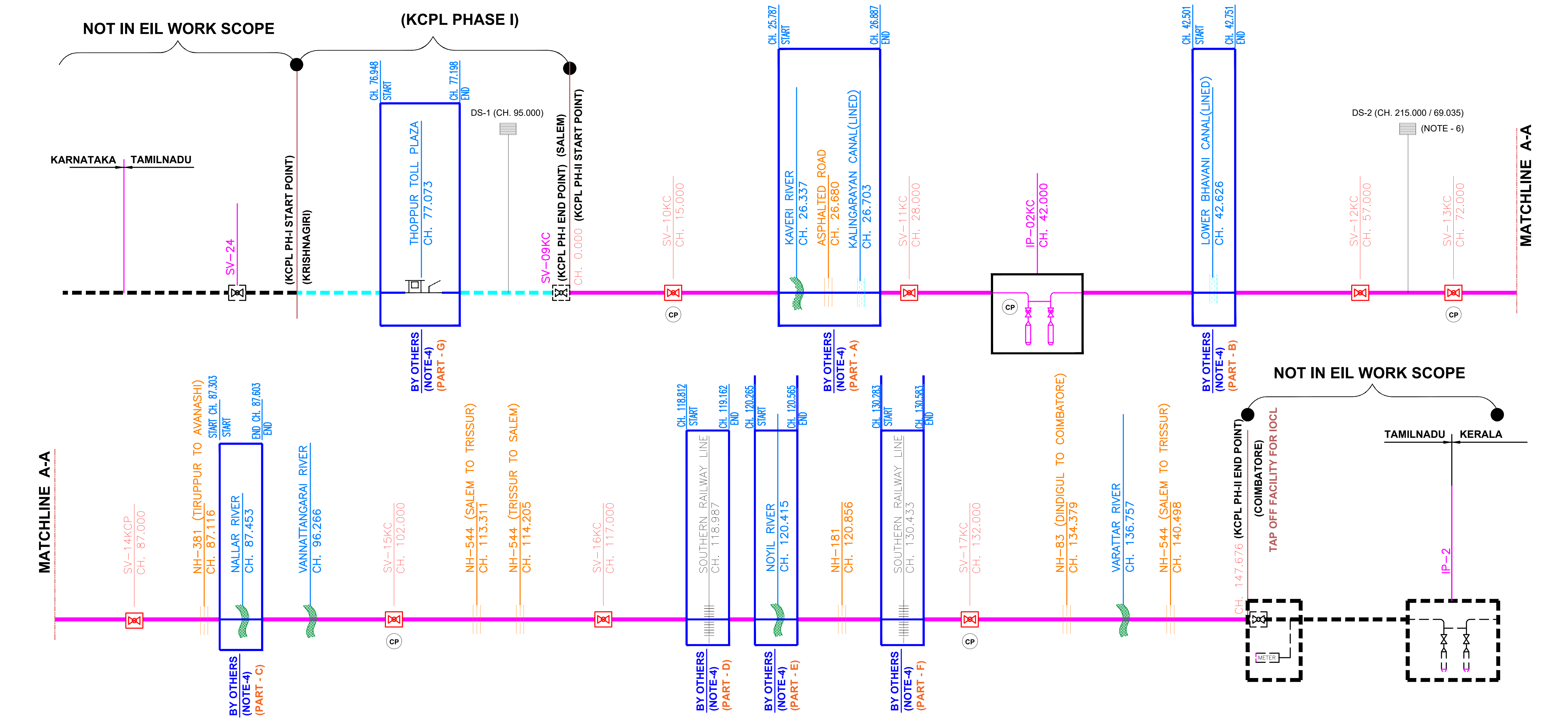
SHEET 1 OF 1

REV. C

ANNEXURE – III

SCHEMATIC ARRANGEMENT OF PIPELINE FACILITIES FOR KCPL PHASE- II (SALEM TO COIMBATORE)

SCOPE DRAWING FOR SALEM-COIMBATORE PIPELINE SECTION (KCPL PHASE-II)



LEGEND:-

IP	INTERMEDIATE PIGGING STATION		KCPL PH-II PIPELINE SCOPE
	SV - SECTIONALIZING VALVE		KCPL PH-I PIPELINE SCOPE
	SV - SECTIONALIZING VALVE (EXISTING)		KCPL PH-II SEPARATE HDD CONTRACTOR SCOPE
	RIVER CROSSING		24" EXISTING PIPELINE
	RAILWAY CROSSING		EXISTING FACILITIES
	NH - NATIONAL HIGHWAY CROSSING	CP	CATHODIC PROTECTION SYSTEM
	DS - DUMP SITE	KCPL	KRISHNAGIRI - COIMBATORE PIPELINE
	PIG LAUNCHER/ RECEIVER	KKBMPL	KOCHI - KOOTTANAD - BANGALURU-MANGALORE PIPELINE
	LINED CANAL CROSSING	TOP	TAP-OFF POINT
	TOLL PLAZA		

NOTES:

1. ALL CHAINAGES INDICATED ARE IN KM AND ARE AS PER THE DETAILED ROUTE SURVEY PROVIDED BY M/s GAIL VIDE EMAIL DATED 01.03.2023.
2. LOCATIONS OF IP & SV STATIONS ARE INDICATIVE ONLY & EXACT LOCATIONS SHALL BE FINALIZED DEPENDING ON AVAILABILITY OF PLOTS.
3. ALL SVs ON THE MAIN PIPELINE SHALL BE REMOTE OPERATED WITH GAS OVER OIL ACTUATORS.
4. PIPELINE INSTALLATION ACROSS THESE CROSSINGS SHALL BE CARRIED OUT BY HDD METHOD BY OTHER CONTRACTORS THROUGH SEPARATE CONTRACT.
5. ALL START & END CHAINAGES FOR THE HDD CROSSINGS (UNDER SEPARATE CONTRACT) ARE INDICATIVE AND SHALL BE FINALIZED BY THE HDD CONTRACTOR.
6. CH. 215.000 IS CUMULATIVE CHAINAGE AS PER FOA PROVIDED TO LINE PIPE CONTRACTOR AND SAME SHALL BE CONSIDERED AS CH. 69.035 KM WITH REFERENCE TO KCPL PHASE-II CHAINAGE.

DETAILS OF PIPELINE (KCPL PH-II)

DESIGN PRESSURE (kg/cm²(g))	92.0	DESIGN TEMPERATURE	-29°C to 65°C
PIPE OD (INCH)	24"	SERVICE	REGASSIFIED LNG
MATERIAL GRADE	API 5L GR. X70, PSL-2		
CORROSION ALLOWANCE (mm)	1.0		
WALL THICKNESS (mm)	CLASS-1&2	CLASS-3	CLASS-4
	10.8	12.7	15.5
COATING	EXTERNAL : 3 LPE , INTERNAL : EPOXY		
PIPELINE LENGTH (Km)	147.676 (Approx.)		

ENGINEERS INDIA LIMITED
NEW DELHI

PROJECT: KRISHNAGIRI - COIMBATORE PIPELINE PROJECT (KCPL PH-II)
CLIENT : M/s GAIL (INDIA) LIMITED
JOB NO : B411

REV.	DATE	REVISION	BY	CHK	APPROVED
C	22.06.23	REVISED & RE-ISSUED FOR INFORMATION	MKM	AG/TT	RK
B	26.05.23	REVISED & RE-ISSUED FOR INFORMATION	MKM	AG/TT	RK
A	10.05.23	ISSUED FOR INFORMATION	MKM	AG/TT	RK

SCOPE DRAWING
(KCPL PH-II)

DRAWING NO.: B411-000-83-41-31003
SHEET 1 OF 1
REV.: C

ANNEXURE – IV

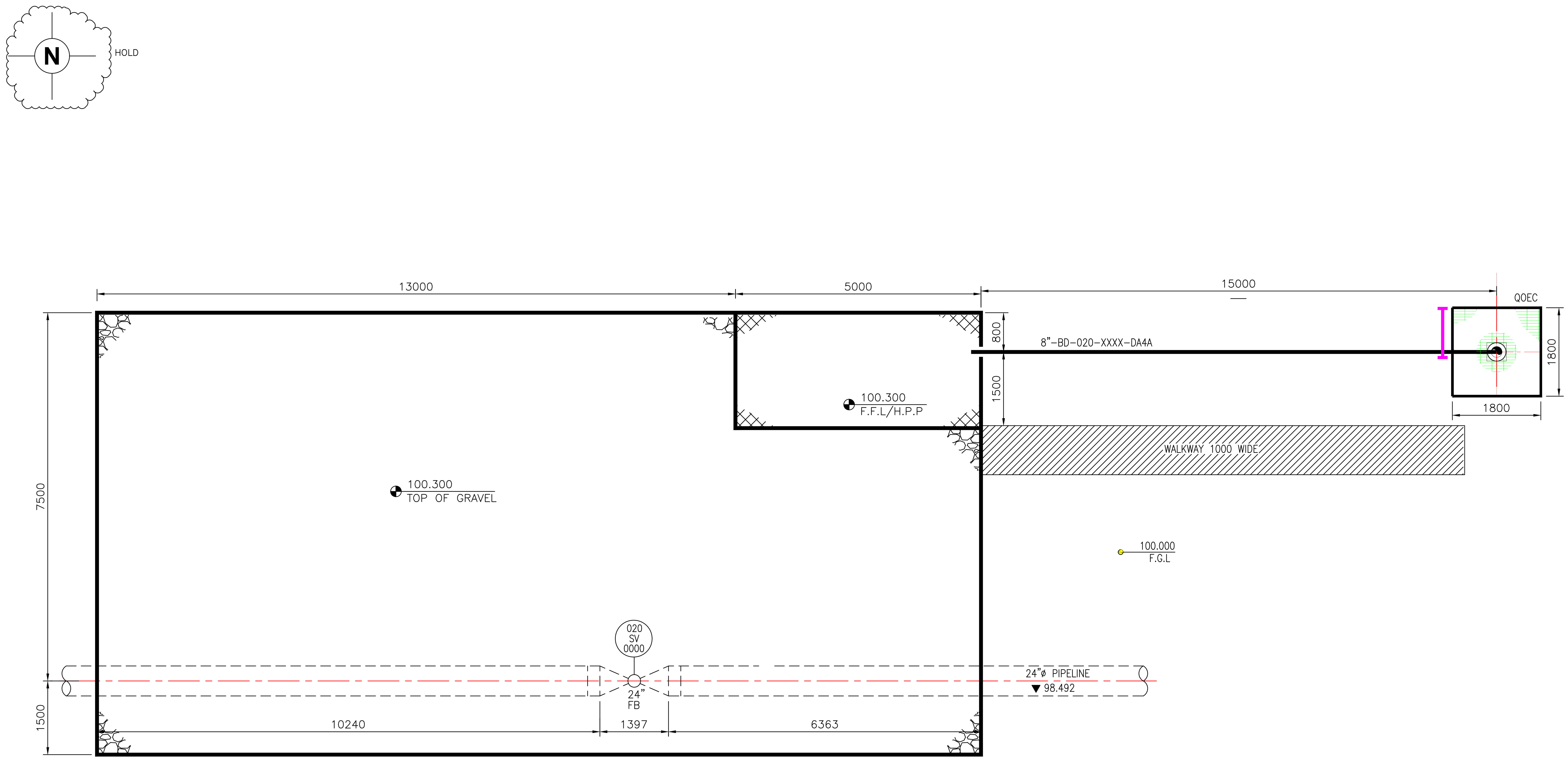
TYPICAL LAYOUT PLAN OF

SECTIONALIZING VALVE (SV) STATION

AND

INTERMEDIATE PIGGING STATION (IPS)

B411-000-83-41-10002



REF. DWG. NO.	REFERENCE DRAWING TITLE
B411-02-42-000-1102	P&ID
B411-020-83-41-SP-0010	PMS

NOTES :-

1. ALL DIMENSION ARE IN MM, CO-ORDINATES & LEVEL ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. REFERENCE ELEVATION 100.000 M CORRESPONDS TO FINISHED GRADE LEVEL.
3. ORIENTATION, NORTHING-EASTING AND KEY PLAN ETC. SHALL BE AS PER CIVIL PLOT PLAN.GRADE LEVEL.

LEGEND :

- LEVEL/ELEVATION
- FINISHED GRADE LEVEL (FGL)
- HPP — HIGHEST PAVEMENT POINT
- FFL — FINISHED FLOOR LEVEL
- FGL — FINISHED GRADE LEVEL
- PN — PLANT NORTH
- FLOOR/PAVED AREA

REV	DATE	REVISIONS	BY	CHKD	APPD	PEM/PC
A	06.08.2021	ISSUED FOR COMMENTS	ISH	MT	RK	

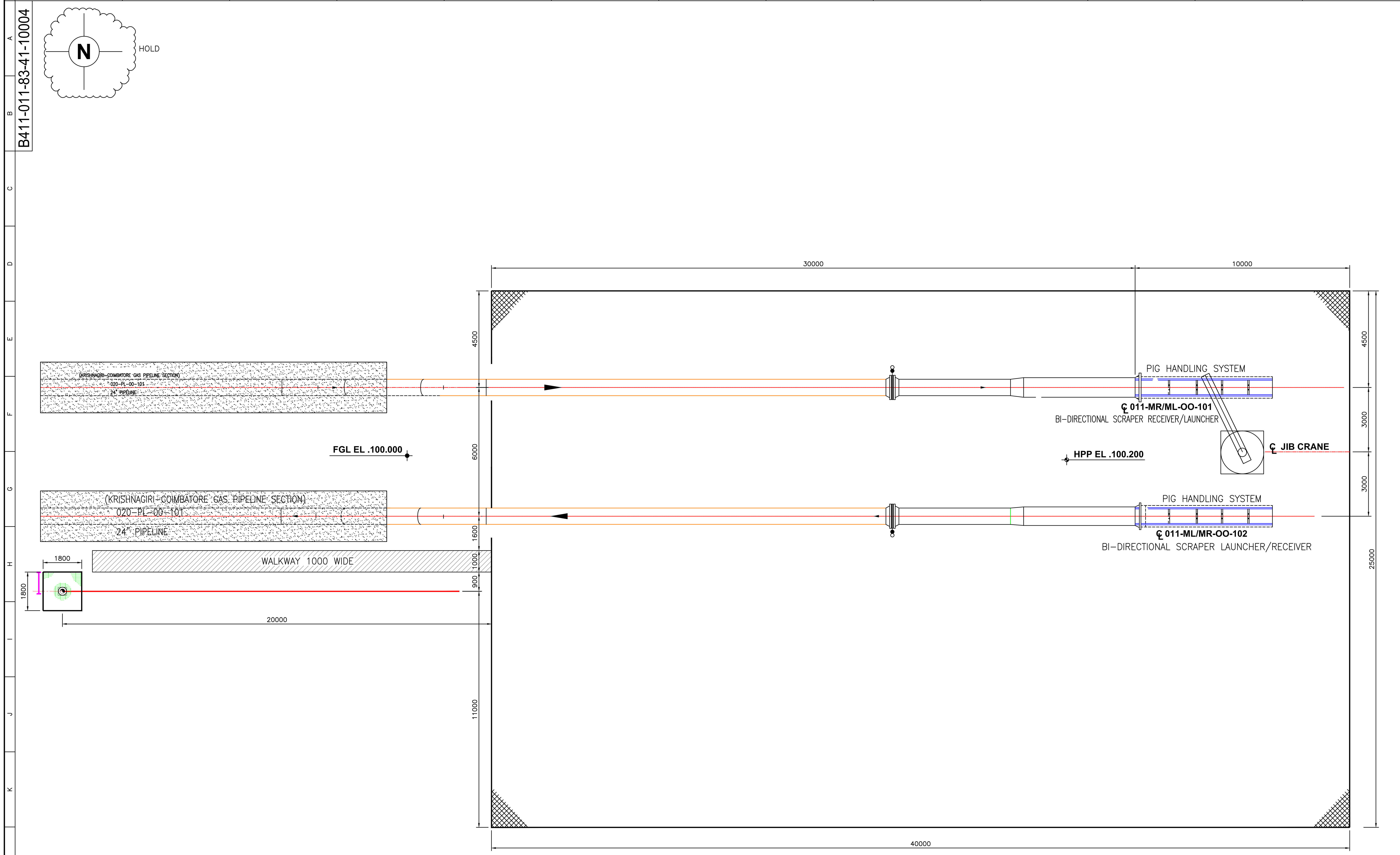
इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम)
ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

गेल (इंडिया) लिमिटेड
GAIL (INDIA) LIMITED

कृष्णागिरी-कोयम्बतुर पाइपलाईन परियोजना	KRISHNAGIRI-COIMBATORE PIPELINE PROJECT
उपकरण विन्यास एस.वी.स्टेशन (टिपिकल)	EQUIPMENT LAYOUT SV STATION (TYPICAL)

SCALE	JOB NO.	UNIT	DEPT.	SECT.	DWG. NO.	REV.
1:50	B 4 1 1	0 0 0	8 3	4 1	1 0 0 0 2	A

The drawing, design and details given on this format are the property of ENGINEERS INDIA LIMITED. They are merely loaned on the borrower's express agreement that they will not be reproduced, copied, exhibited or used, except in the limited way permitted by a written consent given by the lender to the borrower for the intended use.



