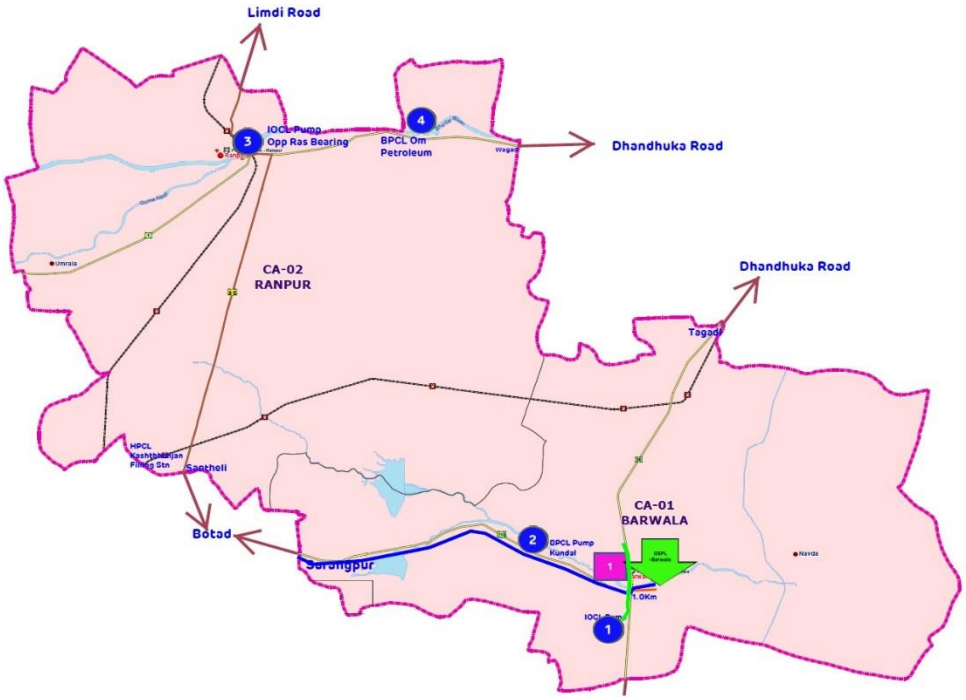
Environmental Impact Assessment

for

Barwala and Ranpur Talukas GA of Botad District
Gas Distribution Project



adani™

Adani Gas Limited

Betterworld Enviro Consultants

113, Plot No: 5 R/8, Neelam Chowk
Faridabad- 121001 (Haryana)
Phone: 2420100, 2430100
www.betterworldenviro.com

June 2019

Table of Contents

List of Tables

List of Figures

Chapter 1

INTRODUCTION

1.1 Background

Adani Group is one of the fastest growing corporate houses in India with diversified interest & businesses. The Group is focused on trading and developing Infrastructure projects. It has created pool of knowledge and resources to implement large infrastructure projects over a short period of time. The group vision is to be globally competitive and to establish leadership in trading and infrastructure.

Adani Gas Ltd. is a leading distributor & supplier of CNG and PNG for industrial, commercial, residential and vehicles purpose in various cities in different states. Adani Gas Limited (AGL) has received the authorization and marketing exclusivity from Petroleum and Natural Gas Regulatory Board (PNGRB) for implementation of Natural Gas Distribution Project in Barwala and Ranpur Talukas Geographical Area of Botad District in the Gujarat State.

Environmental Impact Assessment (EIA) study report has been prepared in order to assess anticipated environmental impacts during design, construction and operation phases of Natural Gas Distribution Project in Barwala and Ranpur Talukas Geographical Area of Botad District. Based on identified environmental impacts, environmental mitigation measures and environmental management plan have been prepared.

1.2 Need of the Project

The primary objective of the project is to set up natural gas (pre-dominantly methane) distribution network in the geographical area of Barwala and Ranpur Talukas in Botad District to supply gas to industrial, commercial, domestic and automobile (CNG) sector in both the districts.

The general objectives of the project are as follows:

- Supply environment friendly fuel to industries, vehicles, commercial establishment and households.

- Expanding gas pipeline network to make natural gas available to maximum number of users.
- Make a significant contribution in reducing the increasing pollution menace in the area.
- Create new benchmarks in environment and safety standards while doing the above.

The two main objectives of the project are:

- Provide a safe, convenient, reliable and environment friendly fuel (natural gas) to the customers in industrial, commercial and domestic sectors.
- Provide a cleaner, environment friendly alternative auto fuel and thus contribute to the reduction of the present alarmingly high pollution levels.

Source

Natural gas for the Barwala and Ranpur Talukas Geographical Area of Botad District will be received from tap off point at GSPL's DJPL pipeline at Rasulpur, which is 1 km from Barwala in Botad District.

Market

Natural gas (predominantly methane) as a fuel and feedstock enjoys several benefits compared to other alternatives like petroleum fuels, wood and coal. It is the cleanest burning hydrocarbon fuel and has become the preferred fuel in progressive economies around the world on account of its safe and eco-friendly characteristics. It produces no solid wastes and is almost 100% combustible, natural gas offers several economic benefits to users, as equipment based on natural gas offer higher efficiencies and lead to significant savings.

On account of the above, natural gas (predominantly methane) is projected to be the "**fuel of the future**" in India too, and is being promoted as a cleaner option for several industrial applications. India has a huge supply deficit on account of the increased demand for gas from the industries and this has given rise to many import options as well.

Realizing the need, pro-actively steps have been taken numerously to meet the growing demand of energy. Petroleum and Natural Gas Regulatory Board has identified geographical areas for distribution and marketing of Natural

Gas to industrial units, household and CNG for vehicles. Petroleum and Natural Gas Regulatory Board (PNGRB) has given authorization to Adani Gas Limited for distribution and marketing exclusivity for implementation of Natural Gas Distribution Project in Barwala and Ranpur Talukas Geographical Area of Botad District in the Gujarat state.

1.3 Need for EIA Study

The project activities must co-exist satisfactorily with its surrounding environment so as to reduce the environmental impacts, likely, to arise due to these activities. In order to assess this, proper environmental impact identification and assessment has to be carried out. Based on the impacts, proper and adequate environment management plan has to be devised and implemented.

1.4 The Assignment of EIA Studies

M/s Betterworld Enviro Consultants, Faridabad has been entrusted by M/s. Adani Gas Limited (AGL) to carry-out Environmental Impact Assessment studies and to prepare Environment Management Plan (EMP) for various environmental components, which may be affected due to the construction and operation phases of the project.

Reconnaissance survey of the area was undertaken in the first week of April 2019 and various sampling locations to monitor various environmental parameters were identified. Subsequently, monitoring was commenced for ambient air quality, surface and ground water quality, soil characteristics and noise levels at the specified locations. The other studies, such as, topography, physiography, geology, meteorology, flora, fauna, socio-economic profile, etc. are based on field visit and secondary data collected from various government agencies and published sources.

1.5 Environmental Setting

The project is located in Barwala and Ranpur Talukas of Botad District in Gujarat state. The location of the project in Gujarat state and Botad district is shown in **Figure 1.1.**

The main features of the project area are:

- Areas along the pipeline route is mostly plain, however some places it is undulating also.
- Project area does not fall under any forest area and environmentally sensitive area like wildlife sanctuary, national park, etc.
- There is no archaeological monument near the pipeline route.

1.6 The Study Area

The area around the Gas Distribution Project in is shown in **Figure 1.2** including settlement and other geographical features in the study area. The study area is dominated by urban, rural and industrial area.

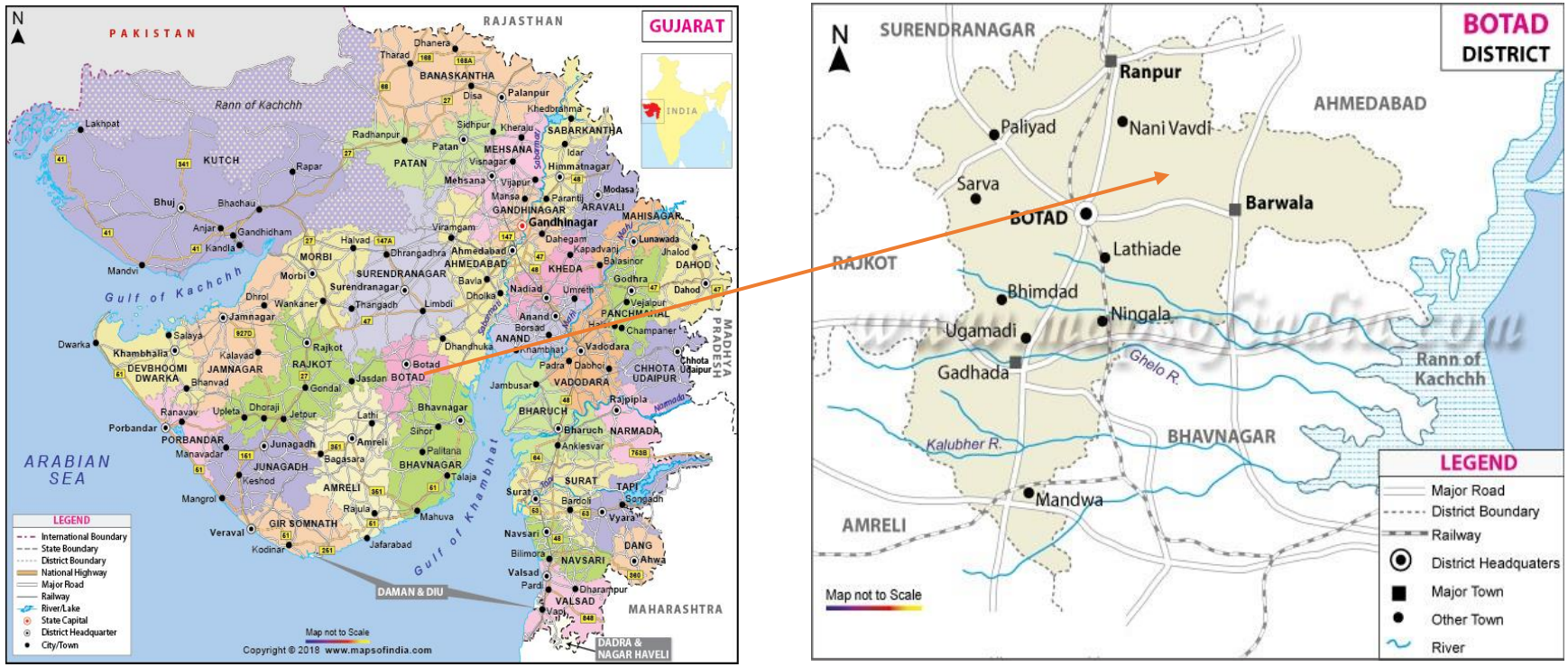


Figure 1.1: Location of Natural Gas Distribution Project in Barwala and Ranpur Talukas GA of Botad District

1.6.1 Scope of EIA Study

I. Baseline Environmental Data Collection

Base line data collection shall be done for following environmental components:

- Air quality
- Noise Environment
- Flora and Fauna
- Water quality
- Soil
- Demography and Socio-economic

Air Environment

- 24 hourly air quality monitoring will be carried out.

- The monitoring and analysis shall be carried out as per CPCB/MOEF&CC monitoring guidelines.

Meteorological Data Collection

Hourly meteorological data shall be collected during study period (for one season) for the following parameters:

- Wind speed
- Wind velocity
- Ambient Temperature
- Relative Humidity

Required climatological data shall also be collected from the nearest Indian Meteorological Department observatory.

Noise

Noise levels shall be measured where air quality monitoring will be carried out.

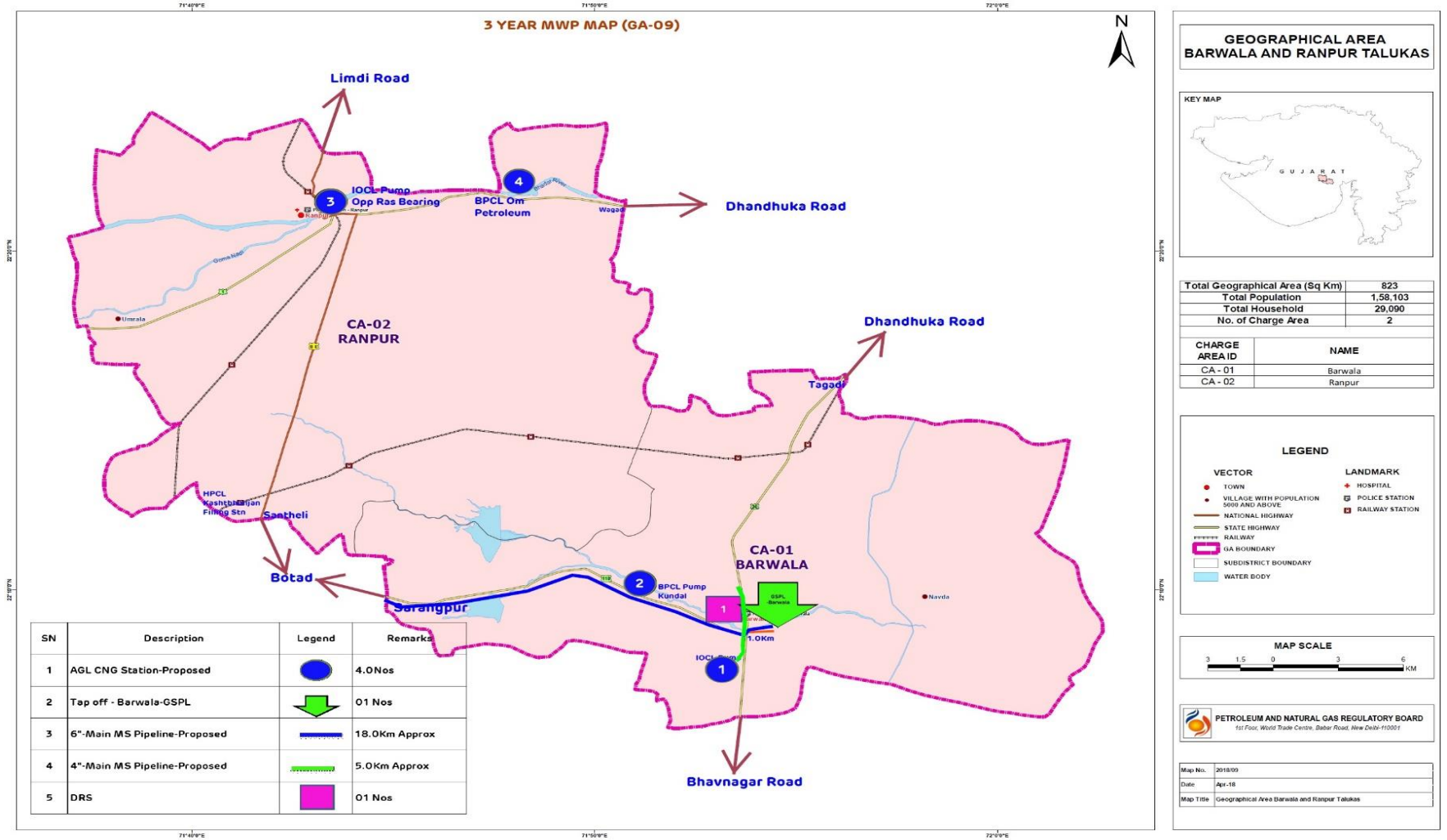


Figure 1.2: Proposed Natural Gas Distribution Project in Barwala and Ranpur Talukas GA of Botad District

Ecology

Information on terrestrial flora and fauna will be collected by field studies and supplemented by published sources.

Water Quality

Ground water shall also be analyzed along the pipeline/DRS. Surface water source also will be analyzed, if any.

Soil

Soil samples will be analyzed for relevant physical and chemical parameters for determining impacts on ground and other potential usage one during the study period.

Demography and Socio-economic

Data on demography, population density, employment structure, economic conditions and infrastructure facilities shall be collected from published sources.

Additional

Places of ecological and any other environmental sensitive habitat shall be identified within 10 km radius.

II. Environmental Impact Assessment

Sources of air pollution from the Natural Gas Distribution Project shall be studied and adequacy of control measures shall be examined.

Impact of noise on surrounding environment shall be studied.

Predication of impact on baseline ambient quality of the environmental components due to the Natural Gas Distribution Project shall be carried out.

The effect of discharge of treated liquid effluent and solid wastes, if any, on water and soil will be assessed, as relevant.

III. Environmental Management Plan

Mitigation Measures

The study will suggest measures to mitigate adverse impacts during construction and operation phases. Special protective or enhancement measures will be recommended for ecological resources, wherever, considered necessary.

Environmental Management and Monitoring Plan (EMMP) will describe pollution control measures for air, water, solid wastes and noise, etc. Environmental monitoring plan will contain the monitoring program to check the effectiveness of mitigation measures to be adopted by the Natural Gas Distribution Project in Botad Districts GA.

1.6.2 Methodology of the EIA Study

To carry out EIA study for the Natural Gas Distribution Project in Barwala and Ranpur Talukas GA of AGL, reconnaissance survey was conducted by field team of Betterworld Enviro Consultants, Faridabad and sampling locations for various environmental parameters were identified on the basis of:

- Predominant wind direction expected during the period of baseline monitoring in the study area
- Topography, location of surface water bodies like, ponds, canals and river
- Location of village/towns/sensitive areas
- Identified pollution pockets, if any within the study area
- Accessibility, power availability and security of monitoring equipment
- Areas, which represent baseline conditions;
- Collection, collation and analysis of baseline data for various environmental attributes.

The field studies and primary data collection have been conducted during April 2019, to determine existing conditions of various environmental attributes.

EIA Methodology

The Gas Distribution Project of AGL in Barwala and Ranpur Talukas GA of Botad may have impact on the physical, chemical and biological attributes of surrounding environment. In assessing the environmental impact, collection, collation and interpretation of baseline data is of prime importance. Environmental impact analysis and assessment should be preferably carried out at the planning stage itself.

The objective of EIA is to foresee and address potential environmental problems/concerns at an early stage of project planning and design. EIA/EMP should assist planners and government authorities in the decision making process by identifying the key impacts/issues as a result of the Natural Gas Distribution Project activity and formulating mitigation measures, leading to an improvement in environmental quality.

In order to achieve the above objectives, the following procedures have been adopted:

- Collection, collation and analysis of baseline data for various environmental attributes (like ambient air quality, meteorology, water quality, noise level, soil characteristics and land use, ecology and socio economic aspects),
- Identification of Environmental Impacts,
- Environmental Impact Assessment,
- Evaluation of impacts leading to preparation of environmental management plan,
- Outline post project monitoring programme.

1.7 Contents of the EIA Report

The EIA report has been divided into following chapters and presented as follows:

Chapter 1: Introduction

This chapter provides background information of the project, details of the Natural Gas Distribution Project, and brief environmental setting of the area. The scope of the study and the EIA methodology adopted in preparation of EIA report has also been described in this chapter.

Chapter 2: Project Description

This chapter deals with the technical and design details of Natural Gas Distribution Project, utilities, sources of pollution from the Project activities and the envisaged pollution control measures.

Chapter 3: Description of Environment

This chapter presents the description of environment of the study area, including, physical, biological and socio-economic conditions, which is also supplemented by secondary sources like published literature.

Chapter 4: Anticipated Environmental Impacts & Mitigation Measures

This chapter describes the anticipated impacts on the environment and mitigation measures for Natural Gas Distribution Project. Assessment of anticipated environmental impacts gives the details of the impact on the baseline parameters, both during the construction and operational phases and suggests the mitigation measures to be implemented by the AGL.

Chapter 5: Analysis of Alternatives

This chapter examines alternative means for the proposed project

Chapter 6: Environmental Monitoring Plan

This chapter describes environmental monitoring requirements for effective implementation of mitigation measures during construction and operational phases along with required institutional arrangements for their implementations.

Chapter 7: Environmental Management Plan (EMP)

This chapter provides mitigation and control measures for environmental management plan (EMP) including mitigation measures for minimizing the negative environmental impacts of the Natural Gas Distribution Project.

Chapter -2

PROJECT DESCRIPTION: GAS DISTRIBUTION PROJECT IN BARWALA AND RANPUR TALUKAS GEOGRAPHICAL AREA

2.1 Introduction

Adani Gas Limited (AGL) has accord the authorization and marketing exclusivity from Petroleum and Natural Gas Regulatory Board (PNGRB) for implementation of Natural Gas Distribution Project in Barwala and Ranpur Talukas Geographical Area of Botad District in the Gujarat State.

2.2 Project Details

Adani Gas Limited (AGL) has planned for the laying of pipeline and setting up 1 No. District Regulator Stations, 4 Nos CNG Stations for CNG and PNG gas distribution in Barwala and Ranpur Talukas Geographical Area. The tap off point will be from GSPL's DJPL, 1 km from Barwala in Botad District. Details for Natural gas distribution system for Barwala and Ranpur Talukas Geographical Area are given below:

Sn.	Description	Details
1.	Tap off Point GSPL Barwala	1
2.	6" Main Pipeline – Proposed	18 Km
3.	4" Main Pipeline – Proposed	5 Km
4.	DRS	1 No.
5.	AGL-CNG Stations – Proposed	4 Nos

2.2.1 Tap off Point GSPL 's DJPL at Barwala

The tap off point will be located on the 24" DJPL of GSPL at Barwala on the Latitude and Longitude (22° 8' 25.49", 71° 54' 28.99"), which located at a distance of 1 km from Barwala in Botad District.

The location of Barwala Tap off Point for Barwala and Ranpur Talukas Geographical Area GAs are given in **Figure 2.1**.

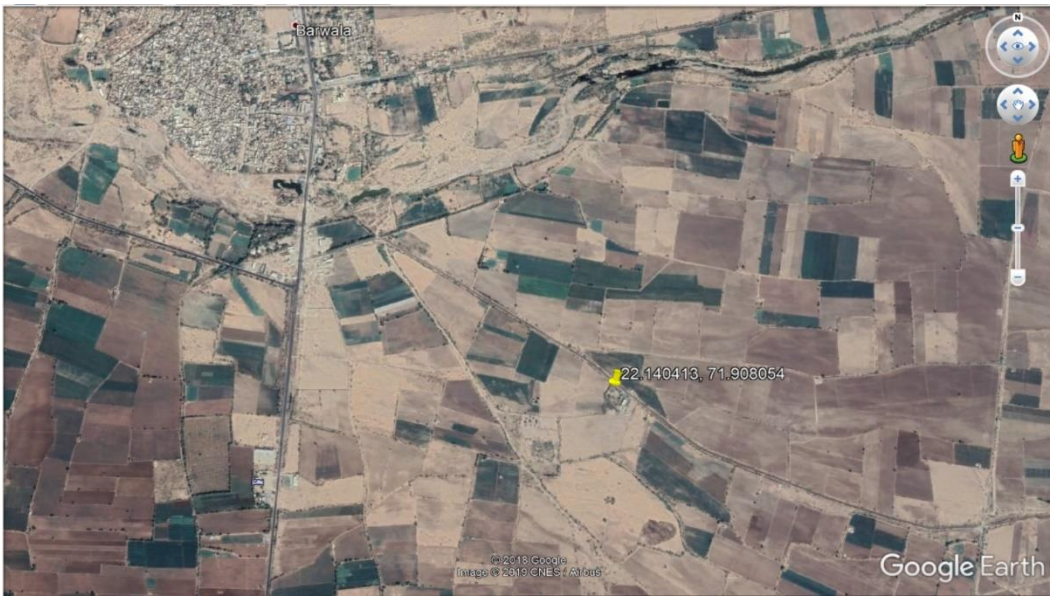


Figure 2.1: GSPL DJPL Barwala in Botad District

2.2.2 Proposed Pressure Regime

The network conceptual plan as per pressure regime is shown in **Figure 2.2.**

Main pipeline from tap off point will be operated at high pressure (37 to 40 Bar-g). Steel network will be operated at 26 bar-g. In the City area, pipeline lines will be operated at 4 bar-g. For industrial customer gas will be supplied at 1.5 bar-g to 110 mbar-g. For residential users pipeline will be operated at 21 to 24 mbar while for commercial users pipeline will be operated at 110 mbar.

