

APPENDIX 16

Satellite Data Analysis and Interpretation –Areas in the neighbourhood of the proposed Mega power Plant, Kutch District, Gujarat State

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	– Regions of Interests: 30kms., 20kms., 10kms., 10kms., and 5kms.



Chapter 1.0

INTRODUCTION

TCE Consulting Engineers Ltd. has retained CARE Sustainability CARE), Navi Mumbai, to carry out “**Satellite Data Analysis, Interpretation and Ground Observations- for the areas of interest located at Kutchch district**, in the State of Gujarat. The scope of work was to derive land use/land cover from satellite data.

In accordance with the terms of reference CARE professionals have undertaken:

- Procurement of satellite data
- Study of relevant documents
- Field Survey- Ground Truthing
- Generation of landuse- landcover maps using IRS-P6 satellite data

The methodology adopted for the study is detailed in Chapter 2.0. Chapter 3.0 describes the field observations and Global Positioning System (GPS) made from ground survey. Chapter 4.0 explains the dominant and representative ground features showing the digital photographs. Chapter 5.0 gives the satellite images, which include classified land use/land cover thematic maps.



Chapter 2.0

APPROACH and METHODOLOGY

Satellite image analysis was carried out for the generation of land use/ land cover map of the study region. The study region, is located the district of Kutchch, Gujarat. The approach for satellite data analysis adopted the well-proven Image processing procedures. The analysis was preceded with a ground survey, which comprised of data collection of ground features along with the respective geographical position in terms of latitudes and longitudes. The interpretation of the satellite data was supplemented by these ground truth studies. The satellite data used has the below specifications:

- Satellite and Sensor: IRS P-6, LIS III (L-3)
- Date on which the image was taken: 26-November-05

The said time period of acquisition of the satellite data has been judiciously chosen to depict the vegetation and other ground features at its best, as also avoid the cloud cover over the satellite data.

The image processing software used is the professional version of ERDAS IMAGINE 8.4 under Windows NT. A Pentium 1V based computing machine with high processing speed and graphic facilities under the operating system of Windows NT is used for the image processing and interpretation.



The detailed description of methodology followed for the generation of landuse-landcover map is given in the paragraphs below.

IRS P6 data were extracted using the ERDAS Imagine's extract utility. The raw satellite data was subjected to the enhancing steps such as edge enhancement and histogram equalization, the built in functions of the image processing software, so as to obtain the best classification results. The satellite data were georeferenced by adopting the raster to raster geocoding. For georeferencing, the ground control points (GCP) recorded by Global Positioning System (GPS) during ground truthing of the study area were used. The GCPs were taken at locations well spread across the study region, and hence enabled to obtain very high georeferencing accuracy. UTM projection system was applied to the image.

The georeferenced image was viewed under different band combinations in the viewer of ERDAS IMAGINE and different features were demarcated based upon the tone, texture shape, size, association etc. The locational maps of study region and ground truthing data were also used for reference. Field studies proved to be very helpful in correctly demarcating the features. For classification, 'supervised classification' was adopted. The classified features were verified with ground truth data. Land use/ land cover maps depicting the classified ground features for different areas of interest were subsetting from the master classified image. Circular regions with project site as center and radial distances of 50kms, as shown in the subsequent sections, were few of the derived areas of interest. The proportional presence of different land uses in terms of statistical percentages was also derived for the said areas of interest. Appropriate legends were used to represent the various categories of landuse-landcover, and are written on the prepared landuse-landcover maps.



Chapter 3.0

GROUND SURVEY AND GPS READINGS

The region for field survey was chosen around the project site, spreading radially on the land side about thirty kilometers from the project site. The field survey was carried out, during May 15-18, 2006 in order to observe and understand the ground features. The GPS readings and observations of land features were taken at several ground locations spread evenly in the study region. The project site, being close to the gulf of Kutchch waters, the field observations have been made mainly on the land.

The following table enumerates the land features and its corresponding GPS readings of all the ground truthing locations selected for the study.

Table 1. Land use features, GPS readings at locations on the land within the radial distance of 35kms from the proposed project site. The Table 1 also provides the taluka and village of each location

Sr No	GPS reading		Category	Description	Taluka	Village
	Latitude	Longitude				
1	22° 48.179' N	069°32.078' E	Sandy Shore	Barren sandy area with no vegetation.	Mundra	Tunda wandh
2	22° 50.602' N	069°31.682' E	Built up area	Concrete buildings with roofed top.	Mundra	Kandagara
3	22° 50.124' N	069°31.271' E	Scrub forest	The area is with small bushes or in many places exposed sandy soil is seen	Mundra	Kandagara
4	22° 49.849' N	069°29.323' E	Agricultural land	Plantation of Kharik. Admeasuring an	Mandvi	Nana Bhadia



				area of > 5acres		
5	22° 49.845' N	069°29.068' E	Built up area	Human settlement	Mandvi	Nana Bhadia
6	22° 49.569' N	069°28.502' E	Artificial Lake	Pond constructed by human effort > 4 acres	Mandvi	Tragadia
7	22° 49.555' N	069°28.179' E	Built up area	Building construction Panchayat office	Mandvi	Tragadia
8	22° 49.818' N	069°26.516' E	Agricultural land	Tilled land ready for sowing.	Mandvi	Gundiyali
9	22° 50.273' N	069°25.405' E	Artificial Lake	Naran Sarovar Artificial Lake of > 25acres With no traces of water.	Mandvi	Gundiyali
10	22° 50.176' N	069°25.198' E	Built up area	Houses built for human settlement	Mandvi	Gundiyali
11	22° 49.945' N	069°24.578' E	Agricultural Land	Cultivation of Hinjwa, used for feeding livestock.	Mandvi	Gundiyali
12	22° 50.180' N	069°23.359' E	Agricultural Land	Coconut Farm	Mandvi	Maska
13	22° 50.211' N	069°23.330' E	Agricultural Land	Bajra Plantation Standing crop Plot admeasuring 1 to 2acres	Mandvi	Maska
14	22° 50.190' N	069°22.920' E	Built up area	A small temple	Mandvi	Maska
15	22° 50.298' N	069°21.982' E	Highway	Mandvi-Bhuj Highway octroy point near Reliance petrol pump	Mandvi	Mandvi
16	22° 49.979' N	069°21.566' E	River	Rukmavathi river near Mandvi bridge	Mandvi	Mandvi
17	22° 50.164' N	069°22.740' E	Built up area	Ek ka Das Mahadev Temple	Mandvi	Maska
18	22° 51.076' N	069°23.788' E	Agricultural land	Ready for sowing >10acres	Mandvi	Bag
19	22° 51.047' N	069°24.141' E	Built up area	Township with good green cover Houses small red tiled roof.	Mandvi	Bag



20	22° 51.675' N	069°24.225' E	Water tank	Shallow water tank artificially created having stagnant water > 500 SqM	Mandvi	Bag
21	22° 51.648' N	069°24.224' E	Agricultural land	Harvested land, used for crop rotation. Crops like wheat, cotton, jowar, are cultivated in these land	Mandvi	Bag
22	22° 52.202' N	069°24.685' E	Agricultural land	Jowar crop ready for harvesting	Mandvi	Bag
23	22° 52.383' N	069°26.137' E	Built up area	Village settlement small houses with roofed top	Mandvi	Pipari
24	22° 53.874' N	069°26.949' E	Agricultural land	Chickoo plantation > 2-4 acres	Mandvi	Bidada
25	22° 53.215' N	069°53.215' E	Built up area	Temple Manav Mandir	Mandvi	Bidada
26	22° 53.750' N	069°28.447' E	Built up area	Human settlement	Mandvi	Bidada
27	22° 51.410' N	069°28.646' E	Built up area	Human settlement	Mandvi	Mota Bhadia
28	22° 50.210' N	069°29.017' E	Artificial lake	>50 acres No trace of water seen	Mandvi	Nana Bhadia
29	22° 48.179' N	069°32.078' E	Sandy Shore	Barren sandy area with no vegetation.	Mundra	Tunda wandh
30	22° 48.447' N	069°42.518' E	Built up area	Human settlement Houses are very peculiar dome shaped with mud wall and thatched roof.	Mundra	Tunda wandh
31	22° 48.881' N	069°32.060' E	Road	Junction road meeting project site with local road.	Mundra	Tunda wandh
32	22° 50.618' N	069°44.428' E	Built up	Houses with	Mundra	Baroi



			area	concrete walls with tiled roof		
33	22° 50.373' N	069°50.447' E	Road	Main Bus depo of Mundra city.	Mundra	
34	22° 50.665' N	069°41.799' E	Dried water coarces or nallah	Dried river trespassing the village	Mundra	Nana Kapaya
35	22° 50.589' N	069°41.663' E	Built up area	Main village	Mundra	Nana Kapaya
36	22° 51.010' N	069°40.465' E	Dried water coarces or nallah	Dried river trespassing the village.	Mundra	Borana
37	22° 51.186' N	069°40.020' E	Built up area	Main village	Mundra	Borana
38	22° 51.365' N	069°39.333' E	Artificial lake	Lake constructed	Mundra	Pratpara
39	22° 51.398' N	069°38.974' E	Built up area	Main village	Mundra	Pratpara
40	22° 51.639' N	069°38.464' E	Agricultu ral land	Castor plantation >5 acres.	Mundra	Bhujpur
41	22° 51.751' N	069°38.300' E	Agricultu ral land	Chickoo plantation inter spaced with kharik	Mundra	Bhujpur
42	22° 52.432' N	069°37.893' E	Built up area	Main village	Mundra	Bhujpur
43	22° 53.048' N	069°37.320' E	River	Nagvanthi river Completely dried.	Mundra	Bhujpur
44	22° 52.941' N	069°37.203' E	Agricultu ral land	Mango plantation Ready for harvesting	Mundra	Bhujpur
45	22° 50.400' N	069°35.823' E	Dried water coarces or nallah	Water coarce trespassing through Village	Mundra	Navianal
46	22° 50.010' N	069°35.907' E	Built up area	Human settlement	Mundra	Navianal
47	22° 49.863' N	069°35.892' E	Artificial lake	>25acres dried	Mundra	Navianal
48	22° 50.169' N	069°37.738' E	River	River crossing the road Dried	Mundra	Navianal



49	22° 50.202' N	069°39.027' E	Built up area	Human settlement	Mundra	Jarpara
50	22° 50.060' N	069°40.811' E	Built up area	Human settlement, Mosque	Mundra	Dhrab
51	22° 50.239' N	069°41.741' E	Highway	Zero point highway Junction leading to adani port	Mundra	Dhrab
52	22° 52.726' N	069°42.192' E	Highway	Bhuj- mundra Highway	Mundra	Mota Kapaya
53	22° 53.817' N	069°41.806' E	Highway	Highway junction near pangrapol Bhuj –mundra	Mundra	Pragpar
54	22° 55.045' N	069°41.089' E	Highway		Mundra	Baraya
55	22° 55.082' N	069°40.936' E	Dried river		Mundra	Baraya
56	22° 56.708' N	069°39.576' E	Built up area	Village settlement	Mundra	Karagoga
57	22° 57.861' N	069°38.899' E	Built up area	Human settlement	Mundra	Bocha
58	22° 58.107' N	069°38.907' E	Barren hilly area		Mundra	Bocha
59	22° 58.321' N	069°38.735' E	Barren hilly area	Rock cliffs	Mundra	Bocha
60	22° 58.637' N	069°38.556' E	Highway	Junction from Bocha village to Bhuj highway	Mundra	Bocha
61	23° 00.084' N	069°34.197' E	Built up area	Human settlement	Mundra	Tumbadi Moti
62	22° 59.945' N	069°33.600' E	Agricultural land	Fertile land for cultivation	Mundra	Moti Tumbadi
63	22° 59.680' N	069°32.446' E	Built up area	Temple	Mundra	Tumbadi Nani
64	22° 59.948' N	069°32.084' E	Barren hill		Mundra	Tumbadi Nani
65	22° 59.981' N	069°32.022' E	Built up area	Temple	Mundra	Tumbadi Nani
66	23° 00.185' N	069°31.672' E	Agricultural land	Fertile land admeasuring >10 acres	Mundra	Tumbadi Nani
67	23° 00.970' N	069°30.128' E	Built up area	Village settlement	Mandvi	Punadi
68	23° 01.080' N	069°28.346' E	Road	Road from Punadi to Mandvi	Mandvi	Punadi



				bhuj highway		
69	22° 59.743' N	069°27.273' E	Road	Junction point at Mota Asambia and Nana Asambia	Mandvi	Asambia Mota & Asambia Nana
70	22° 57.934' N	069°26.344' E	Highway	Junction of Mandvi –Bhuj highway leading to Mota Asambia	Mandvi	Asambia Mota
71	22° 58.526' N	069°26.621' E	Agricultural land	Cultivation of Jowar, ready for harvesting	Mandvi	Goniyasar Mota
72	22° 59.790' N	069°27.255' E	Agricultural field	>5-10 acres fertile land The area is fully infested with thorny undergrowth. These are considered as nuisance weeds, which makes the agricultural activities difficult	Mandvi	Goniyasar Mota



Chapter 4

SIGNIFICANT LAND USE FEATURES

The proposed power plant site is situated in the **Kuchch** district of Gujarat state. A study of the significant ground features were carried out in and around the site within the periphery of 30kms.radial distance from the project site. The study area falls under two Talukas viz, Mundra and Mandvi. There are more than 57 villages covered during the field visit.

1. General Phytogeography of the State of Gujarat

The state of Gujarat is situated on the west coast of India between 20° and 25° north latitude and 68° and 75° east longitudes. Its boundaries are defined by Arabian sea on the west, the state of Rajasthan on the north-east, Madhya Pradesh on the east and Maharashtra on the south east and south. On the north-western fringe it has a common boarder with Pakistan

The state of Gujarat has a landmass of 1,9602400 hectares that accounts for about 6 per cent area of the country which 23,34,400 hectares are under irrigation. The state has 8,48,300 hectares under permanent pasture and grazing land. In addition to this 8,62,800 hectares are under fodder crops. The state has 1600Km of coastal area. Rainfall varies from about 340mm in the western arid district of Kachch to about 1800mm in the southern hills of Dangs and Bulsar. The climate varies from arid to dry sub-humid in Kachch and Bulsar districts. Nearly 25% of the geographical area in the western part is arid.

From the point of view of the forest distribution and description of vegetation the whole of the state can be divided into three distinct zones viz, area of the south of the Narmada consisting of deciduous forests with teak as the main economic species, the areas between



the river Narmada and the extreme north excluding Saurashtra and Kutch covering dry deciduous forests with or without teak, and the area of Saurashtra and Kutch with poor teak forests in Junagadh, scrublands, mangrove forests and desert areas.

2. The Topography of the area covered under study

The present study area falls in Kutch peninsula. The topography of the area is such that the central portion forms the table land sloping on all sides. It is practically an undulating rocky area with small hills and with rann of Kutch lying on the northern end, consisting of vast expanse of tidal mud flats with salt-encrusted mud. The soil vary a great deal from place to place, along the coastline, there are alluvial soil and in some parts they are saline. There are also areas with sandy soil.