REF. DWG. NO.	REFERENCE DRAWING TITLE
B411-02-42-011-1111	P&ID
B411-020-83-41-SP-0010	PMS

NOTES :-

1. ALL DIMENSION ARE IN MM, CO-ORDINATES & LEVEL ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. REFERENCE ELEVATION 100.000 M CORRESPONDS TO FINISHED GRADE LEVEL.
3. ORIENTATION, NORTHING-EASTING AND KEY PLAN ETC. SHALL BE AS PER CIVIL PLOT PLAN.GRADE LEVEL.

LEGEND :

◕	LEVEL/ELEVATION
●	FINISHED GRADE LEVEL (FGL)
HPP	HIGHEST PAVEMENT POINT
FFL	FINISHED FLOOR LEVEL
FGL	FINISHED GRADE LEVEL
PN	PLANT NORTH
(hatch)	FLOOR/PAVED AREA

REV.	DATE	REVISIONS	BY	CHKD	APPD	PEM/PC
A	06.08.2021	ISSUED FOR COMMENTS	ISH	MT	RK	

इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम)
ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

गेल (इंडिया) लिमिटेड
GAIL (INDIA) LIMITED

कृष्णागिरी-कोयम्बतुर पाइपलाईन परियोजना

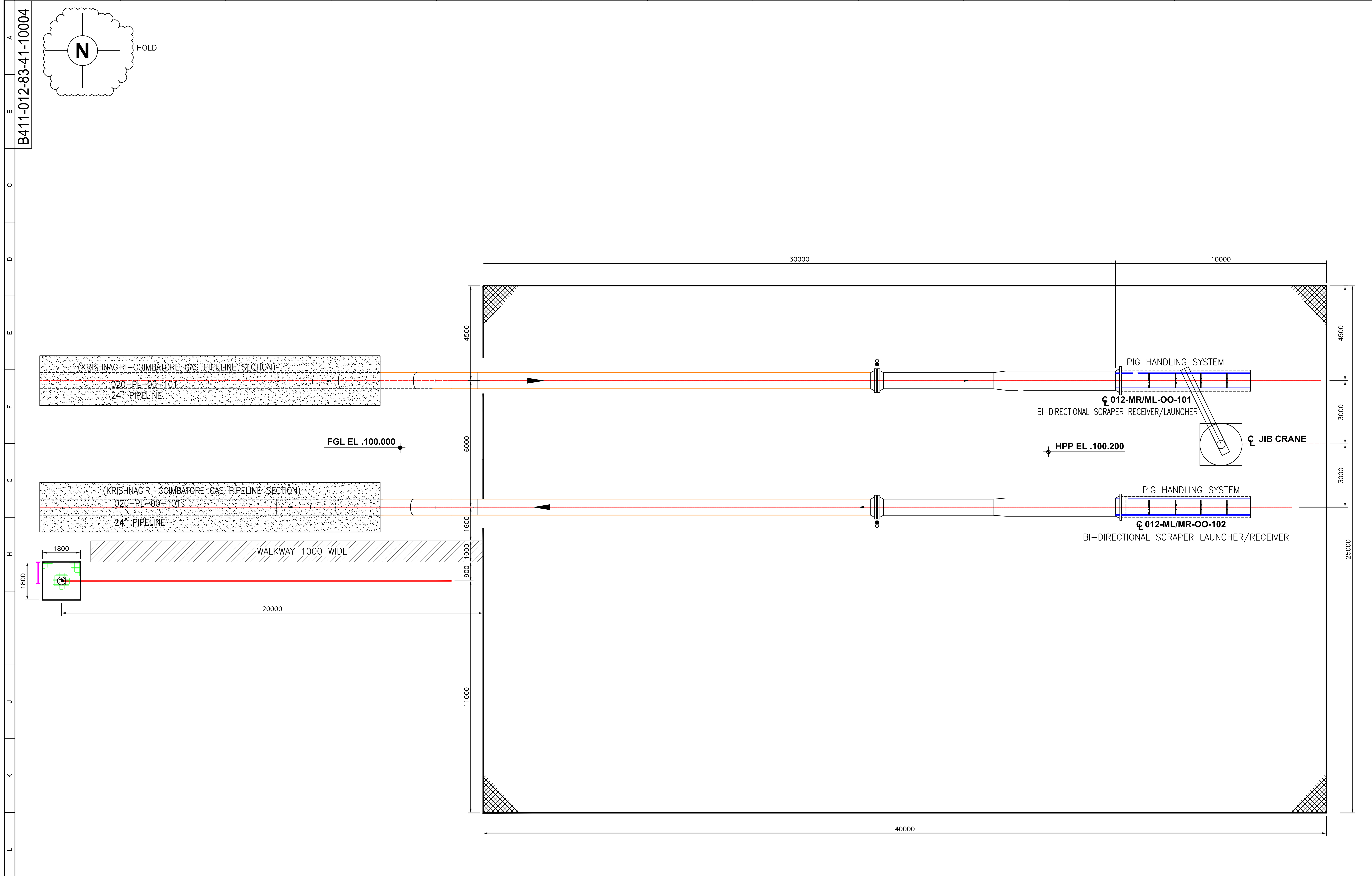
KRISHNAGIRI-COIMBATORE PIPELINE PROJECT

उपकरण विन्यास
इन्टरमीडिएट पिगिंग स्टेशन
(IPS-03)

EQUIPMENT LAYOUT
INTERMEDIATE PIGGING STATION
(IPS-03)

SCALE	JOB NO.	UNIT	DEPT.	SECT.	DWG. NO.	REV.
1:100	B 4 1 1	0 1 1	8 3	4 1	1 0 0 0 4	A

B411-012-83-41-10004



REF. DWG. NO.	REFERENCE DRAWING TITLE
B411-02-42-012-1112	P&ID
B411-020-83-41-SP-0010	PMS

NOTES :-

1. ALL DIMENSION ARE IN MM, CO-ORDINATES & LEVEL ARE IN METERS UNLESS OTHERWISE SPECIFIED.
2. REFERENCE ELEVATION 100.000 M CORRESPONDS TO FINISHED GRADE LEVEL.
3. ORIENTATION, NORTHING-EASTING AND KEY PLAN ETC. SHALL BE AS PER CIVIL PLOT PLAN.GRADE LEVEL.

LEGEND :

◒	LEVEL/ELEVATION
●	FINISHED GRADE LEVEL (FGL)
HPP	HIGHEST PAVEMENT POINT
FFL	FINISHED FLOOR LEVEL
FGL	FINISHED GRADE LEVEL
PN	PLANT NORTH
	FLOOR/PAVED AREA

REV	DATE	REVISIONS	BY	CHKD	APPD	PEM/PC
A	06.08.2021	ISSUED FOR COMMENTS	ISH	MT	RK	

इंजीनियर्स इंडिया लिमिटेड (भारत सरकार का उपक्रम)
ENGINEERS INDIA LIMITED (A Govt. of India Undertaking)

गेल (इंडिया) लिमिटेड
GAIL (INDIA) LIMITED

कृष्णागिरी-कोयम्बतुर पाइपलाईन परियोजना	KRISHNAGIRI-COIMBATORE PIPELINE PROJECT
उपकरण विन्यास इन्टरमीडिएट पिगिंग स्टेशन (IPS-04)	EQUIPMENT LAYOUT INTERMEDIATE PIGGING STATION (IPS-04)

SCALE	JOB NO.	UNIT	DEPT.	SECT.	DWG. NO.	REV.
1:100	B 4 1 1	0 1 2	8 3	4 1	1 0 0 0 4	A

file name : 013-1943_Rev.A

3-1641-0501 REV.2 A1-841x594

ANNEXURE – V

RAPID RISK ASSESSMENT (RRA)

STUDY REPORT

RAPID RISK ANALYSIS STUDY REPORT FOR KRISHNAGIRI-SALEM- COIMBATORE (PHASE-1 & 2 OF KCPL) Section of Kochi-Koottanad-Bangalore-Mangalore (KKBMPL-II) pipeline

Rev. No	Date	Purpose	Prepared by	Reviewed by	Approved by
0	31.01.2024	ISSUED AS FINAL	WA	RSK	DK
A	08.01.2024	ISSUED AS DRAFT FOR COMMENTS	WA	RSK	DK

PREFACE

As part of the execution of Phase 1 and 2 of the KCPL section of KKBML-II Project, M/s Engineers India Limited (EIL) has been entrusted by M/s GAIL (INDIA) LTD, for undertaking the Rapid Risk Analysis (RRA) Study of the Project facilities.

RRA Study identifies the various hazards related to loss of containment events associated within the facility, analyses their potential consequences draws suitable conclusions and provides necessary recommendations to mitigate the hazard with certain recommendations to minimize the consequence.

This RRA Study Report is based on the various data, information made available to the study team during the beginning and progress of the study and EIL's own data source for similar process facilities.

EIL has exercised all reasonable skill, care and diligence in carrying out the study. However, this report is not deemed to be any undertaking, warrantee or certificate.

TABLE OF CONTENTS

LIST OF FIGURES:

LIST OF ANNEXURES:

SECTION-1
EXECUTIVE SUMMARY

1.1 INTRODUCTION

GAIL (India) Limited, the largest state-owned Natural gas Processing and Distribution Company and the youngest Maharatna, is executing Kochi–Koottanad–Bangalore–Mangalore Natural Gas Pipeline (KKBMPL) project in two phases. Pipelines under Phase-I have been completed and commissioned. Under Phase-II, 30”/24” trunk pipelines are being laid covering the states of Kerala, Karnataka & Tamilnadu. Execution of Phase-II is divided into various sections and these are at various stages of completion.

The KKBMPL-II project is having a total main pipeline length of approx. 891 Km excluding spur lines (which includes approx. 450 Km of Kochi-Mangalore section and approx. 441 Km of Koottanad-Bangalore pipeline; these pipeline lengths are indicative only). The Krishnagiri – Coimbatore (KCPL) section is part of Koottanad-Bangalore pipeline of KKBMPL-II.

GAIL has engaged Engineers India Limited (EIL) for providing the Project Management Consultancy (PMC) services for Execution of Krishnagiri – Coimbatore section (KCPL) of KKBMPL-II.

In view of the phase wise permission being granted by District & State Administrations of Tamil Nadu, construction activities of Krishnagiri – Coimbatore section are being taken up in two phases viz.

Phase 1: Krishnagiri – Salem (covering Krishnagiri, Dharmapuri & Salem Districts);

Phase 2: Salem – Coimbatore (covering Namakkal, Erode, Tiruppur & Coimbatore Districts)

M/s Engineers India Limited (EIL) has been entrusted by M/s GAIL (India) Limited under the project scope of Krishnagiri – Coimbatore Section for KKBML-II Pipeline Project for undertaking the Rapid Risk Analysis study of the facilities under this project.

Rapid Risk Analysis study identifies the various hazards related to loss of containment events associated with the proposed facility, analyses their potential consequences draws suitable conclusions and provides necessary recommendations/mitigation measures to reduce the consequence.

1.2 APPROACH METHODOLOGY

RRA study evaluates the consequences of potential failure scenarios, assess extent of damages based on damage criteria's and suggest suitable measures for mitigating the Hazard. RRA involves identification of various potential hazards & credible failure scenarios for various systems based on their frequency of occurrence & resulting consequence. Basically two types of scenarios are identified spanning across various process facilities; Cases with high chance of Occurrence but having low consequence, e.g., Instrument Tapping Failure and cases with low Chance of occurrence but having high consequence, e.g. Full-Bore Rupture of pipeline, Catastrophic Rupture of Pressure Vessels / Large Hole on the outlet of Pressure Vessels. Effect zones for various outcomes of failure scenarios (Flash Fire, Jet Fire, Blast overpressure etc.) are studied and identified in terms of distances on plot plan of each facility of the Pipeline. Based on effect zones, measures for mitigation of the hazard are suggested.

.

1.3 MAJOR OBSERVATIONS & RECOMMENDATIONS OF THE STUDY

The detailed consequence due to release of hydrocarbon gas in case of various credible failure scenarios modeled in terms of release rate, dispersion, flammability and characteristics etc., as applicable have been discussed in detail in this report at various locations.

Based on the assessment of the software output for consequence analysis, major findings and recommendations arising out of this study are summarized in sections below.

ANALYSIS & RECOMMENDATIONS BASED ON CONSEQUENCE MODELING

1. **Typical SV (Annexure-I):** Jet fire radiation intensity of 12.5 kW/m2 is realized up to ~9 m and may impact on eastern side of SV station for u/g leak case. Jet fire radiation intensity of 37.5 kW/m2 is realized up to ~16 m and may impact on eastern side of SV station for a/g leak case. Overpressure explosion distance for 5 psi is reaching upto 22 -25 m in case of 20 mm A/G case. Results for large leak i.e. 50 mm A/G case may be utilized for emergency response plan preparation

   It is recommended to:

- Ensure that entry & exit of guard room are outside of the 12.5 kW/m2 contour of jet fire zone (i.e. 11 meter from SV leak source) to protect the guard room occupant from injury due to fire radiation.
- Ensure safe escape and evacuation plan is in place for guard room occupants in this

scenario.