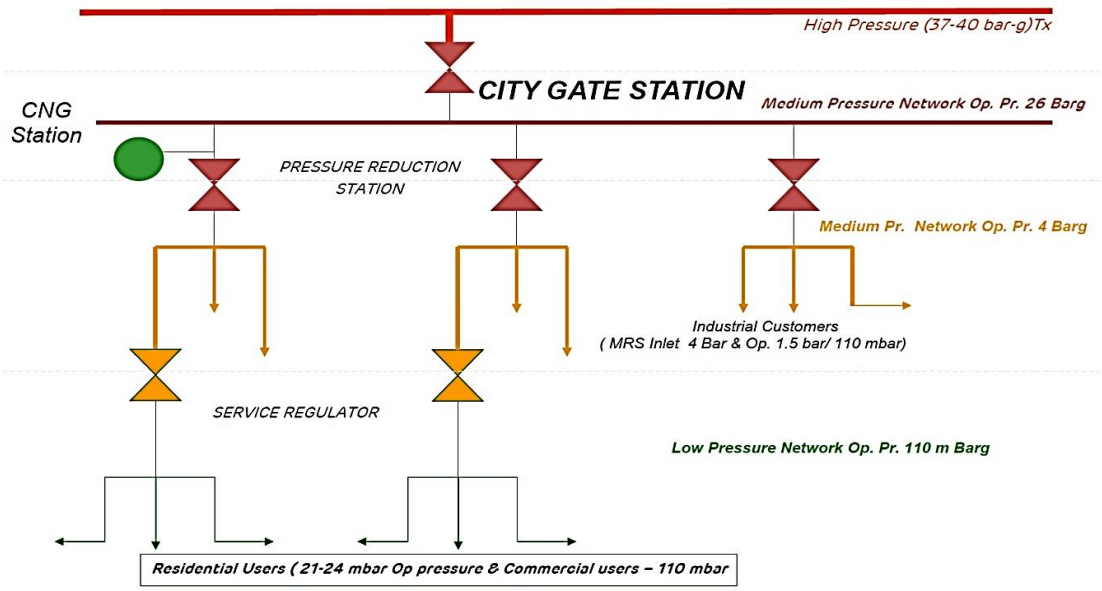


Figure 2.2: Network Conceptual Plan as per Pressure Regime

2.3 Characteristics of Natural Gas

The characteristics of natural gas are given below:

- Name of product : Gas (Predominantly Methane)
- Chemical Name : Methane
- Chemical Family : Hydro Carbon
- Formula : Primarily (87 – 92%) Methane (CH4).
- Boiling Point : -161.5° C
- CAS : 8030-31-7
- Melting Point : -182.0 °C
- Flash Point : -161.5 °C
- Auto ignition Temp : 540.0 °C
- Specific Gravity : 0.60
- Vapour Density : 0.60 – 0.70
- Colour : Colourless
- Odor : Odourless
- Solubility : Soluble in water, Alcohol & ether
- Lower Flammable : 5% (Limit in air)
- Higher Flammable : 15% (Limit in air)
- Reactivity : Stable

Natural Gas produces less air pollution than any other fossil fuel. Use of CNG vehicles can reduce carbon monoxide emissions as much as 93% Nitrogen Oxide reduces about 33% and Hydrocarbons are reduced by about 50%. Natural Gas emits almost no carcinogenic particulates.

Compressed Natural Gas

The proposed CNG stations will be specified to PNGRB Guidelines and Indian Standard, OISD 179 or equivalent.

Assumptions:

1. The CNG stations in all options will be based on a three lines, fast fill system.
2. The area of each proposed CNG sites is assumed to be approximately 40 m X 50m.
3. The extension of the Steel Grid to a CNG to a CNG station is assumed to be no more than 1 km.

4. Based on existing local operation and conditions, it is assumed that all station compressors will operate 12 hour per day.
5. The gas supply to the On-line and Bus stations are taken from the steel Grid pipeline at 26 bar.
6. It has been assumed that the proposed CNG station would require associated station infrastructures, which include shelter over the dispenser; station attendant's building with amenities, concrete apron and driveways.

2.4 Design Philosophy

The Natural Gas Distribution System will require engineering, procurement, construction and commissioning of natural gas distribution facilities adequate to serve industrial units, households, commercial establishments and the automobile segments. These facilities will include high pressure pipelines, district regulator stations (DRS), medium pressure mains and services, meters and CNG stations. The size of the distribution system related to area covered, density of consumers, and types of customers served, will be confirmed as a part of project execution.

The design criteria, in terms of codes, pressures, operating procedures will reflect Indian standards. International standards are applied only when Indian standards refer to them or Indian standards are not available.

The objective of the design basis is to provide the required engineering basis to ensure the gas facilities considered in the feasibility study are of demonstrated quality and capable of providing reliable gas service to identified customer groups in a safe, efficient manner in accordance with the expectations of the owner:

- The total road lengths for steel grid within the city have to be arrived by conducting Reconnaissance Survey & Detail route survey.
- Total length of PE grid for distribution will be calculated considering 10 meters/customer.

2.4.1 Design Summary

The steel network design is based on 2 years implementation schedule and for PE pipeline for domestic/commercial segment is based on 10 years implementation schedule. The built up of execution in terms of percentages

in each sector and is formulated based on knowledge and experience in city gas distribution. Based on the requirement of gas for all sectors, the schedule would suffice for total coverage of city.

The design philosophy shall be to:

- Optimize the use of each component of the overall system (*i.e.* do not make uneconomical decision on one component to compensate for another
- Conserve available energy to distribute the gas (*i.e.* fewer pressure regulating stations). Generally, minimize the use of mechanical components in the system (*i.e.* stations, regulators, meters, and valves which are high capital cost, high maintenance and generally reduce pressure availability for distributing natural gas).

The design philosophy will be achieved by:

- Operating the system at the appropriate rated pressure for each component. Failure to do so leaves latent capacity unused and generally results in expenditures on other system components to compensate.
- Minimizing the number of different system pressures.
- Carefully evaluating the use of mechanical components and generally minimize usage.

The PE Pipeline network will provide service mainly to residential customers with some mix of commercial customers. The present population of the community is expected to grow significantly during the design period.

2.4.2 System Planning Assumptions

The high gas pressure, which will be available for city gas distribution network will be generally 37-40 bar. This high pressure will be regulated to a medium pressure of 26 bar at facility called City Gate Station (CGS). This GGS will also serve the purpose of custody transfer of gas from gas transmission of the CGS will be at 26 bar. Major industrial customers will be supplied directly from DRS at inlet pressure 26 bar-g and out let pressure 4 bar-g.

For the purpose of Piped Natural Gas (PNG) distribution to domestic, commercial & industrial customers, the medium pressure is further regulated to low pressure of 4 bar though the facilities called District Regulating stations (DRS). The distribution network downstream of DRS comprises of Medium Density Polyethelene (MDPE) pipelines network which is laid right uptill the customer premises. It is at this point that the 4 bar distribution pressure is further reduced to service pressure of 21-24 mbar and 110 mbar based on the customer's requirement of natural gas making it safe to use inside customer premises. MDPE material, apart from having commercial benefits over steel pipeline network also has the advantage in laying in city like conditions. MDPE is also recommended to standardize the distribution system as much as possible.

To connect customers, service network is required. These will be installed by fusing a tapping saddle at the top of the distribution main for supply of gas to consumer's premises. At the end of each service, a metal up stand will be installed upon which an isolation valve, regulator and meters will be connected. 21-24 mbar pressure is recommended for domestic customers, however, pressure requirement for that unit.

During the detailed design phase of the project, these routes will be refined and selected in detail, to ensure safety, ease of construction and minimal obstruction of other buried services. In addition, during the detailed deign the exact location of the CGS and DRS will be nominated, as well as issues such as "Risk Factors with respect to third party system" and "Interruption management."

The principal international standards proposed for the distribution project is ANSI /ASME B 31.8, Gas Transmission and Distribution Piping System.' In addition, it is proposed to adopt guideline specified in the American Gas Association (AGA) publication, Volume III Distribution, Book D-1 'System Design'.

Four arm minor junctions principal design variables are nominated for the safety and reliability of a gas distribution system; these are:

Use of a Looped or Redial System: It is proposed to have, as far as practical, a looped distribution design such that back-feed can be supplied

during interruption as the distribution main and at every branch off. These valves will be normally open, but will be made accessible from the surface, such that they can be utilized as emergency isolation valves.

Placement of Valves: It is proposed to have approximately one valve buried every 2.5 km of distribution main and at every branch off. These valves will be normally open, but will be made accessible from the surface, such that they can be utilized as emergency isolation valves.

Layout of Services (Single and Branched): To save on infrastructure cost, it is proposed, where ever practical, to have one gas service to supply up to domestic customers. This will, however, have a minor negative impact on the reliability of the system, in that should the service be interrupted, three customers will be affected.

Design of regulator stations: The proposed CGS and DRS are recommended to be of dual regulator run designs. This feature will ensure a high level of reliability for the supply of natural gas to the distribution network.

The standard ANSI / ASME B31.8 does not adequately cover the topic of plastic pipes. Hence, for the material specifications for plastic pipes, the International standards Organization (ISO) documents are proposed, especially ISO 4431, "Buried polyethylene (PE) pipes for the supply of gaseous fuels-metric services – specifications."

2.5 Method of Supply

2.5.1 Supply Method

Using the domestic/small commercial quantity and large commercial quantity values, and additional information, including location of customers, pressure requirements at major customers, availability of existing supply, and geographic features, optimum method of supply was determined.

2.5.2 Supply Facilities

The supply facilities, existing and new, were considered and include the following:

- High Pressure Steel Pipeline Main
- Medium Pressure Steel Pipelines
- Low pressure MDPE mains
- Low pressure MDPE/GE services
- GGS/ DRS / Hot Taps
- Service Connections
- Odourisation Facilities

2.5.3 Network Analysis

A network analysis program is used to assess that the proposed method of supply is the optimum method. It was necessary to compare a number of methods because reasonable alternatives exist. In this project, the system was designed for the 25-year projection without a need for major reinforcement.

2.5.4 Determine Design for Reticulation Mains

Using the town plan showing the location of existing mains, supply boundary, and major customers, the design and size of mains for the town reticulation were determined.

2.5.5 Initial Reticulation

The implementation is subject to survey results regarding growth potential or willingness to convert or connect to natural gas, and availability of labor resources.

2.5.6 Future Reticulation

The future reticulation usually extends outside the town boundary. For current distribution system the length of PE Pipe is estimated by and allowance of 10 m per customer.

2.5.7 Staged Reticulation

Staged reticulation normally occurs in new estates as various stages are released and developed. After an initial stage in year 1, the later lengths of main can be determined in the same manner as for the first reticulation then allocated in proportion to the customer number provided in the twenty years forecast.

2.6 Size of Distribution Mains, District Regulating Station And City Gate Station

The sizes of PE pipes are standardized to three typical outside diameter sizes of PE 125. The minimum number of pipe sizes for distribution systems will reduce the level of inventory and minimize the capital and operational cost. Laying pipe sizes larger than PE 125, was shown not to be economical viable, when compared to steel pipes. The cost saving of laying PE pipes smaller than DN63 is minimal but the capacity of the distribution system is reduced substantially.

The Steel Grid pipeline sizes shall be restricted to 12" NB & 8" NB whereas, spur lines shall be of 6"NB & 4"NB.

It is proposed that the transmission system extension is coated fully welded steel pipes. The coating is proposed to be extruded polyethylene, with each weld joint coated with either heat shrink sleeves or field applied tape.

Prior to the pipeline extension being put into service, the transmission pipeline extension would be non-destructively tested by two methods. Firstly, welds would be radio graphed and, secondly, the completed pipeline extension would be hydro-statically tested at a higher pressure than its operating pressure.

After hydrostatic testing, the pipeline would be dried, purged and filled with natural gas. The testing and commissioning procedures will be detailed during the detailed design phase of the project.

To protect the pipeline from corrosion, a cathodic protection (CP) system of impressed current is proposed. During the detailed design phase, the CP

capability of the existing transmission system will be investigated to establish if it has the capacity to provide CP to the extension. If it is found that the existing system does not have the capacity additional CP facilities will be designed.

The transmission pipeline extension is proposed to be installed at a minimum depth of 1.0 meter cover, and in accordance with International standards for pipeline laying.

2.7 Odourising Facilities

It is good practice to have the natural gas odorized to ensure a safe natural gas distribution system. The natural gas in the existing KBPL pipeline is un-odorized and therefore it is necessary to install odorizing plants.

One odorizing plant will be installed at each distribution supply point, *i.e.*, at each City Gate Station. It is proposed that the Ethyl Mercaptan odourant will be used which provides a better odourizing impact, especially if there is substantial background odour such as in a mildly polluted environment. Because odourant compounds is also hazardous dangerous organic chemicals and highly flammable, a reduced number of odourant plants will provide a safer environment and is more cost effective.

2.8 City Gate Station

The gas transported by GSPL at city gate station will be at a high pressure of above 30 bar. The pressure reduction facility comprises two full capacity Class 600 regulator runs, each having an active /monitor regulator, each fitted with slam-shut' protection facilities. In addition, allowance was made for natural gas preheaters, should they be required in the future. The pressure reduction and metering equipment can be fitted in a single self-contained skid-mounted cabinet. It is recommended that CGS be located in a fenced off secure area.

To supply the remainder of the distribution system from the 26 bar maximum transmission pressure system, a Class 300 'DRS' will be required. The DRS will be similar in design to the City Gate with different capacity, except no allowance is made for future gas heating and metering.

2.9 Distribution Materials

In modern gas distribution systems, there are currently two non-steel alternative distribution materials. One is nylon. This is commonly Polyamide 11 and 12 with a reasonably high tensile strength of typically 360 bar, which results in nylon pipe having thinner walls compared to polyethylene for the same application, nylon pipes are most commonly joined by solvent adhesive and socket fittings. Polyethylene is the other alternative. It is recommended that the distribution system be constructed from MDPE for two reasons, firstly, installed MDPE is cheaper than nylon for 4 bar applications.

Secondly, polyethylene electro-fused joints are as strong as the parent pipe: this in turn ensures that the integrity of the pipe system is continuous. With nylon systems, fluid sockets are frequently weaker in tension, relative to the parent pipeline material.

2.10 Distribution Mains

To standardize the distribution system, it is proposed to install only three sizes of OD pipes – 63mm, 90 mm and 110 mm. It is proposed that all pipe joining is by electro-fusion couplings. The distribution pipe is proposed to be Standard Dimension Ratio (SDR) 11 up to 63 mm. The term SDR is defined as the normal outside diameter (DN) divided by the minimum wall thickness. It is standard practice in India to have a minimum one meter cover. This additional depth in a densely populated area would be recommended. All MDPE pipe will be back filled with sand around it to protect the plastic material. Emphasis will be placed on utilising modern construction techniques to install the distribution system in line with international trends. This will include, wherever possible, avoiding disruption/ damage to roads and footpaths, by boring and drilling. Large crossings, such as canals, rivers and other long distance crossings will be installed using Horizontal Directional Drilling (HDD). It is proposed to have valves on the distribution and transmission networks after every 2.5 km's located at strategic locations to ensure security of supply.

- All MDPE pipes being sand-baded and padded.
- All MDPE pipe joins being electro-fusion couplings.

- Soil cover of 1 meter.
- 25% of pipe being in the roadway, 75% in natural strips.
- 100 m coils for DN 63 and DN 90 and 12 meter pipe lengths for DN 110 pipe, with allowance for 45° and 90° bends and equal tees.

To ensure system integrity and safety, prior to commissioning, the MDPE pipes are proposed to be air tested for 24 hours.

2.11 Distribution Services

Distribution services are used to connect customers from the mains. As most services must cross roads/footpaths/back yards, to reach the customers, they are often installed by trenchless technology where ever possible, to reduce reinstatement costs. Open excavation is then only needed at the connection to the main and at the service. Where open excavation has taken place, Marker tape is installed. To standardize materials, it is assumed that 20 mm services will be used to supply domestic consumers, 32 mm services for small and large commercial consumers.

2.11.1Backfilling & Restoration

Safety : Initial backfilling shall be done in 300 mm layer, taking precaution that no stones or boulders will impact or damage the pipe.
Cost : Already excavated material is used for back filling, unless soil conditions make this impractical, then imported material will be used.
Standards : API – 1102, Clause 4.62
Current Practice : As above
Design basis : 26 bar as regulated at CGS.

Back filling shall be done as above practice and area shall be dressed in with the existing level. The restoration of any disturbed works including asphalt and concrete road surfaces shall also be done. This shall include all the work necessary to remove surplus material from the work site, permanently repair of replace fences, shrubs, buildings, or other obstructions disturbed by the pipe laying process.

2.11.2Installation

Safety: Piping will carry flammable gas and hence it is much safer to lay underground, away from sources of ignition. This will also give protection from physical damage and ultra-violet radiation to MDPE pipe. However, limited piping within the CGS for custody transfer and flow measuring instruments will be above ground. Piping with in CNG stations will be either above ground or in trenches.

Cost: The land cost in case of underground piping involves only right of users (acquisition of right of users land) Act 1962 No. 50 of 1962 as against land to be acquired for above ground piping. The cost of land for above ground level as desirable for topographical, economic or other special reasons.

Standards: As per Explosive Rule 1976 (clause no. 92.2) pipe lines shall be laid below the ground level except when laying them above the ground level as desirable for topographical, economic or other special reasons.

Current Practice: Current practice is to provide underground pipelines. Minimum depth of cover shall be as per T4S varying from 1 m to 1.5 m depending upon location of the pipeline.

Design Basis: The proposed distribution system shall consist of primarily of underground piping. Installation may be completed by the following methods.

- Trenching
- Trenchless
- Auguring
- Plowing

2.11.3 Stream/Water Crossings

Safety: Additional depth of cover and extra thickness will be provided for safety reasons.
Cost: With respect to over-ground installation, underground installations will be cheaper. In over-ground systems the pipe bridge has to be considered.
Standards: T4S
Current Practice: Under stream/river with extra thickness

Design Basis: All stream and river crossings are to be underground. Installation may be via trenched or trenchless methods providing environmental, safety and cost are considered.

2.11.4Cathodic Protection

Safety: All equipment for cathodic protection coming along the grid will be fenced all around for safety and security reasons.
Cost: Installation and operation cost will be low, at the same time life span of steel pipe will definitely be increased tremendously.
Standards: ANSI/ASME B31.8 Clause 862.4
Current Practice: Cathodic protection will be provided all along the steel pipe.
Design Basis: All underground steel piping as well as the tracer wire installed with the PE pipe will be cathodically protected. Cathodic Protection will be provided by an impressed current system to be designed to accommodate effects of inductive currents and ground fault conditions from adjacent High Voltage AC power lines. The impressed current systems will include a rectifier for the DC power source and shallow anode ground beds. The status of protection will be monitored by use of test stations installed at certain intervals to measure the pipe-to-soil potentials along the pipeline. This distance interval depends on the local climate, soil conditions and the depth of cover for the pipeline system. The stations shall be easily accessible (*i.e.* adjacent to roads), if possible. Insulating flanges shall be installed at station limits of this Project.

2.11.5Pressure Regulators

A distribution pressure of 4 bar (low pressure) requires pressure regulation installed at each meter set to reduce the pressure delivered to the consumer between 21 mbar (service pressure). As per ANSI/ASME B31.8, a single regulator is acceptable for this purpose. If however, distribution pressure exceeds 4 bar, ANSI/ASME B31.8 requires additional overpressure protection such as if provided via two pressure regulators at each meter set. Hence, increasing the distribution pressure above 4 bar increases the cost of each meter set. As a distribution pressure of maximum 4 bar has been selected or the feasibility study a single regulator is considered adequate for the design basis.

2.11.6 District Regulating Stations (DRS)

Safety: DRS need to be secure from vandalism, vehicle damage and other risks.
Cost: There will be no land cost because it will come under acquisition of right of users land.
Standards: ANSI/ASME B31.8 clause 847.2
Current Practice : At the side of lane/road
Design Basis : DRS will be installed on the paved area, side of lane in a metallic lockable cubical. The stations will be unmanned but contain security alarms to detect tampering.

2.11.7Pressure

CGS Outlet: Maximum outlet pressure will be 26 bar.
DRS Inlet: Minimum inlet pressure to individual DRS will be 26 to 19 bar for the purpose of the feasibility study.
DRS Outlet: Maximum outlet pressure of the DRS will be 4 bar for the distribution system.
Over-pressure Protection

Safety: A monitor regulator will be provided down stream of control valve
Cost: For safety of the system, cost is negligible
Current Practices: Required by code
Design Basis: To avoid venting of natural gas to the atmosphere over-pressure protection will be via monitor regulators. Only token relief valves will be installed. This approach is both safe, environmentally friendly and does not result in undue concern from the public in the event of over-pressure.

Records and Instrumentation

Pressure (inlet and outlet) and temperature recorders will be installed at all DRS.

Valving

With the exception of valves installed in DRS, all valves will be underground. All underground valves will be either welded or fused, no mechanical joints will be used. Above ground valves will be weld end, flanged or for smaller

sizes screwed. DRS valve will be no-lubricated ball valves. For ease of maintenance all valves will be manually operated.

2.11.8Continuity of Supply

Parallel second runs will be installed to provide 100% redundant capacity in each station for emergency or for maintenance purposes.

2.12 Network Plan

The proposed project comprises network to cover the industrial/domestic areas mentioned above. The network would comprise of the following:

Tap off point form transmission pipeline; City Station (CGS); and Pipeline network including steel pipelines, MDPE pipelines, District Regulating Stations (DRS) and Industrial Metering and Regulating Stations (IMRS).

It is envisaged that gas will be taken through GSPL's DTPL. GSPL to confirm delivery of gas at 37-40 bar-g pressure at tap-off locations. The gas would be taken to the CGS through and underground steel pipeline.