Photo No-1: General Topography of the area

2.1 General pattern of vegetation

The forest type of the area falls under scrub forest as per the classification of Champion and Seth (1968). These forests are typical of arid and semi-arid zones of the earth where

the total rainfall ranges from 25-100Cm. The vegetation presents a very open appearance so that the trees and shrubs are widely spaced. The bulk of the vegetation consist of co-dominant, spinous shrubs and trees capable of drought resistance.

The typical species found in these areas are given in the following photographs.



Photo No -2: *Dichrostachys cinerea* Photo No:-3 *Capparis decidua*



Photo No-4: *Prosopis juliflora* (swartz) DC.

2.2 Agricultural crops

The major agricultural crops cultivated in the area are Jowar, wheat, cotton, castor etc. Fruit trees like sapota, mango, are also cultivated in some part of the district. The most

dominant species which is found growing in almost all parts of the district is **Phoenix robusta** (Bell.) Bell. & Hook. f. locally known as Kharik. It is a commercial crop cultivated for its edible fruits.



Photo No 5: Phoenix robusta (Bell.) Bell. & Hook.f.

3. Land use pattern of the study area

The following are the significant land use features encountered during the ground truthing survey:

3.1. Open scrub forest

Most of the land area of the district is covered by scrub forest, which is either exposed or sparsely covered by vegetation cover.



Photo No-6: Open scrub forest

3. 2. Barren hilly areas

These areas are mostly seen on both side of the Bhuj- Mundra highway. These are open dry land without any vegetation cover. There are no water bodies present in and around these sites.



Photo No-7 : Barren hilly areas

3.3. Agricultural land

These are agricultural lands spread like the huge tract of land admeasuring 10-50 Acres of area, divided into small, medium and large plots. These lands are found under the possession of landlord or individual farmers. Different agricultural crops such are cotton, jowar, bajra, wheat etc. are cultivated in these plots. Such agricultural lands are found in the villages like Nana Bhadia, Gundiya, Maska, etc. Presently these agricultural fields are tilled and exposed to sun. The sowing is done immediately after the fall of the first shower.

Agricultural land with different crop type, different stage of cultivation such as harvested field, ready for harvesting, standing crop etc. are also covered in the ground truthing survey.

Each of these plot is bordered on four sides with tall perennial species like coconut, Kharik etc.



Photo No-8 : Typical view of agricultural field

3.4. Sandy shore

Are mostly seen in the coastal belt and are subjected to all extremes such as temperature, salinity, turbidity, wave action etc. There are no vegetation seen on these sites, however there are some faunal intertidal molluscan species visits these sites occasionally. The remnants of their shells are most frequently seen.



Photo No-9: Sandy Shore

3.5. Built up area

Are mostly restricted near the village headquarters where the village sarpanch and other infrastructural facilities like schools, hospitals, temple, mosque, market etc are located. Every village has a central point where the human settlement is maximum.



Photo No-10 : Built up areas



3.6. Roads and Highways

There are two major highways passing through the project site viz, Mundra – Bhuj Highway (SH-48) and Mandvi – Bhuj Highway (SH-47). Apart from this another major road (SH-6) connecting the two highways trespasses through the project boundary.



Photo No-11: Highway at zero point

3.7. Rivers

There are two major perennial rivers viz Nagvati and Rukmavathi rivers passes through the project boundary. These rivers are the only water sources for the entire area.



Photo No-12: Rukmavathi River

3.8. Dried water courses or Nallah

There are many small river courses or nallah passing through each village. They are highly seasonal and the water is available only in the limited period of the year. In summer these rivers are literally dry.

3.9. Artificial lake

With the Governments active participation and the sramadhan from the local people there are many artificial lakes constructed. The main purpose is to store water to make it available throughout the year. These lakes are seen in villages like Gundiyali, Tragadia , etc. Many of them are very huge covering more than an area of 25-30 acres.



Photo No-13: Artificial lake at Gundiyali village

3.10. Water tank

These are structures used for storing water to meet the day to day agricultural and livestock requirement. The water is pumped from the ground water which is 200 - 300meters below and stored on the surface in small artificially made water tanks. Such water bodies are recorded from the village Bag, Gundiyali, etc.



Photo No-14: Water Tank at Bag village



Chapter 5.0

SATELLITE DATA INTERPRETATION - CLASSIFICATION

The landuse-landcover in the region comprises of various types, referred as classes. The features derived from the satellite image after validation by the ground observations, have been presented as nine classes and are given below. These classifications types are as per the 'level classification' categories followed by National Remote Sensing Agencies (NRSA), -

1. Cultivated Land
2. Fallow Land
3. Built-up Area
4. Water Bodies
5. Barren Area
6. Marshy Land / Low Land
7. waste land
8. Forest Cover
9. Sparse Forest



Satellite data from IRS-P6 (November 26, 2005) has been used . The approach used for analysis is given at the Chapter 2.0.

Inorder to understand the land use and land features covering the entire study region, both False Composite and classified images have been derived. FCC images depicts the land features such as the coastal boundaries, while the classified images show different land use classes listed above. The coverage statistics, the area covered by each land use class, are also derived through satellite data analysis and given below in different Tables.

FCC and Classified images have been derived for 30kms 20 kms , 10kms and 5kms

The images classified into the above-mentioned nine classes for different regions of interest are given at Exhibits, . Brief description of each type of the class forming landuse-landcover, derived from the satellite data analysis and the ground observations, is depicted in the classified image. Here, it is advised that the photographs given at the Chapter 4.0 are also referred.

The coverage areas of these nine classes of land use existing in the study region have also been derived from the satellite image analysis. The statistical percentage of these various classes, forming the land use/land cover, is also derived for the different regions of interest, 30kms, 20kms., 10kms, and 5kms .

**Table 2:**

Land Use Types and Its Coverage within 5, 10 and 30 Km. radius (Statistical Percentages)

LAND USE CLASSESS WITHIN 5 KM RADIUS

Classes	Area (Km²)
Scrub forest	1.326274637
Salt Pan	8.319278704
Mangrove	0.054819352
Built up area	14.78530965
Fallow land	18.88261409
Nallah	7.241459516
Agricultural land	5.15743997
Water Bodies	5.406779602
Barren hill	5.210490956
Marshy Land	12.89581038
Total	79.28027686

LAND USE CLASSESS WITHIN 10 KM RADIUS

Scrub forest	2.829385891
Salt Pan	13.23445251
Mangrove	0.719725036
Built up area	44.29934123
Fallow land	70.77974062
Nallah	15.3839016
Agricultural land	33.14890827
Water Bodies	63.53651274
Barren hill	25.53697604
Marshy Land	46.71581362
Total	316.1847575

LAND USE CLASSESS WITHIN 30 KM RADIUS

Scrub forest	53.16239253
Salt Pan	32.66260757
Mangrove	6.764000647
Built up area	280.4018678
Fallow land	443.8271969
Nallah	84.7790115
Agricultural land	158.2316376
Water Bodies	515.5998752
Barren hill	414.0859303
Marshy Land	120.9942667
Total	2110.508787