- Provide flammable gas detectors near Sectionalizing Valve (SV). Procedures to be developed for remote closure of Sectionalizing valves in case of leak detection to prevent further escalation of hazardous consequences.
- SV Stations remains unmanned hence no major hazard considered.

2. IPS-1 & IPS-2

The 50 mm leak(large) and pipeline full bore rupture failure frequency is very low so it is suggested to consider all these failure cases hazardous distances as provided in "**Annexure-I"** for emergency response plan and same shall be included in ERDMP of this pipeline facility.

It is recommended to:

- Ensure that entry & exit of guard room are outside of the 12.5 kW/m2 contour of jet fire zone to protect the guard room occupant from injury due to fire radiation.
- Ensure safe escape and evacuation plan is in place for guard room occupants in this scenario.
- Provide flammable gas detectors at each IPS.
- IPS remains unmanned hence no major hazard considered.
- Large leak/breach case probability is very less; hence results may be utilized for ERDMP.
- Regular mock drills to be conducted for remaining alert and ready to handle any unforeseen case.

3. General Recommendations for pipeline facilities:

<u>Preventive Measures</u>

In order to reduce the leakage scenario from pipeline, the following preventive measures are recommended:

- Suitable measures shall be considered to prevent the leakage of the pipeline during the design engineering stage (i.e. pipeline thickness, material selection, corrosion allowance, cathodic protection for buried pipeline, corrosion monitoring system etc. should be considered suitably)
- Periodic health check of instruments and maintenance of piping are required to be ensured. Periodic calibration of instruments and testing of alarms, trips & interlocks should be given due attention.

- Pipeline section passing through seismic zone (if required) to be suitably designed for earthquake resistance.

Mitigating Measures:

Mitigating measures are those measures in place to minimize the damage due to loss of containment event and hazards arising out of Loss of containment. These include:

- Rapid detection of an uncommon event (HC, Flame etc.) and alarm arrangement at all stations along the pipeline route and development of subsequent quick isolation mechanism for major inventory
- Measures for controlling / minimization of Ignition sources inside the operating area.
- Active and Passive Fire Protection for critical equipment's and major structures as per the standard/code.
- Effective emergency response plan shall be in place for the pipeline facilities.

Detection and isolation:

In order to ensure rapid detection of a hazardous event, it is recommended to ensure installation of Hydrocarbon gas detectors at strategic location for early detection and prevention of any major accidental event emanating from the facilities. Once the flammable gas release has been detected, subsequent fire and escalation risk will be reduced by isolation of the major inventory from the release location. Hence, manual / automated mechanism is required to isolate the major inventory during any major credible hazardous event. It is recommended that the station piping should be considered to have remote operated valves so that these valves can be closed from the safe location upon fire or flammable gas detection. Adequate leak detection and surveillance system i.e. CCTV is to be adopted.

Ignition control:

Ignition control will reduce the likelihood of fire events. This is the key for reducing the risk within the IP/SV stations facilities. As part of mitigation measure, it is strongly recommended to minimize the traffic movement (to the extent possible) on road adjacent to the station area during leakage. Smoking and sustaining open flame inside any installation premise shall be prohibited.

Escape routes:

Provide windsocks throughout the facility to ensure visibility from all locations. This will enable people to escape upwind or crosswind from flammable releases. Sufficient escape routes from the facility should be provided to allow redundancy in escape from all areas.

Other Measures

The pipeline should be suitably protected (from external interferences and other failure modes) through the following measures:

- Pipeline integrity monitoring through pigging operation, external Inspection of coating and monitoring of dents, dent-gouges of pipeline (for above ground / buried pipeline as applicable) should be suitably planned to be taken up at regular intervals /as per relevant codal requirements (e.g. PNGRB, OISD etc).
- Patrolling frequency of pipeline sections located in densely populated areas shall be given priority. Consider a reliable leak and intrusion detection system to detect leak at the initial stage to avoid escalation. Procedure for quick isolation through remotely operated valves upon detection should be in place.
- Since most incidents on buried pipelines are caused by external interference (digging, ploughing or drilling in the vicinity of the pipeline), it is recommended that frequent patrolling and pipeline inspection to be instituted so as to enable early detection and cession of all such activities near the pipeline. Further, regular Line Patrolling to be carried out on a defined time schedule.
- Signboards/Pipeline markers as required with important details should be installed all along the pipeline route. Efforts have to be made to educate/make aware the community living nearby about the potential hazards of pipeline leakage and to report the pipeline incidents, if any to the control center.
- Active fire protection system shall be provided at SVs & IP as per the relevant standard/code for preventing escalation of fire.
- Ensure there are no HT power cable crossing over the process facility in SVs & IP stations.
- It shall be ensured that all the vehicles entering the SVs & IP shall be provided with spark arrestors at the exhaust.

SECTION-2
INTRODUCTION

2.1 STUDY AIMS AND OBJECTIVE

The major objective of any Risk Analysis Study is to identify and quantify all potential failure modes that may lead to possible hazardous consequences. Typical hazardous consequences arising from loss of containment event of failure scenarios include Fire, Explosion and Toxic release events.

The Risk Assessment Study also identifies potential hazardous consequences having impacts on population and property in the vicinity of the facilities, and provides information necessary in developing strategies to prevent accidents and formulate the Disaster Management Plan.

The Risk Assessment Study includes the following steps;

a) Identification of failure cases within the process facilities;
b) Evaluate process hazards emanating from the identified potential accident scenarios;
c) Analyze the damage effects to surroundings and populations due to such incidents &
d) Suggest mitigating measures to reduce the hazard/risk.

The RRA Study of the proposed facility has been carried out using the risk assessment software program PHAST ver. 8.4 developed by DNV Technica.

2.2 SCOPE OF WORK

The study addresses the hazards that can be realized due to operations associated with the proposed KCPL (Phase 1 and 2) section of KKBML-II Pipeline Project facilities.

2.3 STUDY METHODOLOGY

Brief descriptions of the major steps involved in RRA study of the project facilities are provided below.

Data Collection:

Under this task, relevant data is obtained with respect to the site, its surroundings, Operating Parameters of facilities, P&IDs, Equipment/Instrument Datasheets, Equipment layouts as well as Plot Plan of all the Stations/Terminals.

Hazard Identification:

A hazard is an undesired situation or event which may cause harm to people or to the environment, or damage to property. The main hazard from pipeline process facilities is that of an uncontrolled release of gaseous hydrocarbons which may subsequently be ignited and cause damage. The causes and consequences of the major hazards with respect to the various stations/pipeline sections have been studied under this task based on historical accidents at similar installations, past experience & expert judgment.

Consequence Analysis:

The consequences of releases of hydrocarbons material have been modeled in terms of release rate, dispersion, flammability characteristics. *However, since the gas contains no toxic components hence no toxic analysis has been done in this study.*

Recommendations:

Effect zones for various outcomes of different failure scenarios (Flash Fire, Jet Fire, Blast overpressure etc.) are studied and identified in terms of distances on respective plot plan. Based on effect zones, measures for mitigation of the hazard / risk are suggested in the report.

SECTION-3
SITE CONDITION

3.1 GENERAL

This chapter describes the site condition of the of Krishnagiri – Coimbatore section (KCPL) of KKBMPL-II pipeline Project and population distribution in and around the facility. It also highlights the meteorological data, which have been used for the RRA Study.

3.2 SITE, LOCATION AND VICINITY

Krishnagiri – Coimbatore section (KCPL) of KKBMPL-II pipeline Project has a total length of 294 km bidirectional and it will traverse through the state of Tamil Nadu. The meteorological data assumed same along the length of the pipeline.

Snapshot of the Krishnagiri – Coimbatore section (KCPL) of KKBMPL-II pipeline Project Pipeline route is provided below;

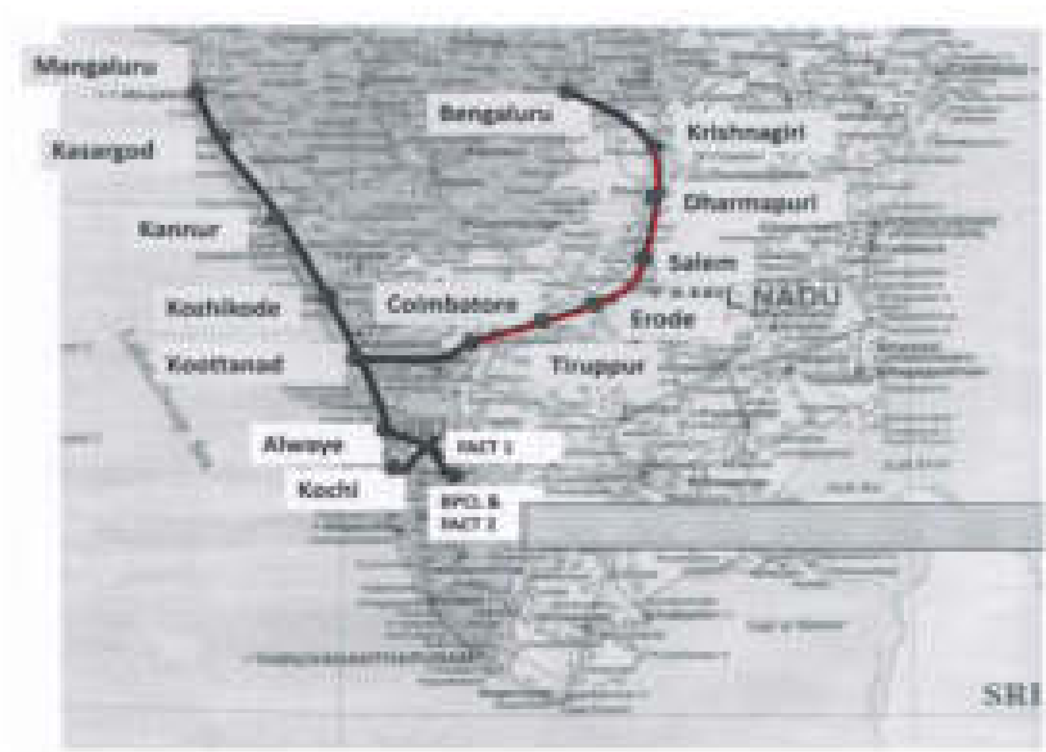


Figure 3.1: Snapshot of Krishnagiri – Coimbatore section (KCPL-1&2) of KKBMPL-II Pipeline Project

3.3 METEOROLOGICAL CONDITIONS DATA

The consequences of released flammable material are largely dependent on the prevailing weather conditions. For the assessment of major scenarios involving release of flammable materials, the most important meteorological parameters are those that affect the atmospheric dispersion of the escaping material. The crucial variables are wind direction, wind speed, atmospheric stability and temperature. Rainfall does not have any direct bearing on the results of the risk analysis; however, it can have beneficial effects by absorption/washout of released materials. Actual behavior of any release would largely depend on prevailing weather condition at the time of release.

The details of Phase-1 of KCPL section of KKBMPL-II are as below:

S. No.	Section	Type : Trunk/Spur Line	Details of Pipeline			State
			Size (Inch)	Length (Km)	Rating	
1	Krishnagiri – Salem (Phase-1 of KCPL)	Trunk Line	24	145.8Approx. (Note-1)	600#	Tamilnadu

Note-1: The exact length shall be as per pipeline engineering documents.

The details of Phase-2 of KCPL section of KKBMPL-II are as below:

S. No.	Section	Type : Trunk/Spur Line	Details of Pipeline			State
			Size (Inch)	Length (Km)	Rating	
1	Salem–Coimbatore (Phase-2 of KCPL)	Trunk Line	24	147.67 Approx.	600#	Tamilnadu

Note-1: The exact length shall be as per pipeline engineering documents.

For weather data of leak location, meteorological data of nearest available city from IMD table is used. Nearest applicable weather data locations used is Salem, Tamil Nadu

Atmospheric Parameters:

The Climatological data which have been used for the RRA Study is summarized below;

Table 3.2: Atmospheric Parameters of Salem

S. No.	Parameter	Average Value Considered For Study
1.	Ambient Temperature (^oC)	31

2.	Atmospheric Pressure (h Pa)	972.65
3.	Relative Humidity (%)	52
4.	Solar Radiation flux (cal/cm^{2}hr)	40.31

Wind Speed:

The average mean wind speed at selected IMD location based upon climatological Normal(1991-2020) selected for the study purpose is as mentioned in the table below;

Table 3.3: Average Mean Wind Speed (kmph)

Location	Jan	Feb	Mar	April	May	June	July	Aug	Sep	Oct	Nov	Dec
Salem	3.4	3.9	3.8	3.7	4.0	5.1	4.9	4.1	3.4	2.2	2.0	2.4

Weather Category:

One of the most important characteristics of atmosphere is its stability. Stability of atmosphere is its tendency to resist vertical motion or to suppress existing turbulence. This tendency directly influences the ability of atmosphere to disperse pollutants emitted into it from the facilities. In most dispersion scenarios, the relevant atmospheric layer is that nearest to the ground, varying in thickness from a few meters to a few thousand meters. Turbulence induced by buoyancy forces in the atmosphere is closely related to the vertical temperature gradient.

Temperature normally decreases with increasing height in the atmosphere. The rate at which the temperature of air decreases with height is called Environmental Lapse Rate (ELR). It will vary from time to time and from place to place. The atmosphere is said to be stable, neutral or unstable according to ELR is less than, equal to or greater than Dry Adiabatic Lapse Rate (DALR), which is a constant value of 0.98 °C/100 meters.

Pasquill stability parameter, based on Pasquill – Gifford categorization, is such a meteorological parameter, which describes the stability of the atmosphere, i.e., the degree of convective turbulence. Pasquill has defined six stability classes ranging from `A' (extremely unstable) to `F' (stable). Wind speeds, intensity of solar radiation (daytime insolation) and night time sky cover have been identified as prime factors defining these stability categories.

Table provided below indicates the various Pasquill stability classes.

Table 3.4: Pasquill Stability Classes

Surface Wind Speed (meter/s)	Insolation			Night	
	Strong	**Moderate**	**Slight**	**Thinly overcast or > 4/8 low cloud**	**<= 4/8 cloud**
< 2	A	A – B	B	E	F
2 – 3	A – B	B	C	E	F
3 – 5	B	B – C	C	D	E
5 – 6	C	C – D	D	D	D
> 6	C	D	D	D	D

Source: PHAST Manual

A = Very unstable, B = Unstable, C = moderately unstable

D = Neutral, E = moderately stable, F = stable

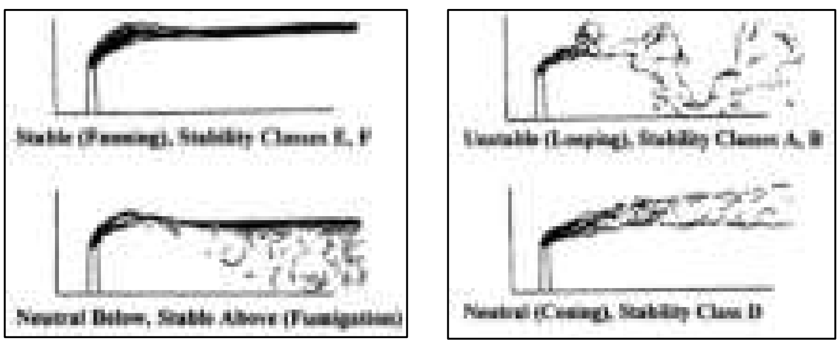


Figure 3.2: Effect of Atmospheric Stability on Plume Dispersion

Source: Guidelines for Chemical Process Quantitative Risk Analysis by Center for Chemical Process Safety of the American Institute of Chemical Engineers

A = Very unstable *B = Unstable*
C = moderately unstable *D = Neutral*
E = moderately stable *F = stable*

When the atmosphere is unstable and wind speeds are moderate or high or gusty, rapid dispersion of pollutants will occur. Under these conditions, pollutant concentrations in air will be moderate or low and the material will be dispersed rapidly. When the atmosphere is stable and wind speed is low, dispersion of material will be limited and pollutant concentration in air will be high. In general, worst dispersion conditions (i.e. contributing to greater hazard distances) occur during low wind speed and very stable weather conditions, such as that at 1/F weather condition (i.e. 1 m/s wind speed and Pasquill Stability class F).