The CGS would reduce the pressure of gas to 26 bar through step pressure reduction and add odorants before distribution. Thereafter, the gas will be charged into the primary steel pipeline network. From here, the gas is taken through district regulating station (DRS) based on the nature of downstream demand profile.

The DRS will be installed at places where group of small industries are to be catered. This helps in consolidating the smaller demand of individual units. From the DRS after reducing pressure to 4 bar, the gas will be charged into secondary MDPE pipeline network to be taken to different industrial units.

Various studies have been carried out including route survey, basic design & engineering and detailed engineering customer survey etc for the domestic/commercial/industrial/transportation areas to be covered in the initial phase.

2.12.1City Gate Station (CGS)

CGS for the network will be located at GSPL tap off point. The CGS would have inlet supply mains from the transmission pipeline, a pressure reduction system with two sages, a filtering unit, gas chromatograph and orifice metering or Turbine metering, odorant injection system and associated piping. The filtering unit would remove entrained particles of size 5 microns and above and with final filtration efficiency of 99.9%. This unit would comprise of borosilicate fiberglass cartridge. The unit also provides for a drain with a manual drain valve. The filter vessels are designed in accordance with industry norms and shall be constructed with carbon steel.

2.12.2District Regulating Station (DRS)

DRS for the network will be located at Industrial area as well as various demand centers for Domestic/ Commercial segment. It would have pressure reduction system, a filtering unit, orifice metering system, valves etc. based on the consumption profile of cluster of users, customized arrangements are designed with online metering arrangement. The filtering unit would remove entrained particles of size 5 microns and above and with final filtration efficiency of 99.9%. This unit would comprise of borosilicate fiberglass cartridge.

The DRS would have slam shut valves, pressure regulating valves, creep relief valve and vent, isolation valves and no-return valves.

2.12.3Pipeline Network

The primary network of steel pipelines will provide the core backbone connecting CGS to various DRS. The pressure levels for primary network are between 26 bar to 19 bar. While most of the industrial customers are not required to be supplied at this pressure level, only a select few units have specific requirement for medium pressure delivery would be connected to through this network. The design of the primary network is based on the demand forecast to be catered. Pipe sizing is carried on basis of Weymouth formula with efficiency and roughness of pipeline set at 0.9 and 20.4 microns respectively. The primary network is designed to meet 20% higher load than

the expected peak flow and is designed to have a 40 meters per second maximum limiting velocity.

Secondary network system consisting of MDPE pipelines operates at pressure level between 4 bar to 1 bar. MDPE pipeline network is planned for cluster of industrial units at low pressure. The secondary network would be developed with MDPE 100 grade pipes. The design of the MDPE pipelines is based on the demand forecast to be catered. Pipe sizing is carried on basis of Weymouth formula and is designed to meet 20% higher load than the expected peak flow. This network is designed to have a maximum limiting velocity of 40 m/sec.

2.12.4Civil

Civil structures are envisaged at stations to provide shelter to man & machinery and facilitate processes and operating activities. The major civil construction would be at the CGS involving a CGS platform and shelter, control room, office building, fire hydrant sump, pump room, DG room, workshop, stores, odorant storage room, utilities, approach road and landscaping. In addition, platform would be built at DRS and underground valve chambers would be built along the steel network.

2.12.5Cathodic Protection

External corrosion of the mainline will be mitigated by a combination of passive and active protection techniques. Passive protection technique will consist of suitable coating on the pipeline system. Active protection technique will consist of sacrificial anode type cathodic protection system. Anodes for this purpose would be of Aluminum- Zinc-Indium alloy. Conventional impressed current cathodic protection system would be installed.

2.12.6Others

In addition to the above main project components, support infrastructure in terms of electrical, communication infrastructure and transport vehicles is also envisaging.

2.13 System Basic Concept

2.13.1Pressure Levels

The concept is based on the pressure levels given in the following sections.

2.13.2High Pressure

This applies to the pipelines connecting the Gas Transmission System to the "City Gates".

2.13.3Design Data for HP System

The maximum inlet pressure for the city gate will be taken as 37-40 bar being known as the supply pressure at off-take points.

2.13.4Medium Pressure

This applies to the pipelines connecting City Gate Station to DRS
Design data for MP system

- Maximum Operation Pressure (MOP) = 26 bar (compatible with ASA Class 300 flanges and fittings);
- Operating Pressure fluctuating between 26 bar to inlet pressure of CNG Compressor and DRS depending on actual operating pressure and pressure drops.

2.13.5LOW Pressure

This applies to the pipelines connecting DRS to customers

Design data for LP system

Maximum Operating Pressure (MOP) = 4 bar

Operating pressure fluctuating between said MOP and the minimum pressure (Pmin) necessary at the inlet to End-Users SC to guarantee MGP to End-users.

City gates are interfacing the High-Pressure system by lowering the pressure to medium pressure level. Pressure reducing stations (DRS) are interfacing MP to LP.

Application to Present Projects

The project development considers both medium pressure and low pressure networks. Major industrial consumers will be directly fed through connection in MP network. CNG On-line/ mother stations will be connected to MP network. Small scale industrial customers in industrial estates will be provided through connections in LP network) shall not be lower than 1.0 bar under normal operation.

2.14 Network Analysis & Design

The following description applies to the basic configuration of the network designed to comply with the flow rats derived from market analysis including the identified customers and some provision for the future.

2.14.1Structure of the Network

The gas network is composed of different parts:

a. The high-pressure network (design above 30 bar) – This part is used to transport the full gas flow rate to the City Gate before entering the medium pressure gas distribution network.
b. The city gates assure the interface between the high and medium pressure network.
c. The Medium Pressure MP network starting at the outlet of the City Gates is branched in a few branches to feed the CNG Stations and local distribution in low pressure.
d. The Pressure Reducing Stations – the maximum operating pressure for the MP network was chosen to be 26 bar. Before delivery to individual customers the pressure shall be reduced firstly in pressure reducing station. At this point, no detailed information was provided on potential consumption areas in low pressure except the global load. However,

general consideration on low pressure network can be drawn. From a central DRS, a LP network shall radiate in several PE mains.

2.14.2Steel MP Network Design

The steel pipeline design was performed regarding the gas demand. Identified customers are of three kinds:

- Industrial customers
- CNG on-line / mother stations
- Commercial and domestic users

Industrial customers

Industrial customers is supplied from MP network via one or two pressure reducing stations.

CNG On-line / Mother Stations

Natural gas is withdrawn from MP to feed compressors supplying future CNG on-line/mother stations. CNG on-line/mother stations supposed to be located near the projected PRS.

Commercial and Domestic Users

Commercial and domestic consumptions are estimated form the number of consumers as derived from Market analysis.

LP Network Design

General design philosophy and network optimization

This detail engineering report presents the results of the conceptual design proposed for the global distribution network. The proposed design is a reasonable compromise between the need and optimal technical solutions in the present situation and consumption growth that can be forecasted in the future years.

MP Medium Pressure Network Diameters

The take-off points has to identified and the associated flow rates are well defined and composed of several huge natural gas users or pressure reducing stations to lower pressure levels. MPS Steel diameters were chosen in agreement with three criteria:

- Limit the velocity and pressure drop in reasonable valves.
- Provide diameter standardization (a few different diameters only)
- Provide provision for future capacity increase

LP Low Pressure Network Diameters

The philosophy adopted to design the LP Low pressure network is thus the following:

- Provide a system satisfying both technical (maximum velocity of 15 m/s in normal operation and Pmin of 1 bar at user connections (Transition box) and commercial constraint.
- Optimize the capital cost by reducing as much as possible the diameter
- Optimize the construction, operating and maintenance costs by using standard PE diameters and limiting the number of different diameters

2.15 Hydraulic Simulations And Calculations

Steady state network simulation was performed to optimize pipe diameters choice on both gas velocity and minimum pressure criteria

Simulation Tool

Simulations were performed with the help of SynerGEE 3.30/Pipeline Studio, software dedicated to natural gas distribution with multiple pressure level systems including regulator elements.

Simulation results of Medium Pressure (MP) Network

In each case, the pressure is fixed at 26 bar at City Gate outlet.

Simulation results of Low Pressure (MP) Network

In all case. The pressure is fixed at 4 bar at Pressure Reducing Station outlet

Sectionalisation

MP Steel Network

As MP medium pressure network is ramifies, and as there is a unique natural gas source for the main part of the system, there is no need for completely isolating pipe sections on both sides but rather isolate each section from the sole injection point.

All sectionalizing valves are manually and locally operated.
Each valve will be supplied with pressuring by-pass and purging arrangement.

LP PE Network

The study has been developed having in mind two basic principles:

- The possibility to isolate a pipe section of the gas distribution network in case of emergency or accidental damage caused to the pipeline and related unforeseen repair intervention.
- This will be achieved in order to limit the shut down of the end customer not involved in concerned pipe section

2.16 Compressed Natural Gas (CNG) Stations

For supply of Natural Gas as fuel for vehicles, NG shall be compressed at the CNG station. CNG station. CNG stations shall be located suitable on the steel network. The pressure of NG at the inlet to the CNG station is above 19 bar. After compression in stages, the pressure of CNG will be approximately 250 bar. The CNG stations could either be located in the premises of existing petrol pumps or shall be independent units.

2.17 Refueling Station Basics

Mother Stations: These are outlets to the CNG pipeline network running throughout the length & width in city/high way. These stations also provide Cascade filling facility at 250 bar, used to fill gas in small cascades and transmitted to Daughter Stations. CNG vehicle storage cylinders need to be filled at a pressure of 200 bar.

On-Line Stations: These are equipped with a compressor, which compresses low-pressure pipeline gas to the pressure of 250 bar for dispensing CNG to the vehicle cylinder at a pressure of 200 bar. Online stations are the same as Mother Stations except that they do not have the Cascade filling facility

Daughter Booster Stations: Installing a booster compressor can eliminate drawbacks of daughter stations. The mobile Cascade can be connected to the dispensing system through a booster. Daughter booster (compressor) is designed to take variable suction pressure and discharge at constant pressure of 200 bar to the vehicle being filled with CNG. The investment in a daughter booster station is slightly higher than that of daughter station.

Pressure : 250 Bar

Safety: The pipeline is only between the high-pressure compressor to cylinder manifold and cylinder manifold to dispensing unit. Also, from dispensing unit to vehicle cylinder. This pipeline will be either above ground with proper supporting and covering or underground within trenches for safety.

Cost : There are not regular pipes but small SS tubing of maximum 15 mm dia size in a small length. The cost of these components will be very low as compared to installation cost of CNG service station.

Material

SS Tubing: SS tubing of appropriate size will be used for 250 bar pressure. Carbon steel ERW pipe conforming to API 5L Grade 'B' will be used for 26 bar & part of 4 bar pressure.

Inlet Pressures

Ideally CNG 'mother' stations will be fed from the steel grid such that the required stages of compression are minimized.

Locations

Looking at our past experience, wherever possible, independent CNG stations will be installed on motorable roads, which can cater to the CNG requirements of the city. In case where land is not available but there is sufficient traffic load, CNG stations can be co-located for filling small vehicles like cars, taxis etc.

Key CNG Refueling Station Equipment

- Gas Dryer (inlet or outlet)
- Compressor package System (bare shaft compressor, inter stage cooler, piping, separators)
  - Driver (electric motor or gas engine)
  - Low pressure inlet train
  - High pressure inlet train
  - Canopy or housing (weather protection / noise attenuation)

- Cascade Storage System
  - Priority Control Panel
  - Dispensing Post
  - Dispenser (single or double hose, metering or non-metering, trickle, fast-fill or ultra fill, card readers, multifuel station integration)

Pressure Regimes

The pressure regime of the gas distribution network is given below:

Sl.	**Network Component**	**Inlet from**	**Inlet Pressure**	**Outlet Pressure**	**Outlet to**
1	CGS	Transmission Line	37-40 bar	26 bar	Steel Grid
2	Steel pipeline	CGS	26 bar	26 –19	DRS /

				27 bar	CNG
3	DRS	Steel pipeline	26 – 4 bar	4 bar	MDPE Pipeline
4	MDPE Pipeline	DRS	4 bar	4 - 1 bar	Industrial MRS DRS
6	Industrial MRS	MDPE pipeline	4 bar	1.5 bar/ 110 mbar	Industrial Internal
		Steel Pipeline	26 – 4 bar	1.5 bar	Pipeline
7	Residential	Steel Pipeline	4 bar	21-24 mbar	Pipeline
8	Commercial	Steel Pipeline	4 bar	110 mbar	Pipeline

2.18 Transmission And Distribution Pressure System

It is assumed that there is no restriction in the quantity of natural gas that is available for the domestic, commercial and CNG for vehicles applications. It was assumed that all the gas would be transported to the city area by the existing GSPL pipeline.

The 4 bar normal operating pressure system will supply all distribution customers with 1.0 bar pressure being the proposed system minimum. The distribution system will be designed to have a 50 years minimum life span. A design temperature of 30 ^{o}C was assumed. Standard size distribution materials are recommended wherever practical to keep capital and operational expenditure to a minimum. The distribution system is therefore proposed to comprise of medium-density is therefore proposed to comprise of medium-density polyethylene (MDPE), Grade 100 mains in the streets, with MDPE services to deliver gas to individual properties. The 4 bar distribution pressure will be reduced to 21-24 m bar and 110 mbar at the properties for supply to individual domestic and commercial consumers.

For CNG On-line and Mother stations, the gas loads are proposed (wherever possible) to be supplied directly from the steel grid.

Pressure : 26 Bar
Safety : These pipe lines will be primarily underground and of steel construction.

Cost : The available pressure from GSPL will above 37-40 bar. If the operating pressure is reduced, a larger line size will be required and the installation cost will be higher. To increase the pressure compressor cost and operational cost in terms of power will be more. Therefore, 26 bar pressure is suitable for the steel main net work.

Standards: National & ANSI/ASME B31.8

Pressure : 4 bar
Safety : The distribution network will be of MDPE construction.
Cost : If we reduce the pressure then line size will be bigger and in that case installation cost will be more. At the same time if we increase the pressure, pipe rating will be increased. If we increase the pressure, two regulators instead of one regulator will be required at each meter set, also increasing the cost. Therefore, 4 bar pressure will be only economical pressure in terms of cost.
Standards : national 4 bar specified in ANSI/ASME B31.8 Clause 845.223

Design basis : 4 Bar

2.19 Line Pipe, Gas Pressure And Material Details

Gas Inlet Pressure	:	26 bar
Gas Outlet Pressure	:	4 Bar
Maximum Allowable Operating Pressure	:	26 bar (MAOP)
Average Gas Flow Temperature	:	25^0 to 35^{0C}
Gas Flow	:	0.50 MMSCMD
Pipeline Design & Construction	:	ASME B 31.8 & OISD 141

Material Specification

Line Pipe	Carbon Steel as per API 5L & ASTM
Fittings	Forged Carbon Steel as per ASTM A ,234 MSS SP 75
Valves	Cast Steel as per API 6D, API 6FA & API RR 6F
Corrosion Coating	: 3 layer PE 3.2 mm thick as per DIN 30670 or FBE min. 400 micron thick as per NACE RP0394-94

Line Pipe Details

Pipe Size	:	12, 8, 6 & 4 inch (NB)
Pipe Specification	:	Minimum API 5L Gr B & IS 1239
Pipe length	:	23 Km (Approx.)
City Gate Station	:	01 No.
Tap-Off Point	:	1 Nos.
End Point	:	At end users premise

2.20 Pipeline Route

2.20.1Route Selection & Facility Locations

Safety : pipe will be route on the other side of road and away from the source of ignition and away from other underground service also.
Cost : Shortest route will be selected to minimize the cost.
Standards: T4S
Current Practice : as mentioned above

Design basis : All HP and MP mains are to be installed in the public road right of way except as may be required for specific safety or economic reasons. Natural gas mains will be installed outside of the actual road structure wherever possible. This will minimize both the costs for restoration (*i.e.* pavement) and public inconvenience. Crossings and/or conflicts with the location of other utilities will be considered during final route selection. Construction conditions in typical streets vary from paved wide roads to narrow side streets, depending on age of district. Accuracy and reliability of foreign utility information (water, sewers, etc.) for older and newer areas of the city, is to be determined.

2.20.2Selection of The Route

In consideration of the environment requirements, construction methodology to be adopted, design and engineering factors, availability of the logistic support during construction, operation and maintenance of pipelines various feasible alternatives were identified based on the desktop study of the relevant topographic maps of the area.

After the desktop study of the route, reconnaissance study of the route was carried out for the collection of the various details of the route. After

collection of the field data once again desktop analysis of data wear carried out for arriving at the optimum routs. For the final route selection, following factors are considered:

- Maximum reach to potential demand center with minimum length
- Use of existing defined pipeline corridors by respective authorities.
- Minimum disturbance to agricultural land
- Compliance with environmental regulations
- Safety of people and property
- Shortest possible route
- Minimum number of bends
- Favourable ground profile for construction
- Accessibility of the pipeline for the operation and maintenance
- Location of pipeline facility and access there to
- Avoidance mining area as far as possible
- Avoidance forest area as far as possible
- Minimum number of road, canal crossing
- Avoidance of rocky terrain
- Flexibility for future expansion
- Avoidance of the notified forest as well as thick plantation area
- Avoidance of the area reserved for the future development
- Avoidance of archaeological and sensitive area
- Safe distance from the village

Pipeline Routes

The alternative routes have been studied for the city gas grid (CGG) pipeline routing for Barwala and Ranpur Talukas Geographical Area. The routs are indicated in the **Figure 2.3.**

2.21 Project Implementation Methodology

The construction method can be described in following major steps:

- Finalisation of RoU (Right of Use)
- Statutory approvals and clearances
- Design and Engineering
- Procurement

- Construction
- Commissioning

Finalisation of RoU (Right of Use)

This will be major activity and the same shall start during pre-construction stage. Majority of the pipeline network falls under the jurisdiction of statutory authorities, like, PWD, MCs, NHAI, Irrigation, railways etc. Before execution of the project necessary permissions shall be acquired from these bodies / agencies.

Design and Engineering

The design of the pipeline will be carried out as per the guidelines of the ASME-B-31.8 as well as applicable guidelines of OISD 141/T4S.

Procurement

The specifications and QA/QC requirements of material will be finalized during the design and engineering stage. It will be ensured that these will comply with the project and statutory requirements. The company shall procure the critical items for the project. The broad list of the same is as follows:

- Line pipe
- City gate station
- District Regulating Station
- Pressure Regulating Station
- Valves
- SCADA system
- Metering & Regulating System
- Compressor for CNG
- Dispenser for CNG stations
- CNG Cylinder cascade for CNG cylinder

All material shall be procured form reputed suppliers. Third party inspection shall be carried out on this material.

Construction

The reputed contractor having good experience of working in the Indian environment shall carry out the construction of the pipeline and CNG stations.

The major stages of the pipeline construction are as follows:

- **Stringing:** Pipe will be transported to the site in trailers and off-loaded with the help of the side Booms. After unloading, pipes shall be laid on the ground for the welding.
- **Welding:** Once the pipeline is stung, a line up crew will position the pipes using side booms. At this point pipes will be lifted above the ground and placed on the sandbags. Using conventional manual welding techniques will do the welding by pre qualifies welders.
- **Radiography:** Sample weld joints (100% of the total line pipe welds and 100% tie-in joints & filled welds) shall be radio graphed to test for the compliance to specification.
- **Joint coating:** On receipt of radiography results joint coating is carried out on successful welded joints. Faulty welded joints are repaired as per the specifications.
- **Trenching:** Trenches excavated up to the required depth. During excavation utmost care will be taken for the topsoil. Generally topsoil of 30 cms depth shall be kept on the one side of the trench and the remaining soil is kept on the other side of the trench.
- **Lowering:** The pipes will be lifted from the supports and lowered in the trenches using the side booms.
- **Tie-in:** Joints between two lowered pipeline section is defined as tie-in joint. It shall be welded within trench by making suitable provision of welding pits. 100% tie-in joints shall be radio-graphed.
- **Back filling:** On completion of the lowering the trench will be back filled with the excavated soil. A small crown will be left on top to allow for settlement.
- **Hydro testing:** After completion of tie-in joints welding and backfilling, pipeline will be hydro tested for 1.1 times design pressure.
- **Commissioning:** On successful completion of the hydro test the pipeline will be dried and purged with Nitrogen. On completion of the above activities, gas will be charged in the pipeline under strict supervision.

2.22 Allied Systems

The major allied systems shall be as follows:

SCADA

The proposed network will have a state of art Supervisory Control and Data Acquisition (SCADA) System to monitor and control process variables for entire pipeline network. The central idea behind the SCADA system is remote flown computer monitoring and to manage the load by controlling the process variables. The main purpose of this system is to monitor pressure and flow and control of the value if required.

SCADA system will be equipped with highly automated networking and instrumentation. Each Remote terminal unit (RTU) will be having programmable logic controller, which scans the live data from local field and transmit it to centralized control rooms can issue the command to individual RTU location. Thus, Bi-directional communication will make the system more sophisticated and advance. Adequate redundancy will be built for the RTU, Communication media and control room instrumentation. Interlocks will be defined in the PLC for flow control valves, compressors units, flow control valves etc. to meet the application requirement. The system will be designed for the future expansions. Gas will be measured through advance flow computers and smart transmitters through orifice metering. The main purpose of this system is to monitor pressure and flow and control of the valve required.

Cathodic Protection System

For corrosion protection purpose entire pipeline shall be coated with 3 layer of polyethylene (PE) as per DIN 30670 or equivalent standards. For additional protection of the pipeline from the corrosion, Cathodic Protection system is applied.

The corrosion of the pipeline is due to the conversion of Fe in to FeO_2. Continuous current passing from pipeline will prevent this conversion. This way pipeline shall be protected from corrosion. Protection System (CP) will be suitably designed for based on "Impressed current" method. The cathodic protection stations will control this system.

2.23 Safety Measures In Design

The pipeline system design for Natural gas Distribution shall be based on ASME B31.8 latest edition – Gas Transmission and Distribution System and applicable standards, Grade of steel, operating environment of Natural gas and Maximum Allowable Operating Pressure (MAOP) 26 bar. Determination of Class Location and Factor of Safety shall be as per ASME B 31.8 clause no. 840.2. Anticipated future development shall be accounted for determination of final classes. We have taken location class 4 for entire route for designing purpose and arrived at Factor of Safety FS = 0.6 & 0.5 respectively.

The line pipe for Distribution of Natural Gas shall be as per API 5L and ASTM. The material shall be fully killed steel and fine grained with grain size as per ASTM 7 & 112. Weldability of line pipe shall be specifically performed in accordance with API 1104. Hoop stress calculation shall be carried out as per ASME B 31.8 1995 Clause. No. 805.233. The daily hoop stress variation (Factored Cycle) shall be monitored through SCADA integration.

The position of pipeline will be indicated at suitable intervals by means of markers. These will be at field boundaries, at all crossings and where practicable at changes in direction. Markers will be installed after mechanical completion and before pre-commissioning of pipeline according to APE RP 1109.

