Chapter 3

Baseline Environmental Status

This chapter illustrates the description of the existing environmental status of the study area with reference to the prominent environmental attributes. The study area covers the entire RJ-ON-90/1 block.

The existing environmental setting is considered to adjudge the baseline environmental conditions, which are described with respect to climate, physiography, geology, hydro-geological aspects, atmospheric conditions, water quality, soil quality, vegetation pattern, ecology, socio-economic profile, land use and places of archaeological importance. The baseline study has been carried out for three months covering continuous/weekly variations in the various domains of environment. This Report incorporates the baseline data monitored for three months period from March 2004 to May 2004 (representing summer season) and secondary data collected from various Government and Semi-Government agencies.

3.1 Study Area

The study area comprises the complete part of the retained block (RJ-ON-90/1) having an approximate area of 4,970 km^2. The entire block has been considered for the purpose of assessment of air, noise, soil quality, water quality, ecological resources and socio-economic environment.

The study area falls within the districts of Barmer and Jalore. Portion of the RJ-ON-90/1 leased block within district of Barmer is bordered by the district of Jaisalmer in the

north-west, by Jodhpur in the north-east, Jalore in the east-south east and the international border with Pakistan on the west. The block within the district of Jalore is bordered by the district Sirohi in the southeast, Pali in the east, Barmer to the west-north west and the state of Gujarat in the south west. The study area comprises of three tehsils viz. Barmer, Baitoo and Gudamalani in Barmer district and two tehsils viz. Bhinmal and Sanchore in Jalore district.

3.2 Baseline Environmental Monitoring and Agencies involved

Various specialists and reputed / credible agencies in their field of work have been engaged to carry out baseline data generation; details of the agencies are mentioned in the **Table 3.1**. NEERI as a management consultant for the preparation of the EIA and risk assessment studies has verified the data through data validation, field verifications and checks to ensure quality assurance of the data.

For the purpose of baseline ambient air quality and noise monitoring two agencies namely Vimta Labs Ltd and Enkay Enviro Services were utilized, this was done considering the vast expanse of the block and the logistics involved for air and noise monitoring.

A brief profile of the agencies involved in the baseline environmental status study for this project within the RJ-ON-90/1 block is presented below.

3.2.1 National Environmental Engineering Research Institute: (NEERI)

The Institute was established in the year 1958, as Central Public Health Engineering Research Institute (CPHERI). The Institute was renamed in 1974 as NEERI. It is recognised nationally and internationally and strives for leadership in environmental science, technology and management, domestically and worldwide. NEERI has pursued an effective R&D program in environmental science and technology to enable sustainable development for development imperatives in various socio-economic sectors. The Institute, while fulfilling its commitment towards the Societal Missions, has made significant contributions in thrust areas of R & D.

3.2.2 Regional Remote Sensing Service Centre (RRSSC)

Government of India has set-up the *National Natural Resources Management System* (NNRMS). NNRMS is an integrated approach for management of natural resources, utilizing conventional systems and remote sensing. *Department of Space* (DOS) is the nodal department in Government of India for evolution, establishment of NNRMS and all remote sensing related activities. With a view to have optimum use of space technology for national development DOS has established five RRSSCs in the country for speedy operationalization

of remote sensing as an integral component of natural resources inventory, monitoring and management. Of the RRSSCs one is located in Jodhpur (Western Region),

3.2.3 Arid Forest Research Institute (AFRI)

AFRI is situated at Jodhpur in Rajasthan, is one of the institutes of the *Indian Council of Forestry Research & Education* working under the *Ministry of Environment & Forests*, Govt. of India. The Objective of the Institute is to carry out scientific research in forestry in order to provide technologies to increase the vegetative cover and to conserve the biodiversity in the hot arid and semi arid region of Rajasthan, Gujarat and Dadara & Nagar Haveli union territory.

3.2.4 Vimta Labs

Established in 1984, Vimta Labs is a leading provider of multi-disciplinary contract research and testing services in India, with international quality systems, world class infrastructure and expert human resources. It has won many International accreditations and Quality certifications such as ISO/IEC 17025-1999. Among its credentials are

- It is recognized by the Ministry of Environment and Forest
- It has valid Certificates of Accreditation from National Accreditation Board for Testing and Calibration Laboratories (NABL), Department of Science and Technology, India for chemical, biological and mechanical testing.

3.2.5 Environmental Resources Management (ERM)

ERM is a multinational environmental and socio-economic consulting group working with clients, government agencies and multi-lateral donor agencies to develop sustainable solutions to the wide range of environmental and social problems arising out of development initiatives across the world. ERM India is a subsidiary of ERM Inc, USA.

3.2.6 Enkay Enviro Services (EES)

EES is located in Jaipur, very active locally in carrying out EIA studies and environmental monitoring. The organisation is involved in a wide range of environmental and pollution related projects.

3.3 Monitoring of Environmental Attributes

The methodology to study the baseline status of various environmental components is highlighted in **Table 3.2**.

The reports generated by the said agencies referred to in **Table 3.2** have been compiled and presented as **Volume 2** which can be referred for further details. Summary of the study reports are presented in this chapter.

The secondary sources utilized in generating the data regarding the general features of the area, geology, hydrogeology, land use, ecology and demography are given in **Table 3.3**.

3.4 Environmental Setting of RJ-ON-90/1 block

The environmental setting of the RJ-ON-90/1 block is discussed under the following heads:

- Physiography, Climate, Geology & Hydro-geological Aspects
- Land environment
- Air environment
- Noise quality
- Water environment
- Biological environment
- Socio-economic environment

Each of these topics is discussed summarily in this chapter. The details of which are presented in **Volume 2**.

3.4.1 Physiography

The study area covers parts of Barmer, Bytoo and Gudha Malani Tehsils of Barmer district, Sanchore and Bhinmal Tehsils of Jalore district. In general the topography of study area covering entire RJ-ON-90/1 is plain. There are no major perennial watercourses flowing through the study area. There are several ephemeral tanks. From the drainage study of the area it can be concluded that the drainage pattern is dendritic to sub

dendritic in nature. The outcrops exposed in the study area indicate a general strike direction of NE-SW. The study has only one integrated drainage system, namely Luni river which is seasonal in nature.

3.4.2 Climate

The study area lies in semi and transitional zone between desert in the West and the Aravali range towards East and has a dry climate, somewhat milder than other adjoining western areas. The winter season is from December to February. The average maximum and minimum temperature is 48.9 °C and -1.7 °C respectively. The monsoon sets slightly late and monsoon period from late June to October. The normal annual rainfall is 255.5mm (source: Indian Meteorological Department, Barmer).

3.4.3 Geology

The block RJ-ON-90/1 is located in the Barmer Basin, part of a north-northwest trending rift system running up from offshore of the Mumbai area. The rift is a northward extension of the Cambay Basin or graben. It is bounded to the east and west by the Malani Group, principally rhyolite with some granite and sediments, of Late Proterozoic age. The graben is floored by rocks of the Malani Group which is in turn underlain by Precambrian basement and in part overlain by basalts (inferred Cretaceous Deccan Traps) and Mesozoic sedimentary rocks (possibly Jurassic Lathi Formation). On top of these lies a thick succession of Tertiary (Palaeocene and Eocene) sandstones, claystones and lignites that were deposited in a predominantly fluvio-deltaic and marginal marine environment. Alluvium and aeolian deposits of Quaternary to Recent age drape nearly all of the Tertiary formations, except for isolated areas located in the north of the block. Table below presents the main geological units in the basin.

Lithostratigraphic units of the Barmer Basin Formation

Formation	Unit	Thickness	Lithology
Akli Formation & younger		0->1,000 m	Shales and lignites; sands in Miocene
Thumbli Formation / Tertiary Sandstone	Thumbli Sand	250-600 m	Sand and semiconsolidated sandstones with interbedded shales.
Thumbli Formation / Tertiary Sandstone	Thumbli Shale (locally absent)	0-300 m	Shale
Dharvi Dungar Formation		200-1,200 m	Shales, locally carbonaceous, rare sands
Barmer Hill Formation		100-1,000 m	Shales and siltstones
Fatehgarh Formation		50-400 m	Sandstones and shales
Basement			Rhyolites and granites

The principal geological unit which will be assessed in this study is the Thumbli Formation, which is essentially identical to the Tertiary Sandstone unit of GWD publications. In the vicinity of Mangala and Aishwariya, the Thumbli Formation subcrops beneath a blanket of dune sand. The formation deepens towards the south where it is overlain by sediments of the Akli Formation and younger strata. The base of the Thumbli rests unconformably on the Dharvi Dungar Formation.

Geologically this is a stable zone and the area has not recorded any major seismic activity.

3.4.3.1 *Shallow Geology*

The soils are predominantly derived from alluvium and are covered by thick wind-blown sand in arid sectors of the study area. The soils of the area can be classified as follows:

- Sandy soil (thal) covering approximately ¾ of the study area.
- Sandy clay (nayar) which can be salt impregnated.
- Patches of deposited loam near river beds.
- Accumulated deposits (par) at the foot of limestone ridges.

The last two classes of soil are very suitable for agriculture and can produce up to two crops per year, sometimes without irrigation.

3.4.4 Hydrogeology

The principal source of recharge to ground water in Rajasthan is rainfall. In canal irrigated areas, a part of canal water through seepage from conveyance system and part of water i.e. utilised for irrigation also returns to ground water and contributes to storage.

For broadly grouping geological formations from ground water occurrence & movement considerations, the various lithological units have been classified into two groups on the basis of their degree of consolidation and related parameters, these are:

I Porous formations

(a) Unconsolidated formations

(b) Semi- consolidated formations

II Fissured formations

(a) Consolidated sedimentary rocks

(b) Igneous and metamorphic rocks

(c) Volcanic rocks

(d) Carbonate rocks

3.4.4.1 Porous Formations

The Quaternary sediments comprising younger as well as older alluvium are the most important unconsolidated formations due to their wide-spread occurrence. The sediments are composed of clay, silt, sand, gravel and mixture of concretions etc. Sand, gravel and admixture of these form the potential aquifers in northern, eastern, north-eastern, western and south-western parts of the state.

The semi-consolidated formations belonging to Palaeozoic, Mesozoic and Cainozoic Groups are composed of siltstone, claystone, sandstone, shale, conglomerate and limestone. Sandstones and limestones form the main aquifers in Barmer, Jaisalmer, Jodhpur, and Bikaner districts. Sandstones of Lathi formation are the most potential aquifers in the districts of Barmer, Jaisalmer and Jodhpur.

3.4.4.2 Fissured Formations

Fissured formations, as hydrogeological unit, occupy 32 % area of the state and can be broadly classified into four units.

Consolidated sedimentary rocks, excluding carbonate rocks, include sandstones and shales. In eastern and south-eastern part of the state these belong to Vindhyan Supergroup whereas in western Rajasthan these belong to the Marwar Supergroup.

Igneous and metamorphic rocks of lower Proterozoic age comprise slate, quartzite, phyllite, schist, gneiss and various crystallines of Bhilwara Supergroup. These are mostly found in the districts of Barmer, Nagaur, Churu, Jaisalmer, Pali, Jalore, Sirohi and Jodhpur districts in western Rajasthan.

Volcanic rocks include Deccan Trap Lava Flows and occur in parts of Barmer, Jhalawar, Chittorgarh and Banswara districts. These are basaltic to doleritic in composition. Occurrence and movement of ground water in these fromations is controlled by the presence of vesicles, extent of weathering, jointing and fracture pattern.

Carbonate rocks include limestone, marble and dolomite of Proterozoic and Upper Palaeozoic to Mesozoic age and occupy parts of Kota, Bundi, Jaipur, Sawai Madhopur and Alwar districts on the eastern side of Aravallis and parts of Nagaur, Bikaner,

Jaisalmer and Jodhpur districts in western Rajasthan.Occurrence and Movement of Groundwater in Rock Formations

This area lies in the belt of arid region. The occurrence and movement of ground water is controlled by the topography and the physical characteristics of the rocks occurring in the area. Based on the topographical features the groundwater movement appears to be from central part towards periphery of study area. The study area is classified into four hydrogeological zones. The zones are presented in **Table 3.5**.

The study area is mostly characterized by Zone III and IV. The aquifer in the study area are mostly brackish with pockets of sweet water in confined aquifers. The aquifer in the study area is estimated to be 100-150 m3 per day. The Rajasthan State Ground Water Board (RGSWB) has been carrying out monitoring of various groundwater wells including the depth to groundwater in the study area falling in Jalor and Barmer district.

As part of the saline water sourcing study, extensive survey coupled with seismic data interpretation and well-log study has been done for the areas around the development sites. The details may be referred in the **Water Sourcing Study – Phase-1 report.**

3.4.5 Depth of Groundwater

Depth to water between 20 m to 100 m is mostly observed in areas located to the west of Aravalli ranges covering Barmer, Jalore, Jhunjhunu, Sikar, Nagaur, Churu, Jaisalmer, Sirohi, Jodhpur, Bikaner, Jaipur, Hnumangarh and Dausa districts.

3.4.6 Groundwater Potential

The main geological formation of the study area is younger alluvium. Groundwater occurs generally under semi-confined conditions in the unconsolidated older alluvium and semi confined to confined in the younger alluvium.

Groundwater potential has been assessed as per the data collected from State Groundwater Department and Irrigation Department. In study area from North-East to South, the yield of wells ranges between 30 m3/day to 90 m3/day. Thus, this area can be developed by means of dug-wells of 15 to 20 meters depth. In study area from North to South West, yield of wells ranges between 40 m3/day to 90 m3/day with dug wells of 15 to 25 m depth.