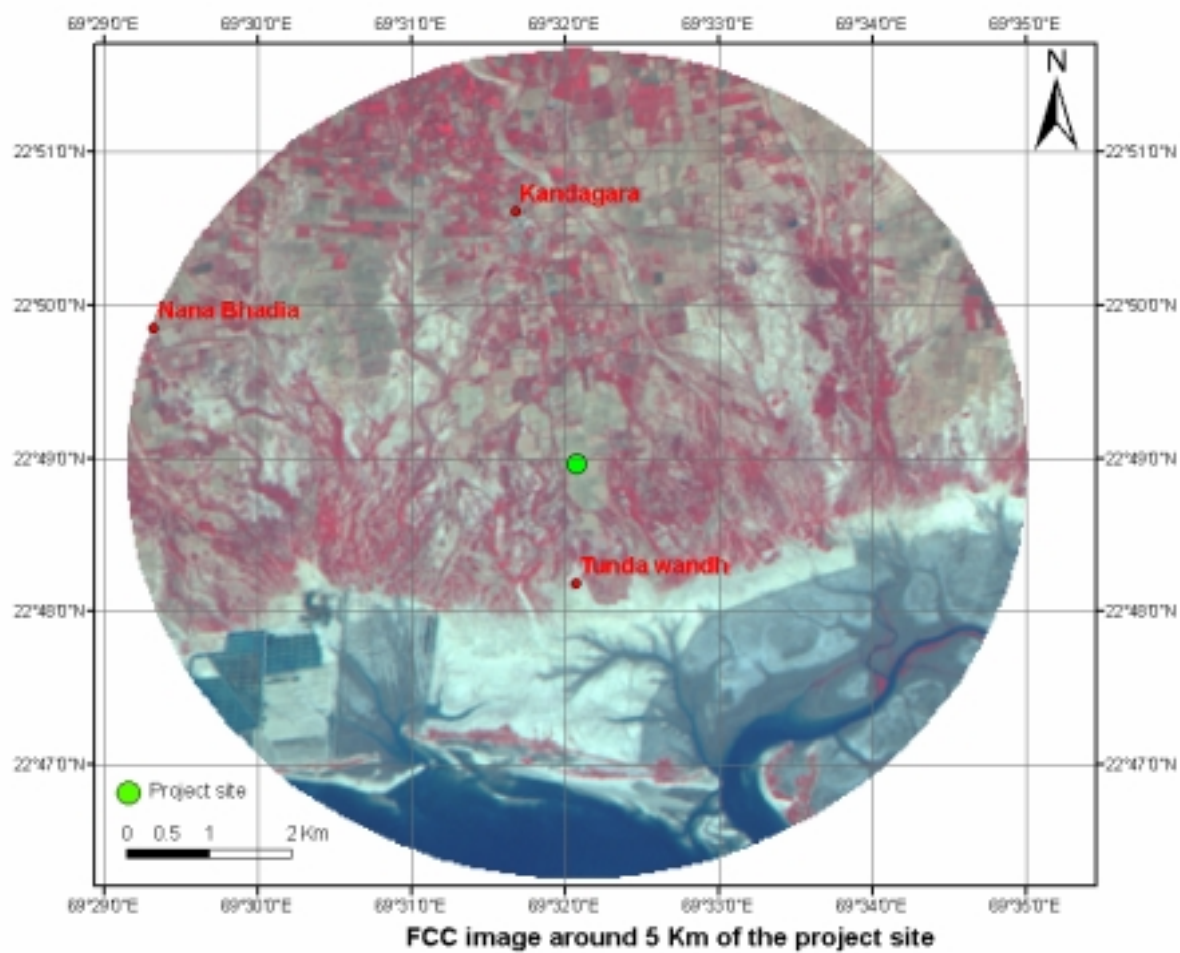
**Figure 1**

Figure 2

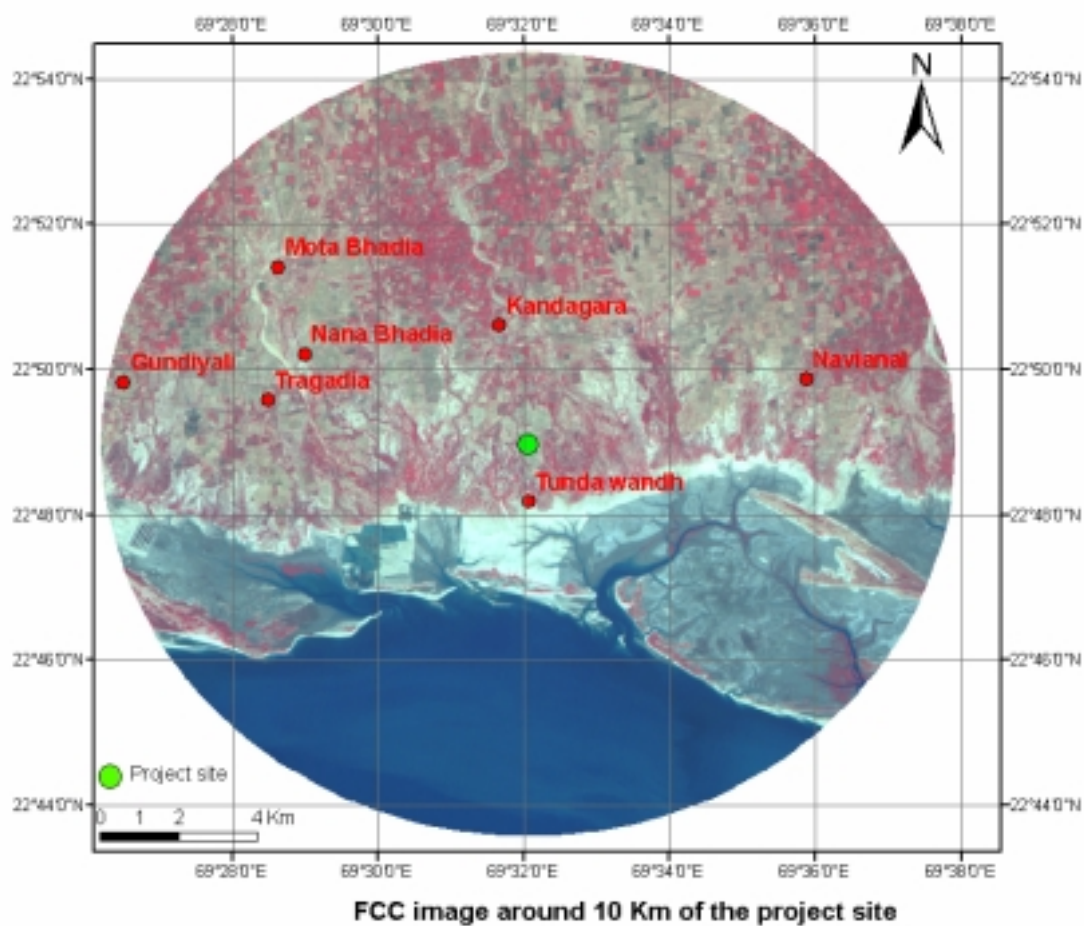




Figure 3

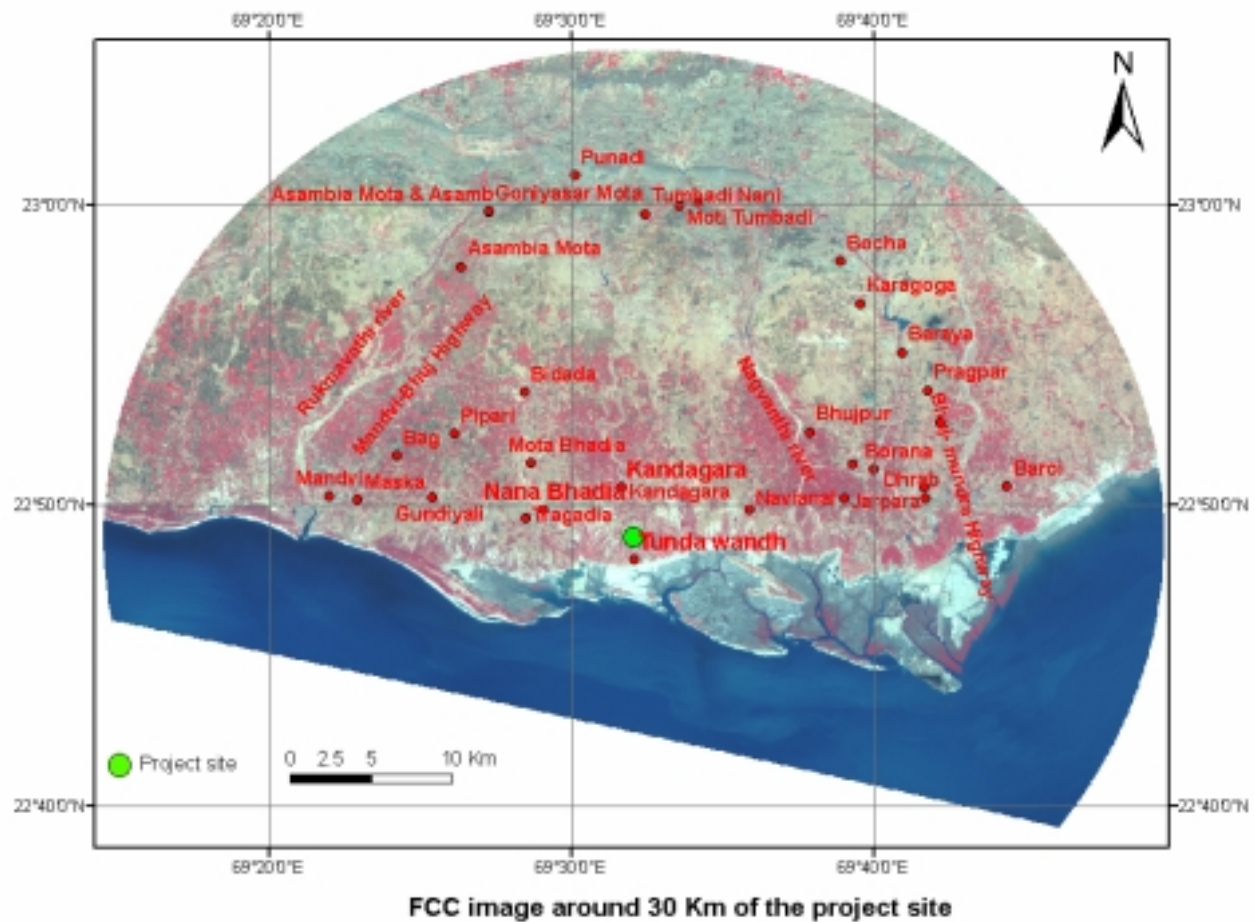




Figure 4

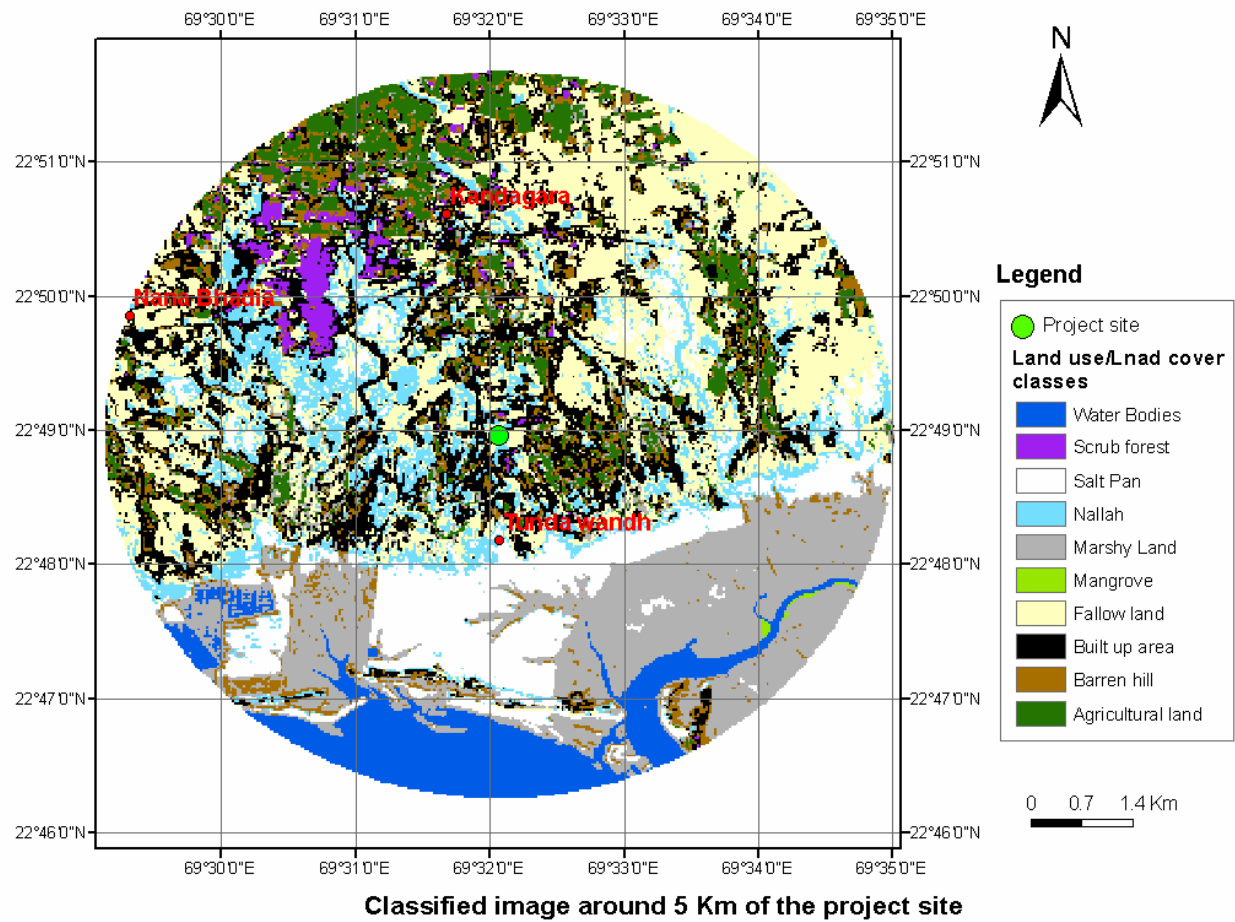




Figure 5

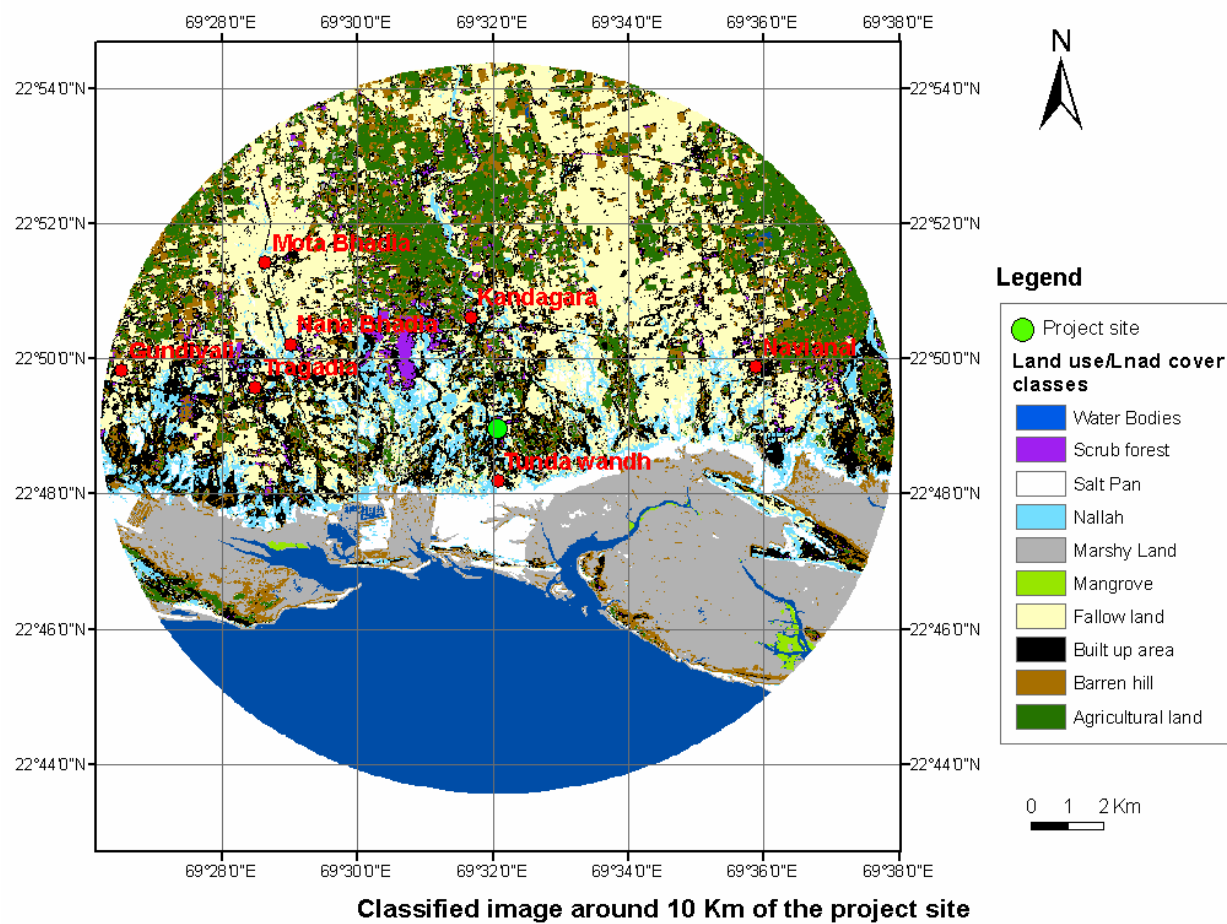
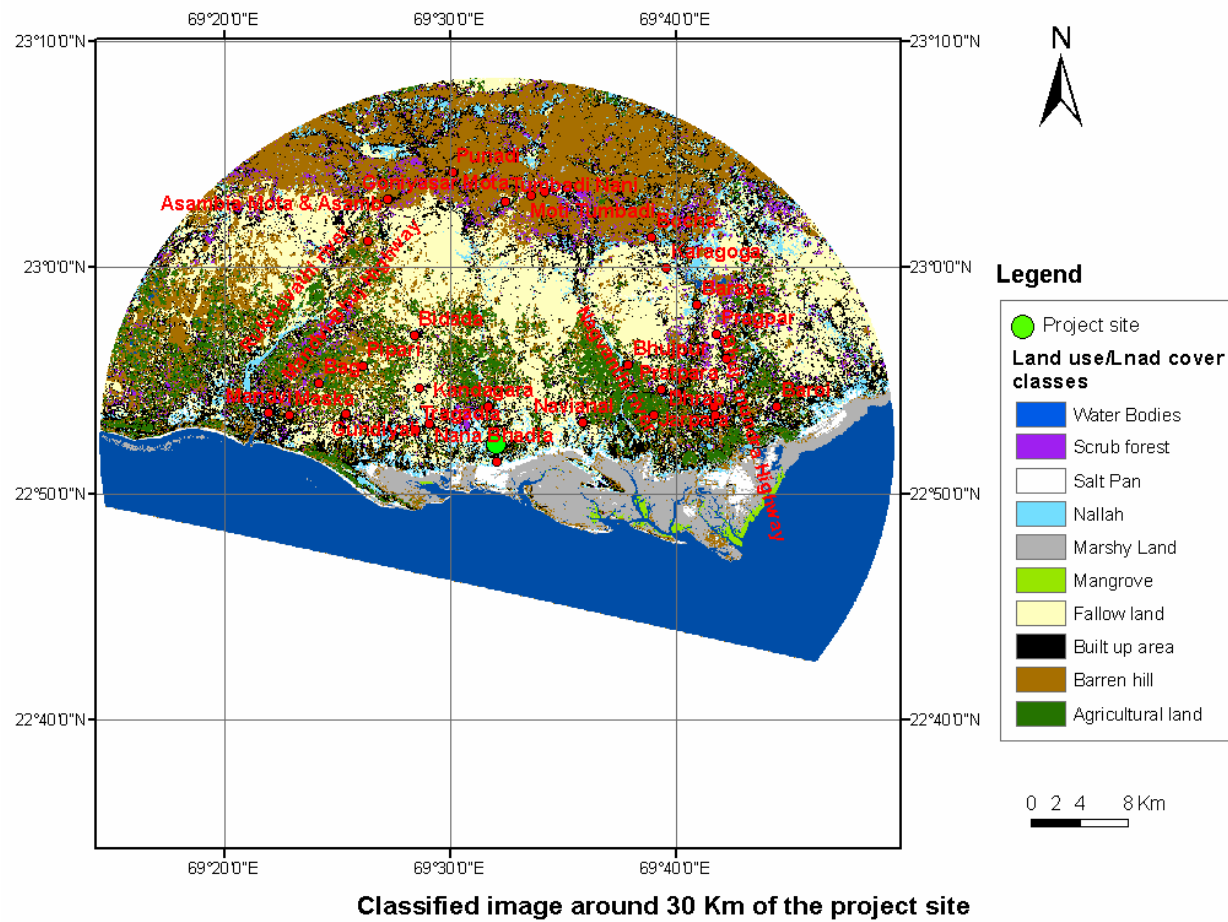