Stability category for the present study is identified based on the insolation data, cloud amount and wind speed at the respective location. For risk analysis, the representative average annual weather conditions for the plant are assessed and considered to be the following;

Table 3.5: Selected Weather Conditions

Location	Wind Speed (m/s)	Stability Class
Salem	**2**	**F**
	3	**D**

SECTION-4

HAZARDS ASSOCIATED WITH THE FACILITIES

4.1 GENERAL

Pipeline is handling the Natural gas which is flammable in nature and has a potential to cause jet fire & explosion on loss of containment events affecting surrounding environment, asset and population. This chapter describes in brief the hazards associated with Natural gas.

4.2 HAZARDS ASSOCIATED WITH GASEOUS HYDROCARBON

Rupture of a piping or holes in a piping transporting hydrocarbon gas can lead to damage effects that can pose a hazard to the surrounding area. The hazard can take the following forms;

- Accidental release of gases from a high-pressure source usually results in a turbulent jet. If ignited, this would form a jet flame. Such a flame impingement causes structural weakness and in turn can cause extensive damage and failure. Thermal radiation due to jet fire can cause various degrees of burns on human body and would pose a potential radiation hazard. Jet fire can also lead to damage of inanimate objects like equipment, piping or vegetation.
- Low pressure vapor release or impinged release will normally spread out in the direction of wind. If it finds an ignition source before being dispersed below Lower Flammability Limit (LFL), a flash fire is likely to occur and the flame may travel back to source of leak. Any person caught in the flash fire is likely to suffer fatal burn injury. In consequence analysis, the distance to LFL value is usually taken to indicate the area, which may be affected by flash fire. Any other combustible materials within the flash fire distance are also likely to catch fire and secondary fire may ensue. In the area close to source of hydrocarbon leak, there is a possibility of oxygen depletion.

SECTION-5
HAZARD IDENTIFICATION

5.1 GENERAL

A classical definition of hazard states that hazard is in fact the characteristic of system/plant/process that presents potential for an accident. Hence, all the components of a system/plant/process need to be thoroughly examined in order to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

In Risk Analysis terminology a hazard is something with the potential to cause harm. Hence, the Hazard Identification step is an exercise that seeks to identify what can go wrong at the major hazard installation or process in such a way that people may be harmed. The output of this step is a list of events that need to be passed on to later steps for further analysis.

The potential failure cases leading to various hazards posed by the facility under the Project scope were identified based on the past accidents, lessons learnt and a checklist. This list of various failure cases includes the following elements.

- Pin hole leak
- Flange leak
- Small hole; cracks or small bore failure (i.e. instrument tapping failure, drains/vents failure etc.) in piping/pipeline
- Large hole in the piping/pipeline
- Full bore rupture of Pipeline Sections

5.2 MODES OF FAILURE

There are various potential sources of flammable hydrocarbon leakage into the atmosphere. These could be in form of gasket failure in flanged joints, bleeder valve left open inadvertently, an instrument tubing giving way, pump seal failure, guillotine failure of equipment/piping or any other source of leakage. Operating experience can identify lots of these sources and their modes of failure. A list of general equipment and piping failure mechanisms is as follows;

Material/Construction Defects

- Incorrect selection or supply of materials of construction
- Incorrect use of design codes
- Weld failures

- Failure of inadequate piping supports

Pre-Operational Failures

- Failure induced during delivery at site
- Failure induced during installation
- Pressure and temperature effects
- Overpressure
- Temperature expansion/contraction (improper stress analysis and support design)
- Low temperature brittle fracture (if metallurgy is incorrect)
- Fatigue loading (cycling and mechanical vibration)

Corrosion Failures

- Internal corrosion (e.g. ingress of moisture)
- External corrosion
- Cladding/insulation failure (e.g. ingress of moisture)
- Cathodic protection failure, if provided

Failures due to Operational Errors

- Human error
- Failure to inspect regularly and identify any defects

External Impact Induced Failures

- Dropped objects
- Impact from transport such as construction traffic
- Vandalism
- Subsidence
- Strong winds

Failure due to Fire

- External fire impinging on piping or equipment
- Rapid vaporization of cold liquid in contact with hot surfaces

5.3 SELECTED FAILURE CASES

A list of selected failure cases was prepared based on process knowledge, engineering judgment, experience, past incidents associated with such facilities and considering the general mechanisms for loss of containment events. A list of cases has been identified for the consequence analysis study based on the following;

- Cases with high chance of occurrence but having low/high consequence: Example of such failure cases includes pin hole leak, two-bolt gasket leak for flanges, instrument tapping failure (10 and 20 mm) etc. The consequence results will provide enough data for planning routine safety exercises. This will emphasize the area where operator's vigilance is essential.
- Cases with low chance of occurrence but having high consequence (example includes large hole (50 mm) on the buried pipeline sections & above ground pipeline facilities and full bore rupture of the buried pressurized pipeline etc.).

This approach ensures that at least one representative case of all possible types of accidental failure events leading to loss of containment is considered for the consequence analysis.

For detail analysis of the consequences due to these failure scenarios refer Section-6 of this Report.

SECTION-6

CONSEQUENCE ANALYSIS

6.1 GENERAL

Consequence analysis involves the application of the mathematical, analytical and computer models for calculation of the effects and damages subsequent to a hydrocarbon/toxic release accident.

Computer models are used to predict the physical behavior of hazardous incidents. The model uses below mentioned techniques to assess the consequences of identified scenarios;

- Modeling of discharge rates when holes develop in process equipment/pipe work;
- Modeling of the size & shape of the flammable gas clouds from releases in the atmosphere;
- Modeling of the flame and radiation field of the releases that are ignited and burn as jet fire and flash fire;
- Modeling of the explosion fields of releases which are ignited away from the point of release.

The different consequences (Flash Fire, Jet Fire and Explosion Effects) of loss of containment accidents depend on the sequence of events & properties of material released leading to the either toxic vapor dispersion, fire or explosion or both.

6.2 CONSEQUENCE ANALYSIS MODELLING

6.2.1.1 DISCHARGE RATE

The initial rate of release through a leak depends mainly on the pressure inside the equipment, size of the hole and phase of the release (liquid, gas or two-phase). The release rate decreases with time as the equipment depressurizes. This reduction depends mainly on the inventory and the action taken to isolate the leak and blow-down the equipment.

6.2.1.2 DISPERSION

Releases of gas into the open air form clouds whose dispersion is governed by the wind, by turbulence around the site, the density of the gas and initial momentum of the release. In case of flammable materials the sizes of these gas clouds above their Lower Flammable Limit (LFL) are important in determining whether the release will ignite. In this study, the results of dispersion modeling for flammable materials are presented through LFL value.

6.2.1.3 FLASH FIRE

A flash fire occurs when a cloud of vapors/gas burns without generating any significant overpressure. The cloud is typically ignited on its edge, remote from- the leak source. The combustion zone moves through the cloud away from the ignition point. The duration of the flash fire is relatively short but it may stabilize as a continuous jet fire from the leak source. For flash fires, an approximate estimate for the extent of the total effect zone is the area over which the cloud is above the LFL value.

6.2.1.4 JET FIRE

Jet fires are burning jets of gas or atomized liquid whose shape is dominated by the momentum of the release. The jet flame stabilizes on or close to the point of release and continues until the release is stopped. Jet fire can be realized, if the leakage is immediately ignited. The effect of jet flame impingement is severe as it may cut through equipment, piping or structure. The damage effect of thermal radiation is depended on both the level of thermal radiation and duration of exposure.

6.2.1.5 VAPOR CLOUD EXPLOSION

A vapor cloud explosion (VCE) occurs if a cloud of flammable gas burns sufficiently quickly to generate high overpressures (i.e. pressures in excess of ambient). The overpressure resulting from an explosion of hydrocarbon gases is estimated considering the explosive mass available to be the mass of hydrocarbon vapor between its lower and upper explosive limits.

6.3 SIZE AND DURATION OF RELEASE

Leak/Rupture size considered for selected failure cases are listed below. Leak/Rupture sizes considered here are representative hole sizes in the upstream/downstream circuit of particular equipment for which failure scenario has been considered.

Table 6.1: Size of Leak/Event Considered for RRA Study

Failure Description	Leak /Event Size
Instrument Tapping Failure	10 mm
Medium Hole in the Piping/Pipeline	20 mm
Large Hole in the Piping/Pipeline	50 mm

The discharge duration from equipment/pipeline/piping is taken as 10 minutes in the analysis for continuous release scenarios (for leaks) as it is assumed that it would take pipeline personnel about 10 minutes to take appropriate action. However, in case of leakage in pipeline system having large inventory, leak may not be stopped within 10 min even after isolation of the respective above ground / buried pipeline section and it may continue even for longer duration. Although the time taken for stopping the leak would be more than 10 mins, however from consequence point of view the maximum hazardous distances are reached within a short time of the failure event due to reaching of the steady state of the dispersing gas plume hence release duration has been considered 10 mins for all failure cases except full bore rupture where complete inventory between pipeline section has been considered for analysis.

6.4 DAMAGE CRITERIA

In order to appreciate the damage effect produced by various leak/rupture scenarios, physiological/physical effects of the blast wave, thermal radiation & vapor exposition are discussed in various subsections below;

6.4.1.1 LFL OR FLASH FIRE

Hydrocarbon vapor released accidentally will spread out in the direction of wind. If a source of ignition finds an ignition source before being dispersed below lower flammability limit (LFL), a flash fire is likely to occur and the flame will travel back to the source of leak. Any person caught in the flash fire is likely to suffer fatal burn injury. Therefore, in consequence analysis, the distance of LFL value is usually taken to indicate the area, which may be affected by the Flash Fire zone.

Flash Fire (LFL) events are considered to cause direct harm to the population present within the flammability range of the cloud. Fire escalation from Flash Fire such that process or storage equipment or building may be affected is considered unlikely.

6.4.1.2 THERMAL HAZARD DUE TO JET FIRE AND FIRE BALL

Thermal radiation due to Pool Fire, Jet Fire or Fireball may cause various degrees of burn on human body and damage to process equipment. The damage effect due to thermal radiation intensity is tabulated below.

Table 6.2: Damage Effects due to Incident Thermal Radiation Intensity

Incident Radiation Intensity (kW/m^2)	Damage to Equipment (Note-1)	Impact on People (Note-1)
37.5	Damage to process equipment;	100% lethality in 1 min, 1% lethality in 10 sec.
32.0	Maximum flux level for thermally protected tanks containing flammable liquid	-
12.5	Minimum energy to ignite wood with a flame, melts plastic tubing	1% lethality in 1 min; 1st degree burns in 10 sec.
8.0	Maximum heat flux for un-insulated tanks	-
4.0	-	Sufficient to cause pain to personnel if unable to reach cover within 20 seconds. However blistering of skin (2nddegree burns) is unlikely. 0 % lethality
1.6	-	Causes no discomfort for long exposure

The hazard distances to the 4 kW/m^2, 10 kW/m^2, 12.5 kW/m^2, 15.8 kW/m^2 and 37.5 kW/m^2 radiation levels are selected based on their effect on population; buildings and equipment and were modeled using PHAST ver. 8.4 software for the various pipeline facilities under the scope of the project.

Note-1: Damage Effect consideration is as per guidelines provided in PHAST software manual, Lee's Loss Prevention in the Process Industries (2012) and World Bank Technical Paper Number 55 "Techniques for Assessing Industrial Hazards", A Manual, 1988.

6.4.1.3 VAPOR CLOUD EXPLOSION

In the event of explosion taking place within the plant, the resultant blast wave will have damaging effects on equipment, structures, building and piping falling within the overpressure distances of the blast. Tanks, buildings, structures etc. can only tolerate low level of overpressure. Human body, by comparison, can withstand higher overpressure. But injury or fatality can be inflicted by collapse of building of structures. The damage effect of blast overpressure is tabulated below.

Table 6.3: Damage Effects due to Blast Overpressure

Blast Overpressure (psig)	Damage Level (Note-1)
5.0	Major structure damage
3.0	Oil storage tank failure
2.5	Eardrum rupture
2.0	Repairable damage, pressure vessels remain intact, light structures collapse
1.0	Window pane breakage possible, causing some injuries

The hazard distances to the 5 psig, 3 psig and 2 psig overpressure levels, selected based on their effects on population; buildings and equipment were modeled using PHAST ver. 8.4 software for the project facilities.

Note-1: Damage Effect consideration is as per guidelines provided in PHAST software manual and information available in “Lee’s Loss Prevention in the Process Industries (2012)”.

6.5 CONSEQUENCE ANALYSIS OF FAILURE CASES

This section discusses the consequences of selected failure scenarios for the project facilities in detail. The consequence analysis of the selected failure case as provided below is based on consequence contours extracted from **PHAST 8.4** software.

The consequence contours for the prevalent case weather condition is attached in “**ANNEXURE-I**” of this report.

6.5.1 CONSEQUENCE ANALYSIS:

Pipeline operates at 49 kg/cm2 g pressure. Process conditions are assumed same throughout for this section. Prevalent weather condition is 3D for this project, 2F occurs during night time results are just tabulated for information.

6.5.1.1 Typical SV

a) 10 mm UG Leak (Refer Annexure-I, Figures 1 and 2)

Based on consequence analysis contours, it is observed that flash fire is not realized. Jet Fire radiation intensity of 4 and 12.5 is realized up to 11 m and 9 m respectively for 3D weather condition; however, radiation intensity of 37.5 kW/m2 is not realized from this scenario. Blast overpressure of 2, 3 and 5 psig is not realized for this case.

Typical results are as follows:

Table 6.5.1 Flash Fire, Jet Fire, Toxic front and Overpressure Hazard Distances

Weather	Flash Fire Distance, m	Jet Fire radiation (kW/m2) Distance, m			Overpressure (psi) distances, m		
		4	12.5	37.5	2	3	5
2F	NR	12	9	NR	NR	NR	NR
3D	NR	12	9	NR	NR	NR	NR

b) 20 mm AG Leak (Refer Annexure-I, Figures 3 and 4)

Based on consequence analysis contours, it is observed that flash fire is not realized to significant level. Jet Fire radiation intensity of 4 and 12.5 kW/m2 is realized up to 24 m & 21 m respectively; however radiation intensity of 37.5 kW/m2 is realized upto 17 m. Blast overpressure of 2, 3 and 5 psig is realized up to 25 m, 24 m & 23 m for this case during 3D weather condition.