3.5 Land Environment

3.5.1 Land Use / Land Cover

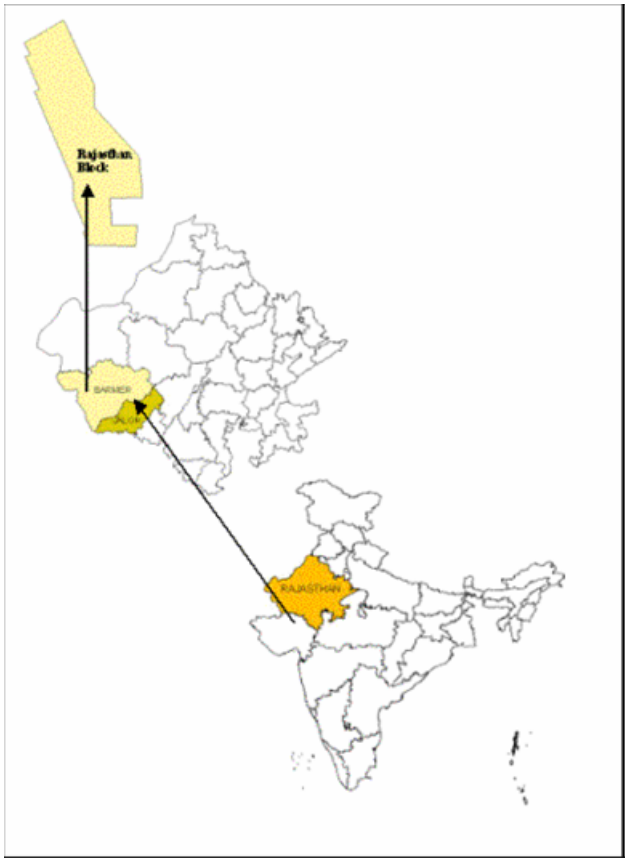
Studies on land use aspects of eco-system play an important role in identifying sensitive issues and to take appropriate action by maintaining 'Ecological Homeostatics' in the past and present development of the region. The objective of this section is to define the present environmental status and evaluate the potential impacts from the proposed developmental activities.

The land use / land cover study was carried out by Regional Remote Sensing Service Center (RRSSC), Jodhpur, using satellite imagery for 3 seasons namely kharif, rabi and summer.

3.5.1.1 Objectives

The objectives of land use studies are:

- To determine the present land use pattern;
- To analyze the impacts on land use due to proposed appraisal project activities in the study area; and
- To give recommendations for optimizing the future land use pattern vis-à-vis growth of proposed appraisal project in the study area and its associated impacts.



Location of Project Area

3.5.1.2 Methodology

Satellite imagery based on hybrid (visual and digital) classification of RESOURCESAT (IRS-P6) AWiFS standard False Colour Composite (FCC) were used for interpretation of landuse / land cover.

Satellite Data: The basic satellite data chosen for the study corresponds to RESOURCESAT-1 (IRS-P6) AWiFS multispectral data for three seasons. The scale of the final maps prepared is 1:250,000. The images, as mentioned below have been procured and used for land use / land cover study in order to understand the variations in the seasonal land use in the study area.

Sl. No.	Season	Date of Image
1	Kharif	December 3, 2003,
2	Rabi	February 22, 2004
3	Summer	April 25, 2004

3.5.2 Land Use/Land Cover Estimation

Land use / land cover study was carried out based on the classification described in the Manual of Nationwide land use / land cover mapping using satellite imagery Part-I, National Remote Sensing Agency, 1989.

The land use / land cover estimation for the study area is presented in the **Table 3.6** and in **Figs. 3.1** & **3.2**.

3.5.2.1 Built-Up Land

The major categories discernible on the satellite data in the study area includes Residential, Mixed Residential, Roads, Rail etc. The residential areas (settlements), Road and Rail confined within the study area estimated is 34.48 km^2 (0.69 %). The others category which is similar to built-up area is estimated as 21.24 km^2 (0.43 %).

3.5.2.2 Agricultural Land

The cropland is the maximum land use category found in the study area i.e. 2485.85 km^2 (50.01%) which includes area under Kharif, Rabi and Summer crop. In the study area it observed that the extent of the summer crop area belongs to Rabi season crop also i.e. summer crop area is double crop area (Rabi + Summer). The fallow land and fallow with shrub area observed are 691.5 km^2 (13.91 percent) and 139.02 km^2 (2.80 percent) respectively.

The major crops grown in Khairf season are Bajara, Gwar, Mung, Moth, Til and in Rabi season Jeera, Isabgol and Wheat crop are cultivated where as in Summer vegetables and plants for fodder are cultivated. The cropped area appeared red in colour on the satellite imagery. The fertile soil and ground water availability in south of the study area near Gandhav and Gudamalani village has contributed substantially to the practice of Rabi and Summer crop cultivation in the study area.

3.5.2.3 Wastelands

The wastelands type identified in the study area is sand dunes, land with / without scrub and temporary waterlogging. The total area under wasteland category estimated is 1552.48 km^2 (31.24 %) of the total study area.

3.5.2.4 Sand Dunes

Sand dunes and inter-dune areas in Rajasthan desert are easily identifiable. In the present study area under this category area estimation is 1351.62 km^2 (27.21%). This the second major category found by area in the study area.

3.5.2.5 Land with scrub and land without scrub

In the study area land with/without scrub area estimated is 198.42 km^2 (3.99%).

3.5.2.6 Waterlogged land

It occurs in river plains, coastal lowlands along canals in association and proximity to flood plains, coastal marshes/swamps, tidal-flats, grounds near canal with water seepages etc. In the study area a very small patch of temporary waterlogging is seen which covers 2.44 km^2 (0.05%).

3.5.2.7 Water bodies

Rivers, drains and tanks are the important waterbodies seen in the study area. The river exists in the study area are Luni, Sukri and Sagi . Some Tanks / Ponds were also seen towards north of Barmer town and near Uttarlai town. The Narmada canal construction is seen in south-west of the study area near Gandhav village. The spatial extent under water body is 38.97 Sq. km. (0.78%).

The river water body is found dry in the rabi season and the area for the same is classified as ‘river sand’ which is 33.8 km^2 (0.68%) of the total study area.

3.5.2.8 Plantations

In the study area few places (near Kawas and Khudala) plantations are also observed. The area found for this category is 4.43 km^2 (0.09%).

3.5.2.9 Mining

In the study area Malani rhyolite rocks are exposed at places in Barmer District. Due the availability of this kind of rock (for building stone), the mining activity is going on near Saranu village. In the study area this category covers an area of 1.93 Sq. km. (0.04%).

3.5.2.10 Forest

There are no reserved forest areas within the block, there are a few patches of protected and unclassified forest areas.

3.5.2.11 Industrial Area

There are five industrial areas in Barmer district namely Balotra, Barmer, Barmer (Automobile), Mokalsar and Samdari. However, there are no demarcated and / or designated industrial areas or industrial development zones within the study area.

The major land cover of the study area is under kharif crop land i.e. 1856.48 km^2 (37.35%) followed by dunes i.e. 1351.62 km^2 (27.20%) of the total study area. The study area belongs to Arid and Desert region hence the major agriculture activity depends on the rains.

3.6 Soil Quality

The reconnaissance revealed that the land around the proposed development sites is dominated by open grassland or by grassland interspersed with trees ad thorny bushes. The major crops in this area are pearl millet, mungbean, moth, til and gaur.

Agriculture is the main source of livelihood besides livestock rearing. The common crops grown in the region include wheat, bajra, zeera, isabgol.

3.6.1 Selection of Soil Sampling Location

For studying soil profile of the region, sampling locations were selected to assess the existing soil conditions around the project area representing various land use conditions. The physical, chemical and heavy metal concentrations were determined along with biological parameters. The samples were collected by ramming an augur into the soil upto a depth of 100 cm. The soil samples were collected during the period 19th March – 26th March 2004, which represents Pre-monsoon season. The sampling locations have been identified with the following objectives:

1. To determine the baseline soil characteristics of the study area; and
2. To determine the impact of proposed project on soil characteristics.

The soil samples were collected from 38 locations covering various landuses namely agricultural fields (37%), barren lands (21%) and sandy areas (42%). Refer location map for soil quality sampling locations **Fig. 3.3**.

3.6.2 Analytical Results

The soil samples fall in the sandy loam type soil textural class. The results of the soil analysis are presented in the **Table 3.7**.

3.6.3 Soil Microbiology

Various ecological cycles in rhizospheric zone of the plant depend upon micrological population. Soils contain a wide variety of microorganisms which include organic matter decomposers, nitrogen fixers, element oxidizers and reducers. They contribute to the chemical and physical properties of the soil. The fertility of soil is basically determined by microorganisms.

The microbial content of the soil was determined by employing the pour plate method. This method involves dispersion of the soil suspension on suitable agar medium wherein each viable microorganism present in the soil, upon incubation develops into discrete and macroscopically visible colonies. The necessary degree of dispersion is usually achieved by making successive dilution of a given soil sample.

The microbial flora analysed included the total viable count (TVC), organic matter decomposers (Fungi), symbiotic nitrogen fixer (Rhizobium), nonsymbiotic nitrogen fixer (Azotobacter) and the Actinomycetes which besides fixing nitrogen, aid in maintaining the nutrients in available forms in rhizospheric zone. The characteristics of soil microorganisms are presented in **Table 3.8**.

3.6.4 Baseline status

3.6.4.1 Physical Parameters

It was observed that the soil in the study area is predominantly of Sandy loam type, sand in the soil samples varied between 70 and 88 %, silt varied between 4 and 12 % and clay between 7 and 19%.

Porosity varied between 23.2 and 41.8 % and infiltration rate varied between 6.6 and 10.2 cm/hr. The water holding capacity varied between 9.4 and 35.8 %. The results of these parameters suggest that due to the sandy nature of the soil the permeability / hydraulic conductivity of water in this soil is high.

The pH of the soil ranged from 7.6 to 9.2, indicating that the soil is neutral to moderately alkaline in nature. The Electrical Conductivity is observed to be in the range of 176–1235 μmhos/cm.

3.6.4.2 Chemical Parameters

CEC varied between 9.3 and 15.8 me/100g and ESP varied between 0.71 and 6.51 %. CEC of the soil is in the moderate range and ESP is between very low to low range.

Nitrogen in the soil ranged between 3.5-7.7 kg/ha, Phosphorus between 5.2–17.1 kg/ha and Potassium between 10.3-39.7 kg/ha. Although the nutrients (NPK) are reported to be very less to less, the soils are reported to be generally good for cultivation after application of organic and inorganic fertilizers.

Of the eleven metals analysed for only iron, manganese and zinc were detected. Iron ranged between 7013 and 10700 mg/kg, manganese varied between 48 and 68 mg/kg and zinc varied between 25.6 and 121.8 mg/kg.

3.6.4.3 Biological Parameters

The soil in the study area was observed to be moderately to highly productive. The total viable count was in the range 89 x 10^5 to 139 x 10^6 CFU/g of soil. The *Rhizobium* population varied in the range of ND to 12 x 10^3 per gram of soil and *Azotobacter* was observed in the range of 2 x 10^3 to 20 x 10^3 per gram of soil. However fungal population was found in the range of 6 x 10^3 to 23 x 10^3 per gram of soil and Actinomycetes were detected in the range of ND to 12 x 10^3 CFU per gram of soil.

Overall it can be inferred from the results that the soils within the study area is of sandy nature with high permeability / hydraulic conductivity, low NPK ratio i.e., low fertility and moderate to highly productive microbial population.

3.7 Air Environment

3.7.1 Meteorology

The methodology adopted for monitoring surface observations is as per the standard norms laid down by Bureau of Indian Standards (IS: 8829) and India Meteorological Department (IMD). On-site monitoring was undertaken for various meteorological variables in order to generate the site-specific data. The generated data is then compared with the meteorological data generated by IMD. Secondary information on meteorological conditions has been collected from the nearest local observatory of IMD at Barmer and analyzed.

3.7.2 India Meteorological Department - (Barmer)

India Meteorological Department has been monitoring surface observations at Barmer. Pressure, temperature, relative humidity, rainfall, evaporation, wind speed and direction are measured twice a day viz., at 0830 and 1730 hr. The wind speed and direction data of IMD, Barmar station has been obtained for 10 years. Data on Cloud cover is compiled form the climatological tables for the IMD station at Barmer.

3.7.2.1 Analysis of the Data Recorded at IMD- Barmer

Temperature

The winter season starts from December and continues till the end of February. January is the coolest month with the mean daily maximum temperature of 25.4^{0}C and the mean daily minimum temperature of 10.6^{0}C. Both the night and day temperatures increase rapidly during the onset of the pre-monsoon season from March to May. During pre-monsoon season, the mean maximum temperature (May) was observed to be 42.0^{0}C with the mean minimum temperature at 26.7^{0}C. The mean maximum temperature in the monsoon season was observed to be 40.3^{0}C in the month of June whereas the mean minimum temperature was observed to be 24.6^{0}C in the month of September. By the end of September, the day temperatures increase slightly, with the mean maximum temperature at 36.8^{0}C in the month of October and the night temperature decrease with the mean minimum temperature at 12.1^{0}C in the month of December.

Relative Humidity

Generally the weather during most parts of the year is dry except during the monsoon when the average relative humidity at 0830 hr. is 74.5% with a maximum and a minimum of 79% and 67% respectively. Similarly, at 1730 hr., the average value was observed to be 46% with the maximum and minimum values of 54% and 34% respectively. Generally the weather during other seasons was observed to be dry.

Rainfall

Rain clouds deposit most of their moisture on the high ranges in Kathiawar in Gujarat or on the slopes of the Aravalli range. A record of the rainfall in the Barmer district is available from nine stations spread around the Barmer district. The average annual rainfall in 1995 in the Barmer district was 275.9 mm. The rainfall decreases towards the west of Barmer. Siwana near the eastern border of the Barmer district received 207.6 mm of rain. About 92 % of the rainfall occurs during the months from June to September. The variation of rainfall from year to year is very large. Rainless years or years with extremely scanty rainfall are not unknown particularly in the western part of the district. The average

number of rainy days (days with rainfall of 2.5 mm or more) in a year is 16.5. (Data Source: Climate of Rajasthan Indian Meteorological Department).

In the study area greatest cloud cover is in July and August, at the height of the southwest monsoon season. Cloud cover is significantly reduced in the winter from November to April. There is no variation in cloud cover according to the time of day. During the rest of the year skies are clear or lightly clouded.

The average annual rainfall based on the 30 years (1951-1980) IMD data, was observed to be 314 mm. The monsoon sets in the month of June and continues till mid October. The maximum amount of rainfall (112.5 mm) occurs in the month of August. The maximum numbers of rainy days were observed in July.

Cloud Cover

During the winter and the pre-monsoon seasons, it was observed that the skies are generally very clear. In the post-monsoon season, generally light clouds were observed in the evenings, with clear mornings. During the monsoon season, both in the mornings and evenings, the skies were found to be clouded.

Wind Speed/Direction

Generally light to moderate winds prevail throughout the year. Winds were light and moderate particularly during the morning hours. While during the afternoon hours the winds were stronger. The season wise discussion of the respective wind roses is given hereunder:

A) Annual Wind Pattern:

A review of the wind rose diagram shows that predominant winds are mostly from SW and NE direction followed by W and NW direction**.**

Predominant winds from SW direction were observed for 13.5% of the total time, with wind speeds and frequencies in the range of 1.0-5.0 kmph (8.8%), 5.01-11 kmph (3.3%) and 11.01-19 kmph (1.0%). Whereas in NE direction the winds were observed for 10.6% of the total time with wind speeds and frequencies in the range of 1.0-5.0 kmph (7.1%), 5.01-11 kmph (3.2%) and 11.01-19 kmph (0.3%). The calm conditions prevailed for 52% of the total time.