Figure 6



APPENDIX - 17

VIEW OF BARREN PROJECT SITE AREA WITHOUT TREE AND HABITATION



APPENDIX - 18

A TYPICAL OPEN SCRUB VEGETATION OF THE STUDY AREA



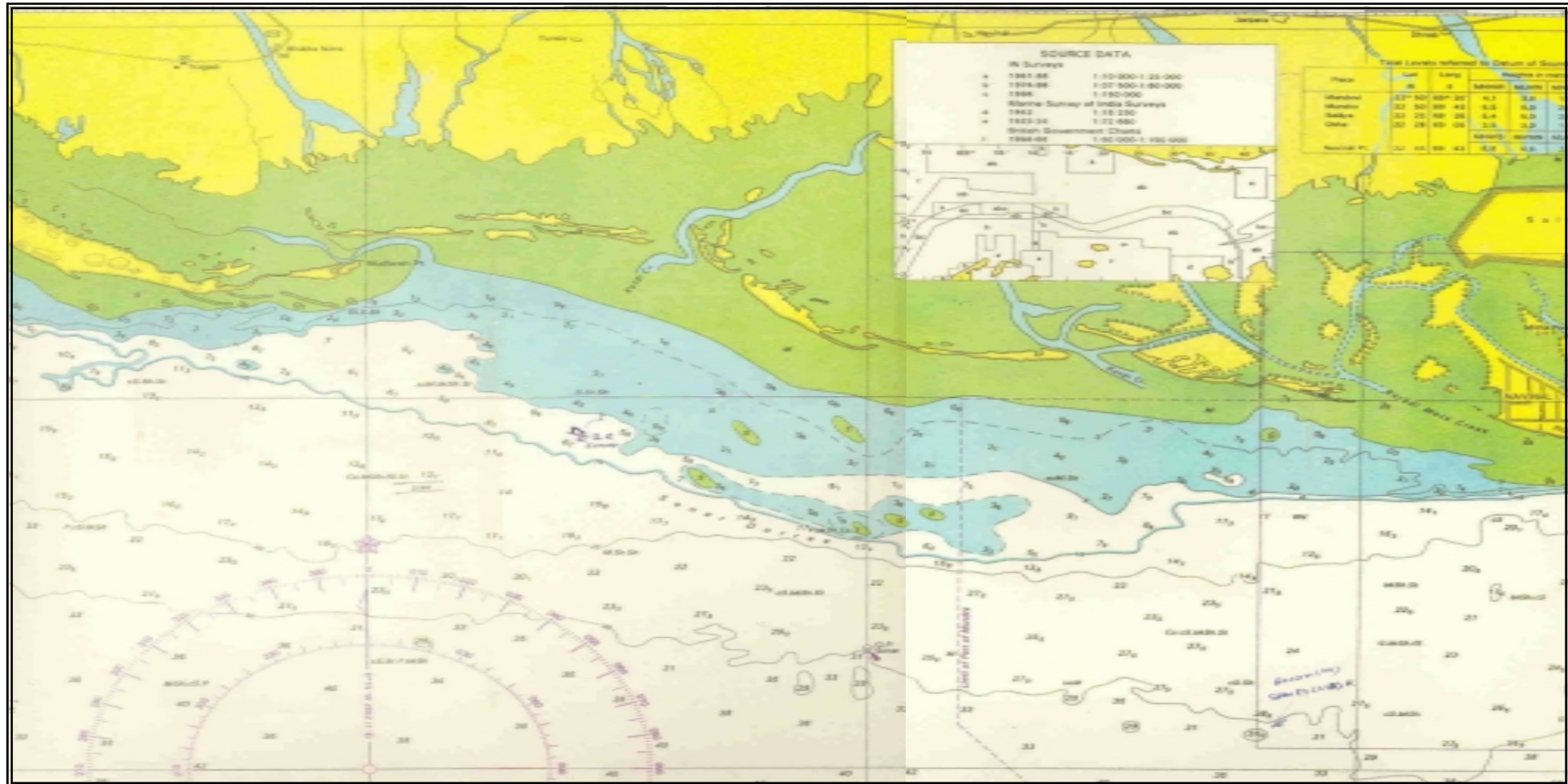
APPENDIX - 19

TYPICAL PHOTOGRAPH OF SAND DUNE AROUND THE SPECIES OF *Prosopis juliflora*



APPENDIX - 20

TOPOGRAPHIC FEATURE OF THE AREA COVERED FOR MARINE ECOLOGICAL STUDY



APPENDIX - 21

THE BOATS USED FOR MARINE SAMPLING



APPENDIX - 22

BIRDS SEEN AT MANDVI BEACH



APPENDIX - 23

A VIEW OF THE BEACH LOCATED NEAREST TO THE PROJECT SITE



APPENDIX - 24

DOMINANT MANGROVE *Avicennia marina* SPECIES OF THE STUDY AREA



APPENDIX – 25a
STABILITY CLASS AND MIXING HEIGHT FOR SUMMER 2006

Hours	Stability Class	Mixing Height
1	F	155
2	F	155
3	E	155
4	E	300
5	E	300
F	E	500
7	D	800
8	C	1500
9	C	2500
10	B	3500
11	B	5228
12	A	5228
13	A	5228
14	B	3500
15	B	2000
1F	C	2000
17	C	1500
18	E	1000
19	E	800
20	E	800
21	E	600
22	E	500
23	E	250
24	F	250

APPENDIX – 25b
STABILITY CLASS AND MIXING HEIGHT FOR POST-MONSOON 2006

Hours	Stability Class	Mixing Height
1	F	155
2	F	155
3	E	155
4	E	200
5	E	300
F	E	400
7	D	650
8	C	1100
9	C	1800
10	B	2500
11	B	2700
12	A	3150
13	A	3150
14	B	2700
15	B	2500
1F	C	2200
17	C	1800
18	E	1100
19	E	650
20	E	350
21	E	200
22	E	200
23	E	155
24	F	155

APPENDIX – 25c
STABILITY CLASS AND MIXING HEIGHT FOR WINTER 2006

Hours	Stability Class	Mixing Height
1	F	155
2	F	155
3	E	155
4	E	200
5	E	200
F	E	350
7	D	550
8	C	1000
9	C	1700
10	B	2350
11	B	2500
12	A	2850
13	A	2850
14	B	2500
15	B	2350
1F	C	2100
17	C	1700
18	E	1000
19	E	550
20	E	350
21	E	200
22	E	200
23	E	155
24	F	155

APPENDIX – 26

ENVIRONMENTAL STANDARDS FOR POWER PLANTS

(i) Thermal Power Plant : Emission Standards

Generation Capacity	Pollutant	Emission limit
Generation capacity 210 MW or more	Particulate matter	150 mg/Nm ³
Generation capacity less than 210 MW	Particulate matter	300 mg/Nm ³

Depending upon the requirement of local situation, such as protected area, the State Pollution Control Boards and other implementing agencies under the Environment (Protection) Act, 1986, may prescribe a limit of 150 mg/Nm³, irrespective of generation capacity of the plant.

(ii) Thermal Power Plants : Stack Height/Limits

Generation Capacity	Stack Height (Metres)
500 MW and above	275
200 MW/210 MW and above to less than 500 MW	220
Less than 200 MW/210 MW	$H = 14 Q^{0.3}$ where Q is emission rate of SO ₂ in kg/hr, and H is Stack height in meters, subject to a minimum of 30 meters.

Source : EPA Notification
[G.S.R. 742(E), dt. 30th Aug; 1990]

(iii) Liquid waste discharge limit

Parameter	Maximum limit of concentration (mg/l except for pH and temperature)
pH	6.5-8.5
Temperature	As applicable for other thermal power plants
Free available chlorine	0.5
Suspended solids	100.0
Oil and grease	20.0
Copper (total)	1.0
Iron (total)	1.0
Zinc	1.0
Chromium (total)	0.2
Phosphate	5.0

Source:MOEF New Delhi Notification G.S.R.7. dated 22.12.1998

APPENDIX -27

TEMPERATURE LIMIT FOR DISCHARGE OF CONDENSER COOLING WATER FROM THERMAL POWER PLANT

A: New thermal power plants, which will be using water from rivers/lakes/reservoirs, shall install cooling towers irrespective of location and capacity. Thermal power plants which will use sea water for cooling purposes, the condition below will apply.

B: New projects in coastal areas using sea water.

The thermal power plants using sea water should adopt suitable system to reduce water temperature at the final discharge point so that the resultant rise in the temperature of receiving water does not exceed 7°C over and above the ambient temperature of the receiving water bodies.

C: Existing thermal power plants.

Rise in temperature of condenser cooling water from inlet to the outlet of condenser shall not be more than 10°C.

D: Guidelines for discharge point:

The discharge point shall preferably be located at the bottom of the water body at mid-term for proper dispersion of thermal discharge.

In case of discharge of cooling water into sea, proper marine outfall shall be designed to achieve the prescribed standards. The point of discharge may be selected in consultation with concerned State Authorities/NIO.

No cooling water discharge shall be permitted in estuaries or near ecologically sensitive areas such as mangroves, coral reefs/spawning and breeding grounds of aquatic flora and fauna.

Source:MOEF New Delhi Notification G.S.R.7. dated 22.12.1998

APPENDIX-27 MATERIAL SAFETY DATA SHEET-----ISSUED: 10/23/97

CHLORINE

REVISED: 11/01/99

SECTION I - PRODUCT IDENTIFICATION

Westlake CA&O
2468 Industrial Parkway
P O Box 527
Calvert City, KY 42029

Telephone No.: (270) 395-4151
Transportation Emergency No.:
CHEMTREC: (800) 424-9300
Medical Emergency No.:
POISON CENTER: (216) 379-8562

Chemical Family: Halogen
Chemical Name/Synonyms: Chlorine
Trade Mark: None
Formula: Cl₂; (Cl-Cl)
C.A.S. Registry No.: 7782-50-5
TSCA Inventory Status: All ingredients are listed on the USEPA's TSCA inventory
Canadian Domestic Substances List Status: All ingredients have been nominated or are eligible for inclusion.
Workplace Hazardous Materials Information System (WHMIS) Classification: C,E
Product Use: Various Applications
SARA 313 Information: This product contains a toxic chemical or chemicals subject to the reporting requirements of section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR part 372.

SECTION II - HAZARDOUS INGREDIENTS

Hazard Summary Statement: WARNING! HIGHLY TOXIC. CORROSIVE. May be fatal if inhaled. Strong oxidizer. Most combustibles will burn in chlorine as they do in oxygen. Read entire Material Safety Data Sheet (MSDS).

<u>Material</u>	<u>C.A.S. Number</u>	<u>Amount in Product</u>	<u>ACGIH TLV-TWA</u>	<u>OSHA PEL-TWA</u>
Chlorine ^{1,2,4,5,6}	7782-50-5	> 99.5%	0.5 ppm 1 ppm short term exposure limit (STEL)	1 ppm - ceiling

N.A. - Not Applicable

N.E. - Not Established

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Legislative Footnotes

¹Ingredient listed on SARA Section 313 List of Toxic Chemicals.

²Ingredient listed on the *Pennsylvania Hazardous Substances List*.

³Ingredient listed on the California listing of *Chemicals Known to the State to Cause Cancer or Reproductive Toxicity*.

⁴Ingredient listed on the *Massachusetts Substance List*.

⁵*Workplace Hazardous Materials Information System* ingredient found on the Ingredient Disclosure List - Canada.

⁶Ingredient listed on the *New Jersey Right to Know Hazardous Substance List*.

Notes:

TLV-TWA - Threshold Limit Value - Time Weighted Average guideline for concentration of the chemical substance in the ambient workplace air. (The skin notation calls attention to the skin as an additional significant route of absorption of the listed chemical.) American Conference of Governmental Industrial Hygienists (ACGIH).

OSHA PEL - OSHA Permissible Exposure Limit, 8-hour TWA. 29 CFR 1910.1000, Transitional Limits column, Table Z-1-A, Table Z-2, and Table Z-3.

SECTION III - PHYSICAL DATA

Appearance: Greenish-yellow gas
or amber liquid

Odor: Pungent, suffocating bleach
like odor

Percent Volatiles: >99.5

Solubility in Water: Slight

Physical State: Gas (liquid under pressure)

Specific Gravity: Dry Gas (2.48 @ 0°C)
Liquid (1.47 @ 0/4°C)

Melting Point: -101°C (-150°F)

Molecular Weight: 70.9

Vapor Pressure: 73 psia @ 50°F

Vapor Density: 2.5 (Air=1)

SECTION IV - FIRE & EXPLOSION HAZARD DATA

Flash Point: Test is not applicable to gases. Not combustible. Chlorine can support combustion and is a serious fire risk.

Flammable Limits in Air: Not Applicable

Note:

Flash Point: The lowest initial temperature of air passing around the specimen at which sufficient combustible gas is evolved to be ignited by a small external pilot flame.

Extinguishing Media: For small fires use dry chemical or carbon dioxide. For large fires use water spray, fog or foam.

Special Firefighting Procedures: Wear full face positive pressure self-contained breathing apparatus (SCBA). Wear full protective gear to prevent all body contact (moisture or water and chlorine can form hydrochloric and hypochlorous acids which are corrosive). Personnel not having suitable protection must leave the area to prevent exposure to toxic gases from the fire. Use water to keep fire-exposed containers cool (if containers are not leaking). Use water spray to direct escaping gas away from workers if it is necessary to stop the flow of gas. In enclosed or poorly ventilated areas, wear SCBA during cleanup immediately after a fire as well as during the attack phase of firefighting operations.

Unusual Fire and Explosion Hazards: Chlorine and water can be very corrosive. Corrosion of metal containers can make leaks worse. Although non-flammable, chlorine is a strong oxidizer and will support the burning of most combustible materials. Flammable gases and vapors can form explosive mixtures with chlorine. Chlorine can react violently when in contact with many materials and generate heat with possible flammable or explosive vapors. Chlorine gas is heavier than air and will collect in low-lying areas.

Explosive Characteristics: Containers heated by fire can explode.

SECTION V - Reactivity

Stability: Stable

Hazardous Polymerization: Will not occur.

Hazardous Decomposition Products: Hydrogen chloride may form from chlorine in the presence of water vapor.

CAUTION! Oxidizer. Extremely reactive.

Incompatibility (Materials to Avoid): Chlorine is extremely reactive. Liquid or gaseous chlorine can react violently with many combustible materials and other chemicals, including water. Metal halides, carbon, finely divided metals and sulfides can accelerate the rate of chlorine reactions. Hydrocarbon gases, e.g., methane, acetylene, ethylene or ethane, can react explosively if initiated by sunlight or a catalyst. Liquid or solid hydrocarbons, e.g., natural or synthetic rubbers, naphtha, turpentine, gasoline, fuel gas, lubricating oils, greases or waxes, can react violently. Metals, e.g., finely powdered aluminum, brass, copper, manganese, tin, steel and iron, can react vigorously or explosively with chlorine. Nitrogen compounds, e.g., ammonia and other nitrogen compounds, can react with chlorine to form highly explosive nitrogen trichloride.

e.g., phosphorous, boron, activated carbon and silicon can ignite on contact with gaseous chlorine at room temperature. Certain concentrations of chlorine-hydrogen can explode by spark ignition. Chlorine is strongly corrosive to most metals in the presence of moisture. Copper may burn spontaneously. Chlorine reacts with most metals at high temperatures. Titanium will burn at ambient temperature in the presence of dry chlorine.

SECTION VI - HEALTH HAZARD DATA

Threshold Limit Value: See Section II.

Primary Routes of Exposure: Inhalation, skin and eye contact.

Effects of Overexposure:

Acute: Low concentrations of chlorine can cause itching and burning of the eyes, nose, throat and respiratory tract. At high concentrations chlorine is a respiratory poison. Irritant effects become severe and may be accompanied by tearing of the eyes, headache, coughing, choking, chest pain, shortness of breath, dizziness, nausea, vomiting, unconsciousness and death. Bronchitis and accumulation of fluid in the lungs (chemical pneumonia) may occur hours after exposure to high levels. Liquid as well as vapor contact can cause irritation, burns and blisters. Ingestion can cause nausea and severe burns of the mouth, esophagus and stomach.

Chronic: Prolonged or repeated overexposure may result in many or all of the effects reported for acute exposure (including pulmonary function effects).

Emergency and First Aid Procedures:

Inhalation (of process emissions): Take proper precautions to ensure rescuer safety before attempting rescue (wear appropriate protective equipment and utilize the "buddy system"). Remove source of chlorine or move victim to fresh air. If breathing has stopped, trained personnel should immediately begin artificial respiration or, if the heart has stopped, cardiopulmonary resuscitation (CPR). Avoid mouth-to-mouth contact. Oxygen may be beneficial if administered by a person trained in its use, preferably on a physician's advice. Obtain medical attention immediately.

Eye Contact: Immediately flush the contaminated eye(s) with lukewarm, gently flowing water for at least 20 minutes while the eyelid(s) are open. Take care not to rinse contaminated water into the non-affected eye. If irritation persists, obtain medical attention immediately.

Skin Contact: As quickly as possible, flush contaminated area with lukewarm, gently running water for at least 20 minutes. Under running water, remove contaminated clothing, shoes, and leather watchbands and belts. If irritation persists, obtain medical attention immediately. Completely decontaminate clothing, shoes and leather goods before re-use, or, discard.