To overcome the effect of buoyancy force and for stable condition of pipeline during installation and subsequent operation against flood and heavy water current, the pipeline shall be provided with concrete coating to ensure negative buoyancy.

Design, Installation, Testing and Inspection of Road, Railway and Canal pipeline crossing will be as per API RP 1102.

Welding will be performed as per API 1104 1994 Welding of Pipeline and Related Facilities/ASME Section IX 1998 Boiler and Pressure Vessel Code and other applicable standards. All pipeline welds will be 100% radiographically inspected and welding of all valves and flange joint will be tested

ultrasonically. All Fillet and Groove Welds will be subjected to dye penetrate / magnetic particle inspection.

The pipelines and all appurtenances will be subject to hydrostatic test after construction. Hydrostatic test shall be performed in accordance with ASME B 31.8.

All piping and structures will be supported to prevent differential settlement and the resultant undue forces and stresses. Static loads and dynamic load, load due to hydrostatic testing, flow induced vibration or pulsation from the gas transmission and hydrotesting will be considered in the foundation design, Based on above recommendations and stress and surge analysis report, underground structures will be supported by RCC or Steel structure.

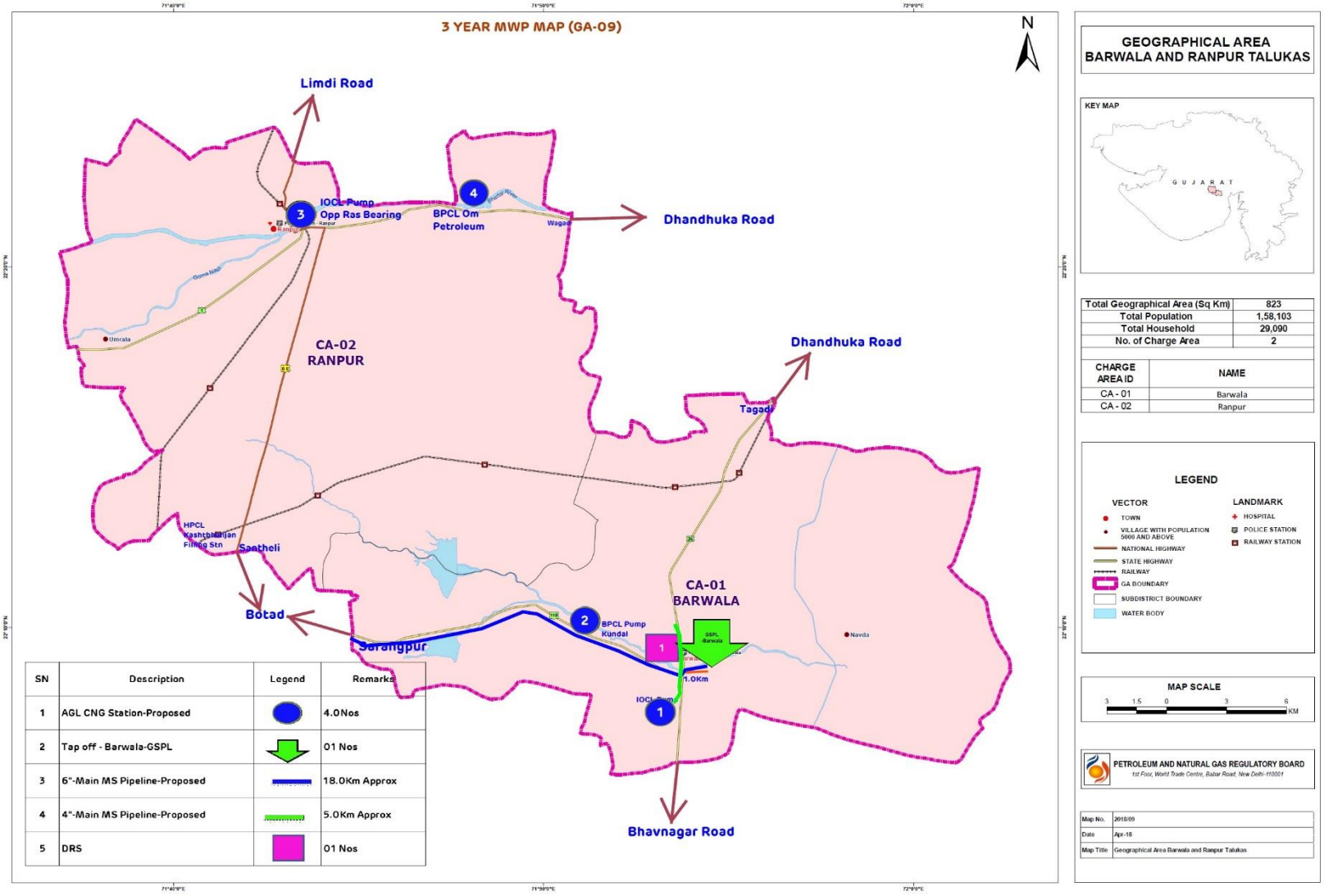
A Temporary Cathodic Protection (TCP) will be provided immediately after backfill until the permanent impressed current system is commissioned. An Impressed Current Cathodic Protection System (ICCP) will be provided Permanent Cathodic Protection (PCP) to the pipeline system. Test posts shall be installed at an interval of maximum 1000-meter, all the crossings, insulating joint and interference locations for monitoring purposes. The anode for the intended purposes shall have a design life of at least 40 years. A close interval potential survey or other corrosion survey shall be completed after the impressed current system commissioning to provide base data for future maintenance work. CP rectifier shall be connected to SCADA to monitor amp/voltage. Monolithic isolation joints at main taps / Branch-off and all Pressure Reduction Station and metering stations will be installed for isolation of pipeline sections to allow better monitoring of corrosion activities or provide isolation from unwanted current drainage.

Independent standby power source will be installed for 100% redundancy to ensure continuous operation. All instrument energisation will be fed through UPS with Battery back-up. Battery charger shall be sized for 200% of the total emergency load. Location of standby power source shall be away from probable hazardous location.

Protection devices will be installed to avoid damage to the electrical equipment and prevent any hazards during all probable abnormal situations.

All electrical equipment used will be flameproof, power and instrument cable will be Fire Retardant Low Smoke (FRLS).

SCADA systems and a number of Remote Terminal Units (RTUs) installed on a pipeline route, which communicate with a Master Control Room computer at a centrally located control room. SCADA system applications involve the integration of various types of instruments. All these devices are inter connected to a SCADA system providing data acquisition and remote control capability at a centrally located control room. Operational parameters such as pressure and flow conditions, will be remotely regulated by centrally-located operator via the SCADA system so that pipeline operations can be routinely monitored for upset conditions or will be regulated to achieve optimal operational condition within the safe limits established for the monitored facilities.



SN	Description	Legend	Remarks
1	AGL CNG Station-Proposed		4.0Nos
2	Tap off - Barwala-GSPL		01 Nos
3	6"-Main MS Pipeline-Proposed		18.0Km Approx
4	4"-Main MS Pipeline-Proposed		5.0Km Approx
5	DRS		01 Nos

Figure 2.3: Pipeline Route, Locations of DRS and CNG Stations

Chapter - 3

DESCRIPTION OF THE ENVIRONMENT

3.1 Introduction – Study Area, Period and Components

The study area for the baseline data collection was considered as geographical area and charge areas. The reconnaissance survey of the study area geographical and charge area was carried out in first week of April 2019. The field studies were carried out to collect baseline primary and secondary data for the present environmental scenario in the study area.

The environmental monitoring was carried out for soil characteristics, ground water quality, ambient air quality, noise levels, meteorology and ecology & biological study and socio-economic studies, etc. Topography & physiography, geology, soils, surface and ground water resources and quality, meteorology, ambient air quality, ambient noise and landuse pattern constitute the physical environment, while flora and fauna constitute biological environment of the study area and both were studied during the study period. Demographic and socio-economic conditions of the study area were also studied from the secondary sources during the study period. Physical, biological and socio-economic environmental conditions within 10 km radius study, collected during the study period have been comprehensively discussed in the following sections.

3.2 Topography and Physiography

Topography of the Botad District geographical area is almost plain. Hilly areas are observed in north west of Botad. Hilly upland area ranges between 100 and 296 m above mean sea level (amsl) and the regional slope of the area is towards east in this area.

3.3 Geology of the Area

Geologically, most of the area is covered by Basalts and part of the area is covered by alluvial formation. The generalized geological succession is given in the following table:

Era	Age	Formation	Lithology
Quaternary	Recent to Sub-Recent	Surface Soil/ Alluvium	Thick beds of calcareous clay, intercalated with layers of trap sand.
-Unconformity-			
Tertiary	Lower Eocene to Upper Cretaceous	Deccan trap	Basalt as stratified lava flows comprising amygdaloidal basalt, fine grained porphyritic basalt and basaltic/dolerite dykes.

Deccan Trap

The Deccan trap encompasses all the intrusive and extrusive acid and basic volcanic formations belonging to upper cretaceous to Paleocene (lower Eocene) age. Deccan traps form highly rugged, undulating to hilly topography and are exposed in the highest reaches, in the western and northern parts. In the plain terrain, 1 – 2 m of soils and weathered part cover these formations.

Deccan traps in this area are represented by basalts, both massive and amygdoidal or vesicular type, dolerite flows, ash beds, basaltic and dolerite dykes. Massive basalt is dark grey or steel grey in colour, very fine grained and compact.

Quaternary Formations

The Quaternary formations in the area are represented by clays fuller's earth), marls, limestones. This formation overlies deccan traps.

Recent to Sub-Recent Formations

The recent and sub-recent formations in the district are sand dunes, coastal & beach sands, tidal mud flats, coral reefs occurring in the coastal areas and fresh water alluvium occurring mainly along the rivers and streams.

The alluvium mainly occurs in the central parts of the district along the Shetrunji River. Here it has a thickness ranging from few meters to about 50 m. The alluvium which primarily rests on the basalt mainly comprise of the sand and clays along with the carbonate nodules (kankar) and weathered pieces of basalt. Weathering of basalt has also given rise to black cotton soils and generally it is difficult to distinguish between *in situ* weathering product of basalt and alluvium**.**

3.4 Soil Characteristics

3.4.1 Soil Type/ Soil Classification

Medium black soils are wide spread and are found in the entire geographical area. These soils are more productive and are rich in lime, magnesium and alumina and poor in phosphorous, nitrogen and organic matters. They can retain considerable moisture and are much suitable for agriculture.

The soil of the study area are mainly *Lithic Ustorthents*, *Vertic Ustochrepts*, *Typic Chromusterts*, *Vertic Halaquepts*, *Typic Salorthids*, *Rock-outcrops*, as per National Bureau of Soil Survey and Land Use Planning. Soil type/ soil classification of the study area is given in **Table 3.1.** Soil map of the study area is shown in **Figure 3.1.**

Table 3.1: Soil Type/ Soil Classification of the Study Area

Map Unit	Description	Soil Taxonomy
199	Rock out crops, Associated with very shallow somewhat excessively drained, loamy skeletal soils on rolling pedimont (with stony waste and rock outcrops) with severe erosion and strong stoniness.	Rock Outcrops Loamy Skeletal, Mixed Hyperthermic Lithic Ustorthents
249	Moderately deep, moderately well drained, calcareous, fine soils on very gently sloping piedimont plain (with mounds) with moderate erosion; associated with deep, well drained, calcareous, fine soils with slight erosion.	Fine, Montmorillonitic (Calcareous) Hyperthemic Vertic Ustochrepts Vertic Ustochrepts
251	Moderately shallow, well drained, calcareous, fine soils on very gently sloping piedimont plain (with narrow valleys) with moderate erosion; associated with moderately shallow, well drained, calcareous, fine soils with slight erosion.	Fine, Montmorillonitic (Calcareous) Hyperthemic Vertic Ustochrepts Typic Chromusterts
253	Deep, well drained, calcareous, fine soils on gently sloping piedimont plain (with narrow valleys) with moderate erosion and slight salinity; associated with deep, well drained, calcareous, fine soils with moderate erosion and slight salinity.	Fine, Montmorillonitic (Calcareous) Hyperthemic Vertic Ustochrepts

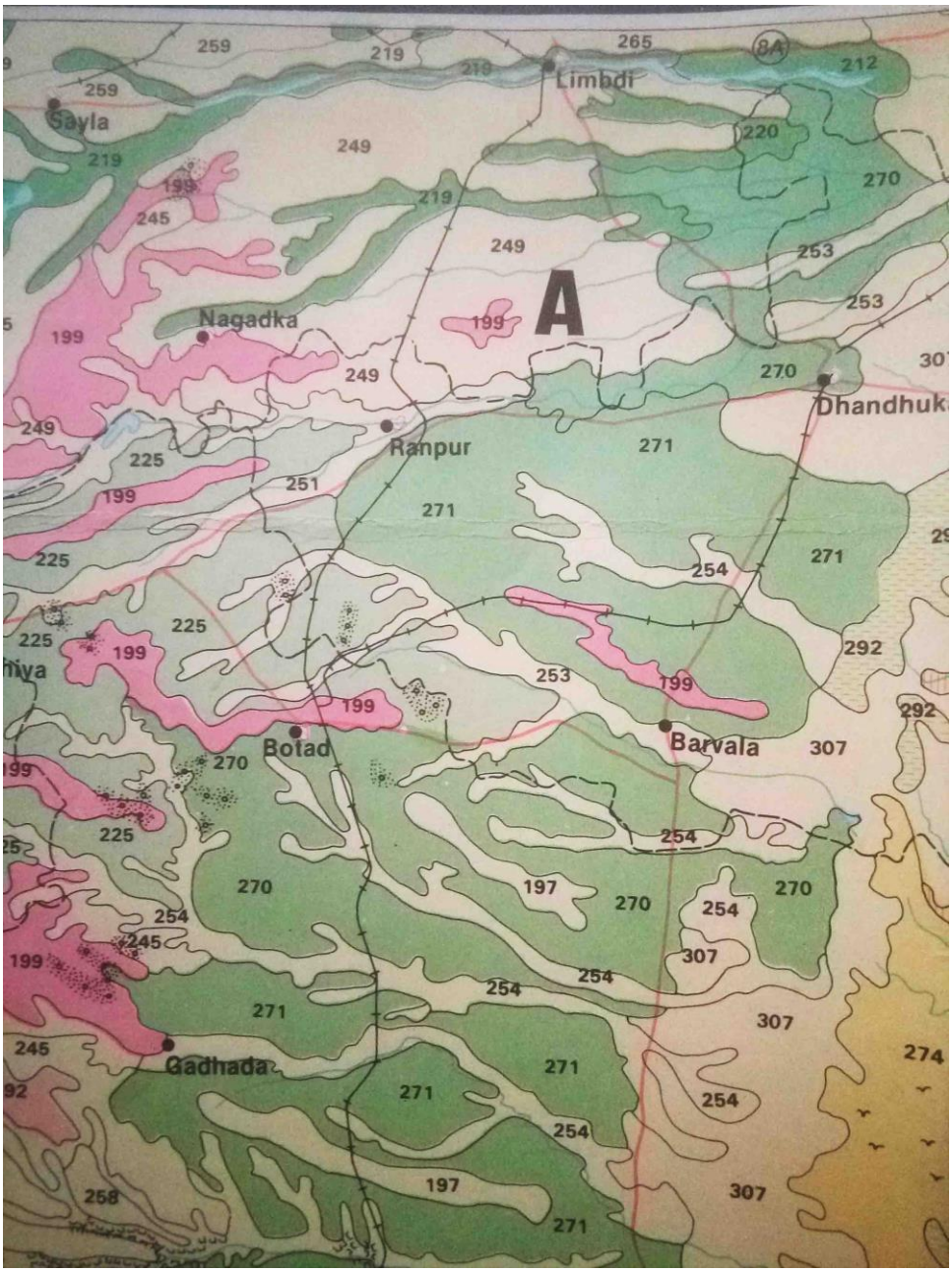
Map Unit	Description	Soil Taxonomy
		Typic Chromusterts
254	Deep, well drained, calcareous, fine soils on very gently sloping piedimont plain (with narrow valleys) with slight erosion, slight salinity; and slight sodicity; associated with deep, well drained, calcareous, fine soils with slight erosion.	Fine, montmorillonitic (Calcareous) Hyperthemic Vertic Ustochrepts Typic Chromusterts
270	Moderately deep, well drained, calcareous, fine soils on very gently sloping piedimont plain (with mounds) with slight erosion and slight salinity; associated with moderately shallow, well drained, calcareous fine soils with slight erosion.	Fine, montmorillonitic (Calcareous) Hyperthemic Typic Chromusterts Vertic Ustochrepts
271	Moderately deep, well drained, calcareous, fine soils on gently sloping piedimont plain (with mounds) with moderate erosion, slight salinity and slight sodicity; associated with moderately shallow, well drained calcareous, fine soils with moderate erosion and slight salinity.	Fine, montmorillonitic (calcareous) hyperthemic Typic Chromusterts Vertic Ustochrepts
292	Very deep, moderately well drained, calcareous, fine soils on nearly level low lying coastal plain with slight erosion, very strong salinity and moderate sodicity; associated with very deep, poorly drained, calcareous, clayey soils with severe salinity.	Fine, montmorillonitic (Calcareous) Hyperthemic Vertic Halaquepts Typic Salorthids
307	Deep, moderately well drained, calcareous, fine soils on nearly coastal plain with slight erosion, strong salinity; associated with deep, moderately well drained, calcareous, fine soils with slight erosion and moderate salinity.	Fine, montmorillonitic (calcareous) hyperthemic Vertic Ustochrepts Typic Chromusterts

3.4.2 Soil Characteristics

The information on soil quality was collected from various secondary sources and supplemented by collection and analysis of soil samples from representative locations from charge area. In order to assess the base line characteristics of soil profile of the study area representing project and nearby areas, the samples were analysed for key and chemical parameters.

The physical and chemical characteristics of soil from the charge areas were determined. The sampling locations have been finalized with the following objectives:

- To enable information on baseline characteristics and,
- To determine the soil characteristics of the study area;
- To determine the impact of plant activities on soil characteristics.



Source : National Bureau of Soil Survey and Land Use Planning

Figure 3.1: Soil Map of the Study Area

The representative soil samples were collected from 2 different locations within the study area. Standard procedures were followed for the sampling and analysis of physico-chemical parameters.

The soil sampling locations are given in **Table 3.2.**

Table 3.2: Soil Sampling Locations

Code	Soil Sampling Locations
S 1	Barwala
S 2	Sarangpur (On NH 118)

The value of important physical and chemical parameters of these soil samples are given in **Table 3.3**. From the tabulated values, the following conclusions can be made about the physical and chemical characteristics of the soil samples.

Texture: Soil samples from the study area (Charge areas) are loamy and sandy loam in texture.

Bulk Density: Bulk density of soil in the study area is found to be in the range from 1.47 to 1.49 g/cm^3.

Water Holding Capacity (WHC): Water holding capacity (WHC) of soil samples of the study area ranges between 46.9 to 49.3 % and these soils are capable of retaining sufficient water during irrigation for facilitating the plant growth.

pH: pH was determined by taking 1:5 ratio of soil and distilled water. pH of soil in the study area is found to be slightly alkaline in the range of 7.97 to 8.03.

Conductivity: Conductivity soil in the study area is found to be in the range of 0.93 to 1.08.

Cation Exchange Capacity (CEC): Cation exchange capacity in the soil samples in the study area ranges from 48.9 to 50.5 meq/100g.

Exchangeable Calcium (Ex Ca): Exchangeable Calcium in the soil samples in the study area ranges from 27.8 to 29.6 meq/100g.

Exchangeable Magnesium (Ex Mg): Exchangeable Magnesium in the soil samples in the study area ranges from 12.3 to 13.3 meq/100g.

Exchangeable Sodium (Ex Na): Exchangeable Sodium in the soil samples in the study area ranges from 4.7 to 5.5 meq/100g.

Exchangeable Potassium (Ex K): Exchangeable Potassium in the soil samples in the study area ranges from 2.9 to 3.3 meq/100g.

Organic Carbon (%): Organic Carbon in the soil samples in the study area ranges from 0.64 to 0.67 %.

Organic Matter (%): Organic Matter in the soil samples in the study area ranges from 0.89 to 0.92 %.

Available Nitrogen: Available Nitrogen content of the soil samples in the study area is ranges from 119 to 121 kg/ha.

Available Phosphorus : Available Phosphorus content of the soil samples in the study area is ranges from 38.8 to 41.2 kg/ha.

Available Potassium: Available Potassium content of the soil samples in the study area is ranges from 247.7 to 256.8 kg/ha.

Table 3.3: Soil Characteristics of the Study Area

Parameters	Units	Barwala	Near Barwala Tap off Point
Texture		Sandy Loam	Loamy
Bulk Density	g/cc	1.47	1.49
Water Holding Capacity	%	46.9	49.3
pH		8.03	7.97
Conductivity	µmS/cm	1.08	0.93
CEC	meq/100g	48.9	50.5
Ex Ca	meq/100g	27.8	29.6
Ex Mg	meq/100g	12.3	13.3
Ex Na	meq/100g	5.5	4.7
Ex K	meq/100g	3.3	2.9
Organic Carbon	%	0.67	0.64
Organic Matter	%	0.92	0.89
Available N	Kg/ha	121	119
Available P	Kg/ha	41.2	38.8
Available K	Kg/ha	256.8	247.7

3.5 Water Resources

3.5.1 Surface Water Resources

The Sukhbhadar River flows on northern border of Botad district in Ranpur taluka. The Kalubhar River flows on southern part of Botad district in Gadhada taluka. Barwala is situated on the bank of Utavli river.

3.5.2 Ground Water Resources

The Deccan trap and Quaternary formations form the aquifer within the district. Groundwater occurs under water table and semi-confined conditions. Dug and dug cum bore well are common structures used for groundwater extraction.

In the project area water level during pre-monsoon lies within a range of 20 to 40 meters. The water level during post monsoon is less than 20 meters in most of the areas. Water level fluctuation is more than 4 m. The project area is located in safe zone category as stage of ground water development is about 66 %.

3.6 Ground Water Quality in Study Area

To evaluate the physico-chemical characteristics of the ground water resources in the study area, ground water samples were collected during the study period.

A. Ground Water Sampling Locations

Reconnaissance survey was carried out for identification of ground water samples. For selection of ground water samples, the following criterion were considered.

1. Drainage Pattern
2. Areas which may be affected due to the proposed activity,
3. Ground water sources which are being used for local population for domestic purpose.

Ground water sampling and analysis were carried out at seven sampling locations as given in **Table 3.4**.

Table 3.4: Ground Water Sampling Locations

Code	Location of Ground Water
GW 1	Barwala
GW 2	Near Barwala Tap off Point

B. Methodology

During study area, grab samples were collected from ground water sources. The ground water samples were filled into a sampling bottles. The ground water samples were collected and analyzed as per the procedures specified in 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA) and relevant Indian Standards codes.

The samples collected during the period, were brought to laboratory. At the time of collection of samples proper preservatives were added in ground water samples. During the transportation samples were stored in deep freezer.