3.7.3 On-site Meteorology

The meteorological data recorded during the monitoring period is very useful for proper interpretation of the baseline information as well as an input for prediction models

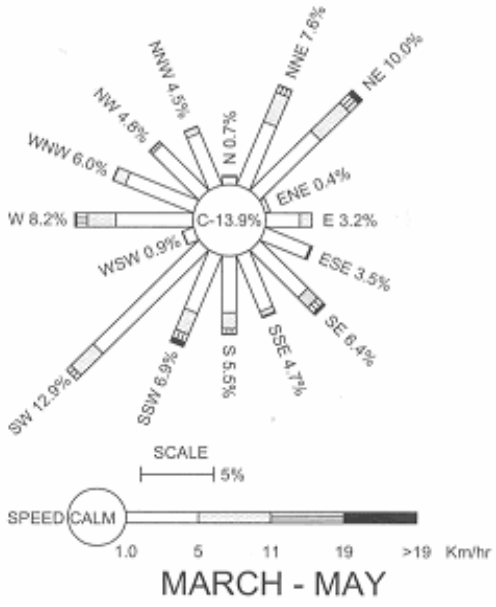
for air quality dispersion. Historical data on meteorological parameters also plays an important role in identifying the general meteorological regime of the region.

On-site monitoring was undertaken at two locations for the following meteorological variables for the summer season (March and June):

1. Wind Speed
2. Wind Direction
3. Temperature
4. Relative Humidity
5. Cloud Cover
6. Rainfall

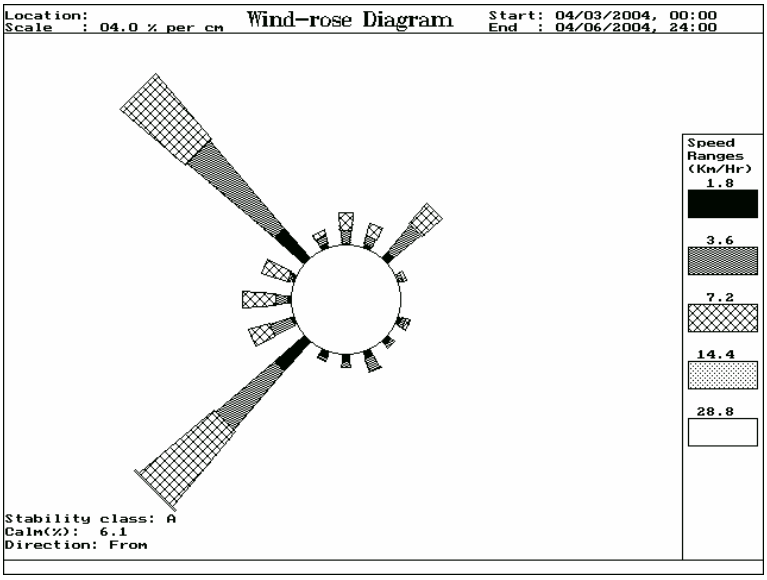
Micro-meteorological data was collected at two met stations established at Kawas and Malion Ki Dhani between March and May 2004 using automatic data logging equipment. The continuous recording meteorological instrument of Dynalab, Pune (Model No.WDL1002) has been used at these locations

In the meteorological station at Kawas in the northern portion of the block, it was observed that the temperature varied between 14.3 °C to 44.1 °C. Relative humidity varied from 23% to 56% and rainfall was observed to be 3.2 mm. The maximum and minimum cloud cover was 6/8 octas and 0/8 octas respectively. During most of the time, cloud free sky was observed. A switch over in wind direction from N-E sector to S-W was observed from March to May. The predominant wind directions were SW and NE with frequencies 12.9% and 10% respectively. Site specific windrose for Kawas monitoring station is presented below:



In the meteorological station at Malion Ki Dhani for monitoring central to southern portion of the block, it was observed that the temperature varied between 9.6 °C to 53.3 °C. Relative humidity varied from 23.4 % to 67.3%. Rainfall was not observed. The most predominant wind directions observed were NW & SW with frequency recording of 27.4% and 24.7% respectively.

Site specific windrose for Maliyon Ki Dhani monitoring station is presented below:



The variation in the temperature, wind direction and speeds ma be attributed to the land topography and landscape conditions.

3.7.4 Ambient Air Quality Monitoring

3.7.4.1 Selection of Sampling Locations

The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality monitoring network and is based on the following considerations:

1. Meteorological conditions on synoptic scale;
2. Topography of the study area;
3. Representatives of background air quality for obtaining baseline status; and
4. Representatives of likely impact areas.

Ambient Air Quality Monitoring (AAQM) stations were selected based on reconnaissance survey jointly conducted by CEIL and the agencies involved. AAQ

monitoring stations were set up at 39 locations with due consideration to the above mentioned points and as per the MoEF guidelines. 62% of the sampling locations were established in rural / residential area, 28% in rural/ residential area, near SH, and 10% in commercial area, near NH. Majority of the sampling locations were established in rural areas, where habitation is concentrated, in order to predict the impact of the developmental activities on these communities.

Monitoring was conducted for a period of three months i.e. from March 1 to May 31, 2004 representing summer season. (Refer location map for ambient air quality sampling locations **Fig. 3.4**.)

Monitoring and analysis has been carried out as per standard methods specified by Central Pollution Control Board (CPCB), IS: 5184 and American Public Health Association (APHA).

3.7.4.2 Baseline Status

The SPM concentrations varied between a minimum of 63.4 and maximum of 230.5 $\mu g/m^3$, 98^{th} percentile and arithmetic mean varied in the range of 95.6-223.4 $\mu g/m^3$ and 81.3-185.7 $\mu g/m^3$ respectively.

The RSPM concentrations varied between a minimum of 13.1 and maximum of 104.8 $\mu g/m^3$, 98^{th} percentile and arithmetic mean varied in the range of 39.1-104.6 $\mu g/m^3$ and 23.6-76.0 $\mu g/m^3$ respectively.

The SO_2 concentrations varied between a minimum of 2.9 and maximum of 11.5 $\mu g/m^3$. 98^{th} percentile and arithmetic mean of SO_2 varied in the range 5.3-11.4 $\mu g/m^3$ and 5.0-8.5 $\mu g/m^3$ respectively.

The NO_x concentrations varied between a minimum of 5.6 and maximum of 15 $\mu g/m^3$. of 98th percentile and arithmetic mean of NOx varied in the range of 5.09-14.9 $\mu g/m^3$ and 4.9-13.6 $\mu g/m^3$ respectively.

The CO concentrations varied between a minimum of 0.011 and maximum of 0.64 $\mu g/m^3$. 98th percentile and arithmetic varied in the range of 0.025-0.600 $\mu g/m^3$ and 0.020- 0.431 $\mu g/m^3$ respectively.

The HC concentrations varied between a minimum of 1.0 and maximum of 1.6 $\mu g/m^3$. 98th percentile and arithmetic varied in the range of 1.1-1.60 $\mu g/m^3$ and 1.0-1.5 $\mu g/m^3$ respectively.

The baseline ambient air quality status, variation in the monitored parameters is presented in the **Table 3.9**.

In majority of the samples, RPM and SPM are well within the standard set by CPCB, however in certain cases they have exceeded the limit. The exceedence is attributable to the dust storms (known locally as aandhi or loo) which prevailed during the sampling period. Sulphur dioxide and oxides of nitrogen are well within the set standards.

3.8 Noise Environment

The main objective of noise monitoring in the study area is to establish the baseline noise levels, and assess the impact of the total noise generated by the exploratory well drilling activities in the surrounding environment.

The noise monitoring has been conducted for determination of noise levels at 57 locations, covering various landscapes, in the study area. Of these sampling locations 65 % were located within rural / residential areas, 26% in commercial areas and 9 % in sensitive areas. The noise levels at each location were recorded for 24 hours. (Refer **Fig. 3.5** for noise sampling locations.)

3.8.1 Baseline Noise Levels

3.8.1.1 Day time Ambient Noise Levels (Lday)

Residential zone: The day time noise levels at few locations are exceeding the prescribed limit of 55 dB (A) because of these locations are either near to national highway or heavy traffic. The noise levels ranged between 44.7 to 61.9 dB (A). The maximum value 61.9 dB (A) was recorded at Bhatala and the minimum value 44.7dB (A) was recorded at Nimbaniyon ki dhani.

Commercial zone: The daytime noise levels at few locations are exceeding the prescribed limit 65 dB (A) because of these locations are very near to heavy traffic. The noise levels ranged between 55.1 to 73.4 dB (A). The maximum value 73.4 dB (A) was recorded at Barmer (Near AAQ station) and the minimum value 55.1 dB (A) was recorded at Gangasar.

Sensitive Zone: The noise levels ranged between 48.1 to 56.1 dB (A). The maximum value 56.1 dB (A) was recorded at Shivkar and the minimum value 48.1 dB (A) was recorded at Bhurtiya.

3.8.1.2 Night time Ambient Noise Levels (Lnight)

Residential Zone: The night time noise levels ranged between 33.1 to 50.5 dB (A). The maximum value 50.5dB (A) was recorded at Bhatala whereas the minimum value 33.1 dB (A) was recorded at Mangna ki dhani.

Commercial Zone: The night time noise levels ranged between 39.3 to 61.74 dB (A). The maximum value 61.74 dB (A) was recorded at Gudamalani (Commercial) and the minimum value 39.3 dB (A) was recorded at Gangasar.

Sensitive Zone: The noise levels ranged between 37.4 to 44.9 dB (A). The maximum value 44.9 dB (A) was recorded at Shivkar and the minimum value 37.4 dB (A) was recorded at Bhurtiya.

The noise levels represent the typical rural environment except in the villages which are nearer to the state highway and national highways and other roads where noise levels found to be higher due to the traffic movement.

3.9 Water Environment

3.9.1 Surface Waters

Surface water resources are limited within the study area. Availability of water resources in Rajasthan is related to the fluctuations of the weather and the river systems. Irrigation is limited by the scarcity of water, and has traditionally been restricted to deep wells and rainwater harvesting systems.

The most important river is the Luni, which runs through the study area. The other two major rivers in the study area are the Sagi and Sukri, which are tributaries of Luni. The river Luni originates near Ajmer and flows through a distance of approximately 320 km covering a total catchment area of 34,250 km^2 before draining into the Rann of Kutch. The catchment area covers the districts of Jodhpur, Nagaur, Barmer and Jalor. At the peak of the monsoon when the flow in the river is high, the water stream is often not able to cut through sand deposits on the river bed which results in the run off spreading to the adjoining fields on both the banks of the river. The unique characteristic of river Luni is that its water is fresh as far as Balotra, beyond which the water of the river becomes brackish. Finally around the edge of the Rann of Kachcch, the river water becomes concentrated brine. The study area is mostly within the brackish aquifer zone.

The river Jawai traverses from the northwest to the southwest of the district of Jalor. Near the village of Saila, it joins the river Khari and the two flow under the name of Sukri and ultimately join the Luni at a point between Guda and Gandav. The channel of Sukri river flowing through the study area was observed to be dry.

The river Sagi originates in the Sunda hills. It becomes a reasonably fast stream when it reaches the Bhinmal tehsil, to the southeast of the study area. The Sagi River joins the river Luni after traversing further south.

In addition to the above there are a few nullahs or seasonal streams, which flow for some distances and then disappear in the expanse of the sandy terrain. All the rivers rise in the hills in the eastern and southeastern part of Rajasthan, and flow westwards. Most of the rivers have changed their course with time, mainly as a result of heavy siltation. During the monsoon the water current in the river cuts the banks and braided channels are formed along the banks.

The rivers are seasonal and flow only during rainy season. In 1979 and 1990, there were very heavy rains in certain pockets of Rajasthan, and the Luni river flooded, causing considerable damage. For most part of the year the river Luni remains dry and gets some water during the rainy season.

3.9.1.1 Drainage Pattern

The drainage pattern of the study area is governed by the river Luni, the river Sukri and the river Jawai . River Luni its numerous tributaries from the Aravallis, like the Lilri, the Guhiya, the Bandi, the Mithri, the Sukri, the Jawai etc join during the course of its journey to the Run of Katch. All these rivers are ephemeral and have wide sandy beds. In addition, tributaries from the isolated hills and rocky uplands in the plain also contribute to the flow of Luni River. All these streams register some flow only during good monsoon rains. All these streams are responsible for the formation of the alluvial plains through which they flow and provide a reasonably good drainage system.

3.9.1.2 Water Bodies and Traditional Water Harvesting

The people of the Barmer District, reside in scattered settlements (dhanis) where sand dunes, interdunal plains and undulating sandy plains are the dominant land forms. In this area, the traditional techniques of rainwater harvesting provide convenient, moderately clean and sweet water for drinking which eliminates the need to search for water in the hot months.

The forms of surface water bodies that are prevalent in the study area are nadis, talab, johad, bandha, sagar, samad, tanks and lakes. Rajasthan can be divided into two areas:

1. One which has rainwater (or the palar water); and
2. Second which has the availability of groundwater (or wakar water).

The study area is essentially in the wakar belt for the Jalore district while in the Barmer district it is dependent on rain water (palar belt). Certain areas within the study area known as Par were observed in the Sanchor tehsil of Jalor and Gudamalani tehsil of Barmer. Par is an area where the flowing water accumulates and seeps into the earth. Wells are dug

in the par region to get sweet water. A par area is identified by the vegetation that grows in the area.

Traditionally there have been a lot of manmade efforts to harvest water in the region. Tankas are one of such efforts and is very common in the area within the Barmer district. A tanka is the rooftop harvesting of rainwater. The rainwater is collected in the rooftop and is taken through pipes to the underground tank built within the main house or in the courtyard. The Barmer region also has kunds, which are underground storage system of rainwater harvested during the monsoon. The Rajasthan government has lately started promoting kunds for minor irrigation and drinking water. In some parts of Dhorimanna block and in other arid tracts of the Gudamalani, and Sanchore tehsil, kunds were noticed during the field visit. However, the kunds were not so common in the Jalor district.

There are certain village ponds or nadis in the Sanchor tehsil. It was observed that the village ponds or nadis, which are used by the local people for cleaning and drinking purpose, were generally dirty and unfit for drinking. Local people reported that nadis, are de-silted before the onset of the monsoon and fresh water is collected for usage during rest of the year.