Ingestion: Not an anticipated hazard.

SECTION VII - SPILL & LEAK PROCEDURE

Steps to be taken in case material is released or spilled: Restrict access to the area until completion of the cleanup. Issue a warning: POISON GAS. DO NOT TOUCH SPILLED LIQUID. Do not use water on a chlorine leak (corrosion of the container can occur, increasing the leak). Shut off leak if safe to do so. Wear NIOSH/MSHA-approved, self-contained, full-face, positive pressure respirator and full protective clothing capable of protection from both liquid and gas phases. Persons without suitable respiratory and body protection must leave the area.

The following evacuation guide was developed by the U.S. Department of Transportation (DOT): Spill or leak from a smaller container or small leak from a tank - isolate in all directions 250 feet. Large spill from a tank or from a number of containers - first, isolate 520 feet in all directions; secondly, evacuate in a downwind direction 1.3 miles wide and 2.0 miles long. Keep upwind from leak. Vapors are heavier than air and pockets of chlorine are likely to be trapped in low-lying areas. Use water spray on the chlorine vapor cloud to reduce vapors. Do not flush into public sewer or water systems. Chlorine can be neutralized with caustic soda or soda ash. Alkaline solutions for absorbing chlorine can be prepared as follows:

For 100 pound containers: 125 lbs. of caustic soda and 40 gallons of water

For 2,000 pound containers: 2,500 lbs. of caustic soda and 800 gallons of water

For 100 pound containers: 300 lbs. of soda ash and 100 gallons of water

For 2,000 pound containers: 6,000 lbs. of soda ash and 2,000 gallons of water

CAUTION: Observe appropriate safety precautions for handling alkaline chemicals. Heat will be generated during the neutralization process.

Waste Disposal Method: Due to its inherent properties, hazardous conditions may result if the material is managed improperly. It is recommended that any containerized waste chlorine be managed as hazardous waste in accordance with all applicable federal, state, and local health and environmental laws and regulations.

SECTION VIII - SPECIAL PROTECTION INFORMATION

Ventilation: Effective exhaust ventilation should always be provided to draw fumes or vapors away from workers to prevent routine inhalation. Ventilation should be adequate to maintain the ambient workplace atmosphere below the legislated levels listed in Section II.

Respiratory Protection: Use NIOSH approved acid gas cartridge or canister respirator for routine work purposes when concentrations are above the permissible exposure limits. Use full facepiece respirators when concentrations are irritating to the eyes. A cartridge-type escape respirator should be carried at all times when handling chlorine for escape only in case of a spill or leak. Re-enter area only with NIOSH approved, self-contained breathing apparatus with full facepiece. The respiratory use limitations made by NIOSH or the manufacturer must be observed. Respiratory protection programs must be in accordance with 29 CFR 1910.134.

Eye/Face Protection: Non-ventilated chemical safety goggles or a full face shield.

Skin Protection: Wear impervious gloves, coveralls, boots and/or other resistance protective clothing. Safety shower/eyewash fountain should be readily available in the work area. Some operations may require the use of an impervious full-body encapsulating suit and respiratory protection.

Note: Neoprene, polyvinyl chloride (PVC), Viton, and chlorinated polyethylene show good resistance to chlorine.

Additional: Do not eat, drink or smoke in work areas. Maintain good housekeeping.

SECTION IX - SPECIAL PRECAUTIONS

Material Handling: Do not use near welding operations, flames or hot surfaces. Move cylinders by hand truck or cart designed for that purpose. Do not lift cylinders by their caps. Do not handle cylinders with oily hands. Secure cylinders in place in an upright position at all times. Do not drop cylinders or permit them to strike each other. Leave valve cap on cylinder until cylinder is secured and ready for use. Close all valves when not in actual use. Insure valves on gas cylinders are fully opened when gas is used. Open and shut valves at least once a day while cylinder is in use to avoid valve "freezing". Use smallest possible amounts in designated areas with adequate ventilation. Have emergency equipment for fires, spills and leaks readily available. Wash thoroughly after handling product. Provide a safety shower/eyewash station in handling area. An emergency contingency program should be developed for facilities handling chlorine.

Storage: Store in steel pressure cylinders in a cool, dry area outdoors or in well-ventilated, detached or segregated areas of noncombustible construction. Keep out of direct sunlight and away from heat and ignition sources. Cylinder temperatures should never exceed 51°C (125°F). Isolate from incompatible materials. Store cylinders upright on a level floor secured in position and protected from physical damage. Use corrosion resistant lighting and ventilation systems in the storage area. Keep cylinder valve cover on. Label empty cylinders. Store full cylinders separately from empty cylinders. Avoid storing cylinders for more than six months. Comply with applicable regulations for the storage and handling of compressed gases.

SECTION X - HAZARD CODES

NFPA

(National Fire Protection Association)

Health:	4
Flammability:	0
Reactivity:	0
Special:	OXY

HMIS

(Hazardous Materials Identification System)

Health:	3
Flammability:	0
Reactivity:	0
Personal Protection:	X*

Key:

0 = Insignificant

1 = Slight

2 = Moderate

3 = High

4 = Extreme

(MSDS - Chlorine)

* See MSDS for specified protection

USER'S RESPONSIBILITY

This bulletin cannot cover all possible situations which the user may experience during processing. Each aspect of the user's operation should be examined to determine if, or where, additional precautions may be necessary. All health and safety information contained within this bulletin should be provided to the user's employees or customers. Westlake CA&O Corporation must rely upon the user to utilize this information to develop appropriate work practice guidelines and employee instructional programs for his or her operation.

DISCLAIMER OF LIABILITY

As the conditions or methods of use are beyond our control, we do not not assume any responsibility and expressly disclaim any liability for any use of this material. Information contained herein is believed to be true and accurate but all statements or suggestions are made without warranty, expressed or implied, regarding the accuracy of the information, the hazards connected with the use of the material or the results to be obtained from the use thereof. Compliance with all applicable federal, state and local laws and regulations remains the responsibility of the user.

SHIPPING INFORMATION

IDENTIFICATION - DOMESTIC TRANSPORTATION

Proper Shipping Name (172.101(c)): **Chlorine**

(Technical Name(s)) 172.203(k): **N/A**

Hazard Class 172.101(d): **2.3**

UN/NA# 172.101(e): **UN 1017**

Haz. Substance 171.8: **RQ (Chlorine)**

Reportable Quantity (Appendix A to 172.101): **10 LB**

Inhalation Hazard 172.2a(b): **Zone B, Poison-Inhalation Hazard, Marine Pollutant**

Package Code 172.101(f): **N/A**

Placarded: **Poison Gas**

PACKAGING (Part 173)

- ♦ Packaging Section (172.101(i)) - Col. 8(a): None
Col. 8(b): 173.304
Col. 8(c): 173.314, 173.315

- ♦ General Packaging Section - General 173.24

Hazard Class: **POISON GAS**

MARKING

A. Proper Shipping Name (172.301(a)) (Technical Name) (172.301(b))

B. UN / NA Number (172.301(a))

C. Name & Address (172.301(d))

D. THIS END UP (172.312(a))

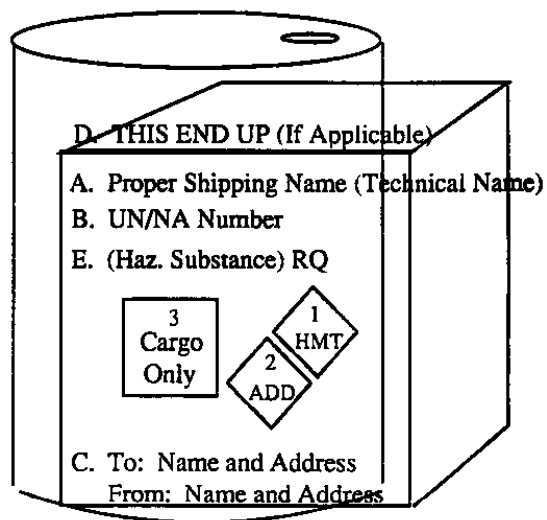
E. Hazardous Substance RQ (Name) (172.324)

ORM Designation (172.316(a))

Inhalation Hazard (172.313(a))

DOMESTIC LABELING

1. HMT LABELS (172.400)
2. Additional Subsidiary Hazard (172.402(a)):
8 (Corrosive)



DANGEROUS GOODS DETERMINATION (38th Edition) IATA

- ♦ Air Transport of This Material if Forbidden (Passenger and Cargo)

APPENDIX – 29

ASH UTILIZATION PLAN

Ash utilization is the need of time that check the degradation of environment and helps in meeting the stipulated environmental regulations. Ministry of Environment and Forest's notification on Ash Utilization dated 14.09.1999 stipulates that new thermal power plants shall have to utilize ash to the extent of 30% in first 3 years of commissioning and to attain 100% utilization by 9th year. Keeping in view, the above stipulation CGPL/ Power developer would consider the brief study for maximum utilization of fly ash.

The study has revealed, inter alia, there will be an annual production of 14.4 crores bricks considering 10% fly ash in making bricks. If Fal-G bricks, which utilizes pozzolanic properties of fly ash without any requirement of sintering, thus saving valuable energy as well as requirement of sintering, thus saving valuable energy as well as topsoil of this fertile land being used in making conventional clay bricks, can be economically produced and marketed. Market survey will be done at appropriate time for use of manufactured bricks through Fal-G technology.

The average annual generation of ash from the 5 x 800 MW Coastal Gujarat Power Limited Mundra shall be as under:

Coal Consumption (85% PLF)	: ~~11-13~~ Tons/annum (average) ~~12~~ — Million Tons/annum
Ash content in coal	: ~~maximum 15%~~ average of 10%
Fly Ash generation	: ~~1.44-0.96~~ Million Tons/annum
Bottom Ash generation	: ~~0.36-0.24~~ Million Tons/annum

Projected year wise utilisation of ash for proposed UMPP at Mundra is shown in Figure – A. While manufacturing Fal-G products including bricks the fly ash collected in ESP hoppers from 2nd field onwards are to be used in making Fal-G mix, while coarser fly ash from other hoppers can be used as aggregate. The Bottom Ash, which normally contains more un burnt carbon and clinkers, is not suitable for conversion into useful products and, as such, can only be used for land-fill for which there is not much requirement in the area. While designing the power station, separate handling system and silos will be provided for storing bottom ash, fly ash from the hoppers of Economiser, Air heater and the 1st field of ESP, and that from the hoppers of 2nd field of ESP onwards separately.

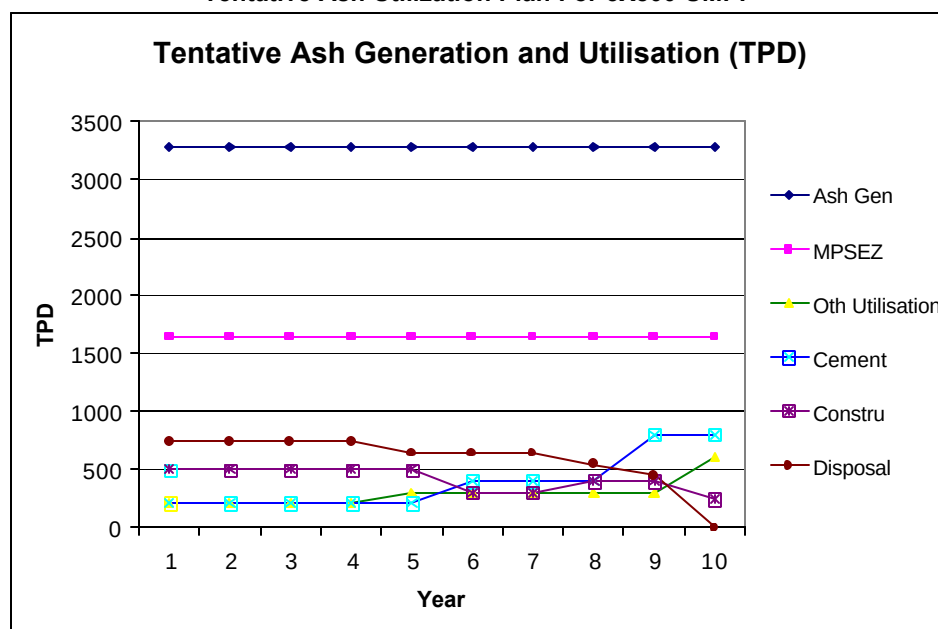
This is expected that existing manufacturers of clay bricks within the target zone may not be adverse to switch over to Fal-G brick making provided the technology is made available to them and the new product is patronized by the Government

Departments as well as certain financial incentives offered to them for the change over. Fa-G brick making process relieves the manufacturers from hassles like scarcity and high cost of coal, ever increasing cost of land and labour, large involvement of working capital, variation of weather, etc.

In fact, workshop organized at country level on Fa-G brick making evoked very positive response from the local brickmakers. If the existing brickmakers and the labour involved in the industry can be converted to Fa-G brick making it would insure against loss of employment to lakhs of labour engaged in this trade while gainfully utilizing the solid waste from the power station with the consequent protection of environment.

The approximate consumption of fly ash, both for making Fa-G mix and for using as aggregate, in manufacture of Fa-G bricks as well as for admixing in cement manufacturing grinding units are shown below. As may be seen from the calculations, 1.0 lakh MT of FA-II (ie. fly ash obtained in ESP hoppers of 2nd field onwards) and 1.67 lakh MT of FA-I (ie. fly ash of coarser variety), ie. 2.67 lakh MT of fly ash can produce 12.91 crores of Fa-G bricks of standard size (230 x 100 x 75 mm) and 3.9 Lakh MT of fly ash can produce 13 Lakh MT of cement. In order to utilize the fly ash generated at the power station as per the guidelines of the Ministry of Environment and Forest, the year-wise production of Fa-G bricks would be 12.91 crores per Lakh MT of fly ash. Tentative flysh utilisation plan is shown in following Figure:

Figure - A
Tentative Ash Utilization Plan For 5X800 UMPP



It may be considered a good prospect of utilizing total fly ash to be generated at

the power station in manufacturing Fal-G bricks as well as in manufacturing of cement with its positive impacts on economy and ecology besides saving the degradation of agricultural land. However, certain logistical problems like the process available to the existing brick makers will have to be solved, technology to be made available, a certain amount of market awareness created and government patronage provided to the existing brickmakers for switching over to Fal-G brick making to make it a success.

CGPL/Power developer has to envisaged the following strategies towards achieving the objective:

I. Fly Ash utilisation in manufacturing of bricks:

- (i) Fly ash will be supplied free of cost from the plant silos to any brickmaker wishing to commence Fal-G brick making.
- (ii) Basic technology as well as initial expert advice for Fal-G brick making will be provided to local brick makers free of cost.
- (iii) Seminars and workshops will be organized at CGPL cost to create market awareness in the large urban conglomerates like Bhuj, Mundra, Mandvi, Gandhidham etc.
- (iv) The State Government will be approached to offer certain financial incentives, in line with some other States who have already done it, to the Fal-G brickmakers as well as ensuring use of Fal-G bricks in public works to the fullest extent possible. We intend to pursue the matter to bring it to a logical conclusion.
- (v) CGPL/power developer intend to use Fal-G bricks in construction of our township as well as the boundary walls, various plant/non-plant buildings of our project to instill confidence in the minds of the local consumers and to provide the initial fillip to Fal-G brickmaking activity in the area from now itself. CGPL/power developer has to establish the contact to local prospective areas, so that fly ash is provided free of cost to the intending brick makers and are in the process of arranging with some of the local brick makers to produce Fal-G bricks with guaranteed that if it materializes, the local brick makers will be induced to switchover to Fal-G brick making once fly ash is available from the Power Station. This practice will enable less consumer resistance towards accepting the new product.
- (vi) CGPL/power developer feels that the major constraint in spreading adoption of this technology will be availability of fly ash as well as lime and gypsum to the brick makers who are scattered all over the area. The State Government can provide valuable assistance in this respect by creating depots near large

consumption centers under its auspices.