The collected water samples were analyzed for organoleptic & physical and chemical parameters as parameters described in IS: 10500:2012.

C. Characteristics of Ground Water Samples

Analyzed characteristics of ground water samples are given in **Table 3.5.**

Colour: The colour of ground water samples was found <1 Hazen unit and meets the acceptable limit of drinking water standards.

Odour: The odour in ground water samples was agreeable and meets the acceptable limit for drinking water standards.

Taste: The taste of ground water samples was agreeable and meets the acceptable limit for drinking water standards.

Turbidity: The turbidity of water samples was found <1 NTU and meets acceptable limit for drinking water standards.

pH: The pH value of ground water samples ranges from 7.93 to 8.10 and meets the acceptable (6.5-8.5) drinking water standards.

Total Dissolved Solids (TDS): The TDS in ground water samples range from 1183 to 1267 mg/l and meet permissible limit of 2000 mg/l in the ground water samples.

Total Alkalinity: Total alkalinity in ground water samples ranges from 297 mg/l to 316 mg/l. Total alkalinity values of the ground water samples exceeding acceptable limit of 200 mg/l at both locations, however meeting permissible limit of 600 mg/l in both the ground water samples.

Total Hardness: The total hardness of ground water samples ranges between 364 mg/l to 381 mg/l. Total hardness values of the ground water samples exceeding acceptable limit of 200 mg/l at both locations, however meeting permissible limit of 600 mg/l in both the ground water samples.

Iron: The iron content in both ground water sample ranges from 0.24 to 0.27 mg/l and meets acceptable limits of 0.3 mg/l for the ground water samples.

Calcium: The Calcium content in ground water samples ranges from 93.8 to 95.4 mg/l. Calcium content of most of the ground water exceeding acceptable limit of 75 mg/l, however meeting permissible limit of 200 mg/l in both the ground water samples.

Magnesium: The magnesium content in ground water samples ranges from 31.6 mg/l to 34.7 mg/l and exceeding acceptable limit of 30 mg/l in both the ground water samples, however meeting permissible limit of 100 mg/l in both the ground water samples.

Chloride: The Chloride content in ground water samples ranges from 414 mg/l to 432 mg/l and exceeding acceptable limit of 250 mg/l in both the ground water samples, however meeting permissible limit of 1000 mg/l in both the ground water samples.

Sulphate: Sulphate content in ground water samples ranges from 71.1 to 73.8 mg/l and meets the acceptable limit of 200 mg/l at both the ground water sampling locations.

Nitrate: Nitrate content in ground water samples ranges from 9.4 mg/l to 10.7 mg/l and meet the acceptable limit of 45 mg/l at both the ground water sampling locations.

Fluoride: Fluoride content in ground water samples ranges from 0.59 to 0.63 mg/l and meets acceptable limit of 1 mg/l at both the ground water sampling locations.

Aluminum: Aluminum content in ground water samples ranges from 0.019 mg/l to 0.022 mg/l and meets acceptable limit of 0.03 mg/l at both the ground water sampling locations.

Boron: Boron content in ground water samples ranges from 0.12 mg/l to 0.15 mg/l and meets acceptable limit of 0.5 mg/l at both the ground water sampling locations.

Cupper: Cupper content in ground water samples ranges from 0.027 mg/l to 0.029 mg/l and meets acceptable limit of 0.05 mg/l at both the ground water sampling locations.

Zinc : Zinc content in ground water samples ranges from 0.71 mg/l to 0.76 mg/l and meets acceptable limit of 5 mg/l at both the ground water sampling locations.

Bacteriological Quality of Drinking Water: Total Coliform including Escherichia coli (E. coli) was not be detectable in any ground water sample.

Other Parameters: Cyanide (CN), Phenolic Compounds (C_6H_5OH), Total Arsenic (as As), Total Chromium (as Cr), Mineral Oil, Cadmium (as Cd), Lead (as Pb), Manganese (as Mn), Tin, Mercury (as Hg), Nickel (as Ni) contents were found below detection limit (BDL) in both the ground water samples.

The results of ground water samples were compared to Indian Standard Specification of drinking water IS: 10500:2012. Some of analyzed parameters in ground water samples meet acceptable limit however all the analyzed parameters are meeting permissible limit in the absence of alternate source as per Indian Standard Specification of drinking water IS: 10500:2012.

Table 3.5: Ground Water Quality in the Study Area

Sn.	Parameters	Unit	Barwala	Near Barwala Tap off Point
1.	Colour	Hazan	<1	<1
2.	Odour	--	Acceptable	Acceptable
3	Taste	--	Acceptable	Acceptable
4.	Turbidity	NTU	<1	<1
5.	pH	--	8.10	7.93
6.	Total Hardness	mg/l	381	364
7.	Total Alkalinity as $CaCO_3$	mg/l	316	297
8.	Iron (Fe)	mg/l	0.27	0.24
9.	Chloride (Cl)	mg/l	432	414
10.	Conductivity	µS/cm	2103	1928
11.	Total Dissolved Solids	mg/l	1267	1183
12.	Calcium (Ca)	mg/l	95.4	93.8
13.	Magnesium (Mg)	mg/l	34.7	31.6
14.	Sulphate (SO_4)	mg/l	73.8	71.1
15.	Nitrate (NO_3)	mg/l	10.7	9.4
16.	Fluoride (F)	mg/l	0.63	0.59
17.	Aluminium (as Al)	mg/l	0.022	0.019
18.	Boron	mg/l	0.15	0.12
19.	Copper (Cu)	mg/l	0.027	0.029
20.	Manganese (Mn)	mg/l	BDL	BDL
21.	Tin as Sn	mg/l	BDL	BDL
22.	Nickel as Ni	mg/l	BDL	BDL
23.	Lead (Pb)	mg/l	BDL	BDL
24.	Zinc (Zn)	mg/l	0.71	0.76
25.	Phenolic Compounds	mg/l	BDL	BDL
26.	Mercury (Hg)	mg/l	BDL	BDL
27.	Cadmium (Cd)	mg/l	BDL	BDL
28.	Selenium (Se)	mg/l	BDL	BDL
29.	Total Arsenic (As)	mg/l	BDL	BDL
30.	Cyanide (CN)	mg/l	BDL	BDL
31.	Anionic Detergents	mg/l	BDL	BDL
32.	Hexa. Chromium (Cr^{+6})	mg/l	BDL	BDL
33.	Mineral Oil	mg/l	BDL	BDL
34.	Total Coliform	MPN/100 ml	Absent	Absent
35.	Faecal Coliform	MPN/100 ml	Absent	Absent

3.7 Climatology And Meteorology

3.7.1 Introduction

The meteorological parameters play a vital role in transport and diffusion of pollutants in the atmosphere. The collection and analysis of meteorological data, therefore, is an essential component of environmental impact assessment studies. The long term and short-term impact assessment could be made through utilization and interpretation of meteorological data collected over long and short periods, respectively.

Climatological (long-term) data is obtained from the closest Indian Meteorology Department (IMD) station or from any other nearby station, which has been collecting meteorological data for more than ten years. Climatological data for the study area was obtained from IMD Station at Rajkot and the same is discussed in following:

3.7.2 Climatological Data for Rajkot IMD Station

A. Climate and Seasons

The climate of the area is characterized by a semi-arid. Generally, these areas experience the following four seasons in a year:

Summer : March to Mid June
Monsoon : Mid June to Mid September
Post Monsoon : Mid September to November
Winter : December to February

B. Temperature

Table 3.6 gives the temperatures at IMD station Rajkot. The area has a semi-arid climate, with hot, dry summers from mid-March to mid-June and the wet monsoon season from mid-June to October. The months from November to February are mild, the average temperature being around 20 °C. Highest temperature is recorded as 43 ^{o}C while lowest temperature is recorded in January (8.1 ^{o}C). Graphical presentation of highest and lowest temperatures is shown in **Figure 3.2.**

Table 3.6: Highest and Lowest Temperatures in the Area

Month	Highest Mean Temperature (^{o}C)	Lowest Mean Temperature (^{o}C)	Relative Humidity (%)	
			08.30	17.30
January	32.7	8.1	57	27
February	35.2	9.4	61	24
March	39.6	13.6	67	22
April	41.9	18.7	72	22
May	43.0	22.3	75	30
June	41.6	23.5	79	51

Month	Highest Mean Temperature (°C)	Lowest Mean Temperature (°C)	Relative Humidity (%)	
			08.30	17.30
July	36.5	23.4	87	69
August	34.6	22.7	89	70
September	36.8	21.7	86	56
October	38.2	18.8	71	32
November	35.8	13.9	55	31
December	32.8	9.9	54	28

Source: IMD Station, Rajkot

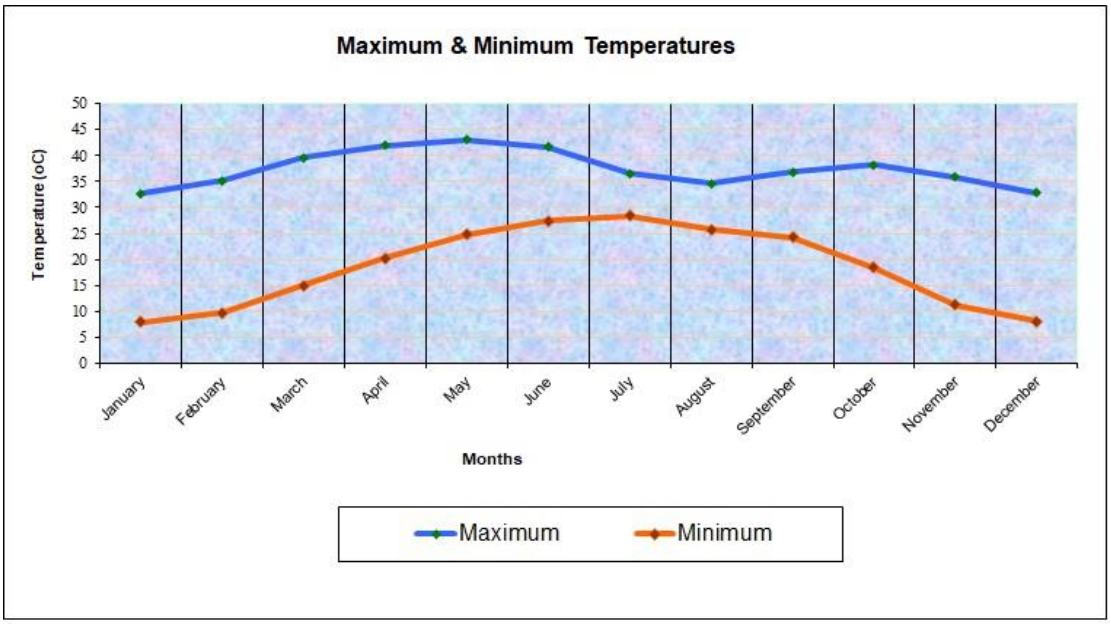


Figure 3.2: Maximum and Minimum Temperature in the Area

C. Humidity

Table 3.6 also gives the relative humidity (RH) data at Rajkot IMD station. Relative Humidity (RH) is highest during August (89% at 8:30 hour and 70% at 17:30 hour) and lowest during March & April (22% at 17:30 hour). RH is higher by 18 to 50% at morning 08:30 hour compared to evening 17:30 hour. Graphical presentation of relative humidity is shown in **Figure 3.3.**

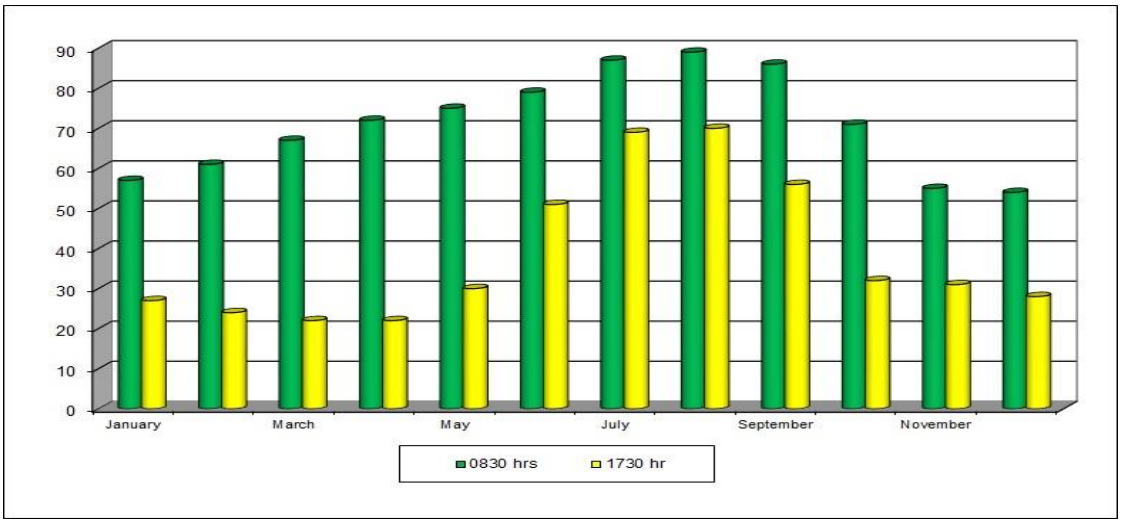


Figure 3.3: Morning and Evening Relative Humidity

D. Wind Speed

Mean wind speed at Rajkot IMD station is given **Table 3.7**. Annual average wind speed at Rajkot IMD station is 15.2 kmph. Highest mean wind speed (23.1 kmph) is observed in May whereas lowest wind speed (8.3 kmph) is observed in November month. Graphical presentation of mean wind speed is shown in **Figure 3.4.**

Table 3.7: Wind Speed in the Area

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
9.8	11.7	14.3	18.3	23.1	22.3	21.6	19.0	15.1	10.3	8.3	9.1	15.2

Note: Values are kmph,
Source: IMD Station, Rajkot

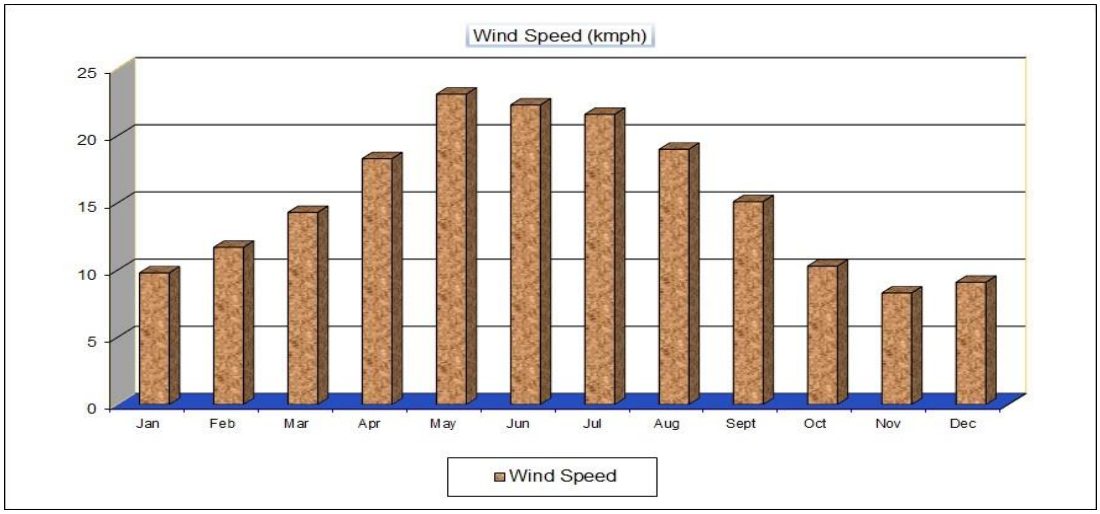


Figure 3.4: Mean Wind Speed In the Area

E. Rainfall

Rainfall at Rajkot IMD station is given **Table 3.8**. The area receives 576.6 mm rainfall. The area receives 93 % rainfall during June to September months. Graphical presentation of the monthly rainfall is shown in **Figure 3.5.**

Table 3.8: Rainfall in the Area

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1.0	0.7	0.1	1.4	4.8	115.2	215.6	127.1	78.3	21.1	10.9	0.5	576.6
(0.1)	(0.2)	(0.0)	(0.2)	(0.1)	(5.0)	(8.7)	(7.2)	(4.4)	(1.6)	(0.6)	(0.1)	(28.3)

Note: Values are mm, Values given in parenthesis
Source: IMD Station, Rajkot

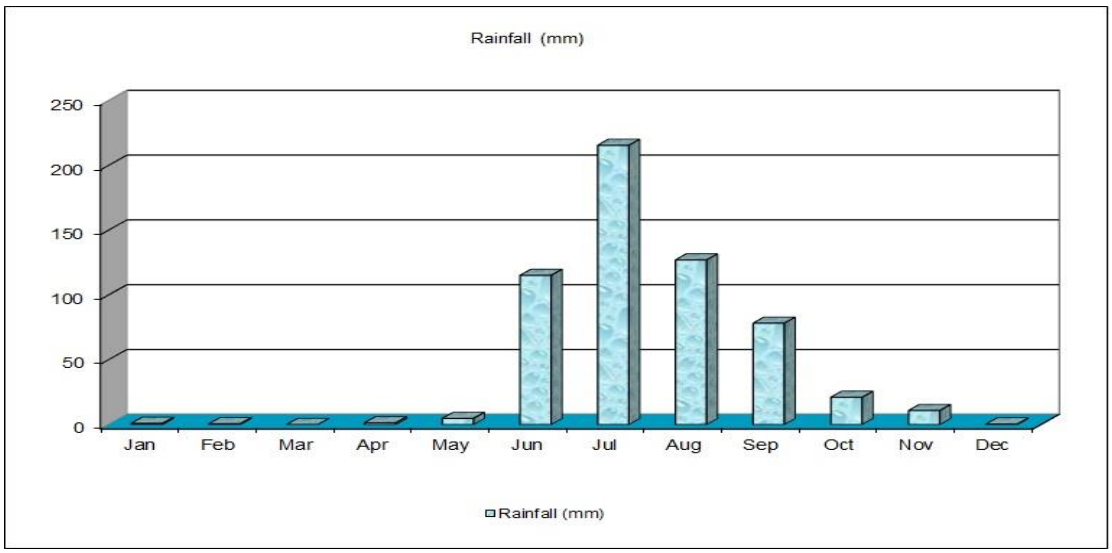


Figure 3.5: Monthly Rainfall in the Area

F. Wind Direction

Wind direction and wind speed for Rajkot IMD station at 8:30 hours and 17:30 hours are also given in **Table 3.9**. The tabulated values show that the prevailing winds, in general, both for morning and evening hours blow from N-NE sector during November to February and from NW-W sector from April to September month. March and October months are transition month. Calm periods vary from 2 to 47 % of the total time. Windrose diagrams for Day and Night time are shown in **Figure 3.6** and **Figure 3.7,** respectively.

Table 3.9: Wind Direction (From) in the Area

Sn	Months	N	NE	E	SE	S	SW	W	NW	Calm
1.	January	11	16	11	2	1	3	3	6	47
		37	22	3	0	0	2	5	26	5
2.	February	10	11	11	2	2	6	10	8	40
		27	16	4	1	0	3	14	32	3
3.	March	8	8	4	1	3	11	25	20	20
		14	8	2	1	0	2	22	46	5
4.	April	5	2	0	0	3	20	42	24	4
		8	2	0	0	1	5	39	43	2
5.	May	1	0	0	0	6	40	41	11	1
		2	0	0	0	2	16	46	32	2
6.	June	0	0	1	3	14	46	28	6	2
		1	1	1	3	11	36	30	16	1
7.	July	1	0	0	1 1	4	60	19	3	2
		0	0	1	1	9	53	30	5	1
8.	August	0	0	0	0	14	57	23	4	2
		1	0	0	0	6	46	35	11	1
9.	September	2	1	0	1	11	35	30	*15*	*5*
		5	2	1	1	5	22	35	25	4
10.	October	9	7	5	3	4	9	16	14	33
		22	22	6	2	3	7	10	21	7
11.	November	7	18	20	3	1	1	1	3	46
		29	36	9	2	1	1	3	11	8
12.	December	9	20	25	3	1	1	1	3	37
		37	29	8	1	1	1	3	15	5
	Annual	5	7	6	2	6	24	20	10	20
		15	11	3	1	3	16	24	23	4

Note: Values are %, Source: IMD Station, Rajkot

G. Special Weather Phenomenon

Special weather phenomena of Rajkot IMD station is given in **Table 3.10**. Thunder storms are observed mostly in April and October (annually 16.3 d). Fog is observed occasionally (10.9 d). Dust Storm, Squall and Hail are rare in the area. More than 0.3 mm precipitation is observed on 46.2 days in a year.