Table 6.5.2 Flash Fire, Jet Fire, Toxic front and Overpressure Hazard Distances

Weather	Flash Fire Distance, m	Jet Fire radiation (kW/m2) Distance, m			Overpressure (psi) distances, m		
		4	12.5	37.5	2	3	5
2F	NR	25	21	16.9	25	24	23
3D	NR	25	21	17	25	24	23

c) 50 mm AG Leak (Refer Annexure-I, Figures 5 and 6)

Based on consequence analysis contours, it is observed that flash fire is realized to 26 m. Jet Fire radiation intensity of 4 and 12.5 kW/m2 is realized up to 65 m & 51 m respectively; however radiation intensity of 37.5 kW/m2 is realized upto 42 m. Blast overpressure of 2, 3 and 5 psig is realized up to 84 m, 81 m & 78 m for this case during 3D weather condition.

Table 6.5.3 Flash Fire, Jet Fire, Toxic front and Overpressure Hazard Distances

Weather	Flash Fire Distance, m	Jet Fire radiation (kW/m2) Distance, m			Overpressure (psi) distances, m		
		4	12.5	37.5	2	3	5
2F	30	65	51	41	85	81	78
3D	26	65	51	42	84	81	**78**

6.5.1.2 IPS-1(KC-1)

d) 10 mm UG Leak (Refer Annexure-I, Figures 1 and 2)

Based on consequence analysis contours, it is observed that flash fire is not realized. Jet Fire radiation intensity of 4 and 12.5 is realized up to 11 m and 9 m respectively for 3D weather condition; however radiation intensity of 37.5 kW/m2 is not realized from this scenario. Blast overpressure of 2, 3 and 5 psig is not realized for this case.

Typical results are as follows:

Table 6.5.4 Flash Fire, Jet Fire, Toxic front and Overpressure Hazard Distances

Weather	Flash Fire Distance, m	Jet Fire radiation (kW/m2) Distance, m			Overpressure (psi) distances, m		
		4	12.5	37.5	2	3	5
2F	NR	12	9	NR	NR	NR	NR
3D	NR	12	9	NR	NR	NR	NR

e) 20 mm AG Leak (Refer Annexure-I, Figures 3 and 4)

Based on consequence analysis contours, it is observed that flash fire is not realized to significant level. Jet Fire radiation intensity of 4 and 12.5 kW/m2 is realized up to 24 m & 21 m respectively; however radiation intensity of 37.5 kW/m2 is realized upto 17 m. Blast overpressure of 2, 3 and 5 psig is realized up to 25 m, 24 m & 23 m for this case during 3D weather condition.

Table 6.5.5 Flash Fire, Jet Fire, Toxic front and Overpressure Hazard Distances

Weather	Flash Fire Distance, m	Jet Fire radiation (kW/m2) Distance, m			Overpressure (psi) distances, m		
		4	12.5	37.5	2	3	5
2F	NR	25	21	16.9	25	24	23
3D	NR	25	21	17	25	24	23

f) 50 mm AG Leak (Refer Annexure-I, Figures 5 and 6)

Based on consequence analysis contours, it is observed that flash fire is realized to 26 m. Jet Fire radiation intensity of 4 and 12.5 kW/m2 is realized up to 65 m & 51 m respectively; however radiation intensity of 37.5 kW/m2 is realized upto 42 m. Blast overpressure of 2, 3 and 5 psig is realized up to 84 m, 81 m & 78 m for this case during 3D weather condition.

Table 6.5.6 Flash Fire, Jet Fire, Toxic front and Overpressure Hazard Distances

Weather	Flash Fire Distance, m	Jet Fire radiation (kW/m2) Distance, m			Overpressure (psi) distances, m		
		4	12.5	37.5	2	3	5
2F	30	65	51	41	85	81	78
3D	26	65	51	42	84	81	**78**

6.5.1.3 IPS-2 (KC-2)

g) 10 mm UG Leak (Refer Annexure-I, Figures 1 and 2)

Based on consequence analysis contours, it is observed that flash fire is not realized. Jet Fire radiation intensity of 4 and 12.5 is realized up to 11 m and 9 m respectively for 3D weather condition; however radiation intensity of 37.5 kW/m2 is not realized from this scenario. Blast overpressure of 2, 3 and 5 psig is not realized for this case.

Typical results are as follows:

Table 6.5.7 Flash Fire, Jet Fire, Toxic front and Overpressure Hazard Distances

Weather	Flash Fire Distance, m	Jet Fire radiation (kW/m2) Distance, m			Overpressure (psi) distances, m		
		4	12.5	37.5	2	3	5
2F	NR	12	9	NR	NR	NR	NR
3D	NR	12	9	NR	NR	NR	NR

h) 20 mm AG Leak (Refer Annexure-I, Figures 3 and 4)

Based on consequence analysis contours, it is observed that flash fire is not realized to significant level. Jet Fire radiation intensity of 4 and 12.5 kW/m2 is realized up to 24 m & 21 m respectively; however radiation intensity of 37.5 kW/m2 is realized upto 17 m. Blast overpressure of 2, 3 and 5 psig is realized up to 25 m, 24 m & 23 m for this case during 3D weather condition.

Table 6.5.8 Flash Fire, Jet Fire, Toxic front and Overpressure Hazard Distances

Weather	**Flash Fire Distance, m**	**Jet Fire radiation (kW/m2) Distance, m**			**Overpressure (psi) distances, m**		
		4	**12.5**	**37.5**	**2**	**3**	**5**
2F	NR	25	21	16.9	25	24	23
3D	NR	25	21	17	25	24	23

i) 50 mm AG Leak (Refer Annexure-I, Figures 5 and 6)

Based on consequence analysis contours, it is observed that flash fire is realized to 26 m. Jet Fire radiation intensity of 4 and 12.5 kW/m2 is realized up to 65 m & 51 m respectively; however radiation intensity of 37.5 kW/m2 is realized upto 42 m. Blast overpressure of 2, 3 and 5 psig is realized up to 84 m, 81 m & 78 m for this case during 3D weather condition.

Table 6.5.9 Flash Fire, Jet Fire, Toxic front and Overpressure Hazard Distances

Weather	**Flash Fire Distance, m**	**Jet Fire radiation (kW/m2) Distance, m**			**Overpressure (psi) distances, m**		
		4	**12.5**	**37.5**	**2**	**3**	**5**
2F	30	65	51	41	85	81	78
3D	26	65	51	42	84	81	**78**

SECTION-7

OBSERVATIONS & RECOMMENDATIONS

7.1 GENERAL

The consequence analysis of release of hydrocarbon in case of major credible scenarios is modeled in terms of release rate, dispersion and flammability characteristics and are discussed in earlier sections of this report.

The various major observations and applicable recommendations arising out of the Rapid Risk Analysis study for this Pipeline Project are given in Executive Summary of this report.

1. ANALYSIS & RECOMMENDATIONS BASED ON CONSEQUENCE MODELING

1.1 Typical SV (Annexure-I): Jet fire radiation intensity of 12.5 kW/m2 is realized up to ~9 m and may impact on eastern side of SV station for u/g leak case. Jet fire radiation intensity of 37.5 kW/m2 is realized up to ~16 m and may impact on eastern side of SV station for a/g leak case. Overpressure explosion distance for 5 psi is reaching upto 22 - 25 m in case of 20 mm A/G case. Results for large leak i.e. 50 mm A/G case may be utilized for emergency response plan preparation

It is recommended to:

- Ensure that entry & exit of guard room are outside of the 12.5 kW/m2 contour of jet fire zone (i.e. 11 meter from SV leak source) to protect the guard room occupant from injury due to fire radiation.
- Ensure safe escape and evacuation plan is in place for guard room occupants in this scenario.
- Provide flammable gas detectors near Sectionalizing Valve (SV). Procedures to be developed for remote closure of Sectionalizing valves in case of leak detection to prevent further escalation of hazardous consequences.

1.2 IPS-1 & IPS-2

The 50 mm leak(large) and pipeline full bore rupture failure frequency is very low so it is suggested to consider all these failure cases hazardous distances as provided in "**Annexure-I**" for emergency response plan and same shall be included in ERDMP of this pipeline facility.

It is recommended to:

- Ensure that entry & exit of guard room are outside of the 12.5 kW/m2 contour of jet fire zone to protect the guard room occupant from injury due to fire radiation.
- Ensure safe escape and evacuation plan is in place for guard room occupants in this scenario.
- Provide flammable gas detectors at each IPS.
- IPS remains unmanned hence no major considered.
- Large leak/breach case probability is very less; hence results may be utilized for ERDMP.
- Regular mock drills to be conducted for remaining alert and ready to handle any unforeseen case.

2. General Recommendations for pipeline facilities:

<u>Preventive Measures</u>

In order to reduce the leakage scenario from pipeline, the following preventive measures are recommended:

- Suitable measures shall be considered to prevent the leakage of the pipeline during the design engineering stage (i.e. pipeline thickness, material selection, corrosion allowance, cathodic protection for buried pipeline, corrosion monitoring system etc. should be considered suitably)
- Periodic health check of instruments and maintenance of piping are required to be ensured. Periodic calibration of instruments and testing of alarms, trips & interlocks should be given due attention.
- Pipeline section passing through seismic zone (if required) to be suitably designed for earthquake resistance.

<u>Mitigating Measures:</u>

Mitigating measures are those measures in place to minimize the damage due to loss of containment event and hazards arising out of Loss of containment. These include:

- Rapid detection of an uncommon event (HC, Flame etc.) and alarm arrangement at all stations along the pipeline route and development of subsequent quick isolation mechanism for major inventory
- Measures for controlling / minimization of Ignition sources inside the operating area.

- Active and Passive Fire Protection for critical equipment's and major structures as per the standard/code.
- Effective emergency response plan shall be in place for the pipeline facilities.

Detection and isolation:

In order to ensure rapid detection of a hazardous event, it is recommended to ensure installation of Hydrocarbon gas detectors at strategic location for early detection and prevention of any major accidental event emanating from the facilities. Once the flammable gas release has been detected, subsequent fire and escalation risk will be reduced by isolation of the major inventory from the release location. Hence, manual / automated mechanism is required to isolate the major inventory during any major credible hazardous event. It is recommended that the station piping should be considered to have remote operated valves so that these valves can be closed from the safe location upon fire or flammable gas detection. Adequate leak detection and surveillance system i.e. CCTV is to be adopted.

Ignition control:

Ignition control will reduce the likelihood of fire events. This is the key for reducing the risk within the IP/SV stations facilities. As part of mitigation measure, it is strongly recommended to minimize the traffic movement (to the extent possible) on road adjacent to the station area during leakage. Smoking and sustaining open flame inside any installation premise shall be prohibited.

Escape routes:

Provide windsocks throughout the facility to ensure visibility from all locations. This will enable people to escape upwind or crosswind from flammable releases. Sufficient escape routes from the facility should be provided to allow redundancy in escape from all areas.

Other Measures

The pipeline should be suitably protected (from external interferences and other failure modes) through the following measures:

- Pipeline integrity monitoring through pigging operation, external Inspection of coating and monitoring of dents, dent-gouges of pipeline (for above ground / buried pipeline as applicable) should be suitably planned to be taken up at regular intervals /as per relevant codal requirements (e.g. PNGRB, OISD etc).

- Patrolling frequency of pipeline sections located in densely populated areas shall be given priority. Consider a reliable leak and intrusion detection system to detect leak at the initial stage to avoid escalation. Procedure for quick isolation through remotely operated valves upon detection should be in place.
- Since most incidents on buried pipelines are caused by external interference (digging, ploughing or drilling in the vicinity of the pipeline), it is recommended that frequent patrolling and pipeline inspection to be instituted so as to enable early detection and cession of all such activities near the pipeline. Further, regular Line Patrolling to be carried out on a defined time schedule.
- Signboards/Pipeline markers as required with important details should be installed all along the pipeline route. Efforts have to be made to educate/make aware the community living nearby about the potential hazards of pipeline leakage and to report the pipeline incidents, if any to the control center.
- Active fire protection system shall be provided at SVs & IP as per the relevant standard/code for preventing escalation of fire.
- Ensure there are no HT power cable crossing over the process facility in SVs & IP stations.
- It shall be ensured that all the vehicles entering the SVs & IP shall be provided with spark arrestors at the exhaust.

SECTION-8

GLOSSARY

The lists of glossary for better understanding of the study report are provided below;

CASUALTY	Someone who suffers serious injury or worse i.e. including fatal injuries. As a rough guide fatalities are likely to be half the total casualties. But this may vary depending on the nature of the event.
EXPLOSION	A rapid release of energy, which causes a pressure discontinuity or shock wave moving away from the source. An explosion can be produced by detonation of a high explosive or by the rapid burning of a flammable gas cloud. The resulting overpressure is sufficient to cause damage inside and outside the cloud as the shock wave propagation into the atmosphere beyond the cloud. Some authors use the term deflagration for this type of explosion.
FLAMMABILITY LIMITS (UFL–LFL)	In fuel-air systems, a range of compositions exists inside which a flame will propagate substantial distance from an ignition source. The limiting fuel concentrations are termed as Upper flammability or explosives limit (Fuel concentrations exceeding this are too rich) and Lower flammability or explosives limit (Fuel concentrations below this are too lean).
FLASH FIRE	The burning of a vapor cloud at very low flame propagation speed. Combustion products are generated at a rate low enough for expansion to take place easily without significant overpressure ahead or behind the flame front. The hazard is therefore only due to thermal effects.
FREQUENCY	The number of times an outcome is expected to occur in a given period of time.
HAZARD	A chemical or physical condition with the potential of causing damage.
JET FIRE	A turbulent diffusion flame resulting from the combustion of a fuel continuously released with some significant momentum in a particular direction or directions.
OVERPRESSURE	Maximum pressure above atmosphere experienced during the passage of a blast wave from an explosion expressed in this report as pounds per square inch (psig).