The power stations may be directed to make available the fly ash in dry form to be loaded directly on brick manufacturer trucks. This practice will reduce handling cost of fly ash for brick manufacturer. The impact of this activity on power cost will be nominal only but the activity would certainly boost fly ash utilization.

The Ministry of Environment and Forests and State pollution Control Board can play a vital role in the matter by coordinating with other concerned ministries and the State Government in taking policy level decisions.

II. Fly Ash utilisation in cement grinding units:

Fly ash utilization in cement admixing is gaining momentum and now a days cement manufacturers are setting their grinding / blending plants near thermal power stations to ensure easy procurement of fly ash. Number of such plants may come out in the future. M/s Sanghi Cement and Adani's may be the potential users of fly ash for cement manufacturing.

III. OUTLINES OF FAL-G TECHNOLOGY

Basic Technology

Fal-G is a ground blend of fly ash, lime and calcined gypsum in suitable proportions, which, upon hydration, yields strengths in the range of 200-400 kg/cm², rendering a water impervious hard matrix, similar to that in Portland cement.

This mix can find the following use:

- (i) As an argillaceous raw material in the manufacture of Portland cement
- (ii) As a pozzolona in the manufacture of Portland Pozzolona Cement (PPC);
- (iii) In making different types of bricks and other building components;
- (iv) As one of the ingredients of concrete mix;
- (v) In the manufacture of sintered aggregates for making light-weight concrete, etc.

Fal-G Brick Manufacturing Process

Fly Ash, Lime and calcined gypsum are mixed in a Pan Mixer in the ratio of 60:30:10 approximately. This mix is then moulded into bricks either manually or mechanically kept in the open for 1-2 days for drying and then water is sprinkled intermittently for the next few days. The brick becomes ready for transportation in 6/7 days time. Brick made of pure Fal-G as above may have compression strength in the range of 275-300 kg/cm². which may be difficult to work within normal construction activity. Some aggregate, therefore, is usually mixed with the

Fal-G mix to arrive at a strength of around 150 kg/cm². These aggregates can be coarse sand, crusher dust, clay or even coarse fly ash (with low carbon content).

The quality of Fal-G mix will depend on the quality of fly ash to be used. It has been found that fine partials of fly ash from modern thermal power plants where abrupt cooling of flue gas takes place in economizer/air heater zone, and collected by dry process is best suited for the mix design. Fly ash collected from economizer/air heater and 1st field of ESP, which is generally coarse, can be used as aggregates in making of Fal-G bricks.

IV. Conversion of Fly Ash into Fal-G Brick

The mix ratio of Fal-G is Fly Ash: Lime: Gypsum: : 60:30:10

Therefore, 1 tonne of Fly Ash will produce $1/0.6=1.67$ tonnes of fal-G

Or, 1.00 lakh MT of Fly Ash will make 1.67 lakh MT of Fal-G mix:

Using coarse fly ash as aggregate in proportion of 1: 1, this mix will consume further 1.67 lakh MT of Fly Ash.

The density of this mix considered to be 1.5 gm/cc.

∴ The resultant mix of 3.34 lakh MT will produce brick of volume:

$$3.34 \times 10^5 / 1.5 = 2.226 \text{ lakh cu.m.}$$

The volume of each brick of standard size is

$$:230 \times 100 \times 75 \text{ mm} = 1725 \text{ cc} = 0.001725 \text{ cu.m.}$$

∴ 1 cu.m. of mix will produce $1/0.001725 = 580$ nos. bricks.

∴ 2.226 lakh cu. m. of mix will produce $2.226 \times 10^5 \times 580$

$$= 1291 \text{ lakh bricks}$$

$$= 12.91 \text{ crore bricks}$$

3288 TPD for 5X800 MW TPP units

$$\text{CGPL} : 3333 \times 360 = 1.2 \text{ MTPA}$$

10 % of generated fly ash has been considered for brick manufacturing = 0.12 MTPA

Therefore, total number of bricks production per year = $12.91 \times 0.12 \text{ MTPA} = 1.55 \text{ Crore bricks}$

APPENDIX – 30

PROSPECTS OF BULK USE OF FLY ASH IN AGRICULTURE & WASTELAND MANAGEMENT - INITIATIVES OF FLY ASH MISSION

Vimal Kumar
Adviser (Fly Ash) &
Scientist 'G'

Gulab Singh
Sr. Project Officer

FLY ASH UTILISATION PROGRAMME

Technology Information, Forecasting & Assessment Council (TIFAC)
Department of Science & Technology
New Delhi - 110016

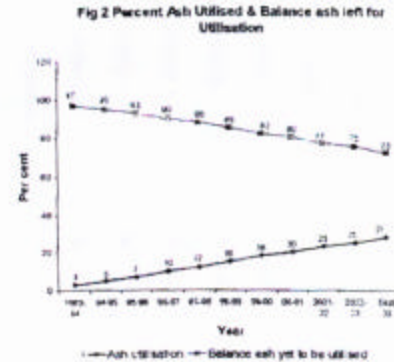
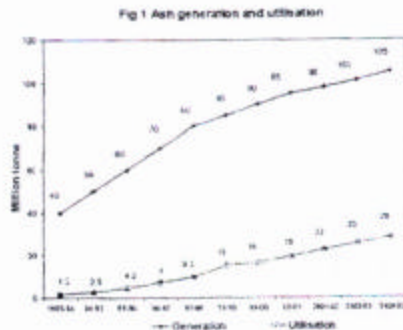
ABSTRACT

Approximately 260 million tonne of coal is consumed per annum by 82 utility thermal power plants (TPPs) in India (2003-04). It constitutes nearly 70 per cent of the total power generation which, in turn, produced 108 million tonne of fly ash* per annum. The annual generation of fly ash is projected to exceed 175 million tonne per annum by 2012 (considering the plans to double the power generation over next 10 years). This large volume of fly ash occupies large area of land and possesses threat to environment. As such, there is an urgent and imperative need to adapt technologies for gainful utilisation & safe management of fly ashes on sustainable basis.

Realising the importance of the subject matter, Fly Ash Mission (FAM) was commissioned by the Govt. of India in 1994, with Department of Science & Technology (DST) as the Nodal Agency and Information, Forecasting and Assessment Council (TIFAC), an autonomous body under the aegis of DST as the Implementing Agency in close cooperation with Ministry of Power (MoP) & Ministry of Environment & Forests (MoEF) to undertake Technology Demonstration Projects for creating awareness / confidence building in ash utilisation / safe management technologies inter alia development and up-scaling of relevant technologies of fly ash. Agriculture and related applications have emerged as one of the potential bulk

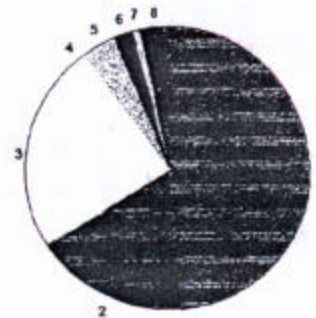
* Unless otherwise stated "fly ash" represents total ash generated at TFP consisting of (i) hopper ash / dry ash (ii) economizer ash (iii) preheater ash (iv) bottom ash. Un-utilised ashes are generally put in lagoons / ash ponds in the form of slurry and are known as pond ash.

utilisation areas for fly ash. Due to concerted efforts of Fly Ash Mission, the utilisation of pulverised fuel ash that has increased from 1 million tonne per year in 1994 to 32 million tonne in year 2004 has also gathered considerable momentum to reach higher levels with appropriate support & facilitation which is graphically presented below:



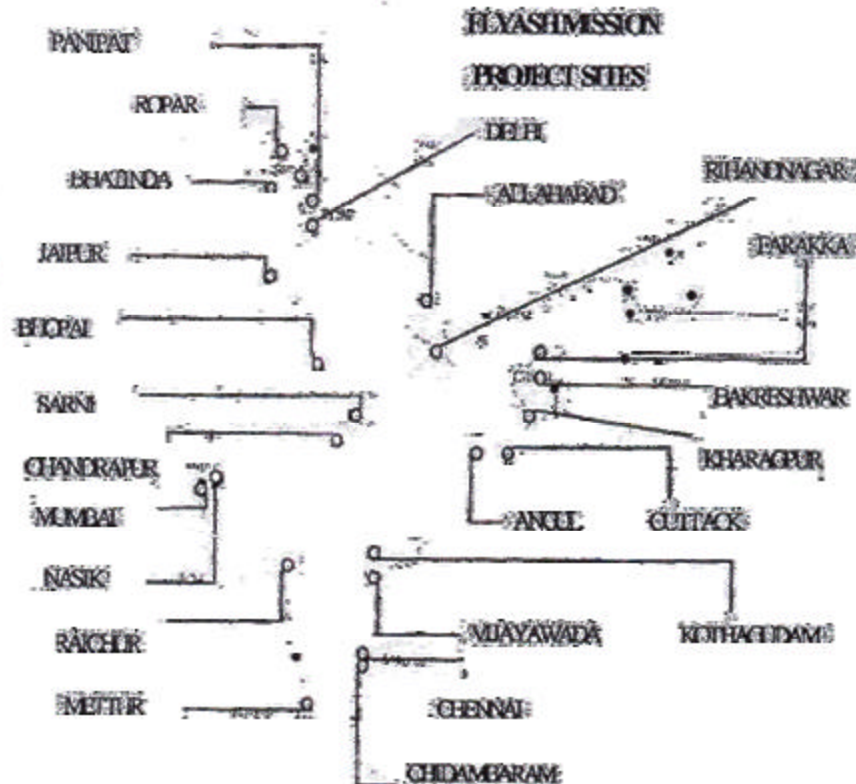
Utilisation Areas – 2004 Total utilisation ~ 32 MnT / year

1	Cement Manufacture / Substitution - 49%
2	Low Lying Area Fill - 17%
3	Roads & Embankments - 22%
4	Brick Manufacturing - 2%
5	Dyke Raising - 4%
6	Minefills - 2%
7	Agriculture - 1%
8	Others - 3%



Technology demonstration projects commissioned by Fly Ash Mission on use of fly ash in agriculture

The focus of project was "To develop empirical data on the effect (beneficial as well as possible adverse) of fly ash / pond ash application in terms of crop growth & yield, status of macro & micro-nutrients; heavy metals & toxic elements and radioactivity of soil, plant produce and water". Accordingly, FAM commissioned 15 R & D projects with fly ash at 55 project sites alongwith different R & D Institutes / Universities and farmers as given below in the map.



The technology demonstration projects carried out in (a) agriculture sector, (b) forestry sector for wasteland management, (c) reclamation of saline-alkali soil / eroded land / ash pond & (d) nutritional quality of crop produce obtained from various field demonstration sites are as follows:

(a) Technology Demonstration Projects undertaken at various sites in the area of agriculture sector

Field crops & vegetables grown with fly ash in different soil types at various project sites are as follows:

S.N.	Soil	Fly ash doses range	Crops & No. of Sites	Location	Executed by
1	Alluvial Soil	0-200 t/ha	Rice, wheat (2)	Farakka	CFRI, Dhanbad
2	Alluvial Soil	0-100 t/ha	Mustard, jute (1)	Farakka	CFRI, Dhanbad
3	Laterite Soil	0-200 t/ha	Rice, wheat (4)	Bakreshwar	CFRI, Dhanbad
4	Laterite Soil	0-100 t/ha	Mustard, Potato, Lentil (1)	Bakreshwar	CFRI, Dhanbad
5	Black Soil	0-50 t/ha	Sugarcane	Chidambaram	Annamalai University
6	Laterite Soil	0-150 t/ha	Groundnut	Neyveli	Annamalai University
7	Laterite Soil	0-100 t/ha	Sugarcane	Neyveli	Annamalai University
8	Black Soil	0-150 t/ha	Rice-Green Gram (1)	Sathamangalam	Annamalai University
9	Black Soil	0-120 t/ha	Cotton-Rice (1)	Vellampudugai	Annamalai University
10	Lateritic Soil	0-10 t/ha	Rice-Groundnut (3)	Kharagpur	IIT-Kharagpur
11	Lateritic Soil	0-20 t/ha	Rice, Groundnut-Mustard (1)	Kharagpur	IIT-Kharagpur
12	Lateritic Soil	0-30 t/ha	Mustard-Rice (1)	Kharagpur	IIT-Kharagpur
13	Lateritic Soil	0-10 t/ha	Rice (2) -Mustard, Groundnut, Potato (1)	Balarampur, Gholghoria, Burari	IIT-Kharagpur
14	Lateritic Soil (Red)	0-80 t/ha	Sunflower-Groundnut (2)	Raichur	CAS, Raichur
15	Black Soil	0-80 t/ha	Sunflower-Maize (2)	Raichur	CAS, Raichur
16	Alluvial Soil	0-650 t/ha	Tomato (1), Cabbage (1), Potato (1), wheat (2), Pea (1) - Maize (6), Wheat-Maize (2)	Dhodhar, Nilgiri, Rihand Nagar	RRL, Bhopal
17	Alluvial Soil	0-650 t/ha	Sunflower (1), tomato (1), Potato (1), Wheat (1), Berseem (1), Red Gram (1), Maize (1), Rice (1)	Nilgiri, Rihand Nagar	RRL, Bhopal
18	Alluvial Soil	0-40/0-80 t/ha	Rice-Wheat (1), Cotton-Wheat (1), Sunflower-Maize (1), Wheat-Rice (1)	Ropar, Bhatinda	PAU Ludhaina
19	Alluvial Soil	0-12 t/ha	Wheat	Ropar (Astalpur)	PAU Ludhaina
20	Alluvial Soil	100% ash body with 7.5 cm soil cover	Arhar-Wheat (1)	Bhatinda	PAU Ludhaina
21	Black Soil	0-640 t/ha (Residual Effect)	Wheat-Maize, Soyabean-Maize, Lemon Grass (1)	Sarni	RRL, Bhopal
22	Alluvial Soil	0-640 t/ha	Maize-Onion, Rice-Sunflower (1)	Angul	RRL, Bhopal

(b) Projects undertaken at various sites in the area of forestry sector for wasteland management

Various forestry species grown with fly ash in wasteland at various sites are as follows :-

S.N.	Soil/Land Type	Fly ash doses range	Tree Species & No. of Sites	Location	Executed by
1	Laterite Soil	0-240 t/ha	Eucalyptus (1)	Chaudwar, Cuttak	TCRDC, Patiala
2	Laterite Soil	0-24% of pit volume	Eucalyptus, Acacia auriculiformis, Casurina equisetifolia, Acacia mangium (1)	Durga Prasad, Cuttack	TCRDC, Patiala
3	Alkali-Saline Eroded land (in Arid Zone)	0-20% v/w	Eucalyptus, Zizyphus, Jojoba (1)	Jaipur	TERI, New Delhi
4	Ash Pond	-	Melia azadirach, Delbergia Sisso, Eucalyptus sp., Populus deltoides (1)	Badarpur	TERI, New Delhi
5	Low Fertile Soil	1/3 Pit volume	Ceiba pentandra, Melia azadirach, Cassia siamea, Erythrina indica, Cassia glauca, Bauhinia purpurea, Putranjiva, Pongamia glabra, Thevetia elifera (1)	New Delhi	TERI, New Delhi

(c) Project undertaken at various sites on reclamation of Saline-Alkali Soil / Eroded Land / Ash Pond:

Different crops, forestry / floriculture species grown on saline-alkali soil / eroded land / ash pond at different project sites are as follows :

S.N.	Soil/ Land Type	Fly ash doses range	Crops/Tree Species	Location	No. of Sites	Executed by
1.	Usar	0-5%	Rice-Wheat	Dailapur	1	IFFCO, Phulpur
2.	Usar	0-5%	Rice-Wheat	Tardih	1	IFFCO, Phulpur
3.	Usar	0-5%	Rice-Wheat	Yakubpur	1	IFFCO, Phulpur

Contd.