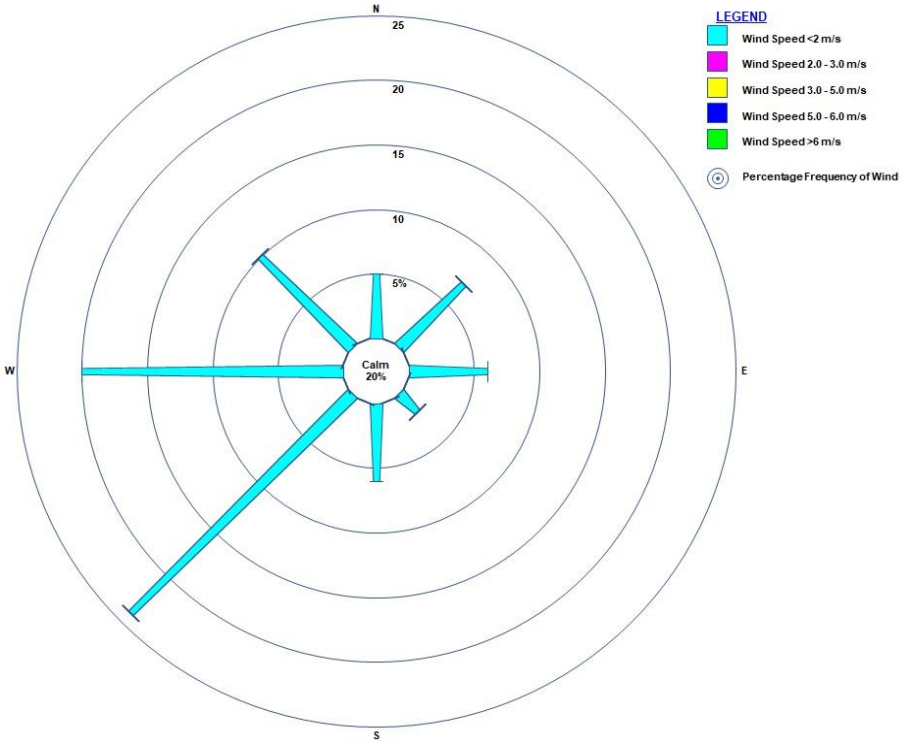


Figure 3.6: Windrose Diagram (From) for Day

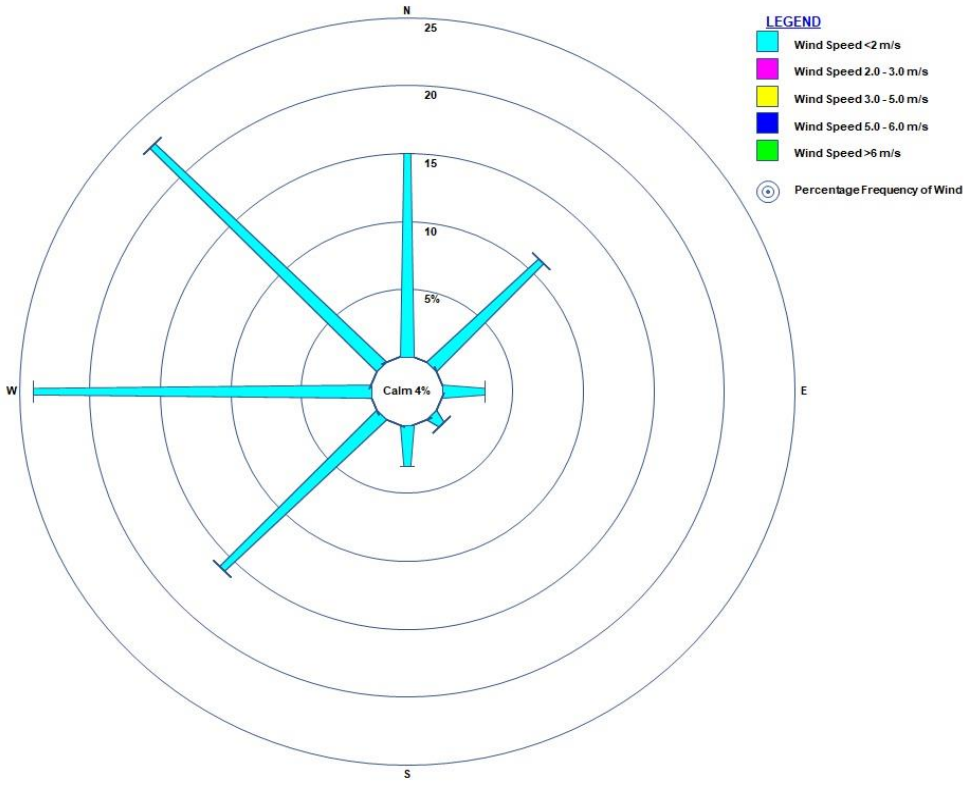


Figure 3.7: Windrose Diagram (From) for Night

Table 3.10: Special Weather Phenomena (days) in the Area

Months	PPT 0.3 mm or more	Hail	Thunder	Fog	Dust Storm	Squall
January	0.4	0.0	0.1	1.6	0.0	0.0
February	0.3	0.0	0.2	2.3	0.0	0.0
March	0.0	0.0	0.0	1.8	0.0	0.0
April	0.3	0.0	0.4	0.6	0.0	0.0
May	0.8	0.0	1.3	0.1	0.2	0.0
June	6.9	0.0	4.6	0.0	0.0	0.0
July	13.5	0.0	2.8	0.0	0.0	0.0
August	13.6	0.0	1.9	0.1	0.0	0.0
September	7.1	0.0	2.8	0.5	0.1	0.0
October	2.3	0.0	1.7	2.3	0.0	0.0
November	0.9	0.0	0.4	0.9	0.0	0.0
December	0.1	0.0	0.1	0.7	0.0	0.0
Annual	**46.2**	**0.0**	**16.3**	**10.9**	**0.3**	**0.0**

Source: IMD Station, Rajkot

3.8 Ambient Air Quality

The prime objective of the ambient air quality monitoring is to evaluate the baseline air quality of the area, which is essential to predict impact of existing plant and operation of plant after expansion. During the study period, ambient air quality monitoring was carried out in the study area. This section describes the selection of sampling locations for air quality monitoring, methodology adopted for sampling, analytical techniques and frequency of sampling.

3.8.1 Selection of Ambient Air Sampling Locations

The ambient air quality monitoring locations were established in the study area. For selection of ambient air quality monitoring locations, the following factors were considered:

- ✓ Meteorological conditions in the area;
- ✓ Topography of the study area;
- ✓ Representativeness of the habitation for establishing baseline status;
- ✓ Likely impact areas.

The ambient air quality monitoring locations in the study area are described in **Table 3.11.**

Table 3.11: Details of Ambient Air Quality Monitoring Locations

Code	Locations of Ambient Air Monitoring Locations	Details of Location
A1	Barwala	Commercial
A2	Sarangpur	Residential

3.8.2 Parameters and Frequency of Ambient Air Quality Monitoring

The baseline ambient air quality was monitored for the following parameters as per National Ambient Air Quality Standards:

- Particulate Matter ($PM_{2.5}$);
- Particulate Matter (PM_{10});
- Sulphur dioxide (SO_2);
- Nitrogen Dioxide (NO_2) and
- Carbon Monoxide (CO);

3.8.3 Sampling and Analytical Techniques

The techniques adopted for sampling and analysis of ambient air quality are given in **Table 3.12** along with the minimum detection limits for each parameter.

Table 3.12: Techniques Used for Ambient Air Quality Monitoring

S. No.	Parameter	Technique	Detectable Limit ($\mu g/m^3$)
1.	Particulate Matter (PM_{10})	Gravimetric [EPA -40 (CFR Part 50)]	2.0
2.	Particulate Matter ($PM_{2.5}$)	Gravimetric [EPA -40 (CFR Part 50)]	2.0
3.	Sulphur Dioxide (SO_2)	Improved West and Gaeke	5.0
4.	Nitrogen Dioxide (NO_2)	Modified Jacob & Hochheiser	5.0
5.	Carbon Monoxide (CO)	NDIR [IS 13270 : 1992]	0.1

3.8.4 Results of Ambient Air Quality Monitoring

The results of ambient air quality monitoring of $PM_{2.5}$, PM_{10}, SO_2, NO_2 and CO are presented in **Table 3.13**. Graphical presentation of summary of the ambient air quality is given in **Figure 3.8.**

Respirable Particulate Matter (PM_{10})

The mean PM_{10} concentration at ambient air quality monitoring locations found 84.9 µg/m^3. The maximum and minimum PM_{10} concentrations measured at various AAQM stations are 85.2 and 68.5 µg/m^3, respectively. 98 %tile value of PM_{10} is 84.9 µg/m^3.

Fine Particulate Matter ($PM_{2.5}$)

The mean $PM_{2.5}$ concentration at ambient air quality monitoring locations found as 40.8 µg/m^3. The maximum and minimum $PM_{2.5}$ concentrations measured at various AAQM stations were 46.3 and 35.7 µg/m^3, respectively. 98%tile value of $PM_{2.5}$ is 46.0 µg/m^3.

Sulphur Dioxide (SO_2)

The mean concentrations of SO_2 at all ambient air quality monitoring locations found 10.5 µg/m^3. The maximum and minimum SO_2 concentrations measured at various AAQM locations are 11.5 and 9.6 µg/m^3, respectively. 98 %tile value of SO_2 is 11.5 µg/m^3.

Nitrogen Dioxide (NO_2)

The mean concentrations of NO_2 at all AAQM locations range from 14.5 µg/m^3. The maximum and minimum NO_2 concentrations measured at various AAQM locations are 16.8 and 12.5 µg/m^3, respectively. 98 %tile value of NO_2 is 16.7 µg/m^3.

Carbon Monoxide (CO)

The mean concentrations of CO at all AAQM locations range from 0.28 mg/m^3. The maximum and minimum CO concentrations measured at various AAQM locations are 0.37 and 0.21 mg/m^3, respectively. 98 %tile value of CO is 0.37 mg/m^3.

Ambient Air Quality Status

National ambient air quality standards for industrial, residential, rural & other areas are met for all monitored parameters at all AAQM locations during the study period.

Table 3.13: Ambient Air Quality In Project Area

Sr. No.	Location/ Date	PM_{10} µg/m³	$PM_{2.5}$ µg/m³	SO_2 µg/m³	NO_2 µg/m³	CO mg/m³
	NAAQMS	**100**	**60**	**80**	**80**	**2**
I.	**Barwala**					
1.	14.04.2019	79.8	41.8	10.7	14.1	0.37
2.	15.04.2019	85.2	46.3	11.5	16.8	0.29
II.	**Near Tap off Point Barwala**					
3.	14.04.2019	73.2	39.4	9.6	12.2	0.24
4.	15.04.2019	68.5	35.7	10.2	14.8	0.21
	Max	**85.2**	**46.3**	**11.5**	**16.8**	**0.37**
	Min	**68.5**	**35.7**	**9.6**	**12.2**	**0.21**
	Mean	**76.7**	**40.8**	**10.5**	**14.5**	**0.28**
	98%tile	**84.9**	**46.0**	**11.5**	**16.7**	**0.37**

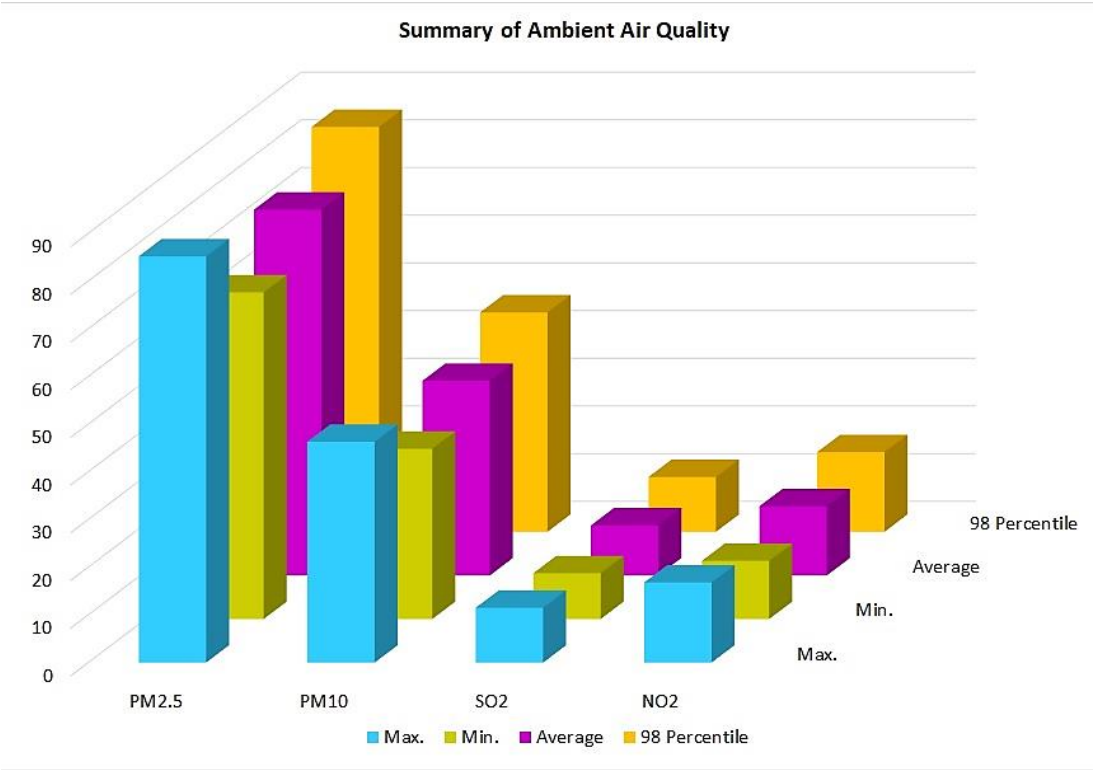


Figure 3.8: Summary of Ambient Air Quality

3.9 Ambient Noise Levels

To understand the noise environment in the study area, noise survey was conducted using Sound Level Meter 2031 manufactured by Cygnet Systems. Noise levels were measured as per IS: 9989:1981 R-2002. Noise measurements were carried out at the same location where ambient air quality

was monitored. The 24-hourly sound levels were measured at each location once during the study period.

3.9.1 Noise Monitoring Locations

For noise monitoring, 2 monitoring locations, where ambient air quality was monitored, were selected in the study area. Noise monitoring locations are given in **Table 3.14.**

Table 3.14: Noise Measurements Locations

Code	Noise Monitoring Stations	Area Details
N1	Barwala	Commercial
N2	Near Tap off Point Barwala	Residential

3.9.2 Day and Night Time Leq Noise Levels In the Study Area

Day and night time Leq noise levels were computed from the hourly Leq noise levels. Day and night time Leq (L_{day} and L_{night}) for ambient noise levels for the study area are given in **Table 3.15** and graphically presented in **Figure 3.9.** It is observed from the day and night time noise level equivalent (L_{day} and L_{night}) were well within limit specified for residential areas *i.e.* 55 dB (A) during day time, 45dB (A) during in night time, and commercial limits *i.e.* 65dB during in day time, 55 dB during night time.

Table 3.15: Day and Night Time Leq at Noise Monitoring Locations

Sr. No	Location	Category	Unit	Results		Prescribed Standard	
				L_{Day}	L_{Night}	Day Time	Night Time
1.	Barwala	Commercial	dB(A)	62.3	45.7	75	65
2.	Tap off Point Barwala	Residential	dB(A)	51.9	43.2	55	45

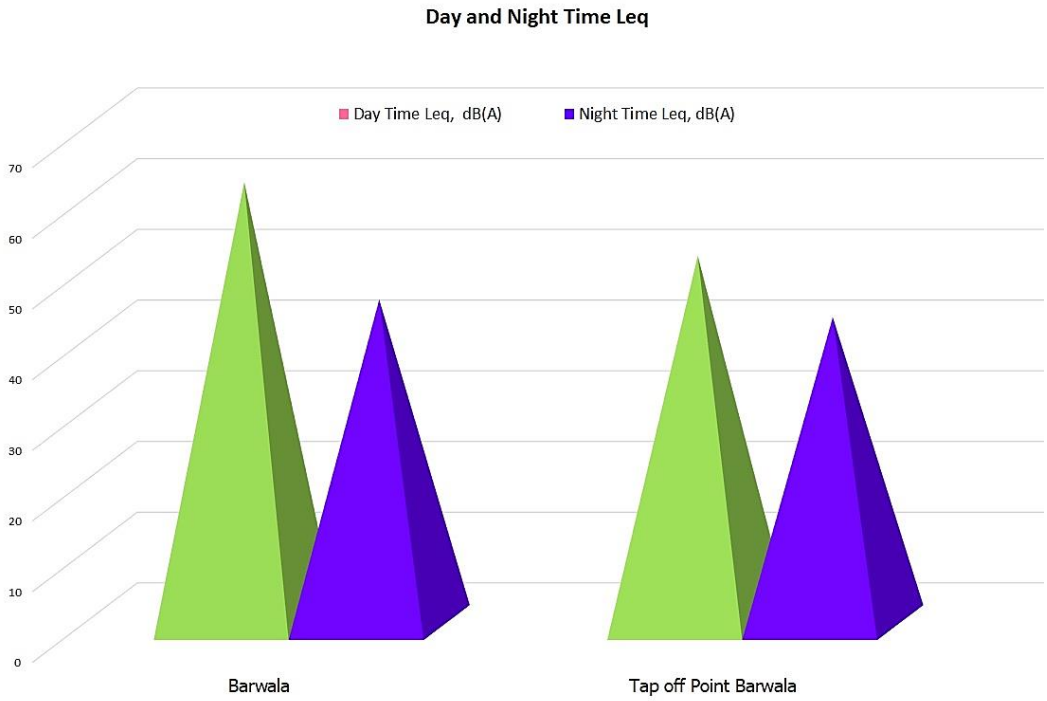


Figure 3.9: Day and Night Time Leq Noise Levels

3.10 Biological Environment

The biotic species are broadly classified into two categories-flora (vegetation) and fauna (animals). All biotic species are organized in natural groups called 'communities' with mutual dependency among their members. Any development usually produces adverse biological impacts of two types – direct & indirect, and of varying duration, short term and long term.

Biological diversity comprises the variability of genus, species and ecosystems and is crucial for maintaining the basic processes on which the life depends. Broadly, it can be divided into two types *i.e.* the floral diversity and faunal diversity. Conservation of the biodiversity is essential for the sustainable development as it not only provides the food, fodder and medicine but also contribute in improvement of essential environmental attributes like air, water, soil, etc. and aquatic ecosystems have been studied to understand the biological environment. During the study period, ecological and biodiversity studies were carried to study to evaluate floral and faunal composition of the study area.

3.10.1Composition and Conditions

According to Champion and Seth classification 1964, the area falls under "Type VI-B Northern Tropical Thorn Forest" - Sub-type C-I Desert Thorn Forest as per the forest working plan of Botad Forest Division.

3.10.2Vegetation Type

The vegetation in the area are characterised by thorny and non-thorny vegetation growth. Trees in the area are sparse. Due to long continued maltreatment, the wild tree growth has become almost entirely confined to thorny species: Bawal and Kher (Acacia classes); Angario (*Balanites aegyptiaca*); Kai (*Mimosa pudica*); Kando (*Prosopis cineraria*), Ked (*Capparis Decidua*), Boradi (*Zizyphus nummularia*) and Kantalo Thor (*Eupnorbia Nivulia*). These thorny species form the greater part of the vegetation growth in the area, together with some non-thorny desert trees and shrubs such as Vad (*Ficus benghalensis*), Nim (*Azadirachta indica*), Aval (*Cassia auriculata*), Akdo (*Calotropis gigantea*), Gangi (*Grewia populifolia*), Lai (*Tamarix indicus*) are observed at some places. The area is sparsely vegetated by small trees, shrubs, climber and grasses.

The plant species observed in the area are listed in **Table 3.16** with their vernacular name, physiognomic types (form), distribution status (frequency) and ethnobotanical values. The plants in the area are sparsely distributed in a heterogeneous manner.

Table 3.16 : Plant Species Observed in the Area

Botanical Name	Vernacular Name	Form	Distribution Status	Ethnobotanical Values
Acacia arabica	Jacha Baval	T	VF	Timber, Fuel
Azadirachta indica	Limdo, Nim	T	VF	Timber, Fuel
Albizia labbeck	Kalo Sarsado	T	O	Fuel, Timber
Acacia catechu	Khair	ST	F	Medicinal
Acacia Leucopholea	Hanno Baval, Pilo Baval	ST	F	Fuel, Timber
Andropogon annulatus	Motu Mindadiu	G	F	Fodder
Andropogan halepensis	Barn Ghas	G	F	Fodder
Aeluropus villosus	Khariyo, Kharo Ghas	G	F	Fodder
Borassus flabellifer	Tad	S	O	Fuel
Cassia auriculata	Aval	T	O	Fuel

Botanical Name	Vernacular Name	Form	Distribution Status	Ethnobotanical Values
Callotropis giganfia	Moto Akdo	S	F	Medicinal
Cactus inducus	Naghani, Hathlo, Tho	S	O	Fuel
Capparis aphylla	Krda, Kera, Dora	S	O	Fuel
Capparis sepiaria	Khantharo	S	O	Fuel
Cymnosporia spinosa	Vingo	T	O	Fuel
Cynodon dactylon	Dhro, Chhabbar	G	F	Fodder, Medicinal
Chloris barbata	MindadiunGhas	G	F	Fodder
Desmostachya bipinnata	Dabhla	G	F	Fodder
Euphoribia nivulia	Kantharo, Thor	S	F	Fuel
Euphorbia Tirucallis	Thor	S	VF	Fuel
Eleusine aristata	Zinko, Nidho	G	O	Fodder
Eragrosfis cynosuroides	Darbh, Kush Ghas	G	F	Fodder
Eragrositis amabilis	Chaki chokha, Phuldo Ghas	G	F	Fodder
Ficus glomerata	Umra	T	O	Fuel
Ficus benghalensis	Vad	T	O	Mythological
Ficus religiosa	Piplo	T	O	Mythological
Halopyrum mucronatum	Dariyai Kans Ghas	G	F	MFP, Medicinal
Leucaena leucocephola	Subabul	ST	O	Timber, Fuel
Leptadenia spartium	Khip, Dariyai Khip	ST	O	Fuel
Phoenix-sylvestris	Tadi, Khajuri	ST	O	Food" MFP
Prosopis spicigera	Khijdo	T	VF	Fuel, Timber
Prosopis juliflora	Gando Baval	ST,S	VF	Timber, Fuel, Fodder
Rhizophora mucronata	Karod	ST	O	Fuel
Salvadora persica	Khari Jar, Pilu	ST	F	Fuel, Food
Salvadora oleoides	Mithi Jar	ST	F	Food, Fuel
Soymida febrifuga	Ron	ST	O	Fuel
Sueda maritima	Lano, Luno	T	O	Fuel, Timber
Tamarindus indicus	Arnli	T	O	Fuel, Food
Zizyphus nummularia	Chani-bor	S	VF	Fuel, Food
Zizyphus mauritiana	Bordi	ST	F	Fuel, Food

Note:

1. Physiognomic Types

T - Tree
ST - Small Tree

2. Distribution Status

F – Frequent

S – Shrub
G – Grass

VF – Very Frequent
O – Occasional

3.10.3 Wildlife of The Study Area

The major part of the study area lies under agriculture field and barren land followed by built-up/industrial areas, which restrict the wildlife habitat significantly.

Ecological Sensitive Area: There is no wildlife sanctuary or national park within 10 km radius area.

Wild animals like Vulpus bengaensis (Lonkadi), *Sus scrofa* (wild boar), *Baselaphus* tragocamelus (Roze) and *Canis aureus (Jaikal) are occasionally observed in the area. Vulpus bengaensis* (Lonkadi) is occasionally observed in the area in crop field. The long drawn eerie howling of ubiquitous canine is a very familiar nocturnal sound heard in the area. It mostly feeds on carrion and is a useful scavenger. Occasionally, it lifts poultry and young ones of goats and sheeps. *Sus scrofa* (wild boar), *Baselaphus* tragocamelus (Roze) and *Canis aureus,* are also common in the study area.

3.11 Socio-Economic Environment

3.11.1Introduction

Baseline environmental scenario in the study area with respect to demographic and socio-economic conditions has been discussed in the subsequent sections of this chapter. Data on number of villages, their land area, number of households and population in each village as well as literacy rate in the study areas has been obtained from District Census Handbook, 2011 for Botad District.

3.11.2Demographic and Occupational Pattern of Botad District

Botad is a district of the state of Gujarat. It was created on 15 August 2013 from the southwestern part of Ahmedabad District and the northwestern part of Bhavnagar District. Botad consist of four taluka Botad, Gadhada, Barvala, Ranpur. Botad city is the administrative headquarters of the district.

This district is surrounded by Bhavnagar District to the southeast, Surendranagar District to the north and northwest, Amreli District to the southwest, Ahmedabad District to the northeast and Rajkot District to the west.

The district had a population of 652556 according to the 2011 census, with an area of 2564 square kilometres and a population density of 255 per square kilometre

As per Census records 2011, total population of Botad District is 1756268, out of which 337234 are males and 318771 are females. The male population constitutes 51.4% while female population is 48.6%.

In Botad district, schedule cast population is 43270 (6.6 % of total population), while schedule 1298 (0.2 % of total population).