The water supply situation has been changing over the last three decades. Previously while most of the houses used pond water, the percentage of households using well water has increased in the past few years because of the increasing number of dug wells constructed with the help of loans provided by the government. It was observed that in the agricultural fields in Jalor district most of the Dhani owners had their own supply of well water. However due to existing drought condition during the dry months some of these wells were non-functional.

3.9.1.3 Water Resources

This region receives very low rainfall and groundwater potential is very limited. Ground water resources are used for drinking and irrigation purposes. Therefore, due to heavy extraction of groundwater in some of the region and its limited recharge, the groundwater is getting depleted at a fast rate.

The region can be classified into four hydrogeological zones. The aquifers in the study area are mostly brackish with packets of sweet water in confined aquifers. The groundwater in many parts of the block especially in the north-western part of Barmer district is saline and has very limited suitability for drinking or agricultural use. However, in south- western region of the block, dugwells are used for irrigation.

There is no perennial river in the block hence water quality assessment was limited to ground water monitoring.

3.9.2 Water Quality

Selected water quality parameters of ground water resources within entire RJ-ON-90/1 block have been studied for assessing the water environment and evaluate anticipated impact of the proposed project.

The information required for the above assessment and evaluation has been collected through primary surveys and such as Ground water board and Dept. of Mines and Geology. The monitoring locations were decided based on:

- Drainage pattern;
- Location of residential areas representing different activities/likely impact areas; and
- Likely areas, which can represent baseline conditions.

Ground water sources within RJ-ON-90/1 block were examined for physico-chemical, heavy metals and bacteriological parameters in order to assess the baseline water quality. The samples were collected from 75 existing tube wells locations, 12% of the samples comprised of water supplied from Nagana village, 7 % from Bothiya and 5 % from Kanji Ka tala village. The water is supplied by the Public Health Engineering Department through its water supply network. The samples were analyzed as per the procedures specified in 'Standard Methods for the Examination of Water and Waste Water' published by American Public Health Association (APHA). (Refer **Fig. 3.6** for water sampling locations.)

3.9.2.1 Baseline Status

Summary of results is presented in the **Table 3.12**.

Physical Parameters

The pH and conductivity varies from 7.0-8.7 and 389-5432 micro-siemens/cm.

Chemical Parameters:

- Total dissolved solids : 295 - 3492.5 mg/l
- Total suspended solids : 0.03 - 0.35 mg/l
- Total hardness (as $CaCO_3$) : 282.34 - 1110.64 mg/l.
- Fluorides : 1.2 - 3.32 mg/l
- Alkalinity : 102.0 - 469.8 mg/l
- Chlorides : 73.0 - 2007.5 mg/l

Nutrient

Nitrates as NO_3 is found to be 8.4- 109.4 mg/l, Sulphates as SO_4 is found to be 37.9 - 362.7 mg/l.

Heavy metals

The heavy metals like Mercury, Copper, Cadmium, Zinc and lead are within the permissible limits in all the samples.

Bacteriological Parameters

Total Coliforms are found to be absent in all the water samples.

The physico-chemical analysis reveals that the ground water samples are hard waters characterized by high total dissolved solids and hardness. All the water samples are crossing the limits for Fluorides. Heavy metals were not found in any of the water samples.

3.10 Biological environment

The RJ-ON-90/1 block is located in Barmer and Jalore districts of the southwestern Rajasthan i.e., within the Indian Thar. The Thar Desert can be understood as a unique natural ecosystem having the following attributes:

- Low and extremely uncertain rainfall,
- Considerable diurnal and seasonal temperature variation,
- Soil deficient in organic matter and nutrients (NPK ratio)
- Soil prone to salinization,
- Shifting sand dunes,

Despite the adversities, The Thar is not devoid of bountiful life supporting systems with abundance of animal and plant species making it a unique biodiversity region in the world. Life in the Indian Desert is extraordinary and inspite of massive biotic and abiotic stresses, the world's largest concentration of large mammals and winter migratory birds exists in the desert. The global significance of the Indian desert lies in the fact that it is not an isolated arid zone but forms part of an extensive desert belt comprising the Sahara and the arid regions of Arabia, Iran and Pakistan.

3.10.1 Major Diversity in the Region

3.10.1.1 Floral Diversity

The Thar Desert of India exhibits 682 plant species. Most of these species are common in Barmer division. The predominant tree species in forest areas are *Prosopis juliflora* (bilayati babool), *Acacia senegal* (kumatha), *Salvadora oleoides* (mitha jal), *Salvadora persica* (khara jal), *Prosopis cineraria* (khezri), *Tecomella undulata* (rohida). *Capparis decidua* (ker), *Zizyphus nummularia* (jhar ber), *Acacia jacmontii* (bhoo bavali), *Lycium barbarum* (murali), *Clerodendrum phlomoides* (irna) are the shrubs species. Under shrubs includes *Leptadenia pyrotechnica* (khimp), *Crotalaria burhia* (sinia), *Aerva pseudotomentosa* (bui), *Tephrosia* species (bipni) etc. Grasses include *Cenchrus bidlorus* (bhurat), *Aristida* species (lapda), *Lasiurus sindicus* (sewan), *Dactyloctenium sindicum* (ganthia), *Indigofera* species (beker), *Tribulus terrestris* (gokharu or kanti), *Boerhaavia hirta* (punarnva). The creepers are *Citrulus colosynthesis* (tumba) and *Citrulus allatus* (matira). The lianas *Cocculus pendulus* (pilwan) is mostly found in association with *P. cineraria* tree.

In 'Oran' and 'Gauchar' lands (community lands), the trees stand far apart singly or in groups in these lands. The vegetation in Oran and Gauchar is dominated by *Salvadora oleoides, P. cineraria, Acacia nilotica, Acacia jacquemontii, Acacia senegal, Acacia tortilis, Azadirachta indica, Prosopis juliflora, Salvadora persica, Sericostomma pauciflora, Vogelia indica, Balanites aegyptiaca, Calotropis procera, Capparis decidua, Cassia italica, Crotalaria burhia, Euphorbia caducifolia, Leptadenia pyrotechnica, Maytenus emarginata, Plumbago zeylanica, Rhus mysuriensis, Zizyphus nummularia, Aristida depressa, Aristida hystrix, Alysicarpus spp., Arthraxon lensuratus, Blepharis linariaefolia, Convolvulus microphyllous, Cymbopagon martini, Cyprus spp., Dactyloctenium aegyptium* (makra), *Panicum turgidum* (murath), *Dichoma tomentosa, Elusine spp., Eragrostris ciliaris, Indigofera cordifolia, Indigofera liniflora, Merremia hederacea* and *Polycarpia coriambosa.*

In the farmer's field *Prosopis cineraria* and *Tecomella undulata* are the common trees constituting 90% of the population. *Z. nummularia* (Ber), *Z. mauritiana, Clerodendrum phlomoides* (Irna), *Balanites aegiptium* (Hingota), *Calotropis procera* (Aak) are the common shrubs of the agricultural land. Among under-shrubs and herbs, *Crotalaria burhia* and *Tephrosia purpurea* (bewna) are the common species. *Crotolaria* burhia is a common weed, *Acacia tortilis* is the common species planted under road side plantation and the rehabilitation of Gauchar lands of the region.

3.10.1.2 Faunal diversity

Species of wild animals that can adapt to these harsh climatic and environmental conditions flourish in the area. Amongst the mammals, chinkara (*Gazella benetti*), Indian fox (*Vulpes bengalensis*), desert fox (*Vulpes vulpes pussila*), jackal (*Canis aureus*), desert cat (*Felis chaus*), jungle cat (*Felis lybia*), desert hare (*Lepus nigricollis dayanas*), nilgai (*Boselaphus tragocamelus*), wolf (*Canis lepus pallips*), black buck (*Antelope cervicaps*) and spotted deer (*Axis axis*) wild boar (*Sus scrfa*) are the animals of the region.

3.10.1.3 Mammalian diversity in the region

Chinkara (*Gazella benetti*), jackal (*Canis aurens*), hare (*Lapus nigricollis*), hedgehog (*Parachinus micropus*), jungle cat (*Felis caus*), mangoose (*Herpestes edwardis*) and wolf (*Canis lapus*) are the common animals in the region

3.10.1.4 Endangered animal species

The endangered mammalian species that were observed in the RJ-ON-90/1 block are as follows:

1. Blackbuck (*Antelope cervicapra*)
2. Chinkara or Indian Gazelle (*Gazella bennetti*)
3. Grey Wolf (*Canis lupus pallipes*)
4. Caracal (*Felis caracal*)
5. Desert Cat (*Felis libyca*)
6. Desert Fox (*Vulpes vulpes pusilla*)

3.10.1.5 Avian Diversity

Over 350 bird species including partridges, quails, sand grouses, Great Indian bustard, shrikes, bayas, sparrows, munias, crows, mynas, starlings, parakeets, kites, hawks, shikras, vultures, doves, bee eaters, bulbuls, babblers, larks, ducks, pea fowls, finches, hoopoe, lapwings, coursers, teals, woodpeckers, pigeons and cranes etc are recorded from the Thar Desert. These bird species have composition of a single major frugivorous bird and two minor frugivorous bird species; 2 raptors; 3 insectivorous and 4 granivorous birds. In the central region spectacular avian bio diversity is witnessed, 81 species, belonging to 37 families. Similarly in the southeastern Thar (400 mm and above rainfall zone), a total of 72 bird species belonging to 40 families inhabit the area. Some of the common birds observed during recent survey by state forest departments indicates the presence of pea fowl or peacock (*Pao cristatus*), bhat titar (*Pterocles exuslus*), gidh (*Neophron peronoterus*), house crow (*Corvus splendense*), wood pecker (*Piecoides nanus*), Baya (*Ploceus philippinus*),

kabboter (*Columbia livia*), owl (*Bubo bubo*), house sparrow (*Passer domesticus*), chil (*Falco jugger*) and Baj or eagle (*Corcatus gallicus*)

In forest and planted areas common species of birds are Owl (*Bubo bubo*), drongo, minivet, hornbill, bulbul, peacock (*Pavo cristatus*), flycatcher, woodpecker, bee-eater, kingfisher, mynas (*Sturmia malabarica*), swallow, swift, partridge, quail, sand grouse, pigeon, doves, parakeet, night jar, roller, barbet, shrike, tree pie, warbler, chat robin etc.

3.10.1.6 Endangered bird species

The endangered bird species that were observed in the RJ-ON-90/1 block are:

1. Great Indian bustard
2. Pea Fowl

3.10.1.7 Diversity of Herpetofauna

Amphibians are generally restricted to freshwater or they depend upon water bodies for breeding purpose. This indicates the importance of freshwater body for their life cycle. They are not harmful to nature rather helpful, their food mainly consists of small insects and their larvae and pupae etc., which are pests of crop and vectors of diseases. All the hydrophilic species of frogs namely *Rana tigerina. Rana cyanophlyctis, Rana hexadactyla, Rana limnocharis* and *Microhyla ornata* and toads *Bufo melanostictus* and *Bufo andersoni* are rare and endangered in western part of Thar. Toad like burrowing frog, *Rana breviceps* is widely spread within the Thar, but not common. On the whole, the amphibian fauna in Thar area is quite poor in diversity as well as in population.

Reptiles There are five orders of reptiles exists today i.e., Crocodilian, Teddies, Sumatra, Amphisbaena and Rhynchocephalia. Only the first three are found in India.

Lizards are other reptiles and most common species recorded in Barmer division are three species of Gekkonids i.e., *Stenodactylus orientalis,* Bark gecko, *Hemidactylus leschenaulti* and Yellow bellied house gecko, *Hemidactylus flaviv* and two species of Agamids i.e., *Calotes versicolor* and Brilliant Agama, *Agama agilis*. One species of skinks namely Indian sand skink, *Ophiomorus tridactylus* and one species of Lacertids like Indian fringe-toed sand lizard, *Acanthodactylus cantoris cantoris* have also been recorded in the area.

Snakes: About twenty-five species of snakes have been recorded so far from different regions of Rajasthan. Family Typhlopidae includes Brahminy, blind snake, (*Ramphotyphlops bramina*) and beaked Blind Snake, (*Typhlina acutus*). Family Leptotyphlopidae includes beaked Thread Snake, (*Leptotyphlops*

macrorhynchus). Family Boidae includes Indian Sand Boa (*Eryx johni johni*) and Russell's Sand Boa (*Eryx conicus*). Family Colubridae includes Dhaman (*Ptyas mucosus*), Trinket Snake (*Elaphe Helena*), Glossy-bellied racer (*Argyrogena ventromaculatus*), Royal Snake (*Sphalerosophis atriceps*), Diadem Snake or Rajatbansi (*Sphalerosophis diadema diadema*), Red Spotted Diadem Snake (*Sphalerosophis arenarius*), Wolf Snake (*Lycodon aulicus*), Checkered Keelback (*Xenochrophis piscator*), Green Keelback (*Macropisthodon plumbicolor*), Green Whip Snake (*Ahaetulla nasutus*); Indian Cat Snake (*Boiga trigonata*) and Afro-Asian Sand Snake (*Psammophis schokari*). Family Elapidae includes Indian Krait (*Bungarus caeruleus*), Binocellate Cobra, (*Naja naja*), Oxus Cobra or Black Cobra (*Naja naja oxiana*). Family Viperidae includes Saw Scaled Viper (*Echis carinatus*), Viper (*Vipera russelli russelli*).

3.10.1.8 Insect Diversity

The study carried out indicated the presence of insects belonging to the family of the orders of Odonata, orthoptera, Dermaptera, Isoptera, Malaphaga, Hemiptera, Neurooptera, Lepidoptera, Diptera, Hymenoptera and coleoptera.

3.10.2 Breeding Sites

The desert animals such as Chinkara, Desert Cat and Great Indian Bustard which inhabit The Thar Desert, breed in it. These animals inhabit flats or undulating plains with shrubs of *Capparis*, *Ziziphus* and *Calotropis* or with tall *sewan* grass. They are generally limited to that particular territory for breeding, which becomes an established breeding ground for these animals.

The study undertaken by AFRI reveals that there are no established breeding grounds within the RJ-ON-90/1 block. However isolated occurrences of un-established breeding grounds may occur within the block, such instances are infrequent.

3.10.3 Migratory Routes

Most of the resident birds of the region breed in the suitable habitat in the region. However, the lesser floricans (*Supheotides indica*) arrive in the southeastern desert of Rajasthan only in the monsoon season.