4.	Usar	0-6%	Rice-Wheat	Purisudi	1	IFFCO, Phulpur
5.	Usar	0-6%	Rice-Wheat	Parasinpur	1	IFFCO, Phulpur
6.	Usar	0-6%	Rice-Wheat	Mobarukpur	1	IFFCO, Phulpur
7.	Alkali Saline Eroded Salt Affected	0-20%	Eucalyptus, Jojoba, Zizyphus	Chaksu	1	TERI, Jaipur
8.	Ash Pond	-	Rajnigandha, Tagetis Carnation, Palmarosa and Sunflower	Badarpur, New Delhi	1	TERI, New Delhi

(d) Project undertaken on nutritional quality of crop produce at National Institute of Nutrition (ICMR) is as follows:

Crop produce namely cereals (rice & wheat), pulses (pea), oilseeds (mustard & groundnut), vegetables (potato, tomato & cabbage) grown on fly ash treated plots and control plots (without fly ash) at various project sites as at (a) above were taken up for the nutritional study with the following scope:

- (i) To evaluate the nutritional quality and heavy metal content of the agriculture produce.
- (ii) To assess the growth promoting activity between samples of agriculture produce obtained with or without fly ash application.

To achieve (i) & (ii) above, the food crops grown with or without fly ash (control) were analyzed for:

1. Nutritive value : Moisture, protein, fat, energy, ash, carbohydrate, crude fibre, vitamins and trace element content.
2. Heavy metal content : Pb, Cd, As and Cr.
3. Growth promoting activity in weanling rats, after feeding for 6 months at 90% level (food).
4. Hematological and histopathological changes in different tissues collected from animals fed on diets containing food grains grown either on fly ash treated plots or on control plots.

APPENDIX-31
Questionnaire for Fly Ash Management

Sr.No	Description	Details
1	Name of the Potential User/Firm/ Company	1.) Sanghi Cement, which is 120 Km from Bhuj. 2.) Concrete Block and Pavers block production next to GAPL port gate.
2	Name of the respondent	-----
3	Suppliers of existing fly ash	AEC (Ahmedabad Electric Corpoarton), Ahmedabad
4	Willingness for use of fly ash	Depends on future demand.
5	Address/Location	1) Sanhgi Cement, Moti Bher, Abdasa, Taluka Naliya. (120 Km from bhuj) 2) PMC, block manufacturers, GAPL gate. (Part of ADANI GROUP)
6	Distance from the Project Site	35 Kms from project site to GAPL
7	Route for transportation	at present possibly by road SH-6 from site to GAPL
8	Potential form of utilization	Utilized for manufacturing of Concrete Block and Paver Block.
9	Current usage, if any	Currently they are using in proportion of 40% of the total constituents.
10	Possible usage (t/month)	176 t/month
11	Likely mode of transportation	Possibly by road.
12	Possible quantity	-----
13	No. of Years for possible utilisation	Depends upon future demand of paver blocks.
14	Mode of transport/ Distance from existing facility	-----
15	Storage area available	-----


 सत्यमेव जयते
 प्रारूप एक
Form 1
 निगमन का प्रमाण पत्र
Certificate of Incorporation

सं०..... U40102DL2006601146110 192 6 1927
 No. U40102DL2006601146110 200 > 200 6
 कोस्टल गुजरात पावर लिमिटेड)
 मैं एतद् द्वारा प्रमाणित करता हूँ कि आज.....
 कम्पनी अधिनियम 1956 (1956 का 1) के अधीन निगमित की गई है और यह कम्पनी परिसीमित है।
 I hereby certify that..... Coastal Gujarat Power Limited
 is this day Incorporated under the Companies Act, 1956 (No. 1 of 1956) and that the
 Company is Limited. 21 मार्च, 1927
 मेरे हस्ताक्षर से आज ता०..... को दिया गया।
 Given under my hand at..... NEW DELHI..... this..... TENTH
 day of FEBRUARY AND SIX
 TWO THOUSAND

 सहस्रक
 Asst. कम्पनी रजिस्ट्रार
 Registrar of Companies
 रा. रा. क्षेत्र दिल्ली एवं हरियाणा
 N.C.T. OF DELHI & HARYANA

4000 MW IMPORTED COAL FIRED MUNDRA ULTRA MEGA THERMAL POWER PROJECT

COASTAL GUJARAT POWER LIMITED, NEW DELHI

(A wholly owned subsidiary of Power Finance Corporation Limited)



Socio - Economic Assessment Study Report

Submitted by



TCE Consulting Engineers Limited

In Association with

Services for Multi-disciplinary Applied Research & Training

August 2006

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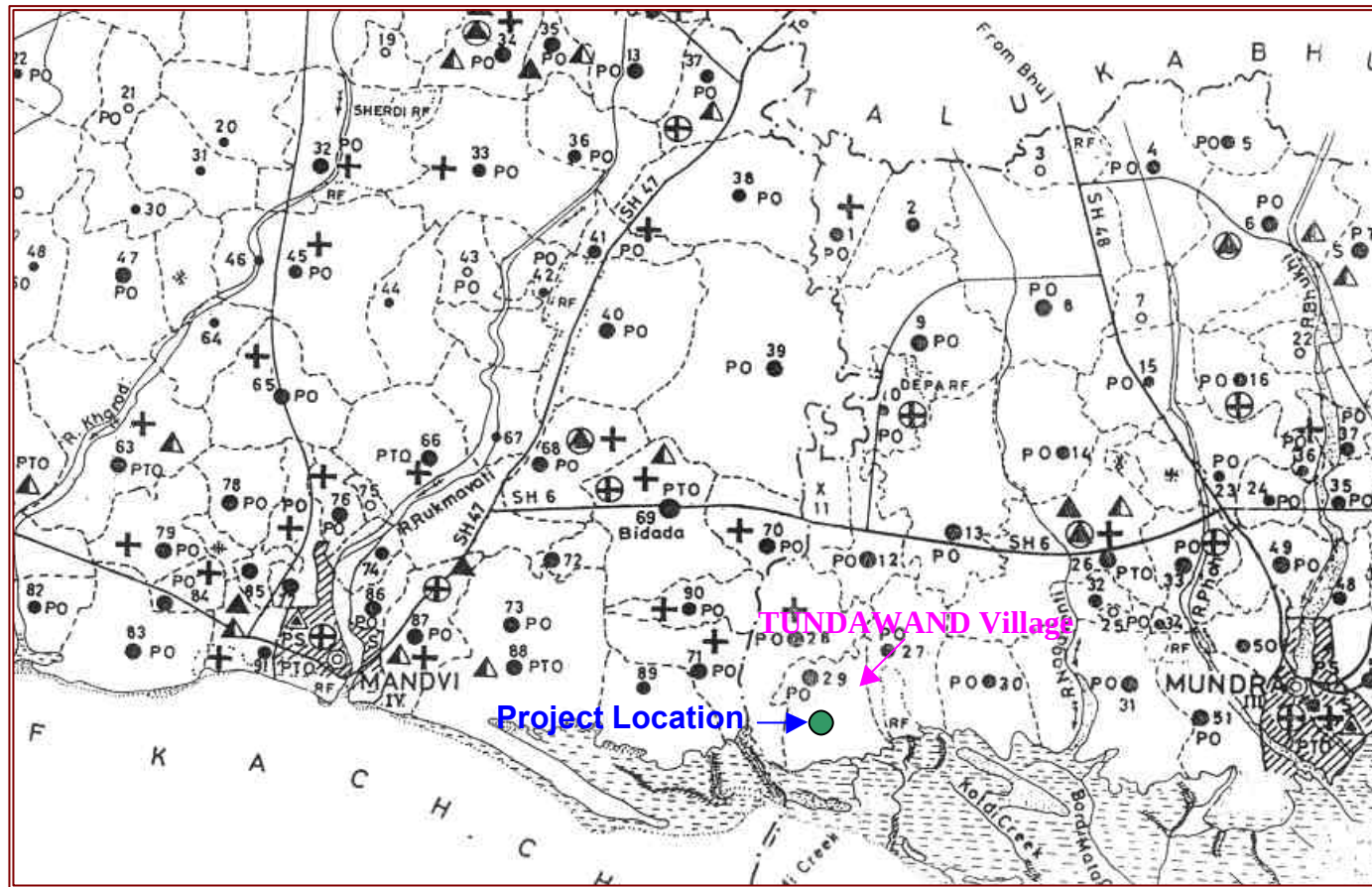
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Map No.1
Map showing Villages of Mundra and Mandvi Taluka in the Study Area



Mandvi Taluka

Bag
Bidada
Faradi
Gundiya
Maska
Mota Bhadiya
Nana Bhadiya
Nani Khakkar
Pipari
Tragadi

Mundra Taluka

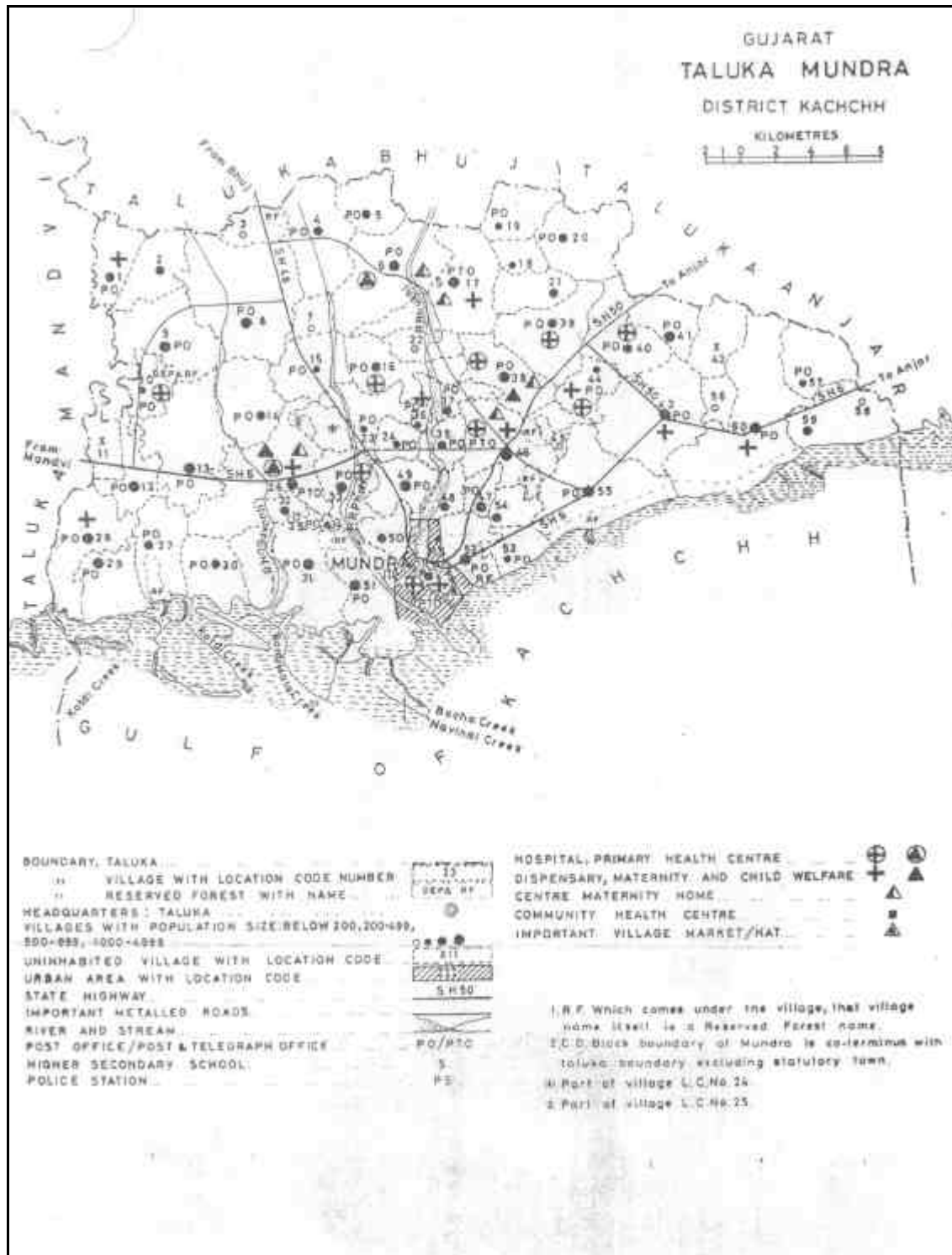
Deshalpur
Jarpara
Kandagara Mota
Khakhar Moti
Moti Bhujpar
Nani Bhujpar
Navinal
Pratappar
Shiracha
Tunda

(Source: District Handbook, 1991)