SECTION-9

LIST OF ABBREVIATIONS

The lists of description of various abbreviations used in this RRA Study report are provided below;

ABBREVIATIONS	DESCRIPTION
AG	Above Ground
CCTV	Closed-Circuit Television
DALR	Dry Adiabatic Lapse Rate
DMP	Disaster Management Plan
DT	Dispatch Terminal
DNV	Det Norske Veritas
EIL	Engineers India Limited
ELR	Environmental Lapse Rate
ERDMP	Emergency Response & Disaster Management Planning
GAIL	Gas Authority of India Limited
HC	Hydrocarbon
IP	Intermediate Pigging Station
LFL	Lower Flammable Limit
NG	Natural Gas
OISD	Oil Industry Safety Directorate
P&ID	Piping & Instrumentation Diagram
PNGRB	Petroleum and Natural Gas Regulatory Board
RLNG	Regasified Liquefied Natural Gas
RRA	Rapid Risk Analysis
RT	Receipt Terminal
SCADA	Supervisory Control and Data Acquisition
SV	Sectionalizing Valve
UFL	Upper Flammability Limit
UG	Under Ground
VCE	Vapor Cloud Explosion

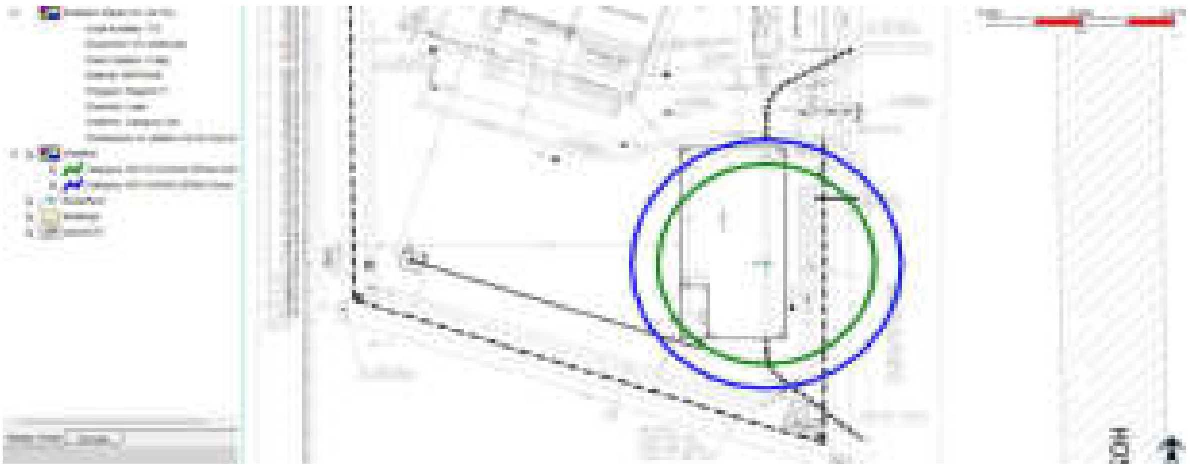
SECTION-10
REFERENCES

1. Guidelines for Chemical Process Quantitative Risk Analysis, 2nd Edition by CCPS (Center for Chemical Process Safety)
2. Climatological Normals (1991-2020) by IMD, Pune, India
3. PHAST/SAFETI-8.71 Software Manual
4. Layout Plans of SV Station and Intermediate Pigging Station

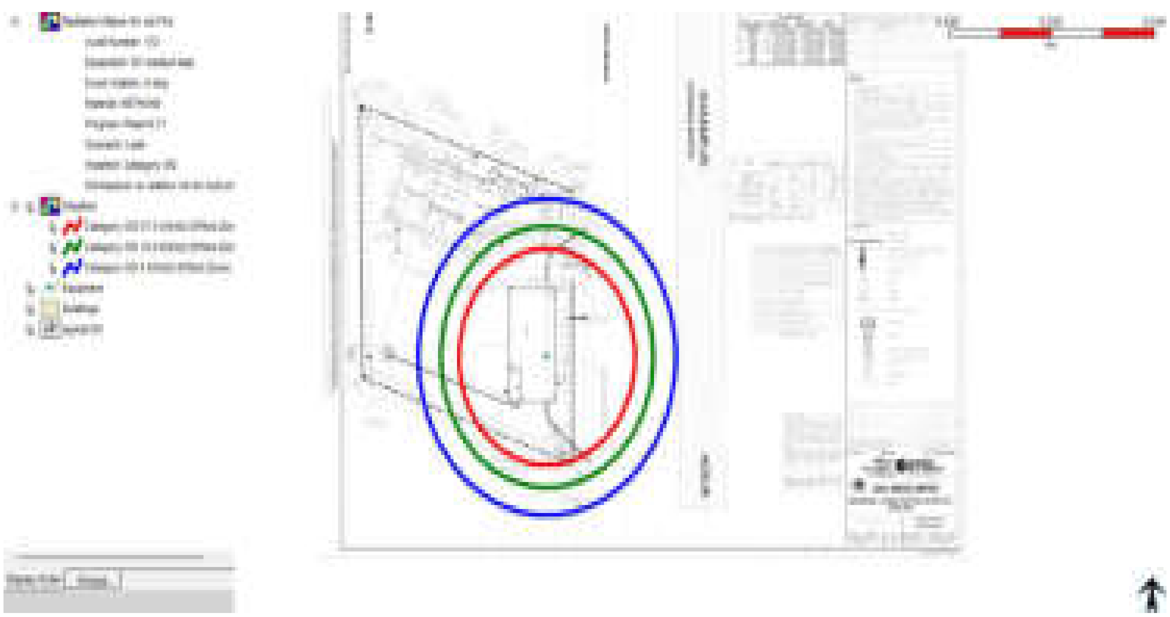
Annexure -I

Hazard Distances Graph

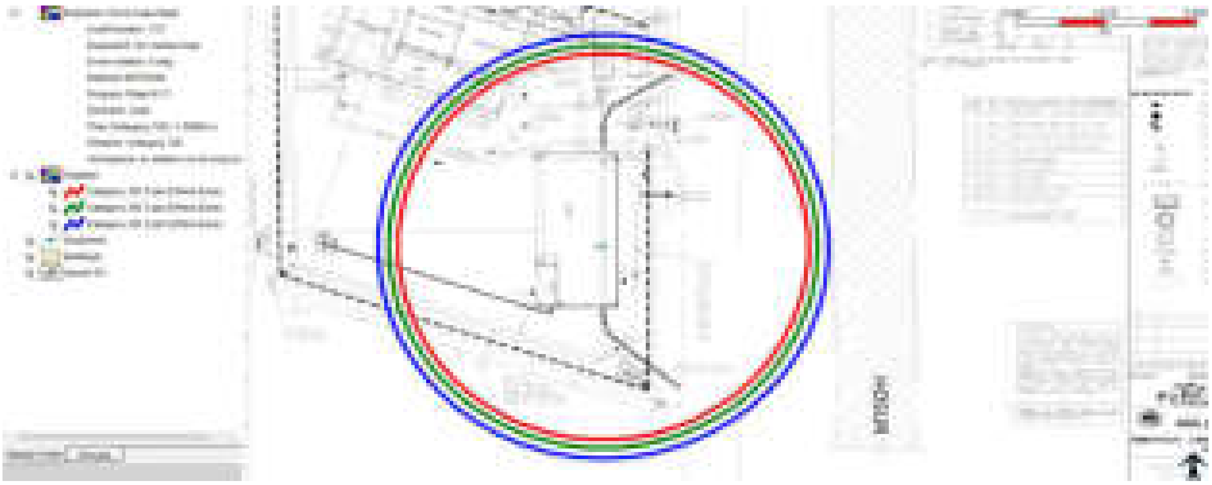
Graph 1 JET FIRE FOR U/G LEAK CASE FOR SV



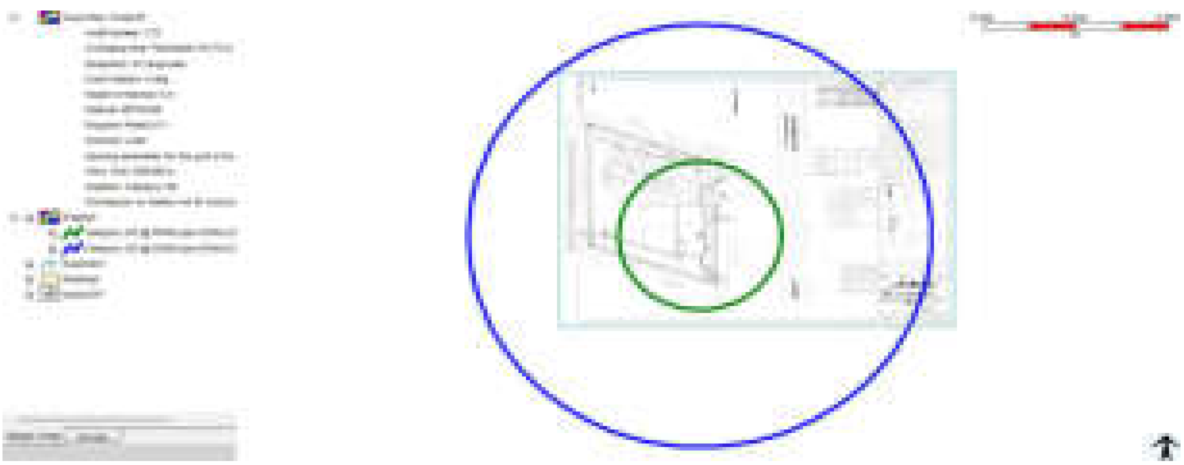
Graph 2 20 mm leak A/G SV jet fire



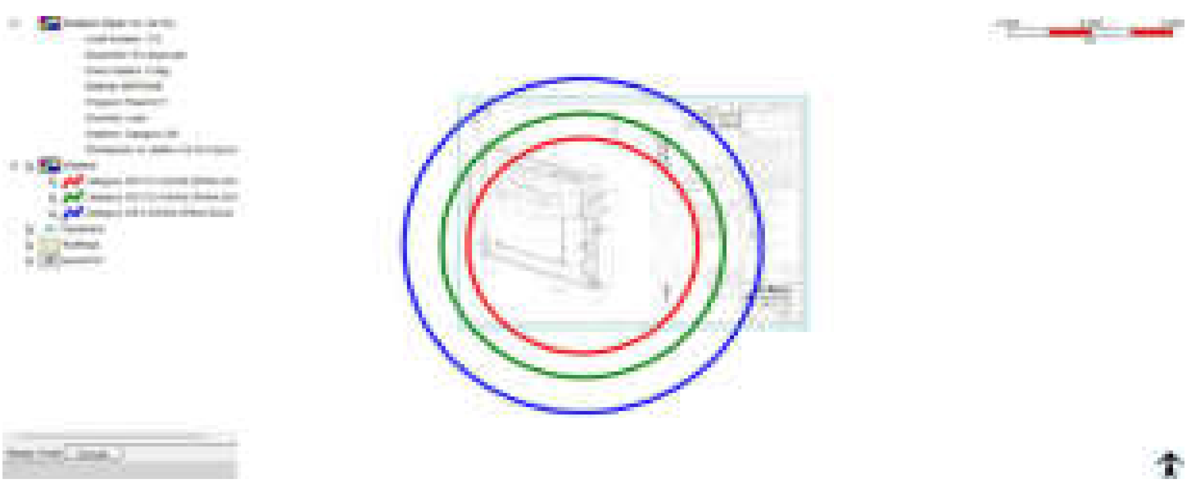
Graph 3 20 mm leak A/G SV Explosion distances



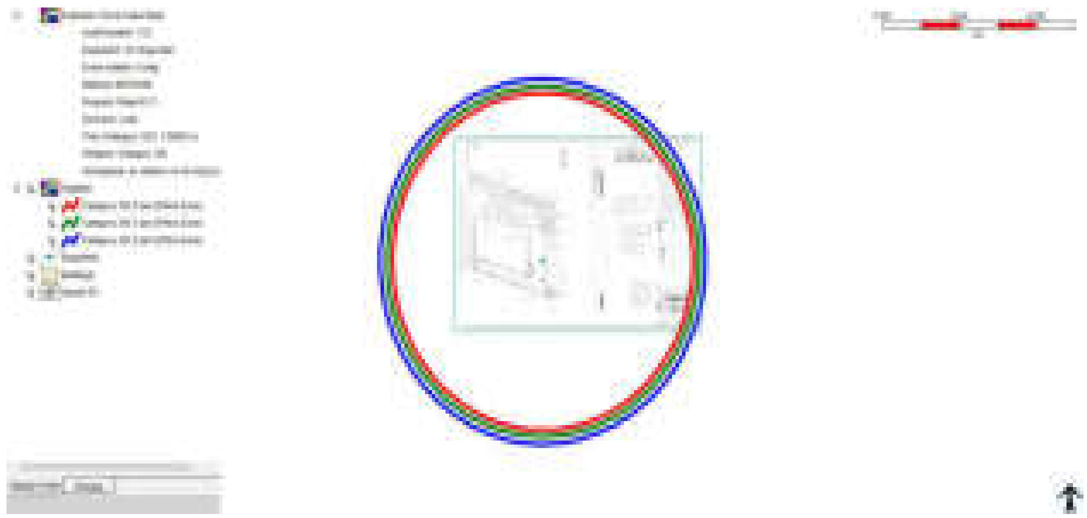
Graph 4 50 mm leak A/G FLASH FIRE DISTANCE