As per 2011, census records, literate population in Botad District is 412386, which is 73.2 % of total population of Botad district.

3.11.3Demographics Details of the Charge Areas (CAs) In Botad District

1. Population

Table 3.17 gives details on village name, number of households and population distribution as per Census Records 2011, for settlements of the study area.

There are total 30892 households in the study area. Total population of the study area accounts for 168912. The male population constitutes 51.6 % while female population is 48.4% of the total population in the study area.

2. Sex Ratio

As per Census records 2011, sex ratio for the study area is 938, and the same is found to be lower than that for district Botad (945) and higher than that for Gujarat state (919).

3. Literacy

Table 3.17 also presents the literacy rate of the study area. Literacy rate of study area is 59.6 % (68.6 % male and 50.1 %female).

4. Scheduled Caste

Scheduled castes population accounts 6.9% of the total population of the study area.

5. Schedule Tribes

Scheduled tribe population accounts for 0.1% of the total population of the study area.

6. Occupational Pattern

The details of occupational pattern and infrastructure facilities in each of the villages of the study area have been obtained from Census 2011, for Botad District.

The employment pattern in the study area is an indicator of number of person employed in various sectors. It also indicates the various categories of employment flourishing in the area. The occupational pattern in the study area is presented in **Table 3.18** as per census records 2011.

In the study area, total main workers account for 31.9% (50.2% males and 12.5% females) whereas non-workers account for 60.0% (44.7 % males and 76.3% females) and marginal workers are 8.1% (5.2% males and 11.2% females) of the total population of study area.

3.11.4 Socio-Economic Status of the Study Area

During the social study of the study area, the following factors were emerged about the socio-economic conditions of the area:

- The study area comprise partly urban areas and mostly rural areas.
- Agricultural activities are also observed in the study area.

- Local people are engaged in industrial, services, commercial and agricultural activities in the area.

Cropping Pattern

The charge areas are primarily an agricultural area with cotton and groundnut as the predominant crops. The other major crops cultivated are Bajra, Sesame, Jowar, Onion, etc.

In the area during Kharif season mainly maize, sorghum, Blackgram, Cluster bean, sesame, etc. crops are also cultivated. During Rabi season crops like wheat, mustard, barley, gram are also cultivated.

Livestock

Livestock is also important source of income in the rural part of the study area. Buffaloes, goat, sheep, etc are reared for milk and meat production.

3.11.5Living Standards And Infrastructure

Availability of amenities like education, medical, water supply, communication, road network, electricity, etc. significantly reflects the level of development of an area. Information on available amenities in the study area was gathered during field studies and the same is discussed in the following subsections:

Educational Facilities

The graduate and post graduate level education facilities are available in charge areas. There are arts & science colleges, ITIs in the area.

Medical Facilities

Good medical facilities are available in area. Residents of the study area have to travel less than 5 km to avail these facilities. The study area has Primary Health Centres, Primary Health Subcentres, Allopathic Dispensaries, Registered Private Medical Practitioners, Community Health Workers, etc.

Drinking Water Supply

In the study area of both charge area, drinking water facility is available. Tap water is available in the charge areas.

Communication

The charge areas have phone connections and broadband facilities. Mobile network is also available in the area. Post facilities are also available.

Approach to villages

All the charge area can be approached by pucca road.

Power Supply

Electricity is supplied in all the charge areas for industrial/agricultural/all purposes.

Table 3.17: Demographic Details of the Charge Areas (CAs) In Botad District

Sr. No	Name of Settlement	House Hold	Total Population			Population Below 6 Years		Schedule Caste		Schedule Tribe		Literacy	
			P	M	F	M	F	M	F	M	F	M	F
1.	Ranpur	17277	92926	47717	45209	7346	6633	3285	3068	40	32	32376	22410
2.	Barwala	13615	75986	39440	36546	5636	5026	2765	2559	81	74	27378	18571
		30892	**168912**	**87157**	**81755**	**12982**	**11659**	**6050**	**5627**	**121**	**106**	**59754**	**40981**

Source: Census Record -2011

Table 3.18: Occupational Pattern of the Charge Areas (CAs) in Botad District

Sr. No	Name of Charge Area	Total Workers		Main Workers		Cultivators		Agricultural Labour		Other Workers		Marginal Workers		Non-Workers	
		M	F	M	F	M	F	M	F	M	F	M	F	M	F
1.	Ranpur	26122	9663	23275	4567	7387	573	7468	2875	8420	1119	2847	5096	21595	35546
2.	Barwala	22084	9702	20440	5612	5132	511	6999	3857	8309	1244	1644	4090	17356	26844
	Total	**48206**	**19365**	**43715**	**10179**	**12519**	**1084**	**14467**	**6732**	**16729**	**2363**	**4491**	**9186**	**38951**	**62390**

Source: Census Record -2011

Chapter - 4

Anticipated Impacts and Mitigation Measures

4.1 Introduction

The anticipated environmental impacts on various components of environment during laying of the proposed natural gas pipeline and construction of the city gas distribution project of AGL can be assessed in terms of i.) physical environment ii.) biological environment, and iii.) demographic, land use and socioeconomic environment. For proper assessment of significance and magnitude of environmental changes in construction and operation phases of the city gas distribution project of AGL, the impacts are analyzed for each environmental parameter. An assessment is made both for adverse and beneficial environmental impacts in the following section:

For proper assessment of environmental impact during construction and operation phases of Natural Gas Distribution Project in Barwala and Ranpur Talukas Geographical area, it becomes essential to understand the various activities involved in construction and operation phases of the project. The activities involved during construction and operation phases are listed below:

A. Construction Phases

For pipeline laying and construction of the proposed City Gas Distribution Project in Barwala and Ranpur Talukas Geographical Area, the following activities will be undertaken:

- Acquiring right of use (ROU)
- Clearing and grading of ROU
- Handling, hauling and stringing of pipes
- Trenching/Horizontal Boring /Auguring/Plowing
- Line up and welding of pipes
- Cleaning and priming of pipe ends
- Applying coating over welding joints

- Lowering of pipes into trench
- Back-filling and dressing of trench
- Cleaning and restoration of ROU
- Hydrostatic testing
- Repair and restoration of damaged pipes
- Final clean up and restoration

Additionally, pipeline laying involves some specialized crossing, like, cased crossing (railway and major roads) and submerged crossing across water bodies. In order to have minimum disturbances, trench /trenchless (horizontal boring method) is used for cased crossings and horizontal directional drilling method is used for submerged crossing of major/flowing rivers.

The major stages of the gas pipeline construction are as follows:

- **Stringing:** The pipes will be transported to the site in trailers and off-loaded with the help of the side booms. After unloading, pipes shall be laid on the ground for the welding.

- **Welding:** Once the pipeline is stung, a line up crew will position the pipes using side booms. At this point pipes will be lifted above the ground and placed on the sandbags. Using conventional manual welding techniques in three stages will do the welding by pre qualifies welders.

- **Radiography:** Sample weld joints (100% of the total line pipe welds and 100% tie-in joints & filled welds) shall be radio graphed to test for the compliance to specification.

- **Joint Coating:** On receipt of radiography results joint coating is carried out on successful welded joints. Faulty welded joints are repaired as per the specifications.

- **Trenching:** Trenches excavated up to the required depth. During excavation utmost care will be taken for the topsoil. Generally, topsoil of 30 cm depth shall be kept on the one side of the trench and the remaining soil is kept on the other side of the trench.

- **Lowering:** The pipes will be lifted from the supports and lowered in the trenches using the side booms.

- **Tie-in:** Joints between two lowered pipeline section is defined as tie-in joint. It shall be welded within trench by making suitable provision of welding pits. 100% tie-in joints shall be radio-graphed.

- **Back Filling:** On completion of the lowering the trench will be back filled with the excavated soil. A small crown will be left on top to allow for settlement.

- **Hydro Testing:** After completion of tie-in joints welding and backfilling, pipeline will be hydro tested for 1.1 times design pressure.

- **Commissioning:** On successful completion of the hydro test the pipeline will be dried and purged with Nitrogen. On completion of the above activities, natural gas will be charged in the pipeline under strict supervision.

B. Operation Phases

The city gas distribution pipelines will be buried under ground minimum one meter below the ground. During the normal operation of project, it will be confined to supply of electric current/voltage to pipeline for cathodic protection and physical patrolling by personnel. There will be no emission or effluent generation during operation of City Gas Distribution Project in Barwala and Ranpur Talukas Geographical areas.

The possible impact on various components of environment due to the proposed City Gas Distribution Project in Barwala and Ranpur Talukas GA can be assessed in terms of:

i.) Physical Environment,
ii.) Biological Environment, and
iii.) Demographic and Socio-economic Environment.

For proper assessment of significance and magnitude of environmental changes during construction and operation of the project, the impact is analyzed for each

environmental parameter. An assessment is made both for adverse and beneficial impacts.

4.2 Physical Environment

4.2.1 Soil

A. Construction Phase

The City Gas Distribution Project will have construction activities, which will generate construction wastes, such as, excavated soil, debris, pipe/other metal wastes and from construction machines small amount of oil/grease waste. This may contaminate soil at the construction site temporarily. The excavated soil will be used for back filling and restoration, the site will be cleared of all construction debris and land occupied for pipeline laying will be restored as per original conditions. Only right of use (ROU) will be kept by AGL for maintenance and other support system, such as, cathodic protection, physical patrolling, etc. The construction wastes will not contaminate ground water and their impact on surface water will be restricted to construction period in small area around the construction site during rainfall only.

Mitigation Measures

- Good Engineering & construction practices
- Stabilization and compaction of excavated areas
- Collection of construction debris, metal cutting, etc and disposal as per Construction and Demolition Waste Rule 2016.
- Collection of paper, plastic and other municipal solid wastes generated by workers during pipeline laying and construction of CNG stations and disposal as per Solid Waste Management Rule 2016.
- Providing portable toilets and urinals for workers during construction phase
- Maintaining house-keeping at pipe line laying, construction site for DRS and CNG Stations.

II. Operation Phase

During normal operation of the project, no impact on soil is anticipated since there will not be any source of contamination from the pipeline. However, from the CNG stations, small amount of solid wastes and oil contaminated wastes from maintenance may be generated. Further, small quantity of sewage will be generated at the CNG stations by the employees and consumers. These can contaminate soil, if not disposed in environmentally sound manner.

Mitigation Measures

- Housekeeping at CNG stations and DRSs will be maintained good.
- Approximately 2-3 kg per day municipal wastes (paper plastic, food wastes, etc) will be generated from CNG stations, which will be collected and segregated. Recyclable wastes like paper and plastic wastes will be sent for recycling through scrape dealers/rag pickers. Biodegradable wastes like food and vegetable wastes will be disposed in compost pit. Non- biodegradable and non- recyclable wastes will be sent to common waste dump site.
- From the maintenance of DG sets, approx. 20 litres used oil may be generated once in six months, which is categorized as hazardous wastes and will be handed over to GPCB/MOEF&CC authorized used oil recyclers.
- Sewage generated from toilets at CNG stations will be disposed to through septic tank followed by soak pit.

4.2.2 Drainage Pattern

I. Construction Phase

During the construction phases, excavation will be temporary, restricted to small area within the ROW only, therefore, the effect as such on-drainage pattern of the area will be negligible.

Mitigation Measures

- After pipeline laying, RoU will be compacted and restored to its original condition.
- Surplus earth will be collected and disposed in low lying areas.
- Dry channels and water course of small streams will be restored to its original conditions.
- Debris and excavated earth from DRSs and CNG stations will be collected and disposed in environmentally sound manner.

II. Operation Phase

During operation phase of gas distribution network, no impact is anticipated on the drainage pattern.

4.2.3 Water Quality

I. Construction Phase

The construction phase of City Gas Distribution Project in Barwala and Ranpur Talukas Geographical areas will result in increased soil erosion in construction area because the same will be cleared from all vegetation. The run off from the construction site during rainfall may cause some increase in suspended solids and turbidity in run-off in natural drain or nearby river. However, this impact will be of temporary nature, limited to a small area and may not last more than one season. As soon as excavated soil and construction debris are disposed-off properly on completion of construction work and the land is restored in its original condition after laying of pipeline, the soil erosion will be stopped.

Small quantity of sewage will be generated at the CNG stations by the employees and workers during construction phase. This can contaminate surface water and ground water if not disposed in environmentally sound manner. No effluent will be generated during the construction of the project.

Mitigation Measures

- Excavated earth during pipeline paying will be compacted properly.
- Excavated earth at the DRS and CNG station will be compacted properly and water will be sprinkled.
- Debris and solid wastes generated from construction activities will be collected and disposed environmentally sound manner.
- Sewage generated from toilets will be disposed to through septic tank followed by soak pit.

II. Operation Phase

During the normal operation of the project, no effluents will be generated from pipeline. Small amount of solid wastes and oil contaminated wastes may be generated from CNG stations. Small quantity of sewage will be generated at the CNG stations by the employees and consumers of CNG stations. Small quality of used may be generated from the maintenance of DG sets at CNG stations. These can contaminate soil, if not disposed in environmentally sound manner.

- Housekeeping at CNG stations and DRSs will be maintained good.
- Approx. 20 litres used oil may be generated from the maintenance of DG sets, which is categorized as hazardous wastes and will be handed over to GPCB/MOEF&CC authorized used oil recyclers.
- Approximately 2-3 kg per day municipal wastes (paper plastic, food wastes, etc) will be generated from CNG station, which will be collected and segregated. Recyclable wastes like paper and plastic wastes will be sent for recycling through scrape dealers. Biodegradable wastes like food and vegetable wastes will be disposed in compost pit. Non- biodegradable and non- recyclable wastes will be sent to common waste dump landfill site.
- Sewage generated from toilets at CNG Stations will be disposed to through septic tank followed by soak pit.

4.2.4 Climatology and Meteorology

The construction and operation phases of City Gas Distribution Project in Barwala and Ranpur Talukas GA geographical areas will have no impact on climatology and meteorology of the study area.

4.2.5 Ambient Air Quality

I. Construction Phase

A certain amount of coarse particulate matter will be generated during the construction phase (especially, during trenching and excavation for pipeline laying and CNG station) of the project. However, the suspended particulate matter in ambient air as a result of construction activities may be relatively coarse and will be settled within a short distance of construction area. Therefore, the impact will be restricted in the close vicinity of the construction activities/site only for short duration.

Mitigation Measures

- Cordoning off pipeline laying, DRS and CNG stations construction area by tin sheets & garden net.
- Dust suppression measures like water sprinkling as per requirement should be followed.

II. Operation Phase

The operation of natural Gas Distribution Project, in Barwala and Ranpur Talukas geographical areas will have no impact on air quality of the study area, since there will be no source of emission during operation phase.

The City Gas Distribution Project will be helpful in improving the ambient air quality of Charge areas of Barwala and Ranpur Talukas Geographical Areas. This will be positive impact of the project. Natural Gas produces less air pollution than any other fossil fuels. Use of CNG vehicles can reduce Carbon Monoxide

emissions as much as 93% Nitrogen Oxide reduces about 33% and Hydrocarbons are reduced by about 50%. Natural Gas emits almost no carcinogenic particulate matter.

Reduction in IDC Mass Emissions with CNG retrofitted as certified by ARAI Pune /VRDE Ahmednagar are given below.

A. Passenger Car (Petrol)

Vehicle	**Pollutants (gm/km)**	**Petrol (gm/km)**	**CNG (gm/km)**	**% Reduction (gm/km)**
Maruti Omni	CO	19.79	0.55	97
	HC	1.14	1.02	11
Maruti Gypsy	CO	4.94	0.59	88
	HC	1.86	1.42	24
Premier Padmini	CO	18.38	0.94	95
	HC	2.83	2.03	28
Premier 118 NE	CO	15.6	2.04	87
	HC	2.57	1.92	25
Ambassador	CO	52.16	0.78	98
	HC	6.37	4.33	32

B. Auto Rickshaws (Petrol)

	Pollutants (gm/km)	**Petrol (gm/km)**	**CNG (gm/km)**	**% Reduction (gm/km)**
Three Wheeler	CO	3.26	3.99/1.2	63.19
	HC	5.48	1.57	71.35
	CO_2	47.44	27.6	41.82
	NOx	0.25	0.2	20.00

C. Diesel Buses

	Pollutants (gm/km)	Petrol (gm/km)	CNG (gm/km)	% Reduction (gm/km)
Ashok Leyland	CO	1.68	1.4	16.67
	HC	4.5	3.77	19.37
	NOx	13.73	8.0	41.77

Therefore, overall impact of natural gas pipeline project on ambient air quality will be significantly positive and beneficial for long term.

At the CNG stations, DG sets may be installed for power back-up, which will be operated in case of grid power failure. Exhaust emissions from DG sets may deteriorate ambient air quality around the CNG stations.

Mitigation Measures

- Discharge of flue gases through stacks height as per CPCB guidelines will result in adequate natural dispersion and greatly reduce the impact of flue gas emissions at ground level.
- Effort should be made to operate power generators through natural gas.

4.2.6 Noise

I. Construction Phase

Some noise will be generated during the construction phase due to operation of construction and pipeline laying machines during natural gas pipeline laying and other construction activities for CNG/DRS stations. However, these noise sources will be of temporary nature mostly during day-time.

During the construction phase, metal cuttings, bending, hammering, erection of equipment, vehicle movement and DG sets/engines will be major sources of noise generation. Relatively high noise levels will be generated during

construction phase. Anticipated noise levels from various sources are as given below in **Table 4.1**:

Table 4.1: Anticipated Noise Levels from Various Sources

Sn.	Sources	Anticipated Noise Levels
1.	DG set/Engines	90 dB(A)
2.	Metal cutting	80 dB(A)
3.	Hammering	85 dB(A)
4.	Erection	75 dB(A)

Generation of noise levels from above sources will be intermittent in the nature for short duration. The noise level generated from the construction site would decrease with increase in distance from the source due to the wave divergence effect.

Modelling for Noise Emissions from Construction Site

For dispersion modelling of noise, standard mathematical model for sound wave propagation have been used. The sound pressure level generated by noise sources decreases with increasing distance from the source due to wave divergence. An additional decrease in sound pressure level from the source is expected due to atmospheric effect or its interaction with objects in the transmission path.

For hemispherical sound wave propagation through homogeneous loss free medium, one can estimate noise levels at various locations due to different sources using model based on first principles, as per the following equation:

$$\text{Noise}_{(\text{Receptor})} = \text{Noise}_{(\text{Source})} - 20 \text{ Log}[\text{distance}_{(\text{Receptor})} / \text{distance}_{(\text{Source})}]$$

The combined effect of all the sources then can be determined at various locations by the following equation.

$$Lp\ (\text{total}) = 10 \text{ Log } (10^{(Lp1/10)} + 10^{(Lp2/10)} + 10^{(Lp3/10)} \ldots\ldots\ldots\ldots\ldots)$$

Where Lp_1, LP_2, LP_3 are noise pressure levels at a point due to different sources.

The resultant maximum noise level from site is calculated as 85 dB (A). Assuming, no environmental attenuation factors, noise modelling has been done which shows that noise level at different distance from the site has been shown in **Table 4.2**:

Table 4.2: Noise Level at Various Distances

Noise Levels (dB (A))	Distance from Source (m)
85	0.9
80	1.5
75	2.7
70	4.8
65	8.5
60	15.1
55	26.9
50	47.9
45	85.1

Graphical presentation of noise attenuation during construction site is shown in **Figure 4.1.**

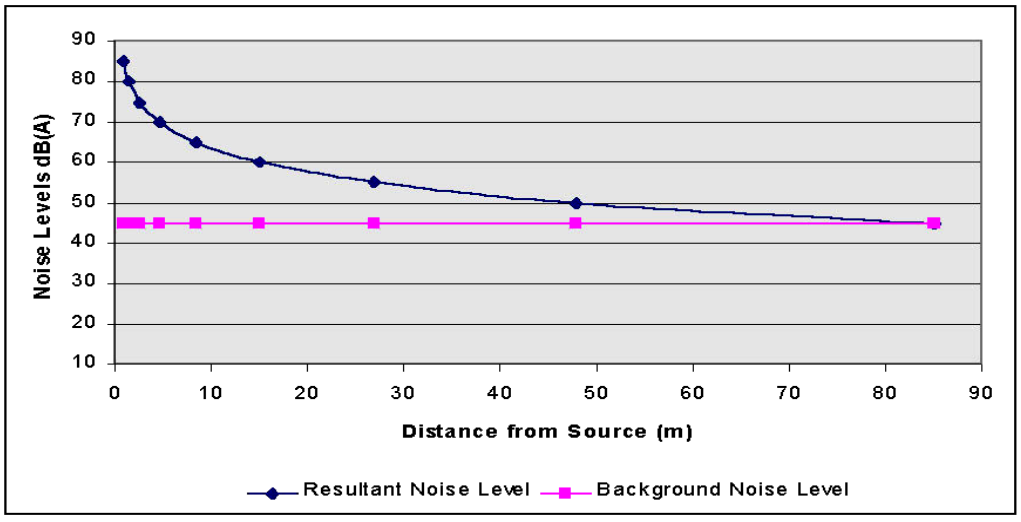


Figure 4.1: Attenuation of Noise Levels

The above noise modeling results show that the noise levels will remain below acceptable level within short distance inside the terminal. Further, the resultant noise level will mingle with the background noise level (assumed to be 50 dB (A) at 26.9 m during day time and 45 dB (A) at 85.1 m during night time). The above noise levels are without mitigative measures. With the mitigative measures, the noise levels will be further restricted within very short distance from the activities.

Therefore, no significant impact is anticipated on noise levels during construction phase of the project.

Mitigation Measures

- Construction machineries required for pipeline laying will be maintained in good conditions.
- Stationary equipment will be placed along un-inhabited area as far as practicable to minimize objectionable noise impacts.
- Construction activities and pipeline laying activities will be strictly prohibited between 10 pm and 6 am near residential areas/schools and hospitals.
- Use of ear muff and ear plugs to workers working in high noise area.
- Construction equipment and machinery will be fitted with silencers.

II. Operation Phase

No noise generation is expected due to the operation phase of City Gas Distribution Project in Barwala and Ranpur Talukas Geographical Areas. Therefore, the impact of the project operation on noise level in the study area will be insignificant.

At the CNG station DG set, compressor/other CNG equipment will be source of noise levels.

Mitigation Measures

- Acoustic enclosure fitted DG set will be installed at CNG station.
- Compressor/other CNG equipment will comply noise standard and generate noise level less than 75 dB(A).

4.2.7 Land Use

The Natural Gas Distribution Project in Barwala and Ranpur Talukas Geographical Areas will have no impact on land use in the area, since the total land requirement for the project will be very small. Further, the pipelines will be laid underground one meter below and as such will need only right of use (ROU). The land after pipeline laying will be restored for their normal use. Therefore, no significant impact is anticipated on the land use of the area due to pipeline.

4.3 Biological Environment

4.3.1 Terrestrial Ecology

I. Construction Phase

The ROU may be affected slightly during construction phase because some of the vegetation/ground flora in ROU along the pipeline route may have to be cleared. However, no tree cutting would be required for the pipeline laying, DRS and CNG stations.