The common crane (*Grus grus*) is a palaearctic breeding species that spends winters in the Mediterranean North Africa and China but sub species *G. gurus* subspecies *lilfordi* migrates in winter to the Indian desert also. The Imperial sand grouse (*Pterocles orientalis*) is a palaeotropical bird and a winter visitor to the desert region and arrives in the Western Rajasthan desert in flocks of 20-500.

The study undertaken by AFRI reveals that there are no established migratory routes within the RJ-ON-90/1 block.

3.11 Socio-economic Environment

3.11.1 Demographic profile of Barmer District

District Profile - Administrative setup – Barmer : Barmer is the headquarters of the district, which is also the principle town; and the district is divided into two subdivisions viz. Barmer and Balotra. The district has three municipalities, 8 panchayat samitis, 225 gram panchayats , 1683 villages and 853 inhabited villages. Socio-economic profile of Barmer District is presented in **Table 3.14.**

The population Characteristics are as follows:

- More than 90% of the population in the study area is predominantly rural and lives in villages.
- Most of the population in the study area resides near the agricultural lands in isolated hamlets (*dhanis in* local parlance). *Dhanis* are household units and typically spread over several kilometres. The *dhanis* due to physical distances and distant locations are sometimes devoid of basic facilities like water, transport, health services, primary education etc. The settlement pattern in the villages in Barmer is spread across several kilometers.
- The average sex ratio of the villages falling in the study area was found to be 937
- The average household size to be 6.57. Some factors that may have contributed to the poor sex ratio in the area include male centred outlook (the desire for male offspring), poor health status of women, female infanticide and neglect of the girl.
- Barmer is sparsely populated with a population density of 69 people / km^2. The village settlement pattern is usually a scattered, often around the main village or central area. It was found that caste considerations are pronounced and social organisation is on strict caste lines.

3.11.1.1 Social Structure

Majority of the population in the district fall either in the general or in the OBC category. The *Rajputs, Jats, Kalbis, Rebairs, Raikas* and *Bisnois* are the land holding class engaged in agricultural and business activities and wield considerable influence in the region. Next in the caste hierarchy are the *Kumahars, Kansaras, Jatiyas, Desantris, Swamis, Suthars* etc who are engaged mostly in agriculture and related activities like wage labour, animal husbandry etc. The *Meghwals, Shansis, Dhobis, Musalmans, Malis, Banjaras,*

Dhatis etc fall low in the caste hierarchy and are engaged in activities like cattle herding, animal husbandry, manual labour etc.

3.11.1.2 Literacy Levels

The district has fairly high levels of literacy rate, at about 60.46%. The literacy rates among male members are high as compared to the female members as indicated below as per the Census 2001.

Literacy	Percentage
Male Literacy	73.56
Female Literacy	46.44
Total Literacy	60.46

Source: Census data & Primary survey figures

3.11.1.3 Occupational Structure

The occupational structure of residents area is studied with reference to main workers, marginal workers and non-workers. The main workers include 10 categories of workers defined by the Census Department consisting of cultivators, agricultural laborers, those engaged in live-stock, forestry, fishing, mining and quarrying; manufacturing, processing and repairs in household industry; and other than household industry, construction, trade and commerce, transport and communication and other services.

The marginal workers are those workers engaged in some work for a period of less than six months during the reference year prior to the census survey. The non-workers include those engaged in unpaid household duties, students, retired persons, dependents, beggars, vagrants etc.; institutional inmates or all other non-workers who do not fall under the above categories. The status of working population is presented in **Table 3.15**.

3.11.1.4 Agriculture

Rajasthan is basically an agrarian economy. Most of its population lives in small villages and *dhanis*. It has a wide range of agro-climatic regions from very low rainfall in western part to high rainfall in south and south-eastern parts of the state. Major part of the state is, however, covered by arid and semi-arid climatic conditions which has a characteristic low, erratic and uneven distribution of rainfall associated with lack of other water-resources for irrigated farming. Areas of Barmer falls in this category, where the farmers grow only one rainfed crop in Kharif season, that too associated with high risk. These factors have led to dependence of village community on livestock. Due to low capital investment capacity, lesser availability of agriculture credit and lack of adequate infrastructure facilities like roads, power, etc., farming system is more subsistence oriented than commercial farming.

All landholding families, including even those who have marginal land holdings keep few animals, goats and sheeps at the least. However on being asked people call themselves as cultivators. The *Rebari* community is the only one that is engaged exclusively in animal husbandry. Further details about animal husbandry are provided in a separate section to follow.

More than 50% of the farmers are small and marginal farmers who cultivate for subsistence. The large farmers who also have availability of groundwater for irrigation grow cash crops as well. The major crop grown in the district under study are wheat, bajra, rapeseed, mustard, and few pulses mainly grown for self-consumption. Oil seeds are the main cash crop. The following tables show the production of different crops in Barmer and Jalor.

Main Crops

The main crops grown are bajra, moong, moth, gowar, wheat, mustard, til, etc. The main cash crops grown are Jeera, Isabgol, Mustard and other Oilseeds. Village Shivkar, which has better groundwater situation, grows vegetables and is the major supplier to Barmer City.

Cropping Pattern

Due to greater dependence on rains for irrigation, most villages practice single cropping pattern through the year. This is entirely dependent on timing and quantity of rainfall. Erratic or delayed rainfalls cause crop failure even in case of Kharif crop. Some of the survey villages have groundwater sources and thus practised double crop.

Irrigation Scenario

Agriculture is largely rain fed. About 60% of the villages surveyed rely entirely on rains for irrigation. In the remaining 40%, there is a small proportion of farmers, about 5% that also use groundwater for irrigation. Such cases are restricted to areas where groundwater situation is better due to higher water-table or availability of deep bore-wells and electric motors for pumping water from as deep as 450 feet.

As per the primary survey, cases of irrigation by groundwater were found in less than half the villages, these are further restricted to elite farmers, in the villages, who can afford to dig deep bore-wells, install electric pumps and pay for electricity connections. At places like Shivkar the water table is high upto 50 feet and hence villages are using open wells also for irrigation. At places like Chokhla, Bhimada and Bhedana although the water table is as deep as 400 feet, still few farmers have bore-wells for irrigation.

The details on major crops are presented in **Table 3.16**.

3.11.2 Infrastructure Facilities

The infrastructure and amenities available in the area denotes the economic well being of the region. The study area as a whole possesses poor to moderate level of infrastructural facilities. However, in comparison with the facilities available in other parts of the districts, this area enjoys higher level of amenities like education, health, drinking water, electrification, transport and communication network.

3.11.2.1 Electricity

Almost 95% of the villages in Barmer district is electrified and the electricity is supplied for domestic, non-domestic, industrial, agricultural and public lighting purposes. The power supply in this area unpredictable and on an average of 15 hours per day is observed.

The power supply in the district comes from Debari Grid Station near Udaipur via Jalore. The 132 KV Grid Station of the district is located at Balotra and the 33 KV station is located at Barmer of the 1,625 villages, 1,500 villages were electrified.

3.11.2.2 Water

Water supply in the study area was mainly from the protected water supply system. The Rajasthan Regional Rural Water Supply System supplies water to the villages through its regional water network system. This piped water supply is supplemented with other sources such as wells, hand pumps, bore wells and tanks. In 1991 about 135 villages had protected tap water supply facility. The sources of water supply in the study area are shown in **Table 3.27.**

The ongoing extension of the Indira Gandhi canal is likely to provide adequate quantity of water for not only drinking but also to irrigate 0.1 million hectares of agriculture land. The canal would also improve water level of the wells in the area.

3.11.2.3 Road Transport

The district is linked by road with Jaisalmer, Jodhpur, Pali, Jalore, Jaipur, Ajmer and Ahmedabad. The total length of roads in the district was 5,109 kms as on 31 March 2000.

3.11.2.4 Rail Transport

The district is linked with neighbouring districts of Jodhpur, Jalore and Jaipur in the State and with Agra in UP and Munawa in Pakistan, by railway line. The total length of rail line in the district is 254 kms with 30 railway stations.

3.11.2.5 Air Transport

The nearest airport is at Jodhpur, about 220 kms from Barmer Town.

3.11.2.6 Communication Facilities

The study area had moderate to good level of Post and Telegraphic services. Altogether there are 479 post offices and 104 Post and Telegraph offices and 897 public call offices in Barmer district.

3.11.2.7 Educational Facilities / Institutions

The educational facilities are evenly distributed in the area. In all, there are 1638 pre-primary and primary schools, 449 upper primary (middle schools), 120 secondary / senior secondary schools. All the high schools and higher secondary schools are situated in larger villages.

3.11.2.8 Health Facilities

Different types of health facilities including hospitals, dispensaries, etc. are available in the study area. The level of health facilities is found to be poor to moderate. There were 3 hospitals, 3 maternity and child welfare center, 66 primary health centers, 4 dispensaries and 414 sub centers.

3.11.2.9 Industries in Study area

There are no major and medium industries in the study area. The study area is industrially backward. Industrial areas in Barmer district are 5 which are involved in Bentonite grinding, cement bricks, embroidery and tailoring, flour mills, granite cutting and polishing, guar gum, non-edible oil, oil mills, plater of Paris, stone crushing, textile dyeing and printing, wooden furniture activities. The industrial areas are Balotra, Barmer, Barmer (Automobile), Mokalsar and Samdari. The major export items from the district of Barmer include Guar gum, Handicraft items, Hand embroidered items and Woollen carpets.

There are no major industrial areas within the RJ-ON-90/1 block

3.11.3 Socio-economic survey

Socio-economic survey was conducted in 44 villages of the study area with reference to the project site. Sarpanch of each village and respondent (adults male-female) were chosen for the collection of awareness and opinion. The salient observations recorded during the survey are :

- 34 of the villages are reported problems in water quality and water scarcity
- Health facilities are not available in16 villages in the study area

- educational institution are not available in 11villages
- 22 villages are reported about road connectivity in the study are
- 20 villages are having problem of electrification or power cut
- Employment development are needed in 11 villages

3.11.4 Quality of Life Study

Quality of life (QoL) is a term, which indicates overall status of socio-economic environment in a given area. Quality of life (QoL) is defined as a function between "objective conditions" and "subjective attitudes" involving a defined "area" of concern. The Socio-economic Indicators for QoL Assessment are Income, Employment and Working Condition, Housing, Food, Clothing, Water Supply and Sanitation, Health, Energy, Transportation and Communication, Education, Environment and Pollution, Recreation, Social Security and Human Rights

3.11.4.1 Baseline Status

The average QoL index value for the study area is leaning towards satisfactory level due to good economic status like income, employment and also availability of basic needs, viz. food, clothing, housing. The area is lacking in medical, educational facilities and social security, besides water scarcity, inadequate irrigation, lack of sanitation, which are subjective conditions and are below satisfactory levels as compared to objective conditions.

3.11.5 Archeological Importance and other important places

In Barmer, the remains of Barmer Fort, a pillar of the ruins of the largest temple of 1295 AD, Juna Barmer, the temple dedicated to Balarikh (the Sun) and three Jain temples which are believed to be from 13th century and are of historically and archaeologically important places in Barmer town.

The state of Rajasthan has a rich cultural heritage and history. It was once the seats of the princely states of the Rajputs and contains some of the most famous architectural buildings and monuments. The richness of this culture is praised all over the world, and attracts a considerable number of tourists both from India and abroad. The tourist centres of Rajasthan can be classified into six broad groupings:

- Hill resorts (Mount Abu);
- Centres for Wildlife (Sawai Madhopur, Ranthambore, Kumbhalgarh, Sariska, Bharatpur);

- Historical centres (Chittorgarh, Jaisalmer, Jodhpur, Nagaur, Bikaner, Jaipur, Amber etc,);
- Archaeological sites (Tilwara, Bhinmal, Ganeshwar, Tonk, Sambhar etc.);
- Religious centres (Ajmer, Dungarpur, Pali, Udaipur, Jaisalmer etc);
- Recreational centres (Tilwara, Baneshwar, Nagaur, Teej).

Barmer has an ancient temple of *Balarikh* (*the sun god),* carved out in wood. *Mevanagar,* northeast from Barmer is another famous religious centre. Rajasthan has a number of well-defined tourist trails, none of which pass through the study area.

Recent archaeological excavation at different sites in Rajasthan further strengthens the claims of the state's richness in ancient cultural heritage. Stone-age equipments found at Bagore (Udaipur) and Tilwara (Marwar) provide links with the stone-age. Excavations carried out at Bhinmal (Jalor), Tilwara (Barmer), Balathal (Udaipur) etc. reveal the cultural links of Rajasthan with the rest of India.

Community festivals are the way of life in Rajasthan. In Dhorimanna an Autumn fair is held every year. In summer a festival is held at Abu (about 100 km from the site). The noted fairs and festivals of Rajasthan are shown in **Table 3.18**. The performances of folk songs and folk dances are very common during these festivals.

For Rajputs, Dussehra is an occasion of special significance. Similarly for the business class, it is Dewali (the festival of light). There are a number of Jain families residing in the Jalor district. For the Jains, *Mahavir Jayanti* and *Pajushan* are main festivals. The district of Jalor being near to the state of Gujarat has being influenced by Gujarati traditions and culture.

3.11.6 Defence Establishment

One of the air fields of the Indian Air Force base is located near to Uttarlai village, Barmer Tehsil which will cater to the national security. The air force station is located about 15 kms from the Barmer town in north easterly direction.

Head Quarters of Border Security Force's Barmer Sectors is located in the town of Barmer.