Graph 5 50 mm leak A/G JET FIRE DISTANCE

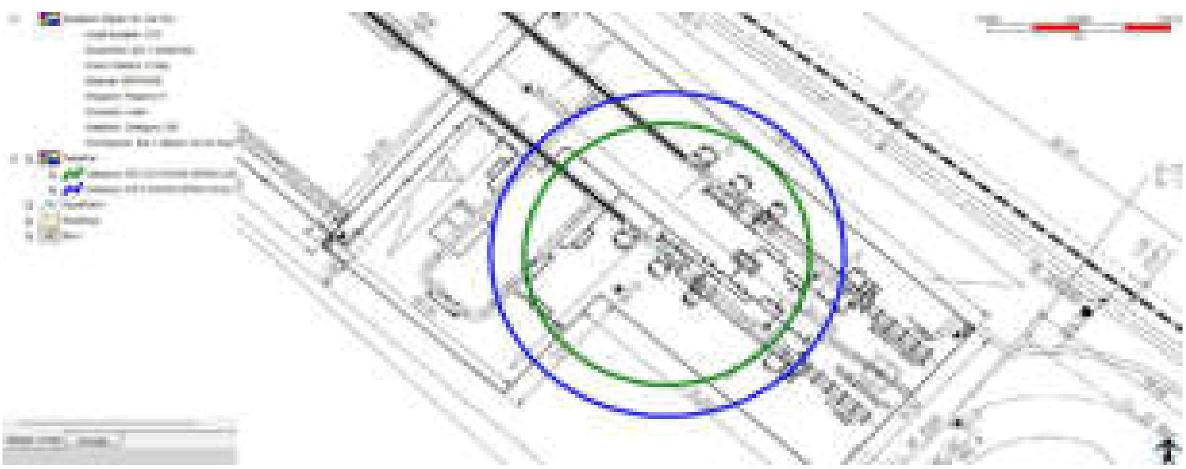


Graph 6 50 mm leak A/G EXPLOSION

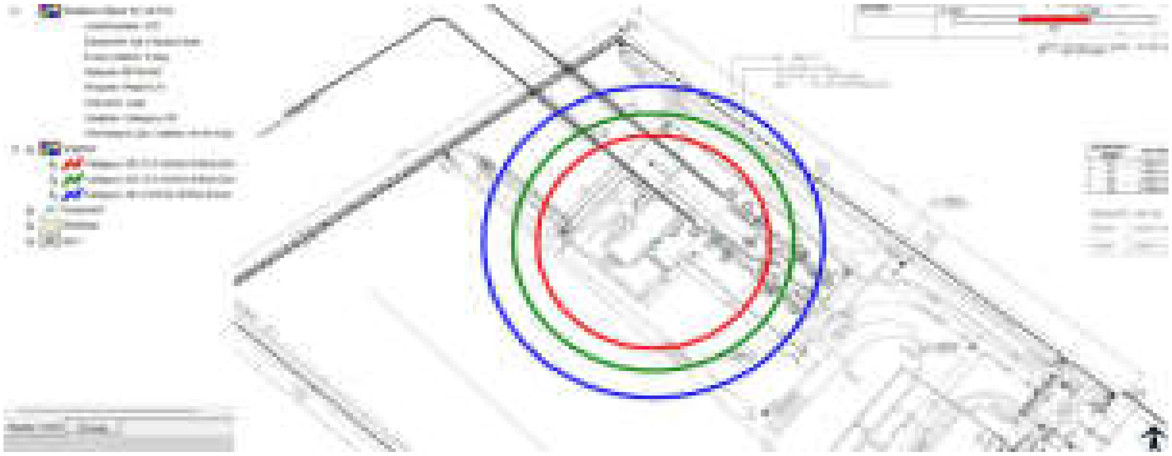


IPS-1

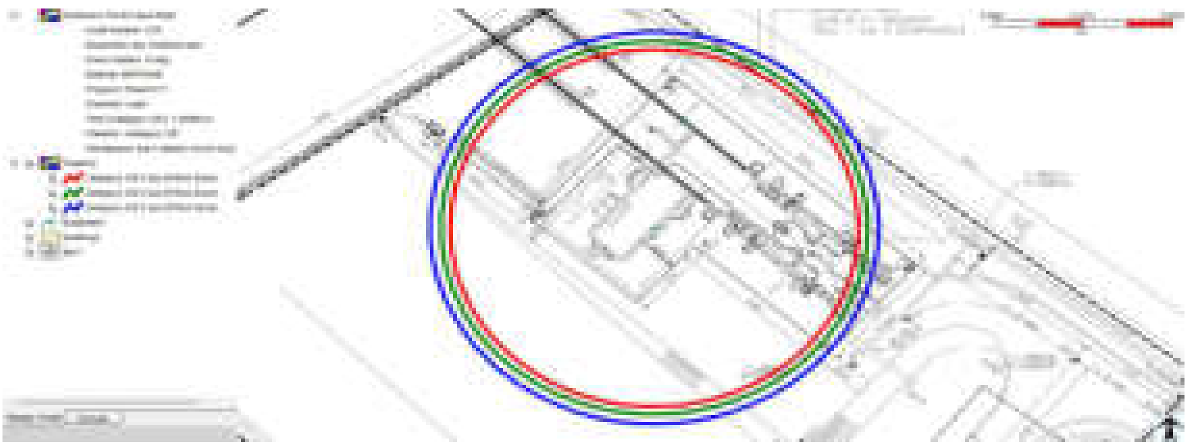
Graph 1 JET FIRE FOR U/G LEAK CASE FOR IPS-1



Graph 2 JET FIRE FOR 20 mm A/G LEAK CASE FOR IPS-1

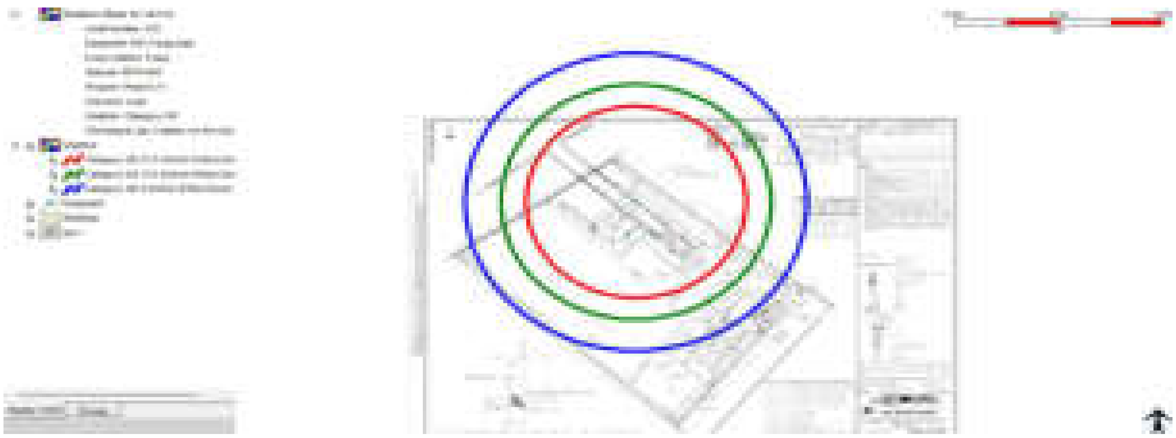


Graph 3 EXPLOSION FOR 20 mm A/G LEAK CASE FOR IPS-1

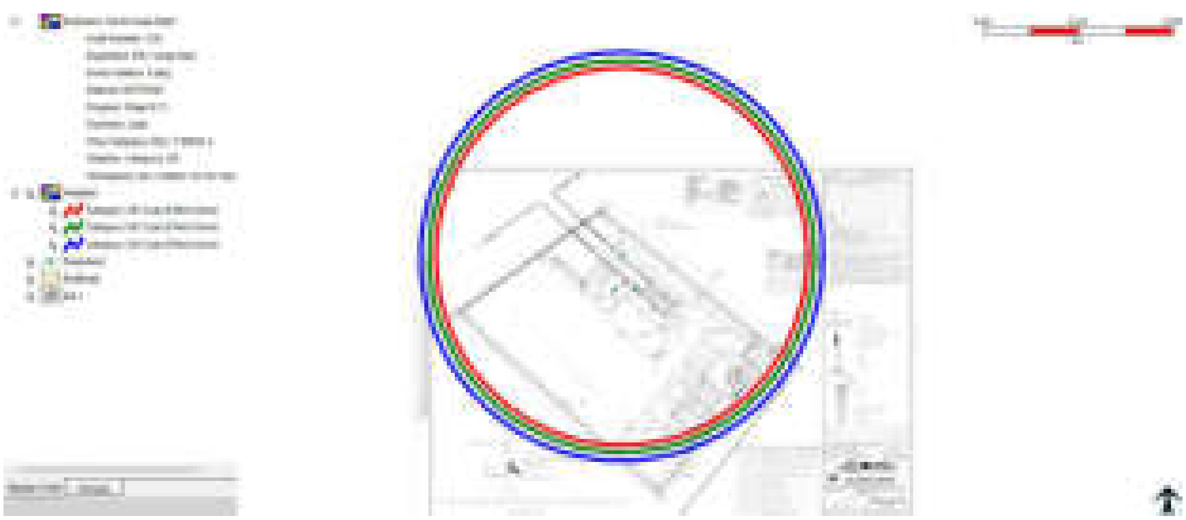


Graph 4 FLASH FIRE FOR 50 mm A/G LEAK CASE FOR IPS-1

Graph 5 JET FIRE FOR 50 mm A/G LEAK CASE FOR IPS-1

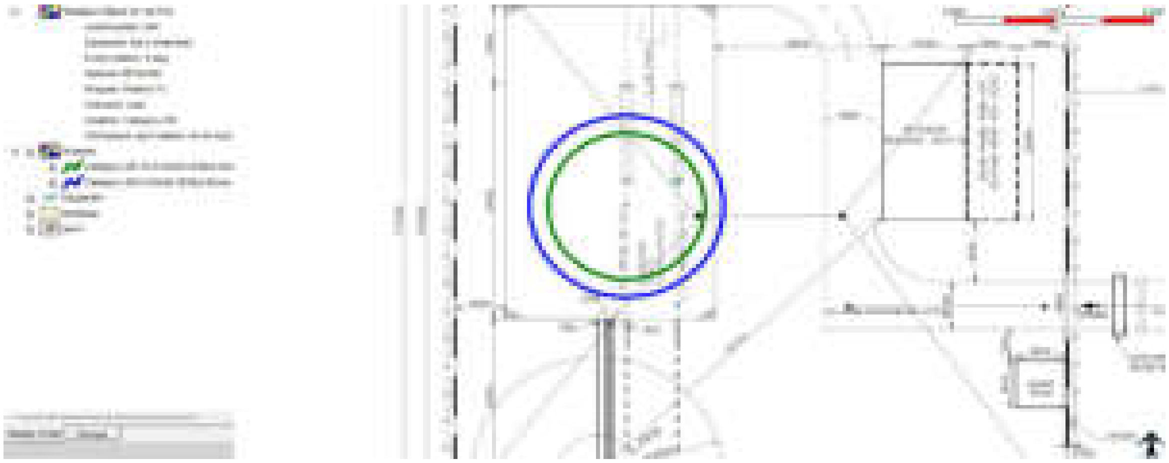


Graph 6 EXPLOSION FOR 50 mm A/G LEAK CASE FOR IPS-1

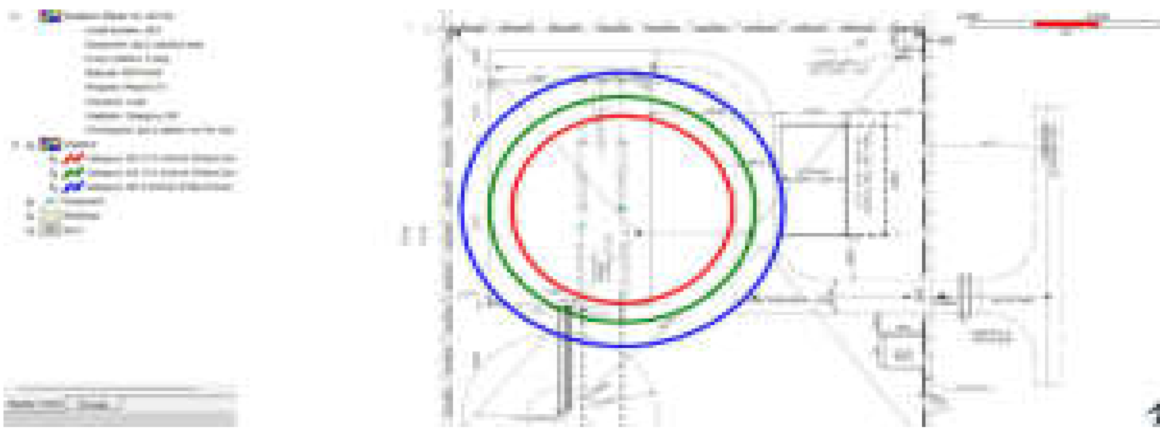


IPS-2

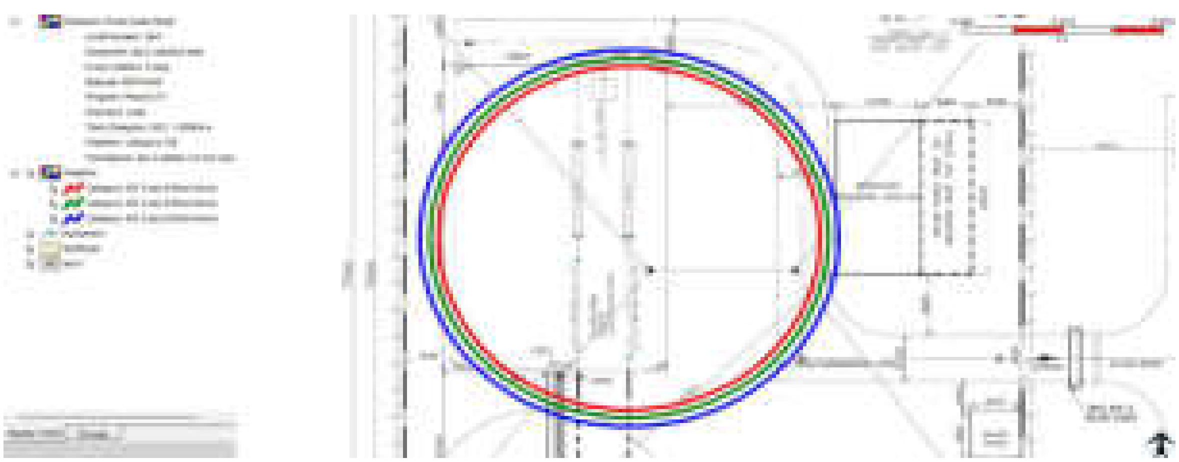
Graph 1 JET FIRE FOR U/G LEAK CASE FOR IPS-2



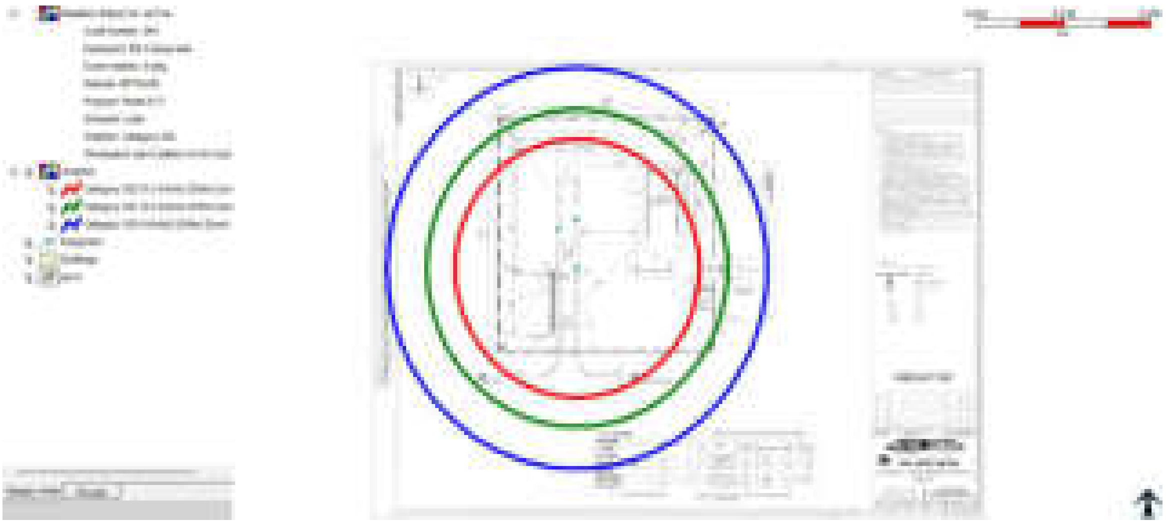
Graph 2 JET FIRE FOR 20 mm A/G LEAK CASE FOR IPS-2