Mitigation Measures

- Careful and proper planning should be done to minimise disturbance to ground flora, shrubs and trees due to laying of pipeline.
- If tree cutting is required, prior permission will be obtained and compensatory plantation will be done with help of forest department or land owner.

II. Operation Phase

The operation of City Gas Distribution Project in Barwala and Ranpur Talukas Geographical Areas will have no impact on ecology of the study area as pipeline will be buried underground. At CNG stations some landscaping through shrubs will be done as per availability of space, which will have positive impacts on the flora and fauna.

4.3.2 Aquatic Ecology

I. Construction Phase

During construction phase of proposed City Gas Distribution Project, pipeline laying may affect aquatic ecology any water body, if pipeline is laid through trench/open cut method.

Mitigation Measures

- The flowing water bodies will be crossed by the horizontal directional drilling method.
- If open cut or trench method is used during pipeline laying to cross small water bodies, all the excavated debris and surplus earth will be collected and site will be restored in original condition.

II. Operation Phase

The operation phase of the proposed City Gas Distribution Project will not affect any water body; therefore, no impact is anticipated on the aquatic ecology.

4.4 Demographic, Land Use And Socio-Economic Environment

4.4.1 Demographic

The construction and operation phases of City Gas Distribution Project in Barwala and Ranpur Talukas GA Geographical Areas will not require large work

force. Workforce deployed for pipeline laying and construction of DRS and CNG stations may be from out site areas as skilled labour will be required for specialized work. For unskilled activities during construction and operation phases, labour will be procured from the local areas. It's impact on generation of new industrial and business activities is likely to be limited in the area. Therefore, immigration of persons will be insignificant and the impact on demography of the local area will not be felt significantly.

4.4.2 Economic Impacts

The construction and operation phases of the City Gas Distribution Project in Barwala and Ranpur Talukas Geographical Areas will have some beneficial impact due to availability of assured supply of clean fuel for vehicles, industries and commercial establishments; and households. Further, some increase in incomes is expected as some local unskilled, semiskilled and skilled persons will gain direct or indirect employment opportunity during construction and operation phases. However, in view of the small manpower and support facility requirements, the beneficial impact is likely to be marginal. Economic benefits will be available indirectly due to assured availability of clean and safe fuel for vehicles, industries and commercial establishments and households and subsequently batter environmental conditions in the Barwala and Ranpur Talukas Geographical Areas.

4.4.3 Social Impacts

Since the immigration of work force during construction and operation phases of the City Gas Distribution Project in Barwala and Ranpur Talukas GA is likely to be very small, the social impacts on literacy, health care, transport facilities and cultural aspects are expected to be insignificant.

Mitigation Measures

- Employment will be given to the local people.
- Labour facilities will be provided as per the Building and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996.

- If construction camp is required to be established, it will be located away from the populated area.

4.5 Sustainable Development And Environmental Protection

At the centre of the socio-economic impact, the question lies whether the economic development and growth can go hand in hand with environmental protection. Natural gas distribution project in Barwala and Ranpur Talukas Geographical Areas is not likely to have any negative impact by implementing the proposed recommendations for environmental management. The project will have a definite long-term beneficial impacts, on environment, infrastructure facilities, health, gross economic product, employment opportunities and socio-economic aspects of the area.

Chapter 5

Alternative Analysis

5.1 Introduction

The consideration of technological alternatives for the proposed gas distribution in Barwala and Ranpur Talukas Geographical Areas, is one of the more proactive side of environmental assessment - enhancing the project through examining options instead of only focusing on the more defensive task of reducing adverse impacts of a single option of the project. This requires the systematic comparison of feasible alternatives for technology and operational alternatives. Alternatives are compared in terms of their potential environmental impacts, capital and recurrent costs, suitability under local conditions, etc.

The examining alternative means of carrying out a project involves answering the following three questions:

(i) what are the alternatives?,
(ii) what are the environmental impacts associated with each alternative?, and
(iii) what is the rationale for selecting the preferred alternative?

5.2 Alternative Technology for Crossing Water Bodies

If pipeline crosses canal, river or other water bodies through open cut or trench methods, there will be major impacts on the water quality and aquatic ecology of that water body. To avoid such adverse impacts on the water bodies, pipeline will be laid using Horizontal Directional Drilling (HDD) through water crossings, such as canals and rivers. Horizontal Directional Drilling will not affect course of water body.

5.3 Alternatives for Corrosion Protection

Steel piping laid underground are prone to corrosion. During repair, replacement of corroded pipeline section, adverse environmental impacts will be appeared similar to laying new pipeline. For proposed gas distribution in Barwala and Ranpur Talukas Geographical Areas, steel pipeline will be

catholically protected to protect it from corrosion.

It is proposed that all underground steel piping will be cathodically protected. Cathodic Protection will be provided by an impressed current system to be designed to accommodate effects of inductive currents and ground fault conditions from adjacent High Voltage AC power lines. The impressed current systems will include a rectifier for the DC power source and shallow anode ground beds. The status of protection will be monitored by use of test stations installed at certain intervals to measure the pipe-to-soil potentials along the pipeline. This distance interval depends on the local climate, soil conditions and the depth of cover for the pipeline system. The stations shall be easily accessible (*i.e.* adjacent to roads), if possible. Insulating flanges shall be installed at station limits of this project.

5.4 Alternative For Monitoring and Control of Operating Pipeline

The proposed gas distribution network will have a state of art Supervisory Control and Data Acquisition (SCADA) System to monitor and control process variables for entire pipeline network. The central idea behind the SCADA system is remote flown computer monitoring and to manage the load by controlling the process variables. The main purpose of this system is to monitor pressure and flow and control of the value if required.

SCADA system will be equipped with highly automated networking and instrumentation. Each Remote terminal unit (RTU) will be having programmable logic controller, which scans the live data from local field and transmit it to centralized control rooms can issue the command to individual RTU location. Thus Bi-directional communication will make the system more sophisticated and advance. Adequate redundancy will be built for the RTU, Communication media and control room instrumentation. Interlocks will be defined in the PLC for flow control valves, compressors units, flow control valves etc. to meet the application requirement. The system will be designed for the future expansions. Gas will be measured through advance flow computers and smart transmitters through orifice metering. The main purpose of this system is to monitor pressure and flow and control of the valve required.

Chapter 6

Environmental Monitoring Plan

6.1 Introduction

Regular monitoring program for the environmental parameters is essential to take account the impacts on the environment due to pipeline laying and construction of gas distribution project. To ensure the effective implementation of the mitigation measures and environmental management plan during operation phase of gas distribution project in Barwala and Ranpur Talukas Geographical areas, it is essential that an effective environmental monitoring plan be designed and followed during construction and operation phases.

The objectives of environmental monitoring plan for gas distribution in the Barwala and Ranpur Talukas Geographical areas are:

- to verify the results of the impact assessment study in particular with regards to proposed project; and
- to check or assess the efficiency of the mitigation measures;

The environmental monitoring is the primary tool for assessing the prevailing quality of air, water, noise, land etc. The environmental monitoring helps in suggesting and taking corrective course corrections, monitored parameters are exceeding. The monitoring of various environmental parameters for ambient air quality, water quality, noise levels, soil quality will be carried out on a regular basis to ascertain the following during the construction and operation phases:

- Pollution caused due to operations of construction machineries.
- To assess environmental impacts during construction phase, and
- Evaluate the efficiency of pollution control measures to be taken as EMP.

The environmental monitoring shall be periodic and comply with the promulgated standards and environmental regulations.

6.2 Monitoring Schedule

Regular monitoring program of the environmental parameters is essential to take into account the changes in the environment due to the construction and operation of gas distribution project in the Barwala and Ranpur Talukas Geographical areas.

The monitoring program during the construction and operation phases is spelled out below:

6.2.1 Ambient Air Monitoring

The ambient air quality monitoring should be conducted at selected construction sites for parameters of particulate matter ($PM_{2.5}$ and PM_{10}), Sulphur Dioxide (SO_2) and Nitrogen Dioxide (NO_2).

During operation phase, concentration of hydrocarbon in ambient air should be monitored time to time. However, no limit has been prescribed for hydrocarbon concentration in the ambient air.

6.2.2 Noise Monitoring

The noise monitoring should be conducted at selected construction sites and at CNG stations ensuring that noise levels are within the limit.

Chapter 7

Environmental Management Plan

7.1 Introduction

A properly prepared environmental management plan will help in proper planning and monitoring the environmental parameters in the area and identify critical parameters for timely corrective actions. As project will facilitate and encourage the clean and safe fuel (natural gas) for vehicles, industries, commercial establishment and households, it will assist in the environmental management and improving ambient air quality of the Barwala and Ranpur Talukas Geographical Areas in Botad District. The discussions in the following subsections are to suggest the mitigation measures and environmental management plan for the City Gas Distribution Project in Barwala and Ranpur Talukas Geographical Areas in Botad District.

7.2 Physical And Biological Environment

7.2.1 Soils

During construction phase, topsoil removed from fertile area (if any) during excavation/trenching work for the laying of pipeline should be preserved and reutilized at the site after the completion of laying of pipeline and construction work.

Furthermore, the clearing and grubbing of vegetation in right of use (RoU) should be restricted to the actual place of construction to reduce impact on ground flora and soil erosion during rainfall.

All the construction derbies, metal cuttings and other construction wastes will be collected and disposed suitably as soon as construction is over.

There will be no impact during the operation of the pipeline on the soil of the area, therefore no management plan is required for operation phase.

7.2.2 Drainage Pattern

During the construction phase, impact on surface water hydrology will be minimized by preserving the natural drainage pattern as far as possible through back filling and restoration of affected area due to pipeline laying, DRS and CNG stations.

The operation phase will have no impact on drainage pattern as pipeline will be buried under ground, therefore, no management plan is required for drainage pattern during operation phase.

7.2.3 Water Quality

During construction phase, surface water quality is likely to be affected due to soil erosion during first few rains and generation of untreated domestic waste-water by construction labour, if construction camp is established. However, this phenomenon will be temporary and restricted to close vicinity to the construction site only. By restricting the area of clearance of vegetation to actual location of pipeline laying and re-utilizing & compaction of excavated soil at the site properly after completion of work, the impact on turbidity of the surface water during rains can be greatly reduced. By providing proper hutment and toilet facilities fitted with septic tank and soak pit for construction workers, in case there is provision of construction camp, the impact of untreated domestic waste-water on surface water and ground water quality can be greatly reduced.

During the operation phase, there will be no water consumption in the gas pipeline. Water consumption at the DRS and CNG stations will be restricted to domestic purpose only. Sewage/waste water generated from CNG Stations will be treated in a properly designed septic tanks followed by soak pit.

7.2.4 Meteorology and Climatology

Meteorology of the area is not likely to be affected during the construction and operation phases of the City Gas Distribution Project (including CNG stations) in Barwala and Ranpur Talukas Geographical Areas in Botad District and as such no management plan would be required.

7.2.5 Air Environment

During construction phase of pipeline laying and CNG station, a certain amount of dust and gaseous emissions may be generated due to excavation, vehicular movement and operation of the construction equipment, however quantum of dust and gaseous emissions will be very small. This will marginally deteriorate the ambient air quality around the construction and pipeline laying site but the impact will be of temporary in nature and will be diminished once construction work is over. Necessary precautions and mitigation measures will be adopted to control such dust emissions. For reduction of dust generation at the construction site, dust suppression by means of water sprinkling may be followed during construction phase as per requirement. Vehicles bringing construction materials to construction sites should be covered so that construction materials will not be spilled and emitted on the road used for transportation of materials for pipeline laying.

During the operation phase, DG set at CNG station will release exhaust at a height as per CPCB norms for dispersing pollutants into the atmosphere by natural dispersion process.

During the operation phase, the City Gas Distribution Project will be helpful in improving the ambient air quality in K Barwala and Ranpur Talukas Geographical Areas in Botad District by facilitating clean fuel for vehicles, industries, commercial establishments and households. This will be long term positive and beneficial impact of the project.

7.2.6 Solid Wastes

In case top soil generated during excavation for pipeline laying, DRS and CNG stations are fertile, these should be utilized at the construction site. On completion of construction work, all kind of debris, construction wastes, metal cuttings, etc. will be collected and disposed-off properly as per the Construction and Demolition Waste Rules 2016.

No solid waste will be generated due to the operation of pipelines, DRS and CNG stations for City Gas Distribution Project in Barwala and Ranpur Talukas Geographical Areas in Botad District.

7.2.7 Noise

The noise generated during construction phase due to operation of construction machineries will be temporary and restricted close to construction area only.

The mitigation measures for the construction phase are given below:

- Rotating equipment used in construction activities will be maintained well and strictly conform to noise generation standards.
- Vehicles and equipment used at construction site will be fitted with silencer and maintained accordingly.
- Noise standards for industrial enterprises will be enforced to protect construction workers from adverse noise impacts.
- Workers engaged in high noise area will be provided with appropriate ear muffs/plugs.
- Noise levels will be monitored during the construction phase as mentioned in the Environmental Monitoring Plan.

7.2.8 Land Use

The natural gas distribution pipelines will not require significant area of land since pipeline will be buried under ground. AGL will retain right of use (ROU) only. For DRS and CNG stations small area of land will be required. Therefore, no significant change in land use pattern is anticipated, which may require any management plan.

7.2.9 Terrestrial Ecology

Since no significant adverse impact on terrestrial ecology due to City Gas Distribution Project is anticipated, hence no management plan is needed.

7.3 Demographic And Socio-Economic Environment

The City Gas Distribution project will require small number of workers employed by contractors during construction phase and these workers will leave the site once construction activities are over. Necessary facilities like drinking water, sanitation, waste-water disposal will be provided to the construction workers.

Operation of the project will require small number of skilled workers at pipeline patrolling, DRS and CNG stations, which will have no adverse impact on demographic and social environment of the area, hence no management plan is required.

The following suggestions are given to strengthen the beneficial impacts on the socio-economic conditions during construction and operation phase of the project:

- Local people shall be given preference for employment.
- All the applicable guidelines under relevant acts and rules related to labour welfare and safety should be implemented during the construction work and operation activities.

7.4 Environmental Management Plan

The description of the anticipated environmental issues/impacts and various management measures during the construction and operation phases of proposed natural gas distribution project in Barwala and Ranpur Talukas Geographical Areas in Botad District have been detailed in **Table 7.1**.

Table 7.1: Anticipated Adverse Impacts and Mitigation Measures with responsibility

Sn.	Anticipated Adverse Impacts	Mitigation Measures / Best Practices	Responsibility
I.	**Design Phase**		
1.	Tree cutting	Pipeline alignment will be finalised in such way that tree cutting should be minimal.	AGL
2.	Avoidance of forest land	After finalisation of alignment, it will be ensured that pipeline does not pass through forest area. If pipeline passes through the forest area, necessary forest clearance will be obtained from the forest department.	AGL
II.	**Pre-construction Phase**		

Sn.	Anticipated Adverse Impacts	Mitigation Measures / Best Practices	Responsibility
3.	Impacts due to removal of tree	If tree cutting is required for pipeline laying, necessary tree cutting permission will be obtained from the state Forest Department or District Authorities as applicable.	AGL
4.	Impacts due to relocation of community utilities and common property resources	Any community properties and utilities *i.e.* open wells, sewer lines, community structures, etc falling in the alignment of the proposed pipeline will be relocated appropriately before start laying of pipelines.	AGL
5.	Acquisition of land for laying of pipeline and construction of DRS and CNG stations	Prior to commencement of pipeline laying and before start the construction of DRS and CNG stations, required land will be acquired or purchased as per applicable regulations.	AGL
6.	Employment Opportunities	The contractor preferably will use unskilled labour drawn from local communities to give the maximum benefit to the local community.	Contractor/ AGL
7.	Regulatory Permissions and Statutory Compliance	Before start the pipeline laying and construction of DRS and CNG stations, AGL/ Contractor will obtain necessary permissions/ clearance/consent.	Contractor/ AGL
III.	**Construction Phase**		
8.	Impacts due to clearing and grubbing loss of shrubs and ground flora.	If required vegetation will be removed from Right of Use before commencement of pipeline laying. All works will be carried out such that the damage or disruption to flora	Contractor

Sn.	Anticipated Adverse Impacts	Mitigation Measures / Best Practices	Responsibility
		other than those identified for cutting is minimum. Only ground flora/shrubs that impinge directly on the permanent works or necessary temporary works will be removed. The Contractor, under any circumstances will not cut or damage any trees. Trees identified under the project will be cut only after obtaining necessary permissions.	
9.	Disposal of debris, solid wastes and surplus excavated earth.	Contractors will collect all debris, solid wastes and surplus excavated earth; and disposed in environmentally sound manner.	Contractor
10.	Fugitive dust emissions from transportation of construction materials and operation of construction machineries	Contractor will maintain roads, which are used for transporting construction materials, equipment and machineries as practical. All vehicles delivering fine materials to the site will be covered to avoid spillage of materials. Contractor will arrange for regular water sprinkling as necessary for dust suppression from excavated area for pipeline laying.	Contractor
11.	Natural drainage in ROU	Appropriate provisions will be made to maintain natural drainage in RoU by levelling and compaction of excavated areas and restoring ground	Contractor

Sn.	Anticipated Adverse Impacts	Mitigation Measures / Best Practices	Responsibility
		surface in its original condition.	
12.	Water pollution from fuel and lubricants	Contractor will ensure that fuel/lubricants storage sites required for vehicle, machineries for pipelines laying and refuelling sites will be located at least 100 m away from river/water bodies.	Contractor
13.	Sewage discharge from camps and portable toilets	Raw sewage shall not be discharged on land or in any water body. Proper septic tanks followed by soak pits will be provided to toilets at work sites and labour camps.	Contractor
15.	Labour facilities at Work Sites	• The Contractors shall provide drinking water and portable toilets and urination facilities with septic tanks followed by soak pits for workers at works sites. • Open defecation and urination will be strictly be prohibited.	Contractor
16.	Waste Disposal at work sites	The contractor will provide garbage bins at work sites and ensure that these are regularly emptied and disposed off in a hygienic manner.	Contractor
17.	Fugitive Dust Pollution	Contractors will take every precaution to reduce the level of dust from excavated area for pipeline laying by sprinkling of water and encapsulation of dust source.	Contractor
19.	Exhaust/vehicular emission from	Contractors will ensure that all vehicles, equipment and machineries used for pipeline	Contractor

Sn.	Anticipated Adverse Impacts	Mitigation Measures / Best Practices	Responsibility
	construction vehicles, equipment and machineries	laying /construction of DRS and CNG stations are regularly maintained and confirm that pollution emission levels comply with the relevant requirements of CPCB and/ Motor Vehicles Rules. The contractor will submit PUC certificates for all vehicles/ equipment/machinery deployed for the pipeline laying.	
20.	Noise from vehicles, and pipeline laying equipment	The contractors will confirm the following: • All pipeline laying equipment and machineries shall strictly conform to the CPCB noise standards. • All pipeline laying equipment and machineries will be fitted with exhaust silencers. • Maintenance and servicing of all pipeline laying equipment and machineries will be done regularly. Use of high noise generation equipment will be stopped during the night time between 10.00 pm to 6.00 am. Working hours of the pipeline laying activities will be restricted around educational institutes/ health centers (silence zones) up to a	Contractor

Sn.	Anticipated Adverse Impacts	Mitigation Measures / Best Practices	Responsibility
		distance of 100 m from the sensitive receptors.	
21.	Personal Safety Measures for Labour	The Contractors will provide: • Necessary Personal Protective Equipment's (PPEs) like safety shoes, gumboots, hand gloves, helmets, protective goggles, ear muff, ear plug, high visible jackets, etc shall be provided to the workers employed pipeline laying and construction sites for DRS&CNG. • The Contractor will make sure that during pipeline laying and construction work for DRS and CNG stations all relevant provisions of Building and other Construction Workers (regulation of Employment and Conditions of Services) Act, 1996 are adhered to. The contractor will not employ any person below the age of 14 years for any work.	Contractor
22.	Risk Force Measure	• Contractors will make required arrangements before start pipeline laying so that in case of any mishap happens, all necessary steps can be taken for prompt first aid treatment. • Construction safety plan for pipeline laying will be	Contractor

Sn.	Anticipated Adverse Impacts	Mitigation Measures / Best Practices	Responsibility
		prepared by the Contractor, will identify necessary actions in the event of an emergency.	
23.	First Aid	Contractor will arrange the following: • A readily available first aid unit including an adequate supply of sterilized dressing materials and appliances as per the Factories Rules in every work zone. • Availability of suitable transport at all times to take injured or sick person(s) to the nearest hospital.	Contractor
24.	Informatory Signs and Hoardings on the pipeline route	The contractors will provide, erect and maintain informatory/ safety signs, hoardings written in English and local language (Hindi) during pipeline laying specially along the highway, wherever required.	Contractor
IV.	**Labour Camp Management**		
25.	Labour Accommodation for worker engaged in pipeline laying and DRS & & CNG Stations construction	Contractor will follow all relevant provisions of the Building and the other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996 for construction labour camp. The Contractor will maintain necessary living well ventilated accommodation and ancillary facilities in functional and hygienic manner.	Contractor

Sn.	Anticipated Adverse Impacts	Mitigation Measures / Best Practices	Responsibility
26.	Sanitation and Sewage System at labour camps sites	The Contractors will ensure that: • Toilets shall be provided with septic tanks followed by soak pits, • Open defecation will be strictly be prohibited.	Contractor
27.	Wastes Disposal at camps sites and work sites	The contractor will provide garbage bins in the camps and work sites; and ensure that these are regularly emptied and disposed-off in a hygienic manner.	Contractor
V.	**Operation Phase**		
28.	Sewage Treatment facilities	At CNG stations, toilets shall be provided with septic tanks followed by soak pits	AGL
29.	Wastes Disposal at DRS and CNG stations.	The contractor will provide garbage bins at DRS and CNG stations.; and ensure that these are regularly emptied and disposed in a hygienic manner as per Solid Wastes Management Rule 2016.	AGL

7.5 Safety And Environment Management Cell

7.5.1 Environmental Management Cell

AGL has full-fledge Safety and Environmental Protection Cell (HSE) at Corporate level to take care of any environmental and safety issue. It is suggested that AGL should designate one of its official for implementing EMP during construction and operation phases of the project. This official will be responsible for day-to-day environmental management and safety affairs during construction and operation phases.

7.5.2 Environmental Training

To achieve the objective of pollution control and enhance safety, it is essential not only to provide best mitigation measures but also to provide trained manpower resources to operate the same. The regular in-house training programme should cover the following:

- Fire fighting in Natural gas distribution system
- Environmental Management Plan for construction and operation phases of pipeline laying, DRS and CNG stations.
- Awareness of pollution control and environmental Management Regulations.
- Knowledge of norms, regulations and procedures related to natural gas pipelines, DRS and CNG stations.
- Occupational health and safety in natural gas distribution project.

Signature:

Email: mitesh.patel4@adani.com