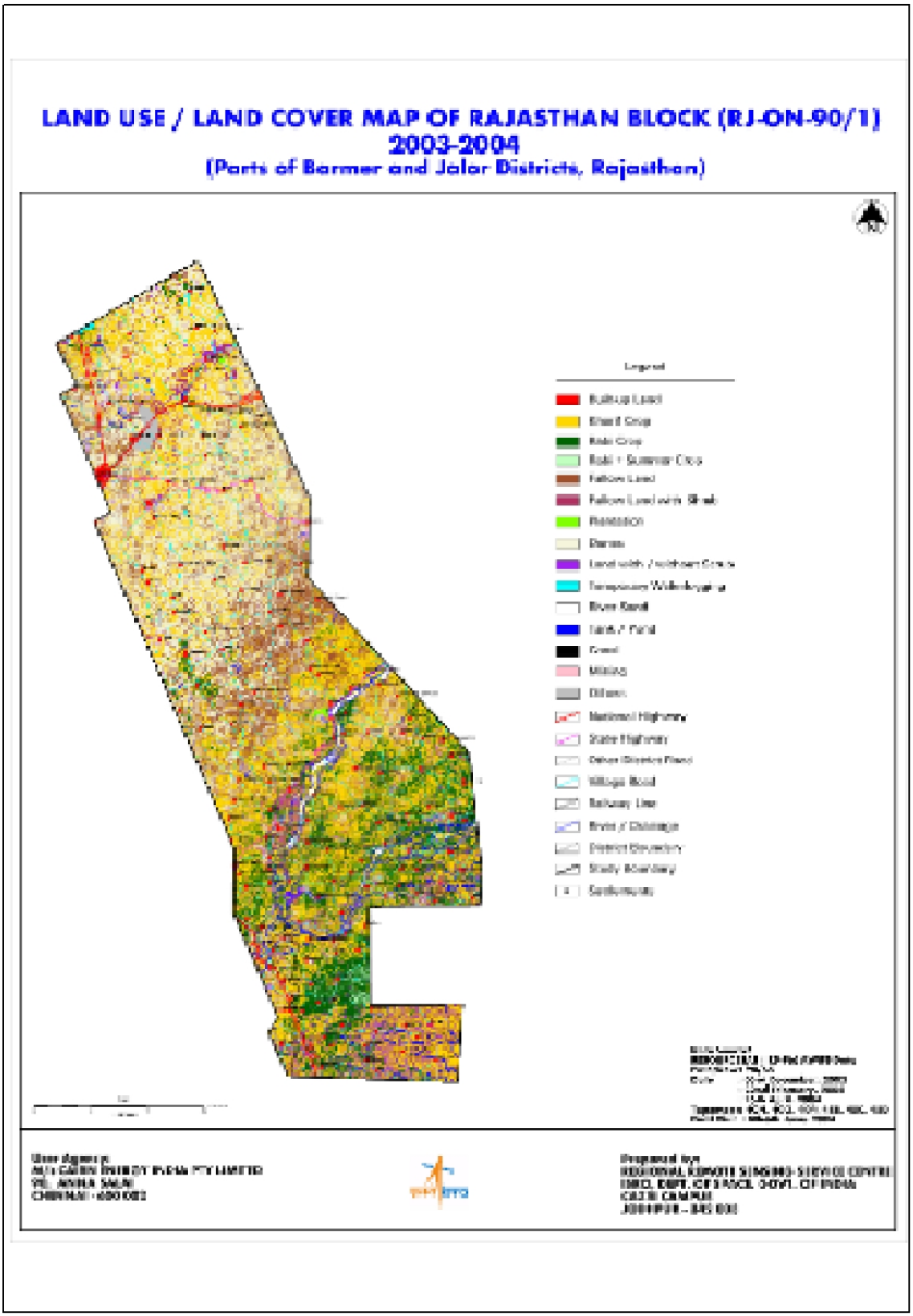


Fig. 3.1 : Land Use / Land Cover

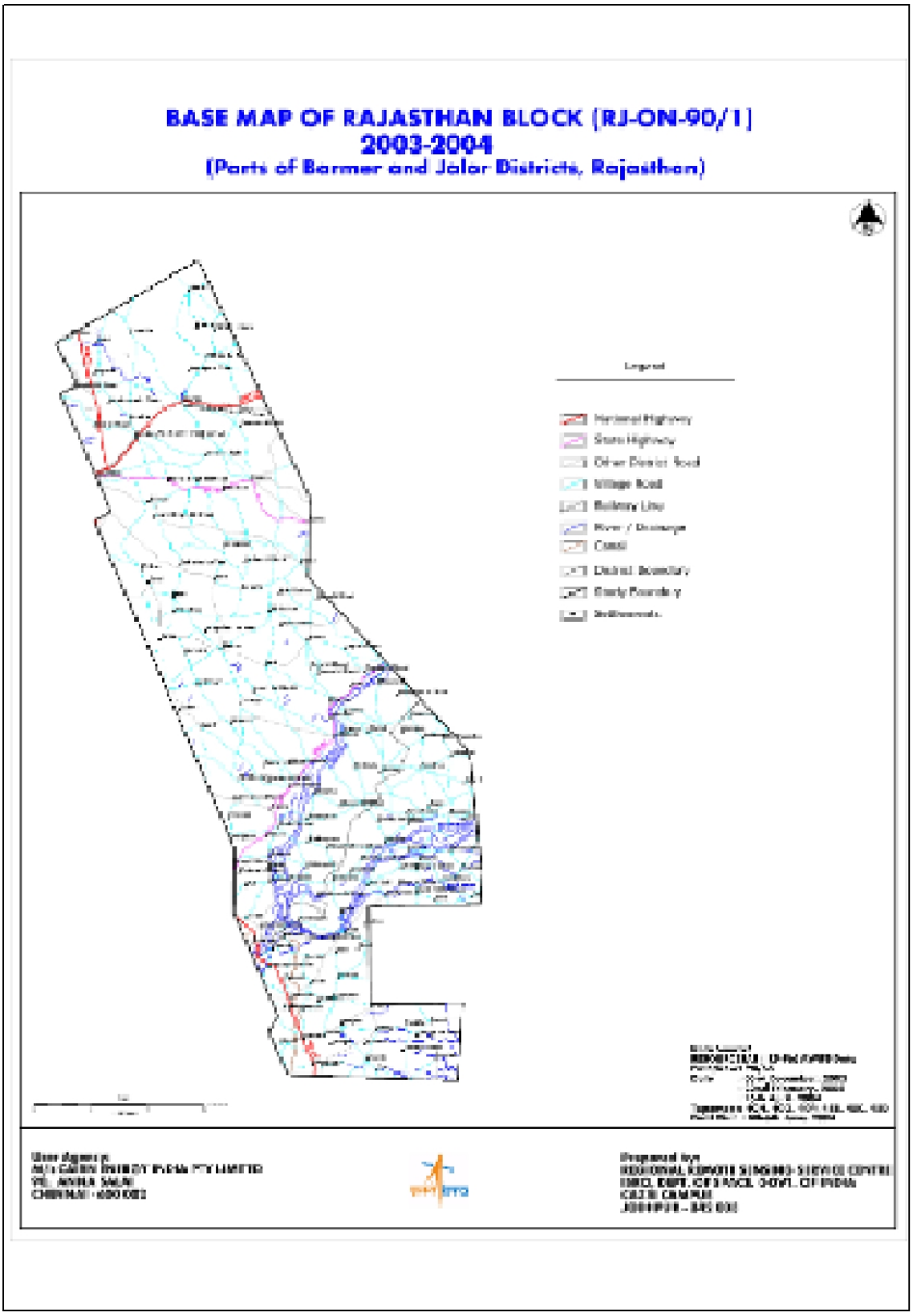


Fig. 3.2 : Linear Features

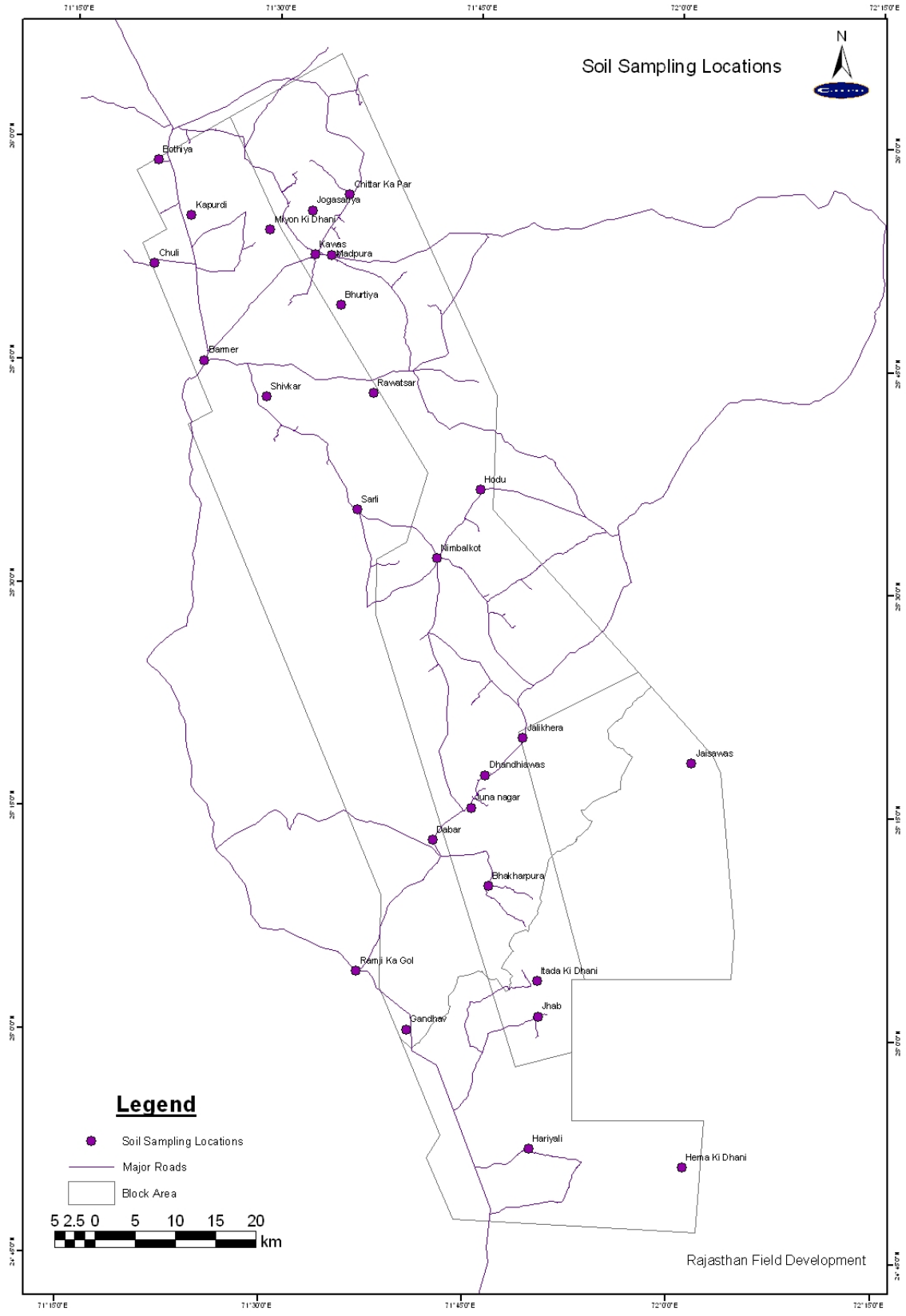


Fig. 3.3 : Soil Sampling Locations

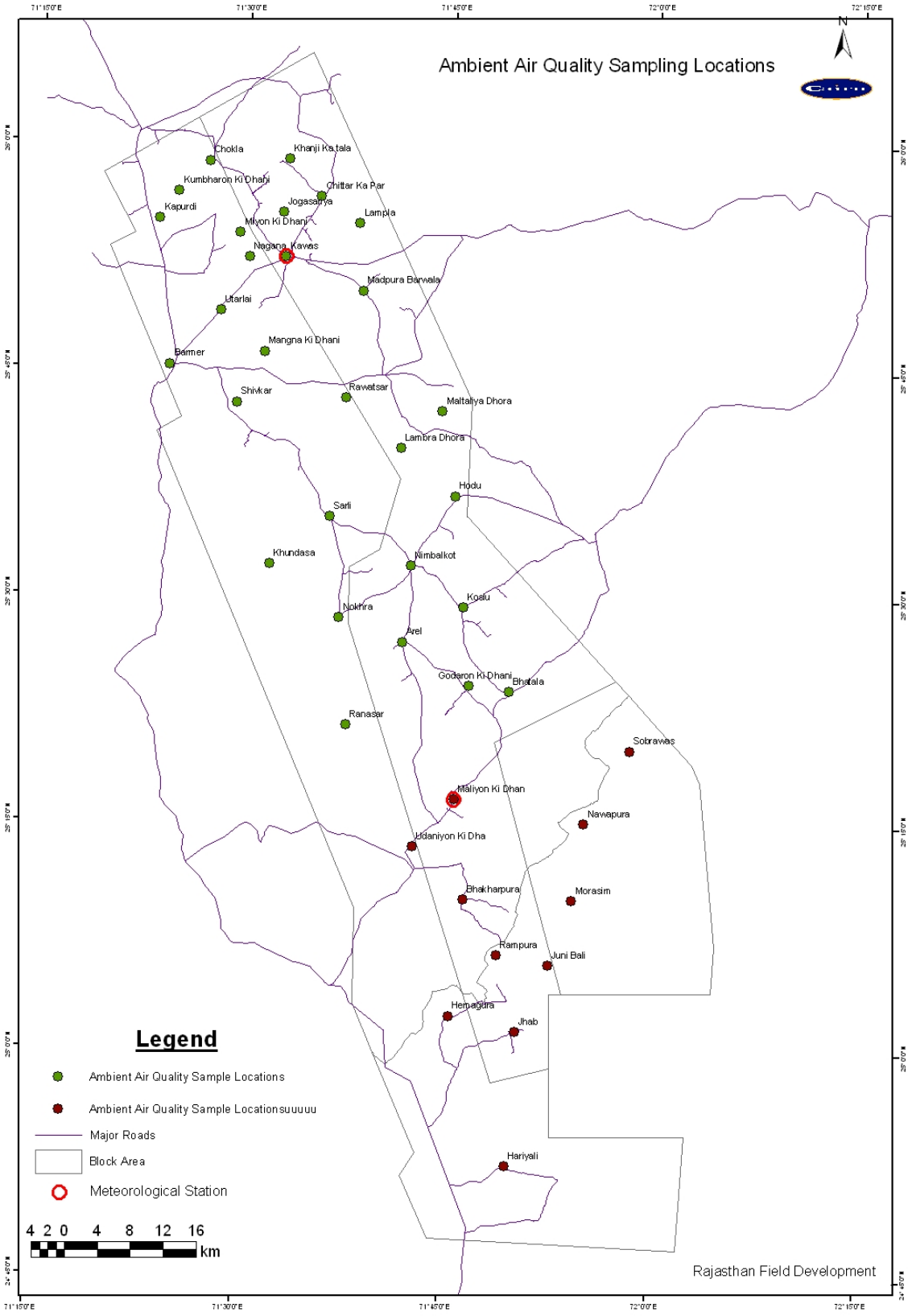


Fig. 3. 4 : Ambient Air Quality & Meteorological Monitoring Locations

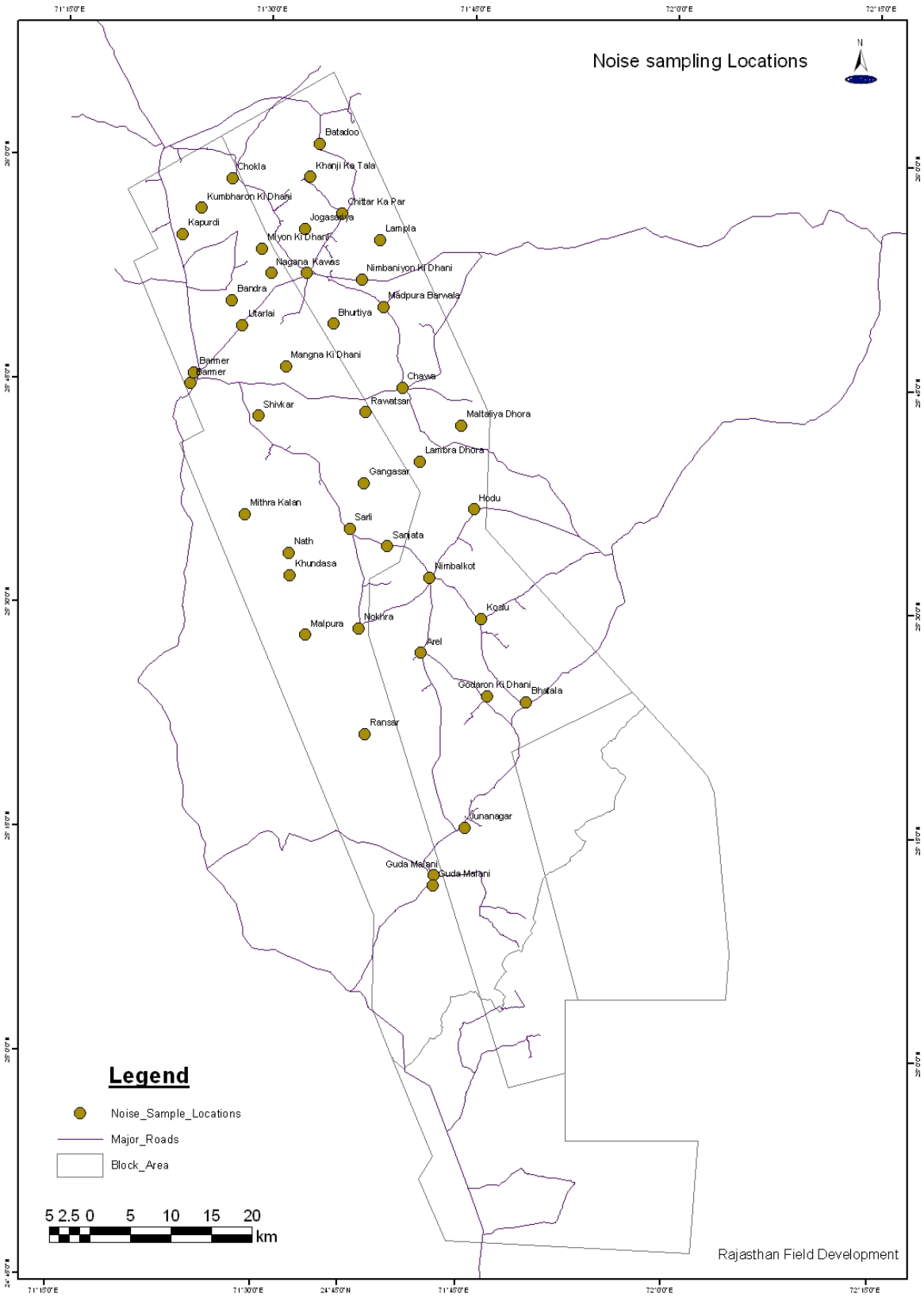


Fig. 3.5 : Noise Monitoring Locations

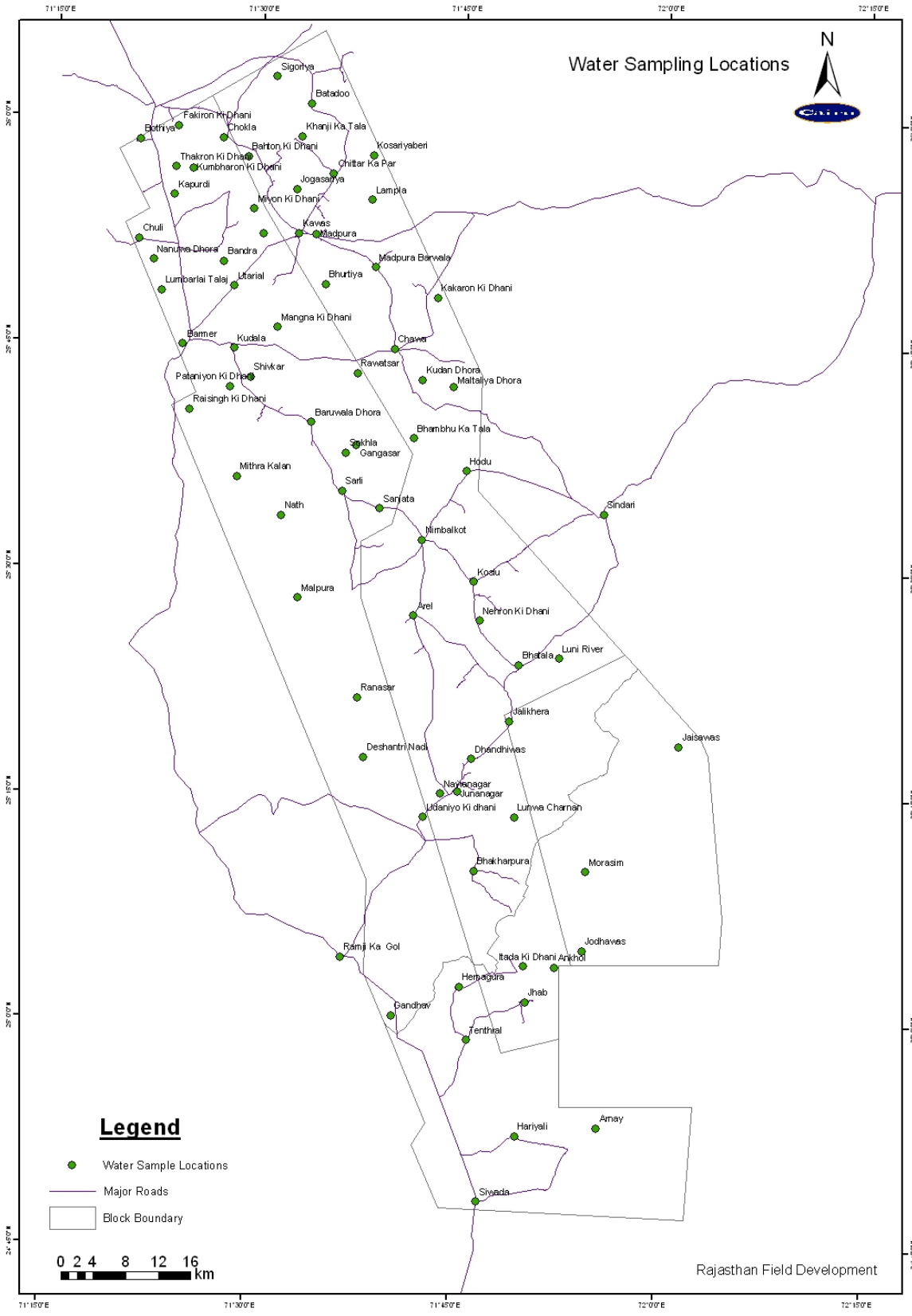


Fig. 3.6 : Water Sampling Locations

Table 3.1

Environmental Attribute And Monitoring Agencies

Environmental Attributes	Monitoring Agency
Ambient Air Quality	a) Vimta Labs Ltd., Hyderabad
Noise	b) Enkay Enviro Services, Jaipur
Soil Quality Microbiological Studies	a) Vimta Labs Ltd., Hyderabad b) National Environmental Engineering Research Institute (NEERI), Nagpur
Groundwater Quality	a) Vimta Labs Ltd., Hyderabad b) National Environmental Engineering Research Institute (NEERI), Nagpur
Land use/land cover Study	Regional Remote Sensing Service Center (RRSSC), Jodhpur
Biological environment study	Arid Forest Research Institute (AFRI), Jodhpur
Demographic / infrastructure data collection Quality of life study	a) Environmental Resource Management (ERM), New Delhi b) National Environmental Engineering Research Institute (NEERI), Nagpur

Table 3.2

Environmental Attributes & Frequency of Monitoring

Sr No	Attribute	Parameters	No. of sampling locations	Frequency of Monitoring/Data collection
1	Ambient air quality	SPM, RPM, SO2,, NOx, CO & HC	39	24 hourly samples twice a week for twelve weeks.
2	Meteorology	Wind speed and direction, temperature, relative humidity and rainfall.	2	Data collected during the study period on hourly basis. Historical data also collected from IMD Barmer and Jalore for corroborating the data and planning the monitoring network.
3	Groundwater quality	Physical, Chemical and Bacteriological parameters.	75	Once during the study period.
4	Ecology	Existing flora and fauna.	Whole block	Through field visit during the study period and substantiated through secondary sources of BSI and ZSI.
5	Noise levels	Noise levels in dB(A)	57	Hourly observation for 24 hours once during the season.
6	Soil characteristics	Physical, Chemical and biological parameters to assess agricultural and afforestation potential.	38	Sub surface composite samples collected once during the study period.
7	Land use / Land Cover	Land use for different land use classifications.	Kharif, Rabi and Summer season	Land use / Land Cover Analysis using satellite imaging and GIS Technique
8	Socio-economic aspects	Socio-economic characteristics, labour force characteristics, population statistics existing amenities in the study area and quality of life.	Whole block	Based on field surveys and data collected from secondary sources (census handbooks, 2001, district Gazetteers).

Table 3.3

Sources of Secondary Data

Sr. No	Attributes	Source
1	Land use pattern	District Statistical office, Barmer Census of India, Directorate of Census operations, Jaipur
2	Geology and Hydrogeology	Dept. of Mines and Geology Rajasthan State ground water board
3	Water resources	State and Central Groundwater Board Public Health Engineering Department, Rajasthan
4	Ecology	Central Arid zone Research Institute, Jodhpur
5	Demography	National Informatics Centre, Delhi Census of India, 2001 Provisional Population Totals; Paper 2 of 2001

Table 3.4

Achaean succession

Pre-Cambrian	Delhi System
----------Unconformity----------	
Archaean	Raialo Series
	----------Unconformity----------
	Aravalli System
	----------Unconformity----------
	Banded Gneiss Complex and Bundelkhand gneiss

Table 3.5

Various Hydrogeological Zones

Hydro-geological zones	Type
Zone I	Covers the foothill and valley floors; Dugwell and complete aquifer thickness