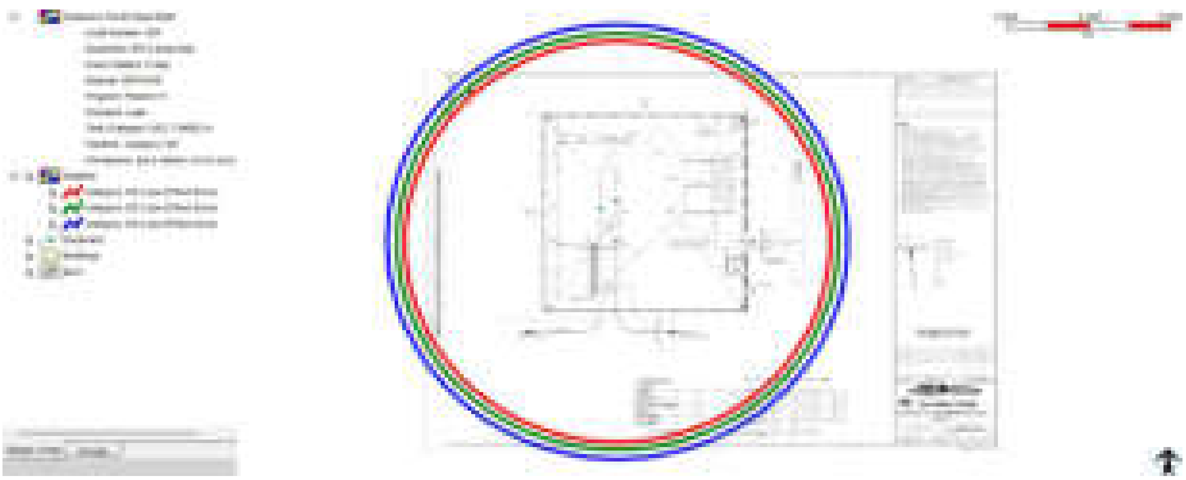
Graph 3 EXPLOSION FOR 20 mm A/G LEAK CASE FOR IPS-2



Graph 4 JET FIRE FOR 50 mm A/G LEAK CASE FOR IPS-2



Graph 5 EXPLOSION FOR 50 mm A/G LEAK CASE FOR IPS-2



Graph 6 FLASH FIRE FOR 50 mm A/G LEAK CASE FOR IPS-2

ANNEXURE – VI

THE HEALTH, SAFETY AND ENVIRONMENT POLICY OF GAIL

गेल (इंडिया) लिमिटेड

GAIL (India) Limited

निगमित स्वास्थ्य, संरक्षा और पर्यावरण नीति

गेल (इंडिया) लिमिटेड अपने व्यावसायिक क्षेत्रों तथा विभिन्न हितधारकों के व्यावसायिक स्वास्थ्य, संरक्षा और पर्यावरण में सतत विकास के माध्यम से मूल्य उत्पन्न करने के लिये प्रतिबद्ध है और ये विश्वास हमारे मुख्य संगठनात्मक मूल्यों के भीतर अंतर्निहित हैं।

गेल प्रतिबद्ध है :

- नवीनतम प्रौद्योगिकी और डिजिटलीकरण को अपनाकर संरक्षा, व्यावसायिक स्वास्थ्य और पर्यावरण संरक्षण में अग्रणी बनने हेतु।
- अपने व्यावसायिक क्षेत्रों तथा विभिन्न हितधारकों की पर्याप्त संरक्षा सुनिश्चित करने हेतु अपनी सुविधाओं का राष्ट्रीय / अंतर्राष्ट्रीय मानकों के अनुसार डिजाइन, निर्माण तथा प्रचालन एवं अनुरक्षण करने हेतु।
- जिन देशों में हम कार्य करें उनके लागू वैधानिक नियमों और विनियमों का अनुपालन करने हेतु।
- एचएसई संसाधनों का अनुकूलन और व्यवहार आधारित संरक्षा सहित एचएसई प्रबंधन प्रणाली पर संरचित प्रशिक्षण प्रदान करने और सभी प्रतिष्ठानों पर प्रभावी आपातकालीन तैयारी और प्रतिक्रिया सुनिश्चित करने हेतु।
- अपने कर्मचारियों के अच्छे स्वास्थ्य और भलाई को सुनिश्चित करने के लिए व्यावसायिक स्वच्छता उपायों और नियमित चिकित्सा निगरानी और जोखिम आधारित निगरानी को लागू करने हेतु।
- स्वच्छ और हरित पर्यावरण के लिए लागू प्रभावी अपशिष्ट प्रबंधन प्रणाली का उपयोग करने हेतु।
- दुर्घटनाओं को रोकने और एचएसई कार्यनिष्पादन को बेहतर करने हेतु समकक्ष उद्योगों की सर्वोत्तम प्रथाओं को अपनाने और बढ़ावा देने हेतु।
- सभी इच्छुक हितधारकों के साथ एचएसई नीति और एचएसई कार्यनिष्पादन साझा करने हेतु।

हम संगठन के भीतर सकारात्मक एचएसई संस्कृति बनाने के लिए सुरक्षित काम करने की आदतों और व्यवहार को अपनाने के लिए अनुबंध कर्मचारियों सहित सभी कर्मचारियों को प्रोत्साहित करते हैं। उनके पास किसी भी असुरक्षित कार्य / अधिनियम को अधिसूचित करने और रोकने के लिए जिम्मेदारी और अधिकार है, जैसा कि समझा जाता है।

तिथि/Date : 17.11.2022

CORPORATE HEALTH, SAFETY & ENVIRONMENT POLICY

GAIL (India) Limited endeavors to generate value through sustainable development by placing commitment to occupational Health, Safety and Environment of our business areas & various stakeholders and these beliefs are embedded within our core organizational values.

GAIL is committed to :

- Be a leader in Safety, occupational Health and Environment protection by adopting latest Technology and Digitalization.
- Design, construct, operate and maintain its facilities as per National/ International standards to ensure adequate safety of our business areas and various stakeholders.
- Comply with applicable statutory Rules and Regulations of the Countries wherein we operate.
- Optimize the HSE resources and provide structured trainings on HSE Management System including Behavior Based Safety (BBS), and ensure effective emergency preparedness & response at all installations.
- Implement occupational hygiene measures & regular medical surveillance and risk based monitoring to ensure good health & well being of Employees.
- Make use of effective waste management system as applicable for a Clean & Green Environment.
- Adopt & promote peer industries best practices to prevent incidents and improve HSE performance.
- Share HSE Policy and HSE performance with all interested stakeholders.

We encourage all employees including contract workmen to adopt safe working habits and behavior to create positive HSE culture within organization. They have responsibility and authority to notify and stop any unsafe work /act, as deemed fit.

संदीप कुमार गुप्ता/Sandeep Kumar Gupta
अध्यक्ष एवं प्रबंध निदेशक/Chairman & Managing Director

ANNEXURE – VII

CSR EXPENDITURE IN VARIOUS

PROJECTS/FIELDS REVISED

IN MARCH 2015

GAIL – Hriday

Corporate with a heart

GAIL CSR POLICY

[REVISED IN MARCH 2015 IN TERMS OF THE PROVISIONS UNDER SECTION 135 OF THE COMPANIES ACT, 2013, CSR RULES AND OTHER RELEVANT SECTIONS.]

GAIL CSR POLICY

1. CSR VISION STATEMENT & OBJECTIVES:

1.1 **VISION STATEMENT** - GAIL, through its CSR initiatives, will continue to enhance value creation in the society and in the community in which it operates, through its services, conduct & initiatives, so as to promote sustained growth for the society and community, in fulfillment its role as a Socially Responsible Corporate, with environmental concern.

1.2 **OBJECTIVES**

- Ensure an increased commitment at all levels in the organization, to operate its business in an economically, socially & environmentally sustainable manner, while recognizing the interests of all its stakeholders.
- To directly or indirectly take up programmes that benefit the communities in & around its work centres and results, over a period of time, in enhancing the quality of life & economic well-being of the local populace.
- To generate, through its CSR initiatives, goodwill and pride for GAIL among stakeholders and help reinforce a positive & socially responsible image of GAIL as a corporate entity.

2. COMPOSITION OF CSR COMMITTEE OF THE BOARD:

2.1 The composition of the Corporate Social Responsibility Committee of the Board shall be notified from time to time, in terms of the provisions of Sub – section (1) of Section 135 of the Companies Act, 2013.

2.2 The present composition of the CSR Committee is - C& MD as Chairman of the Committee and Director (HR) and Joint Secretary (Ministry of Petroleum and Natural Gas) as member*.

3. PLANNING

3.1 RESOURCES

3.1.1 For achieving its CSR objectives through implementation of meaningful & sustainable CSR projects or programmes, GAIL will ***spend 2% of the Average Net Profit made by the company during the three immediately preceding financial years. (Net profit to be calculated in accordance with the provisions of Section 198 of Companies Act, 2013).***

3.1.2 The unspent CSR amount in a particular year would not lapse. It would instead be carried forward to the next year for utilization for CSR activities only.

*Committee shall be re – constituted on appointment of Independent Director(s) to the Board.

3.2 IDENTIFICATION OF FOCUS AREAS:

3.2.1 GAIL shall undertake CSR projects or programmes targeted at upliftment of beneficiaries belonging to the under privileged section of the society. The overarching goal of GAIL's CSR initiatives is socio-economic empowerment of people from all disadvantaged groups, as per the intent and provisions of Schedule VII of Companies Act, 2013.

Keeping in view the spirit of executing CSR activities, the broad umbrella of GAIL CSR initiatives will be titled '***GAIL Hriday'*** *(Corporate with a Heart)*.

3.2.2 GAIL shall undertake CSR projects in sectors as identified under Schedule VII of the Companies Act, 2013 with special focus on the areas given below, each of which is titled by the objective they seek to achieve:

I. ***GAIL Arogya*** (Wellness) - Nutrition, Health and Sanitation and Drinking Water projects

II. ***GAIL Ujjwal*** (Towards a Bright future) – Education initiatives

III. ***GAIL Kaushal*** (Skill) - Livelihood Generation and Skill development initiatives.

IV. **GAIL *Unnati*** (Progress)- Rural Development

V. ***GAIL Sashakt*** (Empowerment)- Women Empowerment initiatives

VI. ***GAIL Saksham*** (Capable) - Care of the elderly and differently abled.

VII. ***GAIL – Harit*** (Green) - Environment centric initiatives

The nature of the CSR programmes to be undertaken under each of the above focus areas will be indicated in the 'Operating Guidelines to GAIL CSR Policy'.

3.2.3 As a part of the sustainability initiatives within the organization, GAIL shall give due importance to environmental sustainability even in normal mainstream activities by ensuring that our operations and processes promote renewable sources of energy, reduce / re-use / recycle waste material, replenish ground water supply, protect / conserve / restore the ecosystem, reduce carbon emissions and help in greening the supply chain. However, expenditure towards such sustainability initiatives would not constitute a part of CSR spends from 2% of profits as stipulated in the Act and the CSR Rules.

4. IMPLEMENTATION:

4.1 CSR programmes will be undertaken by various work centers of GAIL within the defined ambit of Schedule VII of Companies Act, 2013 with special focus on the heads as listed at Clause 3.2.2.

4.2 Majority of the CSR programmes by value (at least 75%) will be implemented in and around the 'local areas' (within a radius of 100 Kms) adjoining GAIL installations which are largely located in remote areas/along the GAIL pipeline. The balance projects can be taken up anywhere in the country, as per the company requirement/imperatives from time to time.

4.3 CSR activities shall be undertaken through various agencies including registered trusts/ societies or companies or autonomous bodies/government departments. In case of NGOs/Trust/Pvt. Companies, an established track record of 03 years in undertaking similar projects or programs would be essential.

5. MONITORING AND FEEDBACK

5.1. To ensure transparency and effective implementation of the CSR programmes undertaken at each work centre, a robust monitoring mechanism will be instituted by the company, providing for periodic monitoring at different levels using the following indicative medium:

1. **Monthly Progress Report**
2. **Quarterly Progress Report**
3. **Video Conferencing**
4. **Site Visits**
5. **Documentary evidence including photographs, films and videos.**
6. **Other in – house monitoring mechanisms**, as determined by Work Centre CSR Review Committee/CSR Task Force at Corporate Office.

6. REPORTING

6.1 An Annual Report on CSR containing details about the CSR policy and programmes implemented by GAIL shall be included in the Board of Directors' Report for every FY, as per the format prescribed under the Rules to Section 135 of Companies Act, 2013.

6.2 Composition of the GAIL CSR Committee will be included in the Annual Report on CSR and also displayed on the GAIL website.

6.3 The proforma containing the details of CSR activities to be undertaken by GAIL will be annexed on an annual basis with the policy document.

6.4 The Board of Directors' Report shall include a *Responsibility Statement* of the CSR Committee that the implementation and monitoring of CSR Policy is in compliance with CSR objectives and Policy of GAIL

6.5 If for some reason, GAIL fails to spend 2% of the avg. net profit of the preceding three FYs on CSR, the reasons thereof, shall be furnished in the report of the Board of Directors under Section 134 (3) *(o)* of the Companies Act, 2013.

7. GENERAL PROVISIONS

7.1 GAIL shall execute all CSR activities and programmes in terms of the systems and procedures as detailed in the '*Operating Guidelines to CSR Policy*' (as maybe notified from time to time) which are aligned/based on the provisions of Section 135 of the Companies Act, 2013, the CSR Rules and the subsequent clarifications and amendments as notified by Ministry of Corporate Affairs.

7.2 If necessitated, new CSR activities / projects can be taken up during the course of a year, in addition to CSR activities already incorporated in the CSR policy of GAIL on annual basis, with the Board's approval based on the recommendations of the CSR Committee. The same would be treated as amendment to the policy.

7.3 The surplus arising out of CSR projects or programmes or activities shall not form part of the business profit of the company.

7.4 No contribution shall be made to any political party through CSR Fund.

7.5 The CSR projects or programmes or activities that benefit only the employees of GAIL and their families shall not be considered as CSR activities in accordance with Section 135 of the Act.

7.6 For every CSR project/ programme of GAIL, the implementing agency shall abide by the provisions of the GAIL's Fraud Prevention policy as available on http://www.gail.nic.in/final_site/pdf/Drfat_Policy2012.pdf

LIST OF CSR PROJECTS/ACTIVITIES OR PROGRAMMES FOR THE YEAR 2014 – 15 **(ANNEXURE TO GAIL CSR POLICY CLAUSE 6.3)**

1	2	3	4	5	6	7	8
S. NO.	**CSR PROJECT OR ACTIVITY IDENTIFIED**	**SECTOR IN WHICH THE PROJECT IS COVERED**	**PROJECTS OR PROGRAMMES (1) LOCAL AREA OR OTHER (2) STATE OR DISTRICT WHERE PROJECTS OR PROGRAMME WAS UNDERTAKEN**	**AMOUNT OUTLAY (BUDGET) PROJECT OR PROGRAMME WISE**	**AMOUNT SPENT ON THE PROJECT OR PROGRAMMES SUBHEADS: (1) DIRECT EXPENDITURE ON PROJECTS OR PROGRAMS (2) OVERHEADS^**	**CUMULATIVE EXPENDITURE UP TO THE REPORTING PERIOD^**	**AMOUNT SPENT: DIRECT OR THROUGH IMPLEMENTING AGENCY**
1	Long term Flagship and CSR Initiatives with multi – year spread. Projects identified and monitored by Corporate Office but implemented across India, with major focus on areas/regions around GAIL's operations.	As per Schedule VII to Section 135, Companies Act, 2013.	Pan India	Rs. 97.87 cr (83% of annual CSR allocation of Rs. 118.67 cr)			NGOs/Companies/Trusts/ Govt. bodies/Direct
2	Local Projects identified by work centres	As per Schedule VII to Section 135, Companies Act, 2013.	Pan India	Rs. 20.19 cr (17% of annual CSR allocation of Rs. 118.67 cr)			NGOs/Companies/Trusts/ Govt. bodies/Direct

^ Actual expenditure details to be entered upon compilation of the same.