Zone II	Covers deep valley floor areas, unconfined and semi-confined aquifer
Zone III	Covers western and northwestern and central part of the district. The aquifer depth varies from 3 to 30 m. the alluvial thickness varies up to 150 m.
Zone IV	Occurs along the river flowing in the area. The alluvial thickness is shallow water table, zone suitable for dug well.

Table 3.6

Land Use / Land Cover Estimates for Study Area

S. No.	Land Use / Land Cover LEVEL-I	Land Use / Land Cover LEVEL-II	Part of Barmer District		Part of Jalor District		Total Block Area (RJ-ON-90/1)	
			Area (Km^2)	% Area	Area (Km^2)	% Area	Area (Km^2)	% Area
1.	Built-up land	Built-up land	22.97	0.46	11.51	0.23	34.48	0.69
		Others	21.24	0.43	0.00	0.00	21.24	0.43
2.	Agricultural land	Kharif Crop	1249.87	25.15	606.61	12.21	1856.48	37.35
		Rabi Crop	218.12	4.39	377.72	7.60	595.84	11.99
		Rabi + Summer Crop	2.898	0.06	30.63	0.62	33.53	0.67
		Fallow Land	563.46	11.34	128.04	2.58	691.50	13.91
		Fallow with shrubs	127.62	2.57	11.40	0.23	139.02	2.80
3.	Wasteland	Sand Dunes	1297.87	26.11	53.75	1.08	1351.62	27.21
		Land with / without scrub	64.01	1.29	134.41	2.70	198.42	3.99
		Temporary Waterlogging	2.44	0.05	0.00	0.00	2.44	0.05
4.	Water Bodies	River Sand	25.53	0.51	8.27	0.17	33.80	0.68
		Tanks / Pond	1.65	0.03	0.00	0.00	1.65	0.03
		Canal	0.21	0.00	3.31	0.07	3.52	0.07
5.	Others	Mining	1.93	0.04	0.00	0.00	1.93	0.04
		Plantation	4.43	0.09	0.00	0.00	4.43	0.09
	Total		1365.65	27.48	3604.25	72.52	4969.90	100.00

Table 3.7

Physico-chemical Characteristics of Soil

Sr. No.	Parameter	Min	Max
1	Texture	Sandy	Sandy
2	pH (1:2:5 soil-water extract)	7.6	9.2
3	Electrical Conductivity (mhos/cm)	176	1235
4	Bulk Density gm/cm^3	1.03	1.85
5	Porosity (%)	23.2	41.8
6	Organic Carbon (%)	0.13	0.51
7	Moisture Content (%)	0.32	1.6
8	Sand (%)	70	88
	Silt (%)	4	12
	Clay (%)	7	19
9	Infiltration Rate (cm/hr)	6.6	10.2
10	Water holding capacity (%)	9.4	35.8
11	Cation exchange capacity (CEC)	9.3	15.8
12	Exchangeable Sodium Percentage (ESP)	0.71	6.51
13	Available Nitrogen as N (kg/ha)	3.5	7.7
14	Available Phosphorus as P_2O_5 (kg/ha)	5.2	17.1
15	Available Potassium as K_2O (kg/ha)	10.3	39.7
16	Exchangeable Calcium as Ca (mg/100gm)	408	2846
17	Exchangeable Magnesium as Mg (mg/100gm)	12.2	1273
18	Exchangeable Sodium as Na (mg/100gm)	28.4	135.2
19	Exchangeable Potassium as K (mg/100gm)	19.6	56.8
20	Chloride as Cl mg/100gm)	16.7	96
21	Sulphates as SO_4 (mg/100gm)	15.6	79.4
Heavy Metals			
22	Cadmium as Cd (mg/kg)	<0.01	<0.01
23	Chromium as Cr (mg/kg)	<0.01	<0.01
24	Copper as Cu (mg/kg)	<0.01	<0.01
25	Nickel as Ni (mg/kg)	<0.01	<0.01
26	Lead as Pb (mg/kg)	<0.01	<0.01
27	Iron as Fe (mg/kg)	7013	10700
28	Manganese as Mn (mg/kg)	48	68
29	Zinc as Zn (mg/kg)	25.6	121.8
30	Mercury as Hg (mg/kg)	<0.01	<0.01
31	Selenium as Se (mg/kg)	<0.01	<0.01
32	Arsenic as Ar (mg/kg)	<0.01	<0.01

Table 3.8

Microbiological Characteristics of Soils

Sr. No	Sampling Location	Sample Code	TVC	Fungi	Aclino-Myceles	Rhizo-bium	Azoto-bacter
1.	Khanji ka Tala	S1	142×10^5	15×10^3	3×10^3	ND	6×10^3
2.	Nagana	S2	199×10^5	6×10^3	ND	ND	5×10^3
3.	Kawas	S3	121×10^5	10×10^3	2×10^3	ND	5×10^3
4.	Kogasariya	S4	135×10^6	23×10^3	12×10^3	8×10^3	20×10^3
5.	Koshlu	S43	139×10^6	18×10^3	6×10^3	12×10^3	12×10^3
6.	Arnay	S48	81×10^5	6×10^3	2×10^3	2×10^3	2×10^3

Table 3.9

Summary of Ambient Air Quality Monitoring

Averaging Period : 24 hours Unit : $\mu g/m^3$

Parameter	Arithmetic Mean Concentrations	98th Percentile Concentrations	CPCB Standard *
RPM	23.6 - 76.0	39.07 - 104.6	100
SPM	81.3 - 185.7	95.6 - 223.4	200
SO_2	4.96 - 8.5	5.3 - 11.4	80
NOx	4.88 - 13.6	5.09 - 14.9	80
CO	0.020-0.431	0.025-0.600	2000
HC	1.0-1.5	1.1-1.60	NS

* for residential/rural region and compared with 98th Percentile Concentrations

Table 3.10

Ambient Air Quality

All values are represented in $\mu g/m^3$ except CO.

Sl No	Location	CO (ppm)				HC			
		Min	Max	Avg.	98% tile	Min	Max	Avg.	98% tile
1	Bhatala	0.014	0.036	0.023	0.029	1.4	1.6	1.5	1.6
2	Godaron ki dhani	0.012	0.046	0.020	0.031	1.2	1.4	1.3	1.4
3	Ranasar	0.012	0.048	0.024	0.041	1.2	1.5	1.4	1.5
4	Koshlu	0.011	0.045	0.029	0.042	1.4	1.6	1.5	1.6
5	Adel	0.016	0.090	0.029	0.047	1.4	1.5	1.4	1.5
6	Nokhra	0.015	0.051	0.028	0.049	1.3	1.5	1.4	1.5
7	Khundasa	0.012	0.055	0.029	0.052	1.4	1.5	1.4	1.5
8	Nimbal kot	0.023	0.052	0.037	0.051	1.3	1.5	1.5	1.5
9	Sarli	0.020	0.066	0.049	0.065	1.3	1.5	1.4	1.5
10	Mithra dhora	0.015	0.036	0.021	0.035	1.2	1.4	1.3	1.4
11	Lambra dhora	0.015	0.027	0.020	0.025	1.3	1.4	1.4	1.4
12	Hodu	0.014	0.056	0.026	0.046	1.2	1.6	1.4	1.5
13	Shivkar	0.015	0.065	0.033	0.046	1.3	1.6	1.5	1.6
14	Rawatsar	0.013	0.057	0.039	0.055	1.3	1.5	1.4	1.5
15	Kawas	0.012	0.061	0.032	0.058	1.2	1.6	1.5	1.6
16	Uttarlai	0.012	0.055	0.030	0.038	1.3	1.5	1.4	1.5
17	Barmer	0.025	0.066	0.050	0.065	1.4	1.6	1.5	1.6
18	Mangna ki dhani	0.015	0.027	0.022	0.026	1.2	1.3	1.3	1.3
19	Kapurdi	0.021	0.039	0.032	0.038	1.4	1.6	1.5	1.6
20	Kumbharon ki dhani	0.021	0.035	0.025	0.032	1.2	1.3	1.3	1.3
21	Chokla	0.012	0.041	0.028	0.036	1.2	1.4	1.3	1.3
22	Nagana	0.023	0.046	0.036	0.044	1.2	1.5	1.3	1.5
23	Jogasariya	0.012	0.035	0.024	0.033	1.2	1.4	1.3	1.4
24	Khanji ka tala	0.012	0.026	0.021	0.026	1.2	1.3	1.2	1.3
25	Miyon ki dhani	0.015	0.030	0.023	0.029	1.2	1.3	1.3	1.3
26	Chittar ka par	0.012	0.037	0.027	0.036	1.3	1.5	1.4	1.5
27	Lampla	0.012	0.031	0.023	0.028	1.2	1.4	1.3	1.4
28	Madpura barwala	0.012	0.036	0.023	0.027	1.2	1.3	1.3	1.3
29	Sobrawas	0.080	0.240	0.129	0.200	1.0	1.4	1.2	1.4
30	Nawapura	0.080	0.160	0.102	0.160	1.0	1.3	1.2	1.3
31	Morsim	0.080	0.240	0.135	0.240	1.0	1.3	1.1	1.3
32	Bhankarpura	0.080	0.240	0.154	0.240	1.1	1.6	1.3	1.6
33	Rampura	0.080	0.160	0.092	0.160	1.1	1.2	1.1	1.2
34	Juni Bali	0.080	0.240	0.138	0.240	1.0	1.4	1.2	1.4
35	Jhab	0.080	0.320	0.209	0.280	1.1	1.6	1.3	1.5
36	Malion Ki Dhani	0.080	0.240	0.157	0.240	1.1	1.6	1.2	1.6
37	Udaiyion Ki Dhani	0.080	0.640	0.431	0.600	1.0	1.1	1.0	1.1
38	Harayali	0.080	0.320	0.160	0.280	1.0	1.3	1.1	1.3
39	Hemaguda	0.240	0.480	0.338	0.480	1.0	1.4	1.2	1.4
Industrial Zone		5000				NS			
Residential Zone		2000				NS			

NS - Not specified

Table 3.11

Noise Levels

Sl. No.	Location	L_{day}	L_{night}	L_{dn}
1	Batala	61.9	50.5	61.4
2	Godaron ki dhani	54.7	43.5	54.3
3	Ranasar	60.7	46.1	59.5
4	Koshlu	60.2	47.3	59.3
5	Guda malani (Near market)	68.7	50.5	67.0
6	Guda malani (Near Ramji ka gol choraha)	64.1	51.2	63.2
7	Adel	56.5	44.1	55.7
8	Juna nagar	58.6	42.7	57.2
9	Chawa	61.9	45.3	60.4
10	Nokhra	49.3	38.5	49.0
11	Khundasa	52.8	41.7	52.4
12	Nimbal kot	55.6	44.2	55.1
13	Sarli	58.5	48.3	58.4
14	Sanjhta	52.1	41.2	51.8
15	Mithra dhora	48.2	38.0	48.1
16	Lambra dhora	50.4	40.1	50.3
17	Malpura	55.4	43.9	54.9
18	Hodu	52.9	42.1	52.6
19	Shivkar	56.1	44.9	55.7
20	Rawatsar	56.3	45.3	56.0
21	Kawas	68.5	53.7	67.2
22	Mithra kalan	49.5	38.4	49.1
23	Nath	50.3	40.1	50.2
24	Utarlai	67.0	50.8	65.5
25	Barmer (Near AAQ location)	73.4	55.2	71.7
26	Barmer (Near Sindhary Choraha)	68.2	51.1	66.6
27	Mangna ki dhani	45.4	33.1	44.7
28	Kapurdi	54.7	44.5	54.6
29	Kumbharon ki dhani	48.9	38.2	48.7
30	Chokla	49.0	38.5	48.8
31	Nagana	51.7	40.3	51.2

Sl. No.	Location	L_{day}	L_{night}	L_{dn}
32	Jogasariya	48.5	38.1	48.4
33	Khanji ka tala	52.5	41.7	52.2
34	Miyon ki dhani	49.6	37.5	48.9
35	Chittar ka par	54.9	43.6	54.5
36	Lampla	51.7	40.6	51.3
37	Madpura barwala	50.2	38.1	49.5
38	Bhurtiya	48.1	37.4	47.9
39	Batadoo	57.1	44.5	56.3
40	Banghra	46.8	36.2	46.6
41	Nimbaniyon ki dhani	44.7	33.6	44.3
42	Gangasar	55.1	39.3	53.7
43	Sobrawas	55.18	48.14	56.4
44	Nawapura	53.3	48.09	55.53
45	Morsim	65.68	48.2	64.29
46	Bhankarpura	64.13	49.44	63.05
47	Rampura	51.43	43.59	52.27
48	Juni Bali	62.96	52.71	62.88
49	Jhab	59.38	49.63	59.46
50	Malion Ki Dhani	54.82	48.63	56.49
51	Udaiyion Ki Dhani	65.34	48.81	64.04
52	Harayali	52.66	48.18	55.34
53	Hemaguda	59.25	49.87	59.47
54	Gudamalani (Residential)	59.92	50.11	59.99
55	Gudamalani (Commercial)	72.05	61.74	71.95
56	Siwara	54.33	50.39	57.36
57	Banta	52.18	48.27	55.23

Table 3.12

Water Quality

Sr. No	Parameter	Unit	Minimum	Maximum
1	pH	-	7	8.7
2	Colour	Hazen	1	3
3	Odour	-	0	0
4	Temperature	^{o}C	23.9	27.5
5	Turbidity	NTU	1	3
6	Conductivity	mhos/cm	389	5432
7	Residual Free Chlorine	mg/l	0	0
8	Free CO_2	mg/l	0	0
9	Total Dissolved Solids	mg/l	295	3492.5
10	Total Suspended Solids	mg/l	0.03	0.35
11	Total Solids	mg/l	134.34	3492.69
12	Total Hardness as $CaCO_3$	mg/l	161.22	1110.64
13	Calcium Hardness as $CaCO_3$	mg/l	58.75	602
14	Magnesium Hardness as $CaCO_3$	mg/l	72.62	508.64
15	Calcium as Ca	mg/l	23.5	240.8
16	Magnesium as Mg	mg/l	17.5	123.6
17	Alkalinity	mg/l	102	469.8
18	Chlorides as Cl	mg/l	73	2007.5
19	Sulphates as SO_4	mg/l	37.9	362.7
20	Nitrates as NO_3	mg/l	8.4	109.4
21	Fluorides as F	mg/l	1.2	3.32
22	Phenolic compounds as C_6H_6OH	mg/l	<0.001	<0.001
23	Cynides as CN	mg/l	<0.02	<0.02
24	Arsenic as As	mg/l	<0.01	<0.01
25	Cadmium as Cd	mg/l	<0.01	<0.01
26	Copper as Cu	mg/l	<0.01	<0.01
27	Lead as Pb	mg/l	<0.01	<0.01
28	Manganese as Mn	mg/l	<0.01	<0.01
29	Iron as Fe	mg/l	0.11	0.51
30	Hexavalent Chromium	mg/l	<0.01	<0.01
31	Mercury as Hg	mg/l	<0.001	<0.001
32	Selenium as Se	mg/l	<0.01	<0.01
33	Zinc as Zn	mg/l	0.01	0.47
34	Total Coliforms	MPN per 100 ml	Absent	Absent
35	Pesticides	Present/Absent	Absent	Absent

Table 3.13

Dominant species in Forest, Community and Farmer Lands of the Region

Name	Tree	Shrub	Grasses
Forest land	*P. juliflora*	*Capparis decidua,*	*Aristida adsensionis, C. ciliaris, C. biflorus, Panicum turgidum, C. ciliaris, L. sindicus*
	P. cineraria	*Z. nummularia*	
	A. senegal	*Leptadenia pyrotechnica*	
	S. oleoides	*Balanites aegiptiaca*	
	S. persica		
Community land	*S. persica*	*Capparis decidua*	*C. biflorus, C. ciliaris, Aristida adsensionis*
	S. oleoides	*Z. nummularia*	
	P. juliflora	*C. procera*	
	A. nilotica	*Crotalaria burhia*	
Farmers land	*P. cineraria*	*C. decidua*	*Aristida adsensionis, C. ciliaris, C. biflorus, L. sindicus, Boerhaavia hirta, Tribulus terrestris*
	T. undulata	*M. emarginata*	
	A. leucophloea	*Balanites aegiptiaca*	
	Ailanthus excelsa	*C. procera*	
	Azadirachta indica		

Table 3.14

Socio-economic Profile of Barmer

Variables	**Unit**	**Barmer**
Human population		
Human population (2001)	Individuals	19,63,758
Density of population	km^{-2}	69
Literacy	%	59.65% of rural and urban
Total working population	%	33.37
Percentage distribution of work force		
Cultivators	%	79.5
Agricultural labourers	%	3.67
Manufacturing, processing servicing and repairs	%	1.32
Other workers	%	15.51
Livestock		
Livestock population (1997)	Individuals	41,76,661
Livestock density	km^{-2}	147
Literacy	Per cent	59.65

Table 3.15

Working Population

Working Population	Numbers
Total working population	19,63,758
urban	1,45,241
rural	18,18,517
Cultivators	2,95,425
Agricultural Laborers	9,806
Manufacturing, processing, servicing and repairs	10,409
Other workers	79,476

Table 3.16

Major Crops and Their Production, Barmer (1999-2000)

Crops	Production (in Tonnes)
Wheat	49,112
Bajra	21,033
Rapeseed and Mustard	19,347
Pulses	4,135
Sesamum	184
Barley	121
Gram	102
Red chillies	68

Source: http:\\rajasthan.gov.in

Table 3.17

Sources of Water Supply in the Barmer

Source of Water	**Barmer**
	% households
Tap	21.2
Well	30.61
Tank	23.96
Tube wells	14.97
Hand Pumps	3.11
River	0.75

Source: Census, 2001

Table 3.18

Fairs & Festivals of the State

Fairs/Festivals	Place	Time
Nagaur Fair Ramdeoji Cattle Fair	Nagaur	February-January
Desert festival	Jaisalmer	Late February
Elephant festival	Jaipur	March
Gangur fair	Jaipur	April
Mewar festival	Udaipur	Early April
Summer festival	Mt. Abu	June
Teej Fair	Jaipur	July
Marwar festival	Jodhpur	October
Pushkar Fair	Ajmer	November
Dussehra	Kota	September-October
Chandrabhaga Fair	Jhalawar	November
Bikaner Festival	Bikaner	January

Source: Rajasthan Resource Atlas