Map No.2
District Kachchh

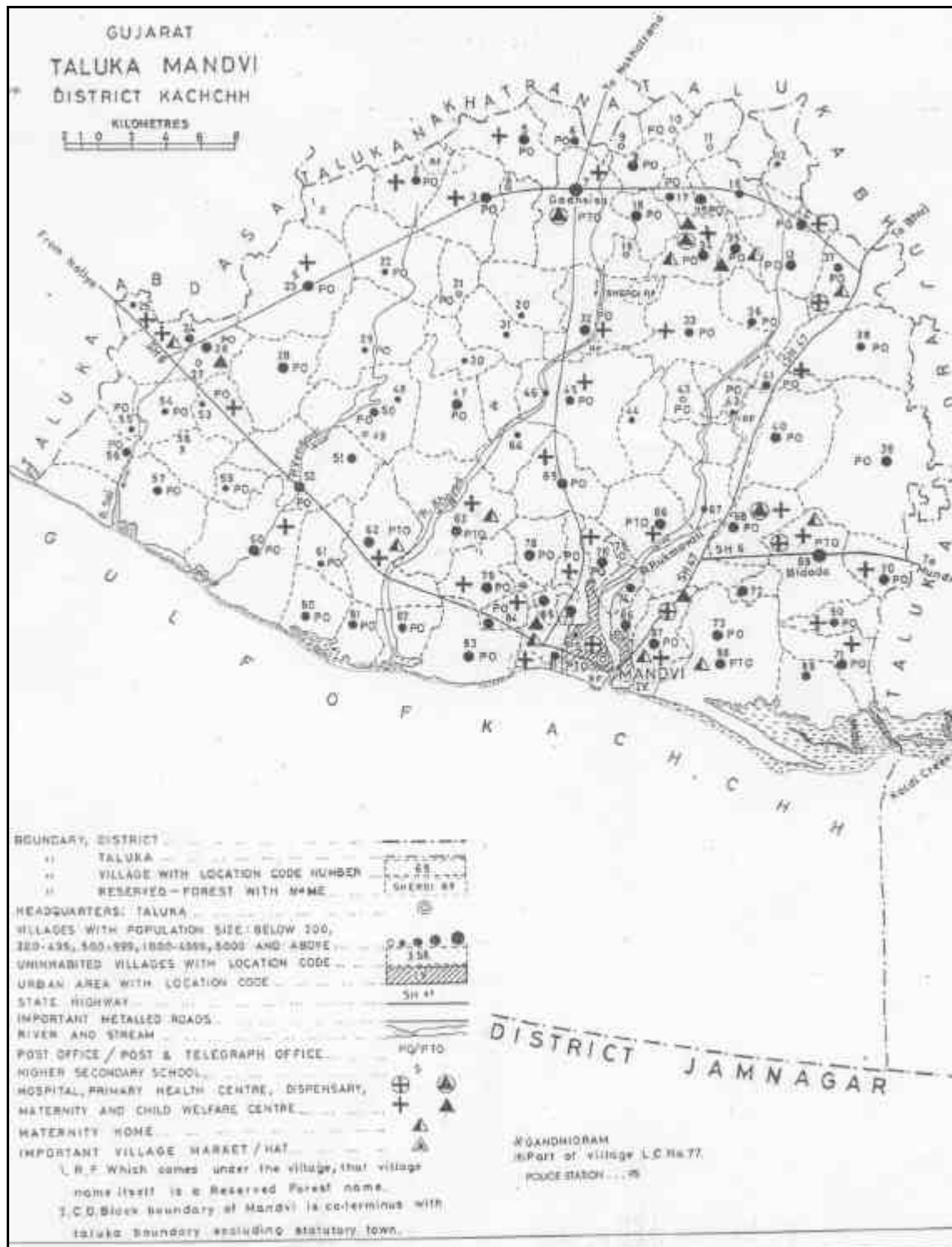


Map No.3
Taluka Mundra



(Source: District Handbook, 1991)

**Map No.4
Taluka Mandvi**



(Source: District Handbook, 1991)

COASTAL GUJARAT POWER LIMITED
SOCIO-ECONOMIC ASSESSMENT SURVEY

Introduction

The Coastal Gujarat Power Limited (A wholly owned subsidiary of Power Finance Corporation (PFC)) has entrusted the task of studying the feasibility of a coal based 8X500 MW ultra mega power plant in the Mundra Taluka of Kutch district of Gujarat to TCE Consulting Engineers Ltd, Bangalore. As a part of this feasibility study, it is aimed at studying the socio-economic aspects of the area in which the plant is proposed to be located. It is also envisaged that this study will establish the baseline condition, access the social-economic impacts due to land acquisition and project activities, establish the number of impoverishment risk to find out the most vulnerable section of society if any and suggest the action which could be initiated immediately to cope up these issues. It will point out the likely impact of the Power Plant on the population, life style, agriculture and cattle and will suggest measures for mitigation of the adverse impact, if any. Considering the views mentioned in former line, the study has been carried out.

Figure No.1
Proposed Site for the Ultra Mega Power Plant near Tunda



The information needed for this study has been collected from primary as well as secondary sources. For secondary information, the Census reports of years 1991 and 2001 have been referred. For collecting primary data, a socio-economic survey questionnaire was circulated to the Gram Panchayat officials of the villages in Mundra and Mandvi Taluka. These questionnaires were filled by Gram Panchayat officials/ Sarpanch and their feedback were received by us. A copy of the questionnaire designed for this study is enclosed in the last pages of report as one of the appendix. Apart from the above methodology, a reconnaissance survey to the study area was also made and information was gathered from the villagers, agriculturists, traders, milkmen and Panchayat officials. The information collected was analysed and has been presented in this report. At the end of the report, likely impact of the power plant along with measures for mitigation has been presented for two stages of the plant viz. 'During the Construction Phase' of the plant and 'After the Plant becomes Operational'.

History of Kuchchh

The site of the PFC's coal based thermal power plant is located near two villages Tunda and Wandh in Mundra taluka of Kuchchh district in the state of Gujarat. The district of Kuchchh derives its name from the sea creature Kachhua (Tortoise/Turtle), because of its shape. The Kuchchh region lies between Sindh (now in Pakistan) and Saurashtra. The history of Kuchchh may roughly be divided into two periods, ancient and modern; before and after the Samma of Jadeja conquest about the beginning of 14th century. It was the conquest of Kuchchh by the Sind tribes of Samma Rajputs that marked the emergence of Kuchchh as a separate Kingdom in 14th century. The modern history of Kuchchh dates from the conquest by Sind tribes of Samma Rajputs. According to Sind historians in about 1530, Shah Hussain entered Kuchchh and inflicted on the Rao a severe defeat. At that time, the representatives of the three branches of the Jadeja family were Jam Dadarji, Jam Hamirji and Jam Raval. During the time of Moghul Emperor Jahangir, Bharmal went to Ahmedabad to pay his respects and made 'Nazarana' (presentation). Jahangir was much pleased with him, gave presents in return, and freed Kuchchh from tribute on the condition of giving pilgrims a passage to Mecca. The present district of Kuchchh is formed of the former native state of Kuchchh and 10 enclave villages of the former native state of Morvi. After 1947, it was a part 'C' state administered by the Government of India through the Chief Commissioner. (Reproduced in parts from District Census Handbook: Kachchh District; Census of India 1991)

The district of Kuchchh consists of nine talukas (tehsils) viz. Bhuj, Mundra, Mandvi, Abdasa, Lakhpat, Nakhatrana, Rapar, Bhachau and Anjar. The PFC power plant will be located in the Mundra taluka near the villages Tunda and Wandh at a distance of about 25 Kms from the Mundra town. The seat of the Jadeja rulers is located in Bhuj town at a distance of 60 Kms from Mundra. There are five ports in the Kuchchh district viz. Kandla, Mandvi, Mundra, Jakhau and Koteswar. Of these, Kandla is a major port administered by the Kandla port trust. Mundra is a private port owned by M/s Gujarat Adani Port Ltd (A Joint venture of Gujarat Maritime Board and Adani Group). Fertilizers, sulphur, imported coal, iron scrap and dets, wool and food grains are the main items of import at these ports where as onion, salt and bentonite are the principal items of export through these ports.

Figure No.2
River Nagmati in Mundra Taluka within Study Area



Population Characteristics

The project area within 10 km. radius of the proposed Power Plant consists of 20 villages of which 10 are located in Mundra taluka and 10 in Mandvi Taluka. The site of Power Plant is situated in Mundra Taluka and is located at a distance of 25 Km from Mundra town. The list of villages in Mundra and Mandvi taluka is given below with

the number of households, population, number of males and females, etc according to Census 2001.

Figure No.3

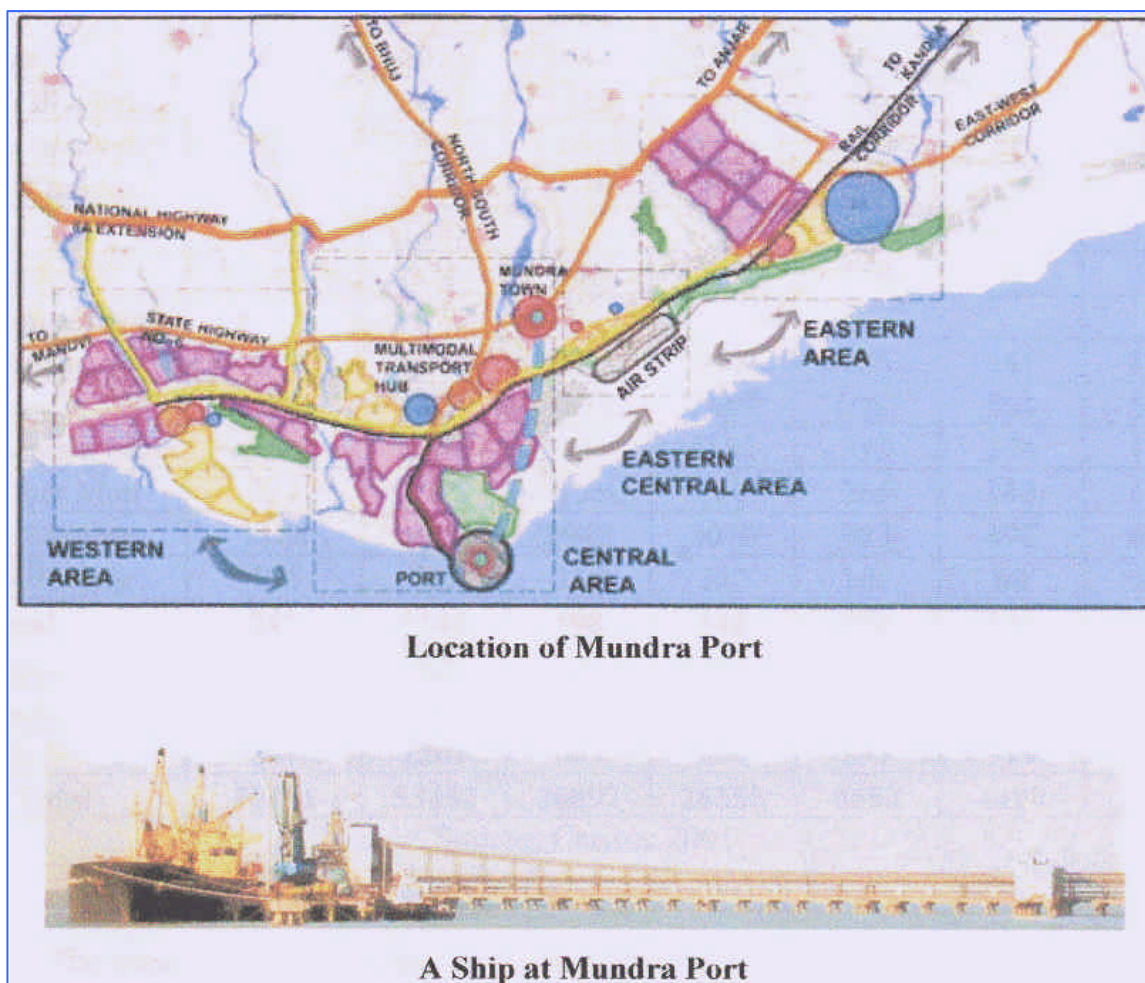


Table No.1
Population Distribution within the Study Area (within 10 kms) (2001)

Name of Village	No. of Households	Total Persons	Total Males	Total Females	Persons age 0-6	Males age 0-6	Females age 0-6
Mandvi Taluka							
Bag	476	2528	1288	1240	387	204	183
Bidada	1491	7595	3842	3753	1034	549	485
Faradi	386	1933	974	959	311	151	160
Gundiyali	891	5353	2705	2648	957	500	457
Maska	932	5055	2546	2509	699	350	349
Mota Bhadiya	511	2822	1417	1405	547	289	258
Nana Bhadiya	179	799	394	405	110	56	54
Nani Khakhar	645	3374	1676	1698	505	253	252
Pipari	283	1485	751	734	263	148	115
Tragadi	143	824	402	422	150	75	75

Name of Village	No. of Households	Total Persons	Total Males	Total Females	Persons age 0-6	Males age 0-6	Females age 0-6
Mundra Taluka							
Deshalpar	424	2013	1045	968	285	161	124
Jarpara	1019	5762	2893	2869	1067	564	503
Kandagara Mota	454	2306	1150	1156	353	174	179
Khakhar Moti	324	1596	810	786	265	143	122
Moti Bhujpar	1188	5952	2942	3010	983	492	491
Nani Bhujpar	126	717	370	347	101	60	41
Navinal	241	1146	598	548	238	131	107
Pratappar	20	62	31	31	7	2	5
Shiracha	187	923	456	467	154	69	85
Tunda	241	1207	607	600	237	119	118
Sub Total	10161	53452	26897	26555	8653	4490	4163

Source: Census 2001

The total population of the area within 10 Km radius of the site is 53,452 persons (Table-1). Projected population of the area in 2006 and 2011 by arithmetic progression is 57,730 and 62,007 persons respectively (Table-2). However, by geometric progression method, the projected population of the area in the year 2010 is estimated at 76,779 persons.

Table No.2
Population Projection (for study area within 10 Km of Power Plant)

Taluka	Population (Census 1991)	Population (Census 2001)	Population (2006) Projected*	Population (2011) Projected*
Mandvi	26324	31768	33801	35834
Mundra	16948	21684	23929	26173
Total	43272	53452	57730	62007

* Projected with decennial growth rate of 20.7% for 'Mandvi' and 12.8% for 'Mundra'

Figure No.4

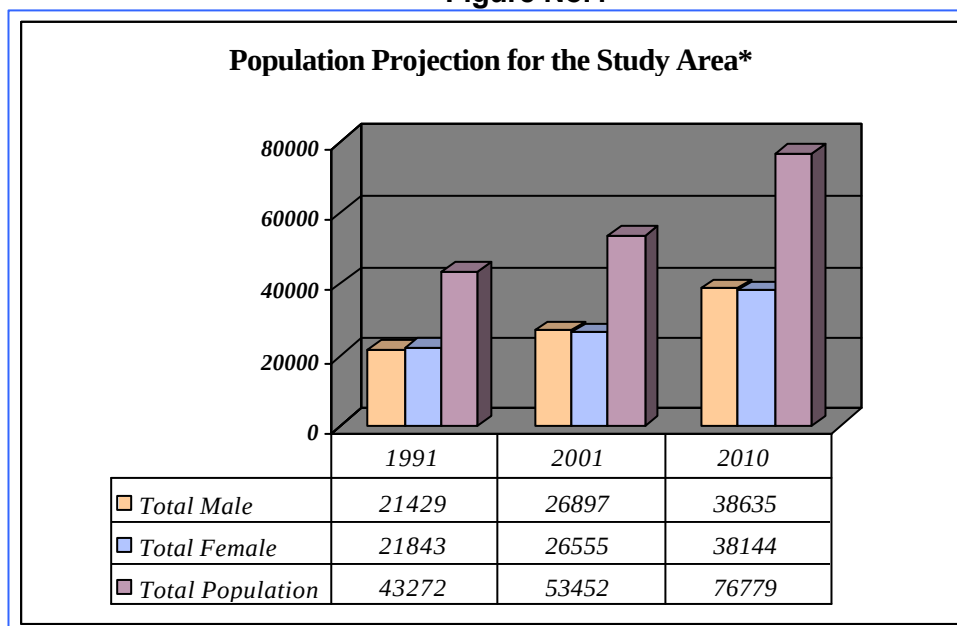
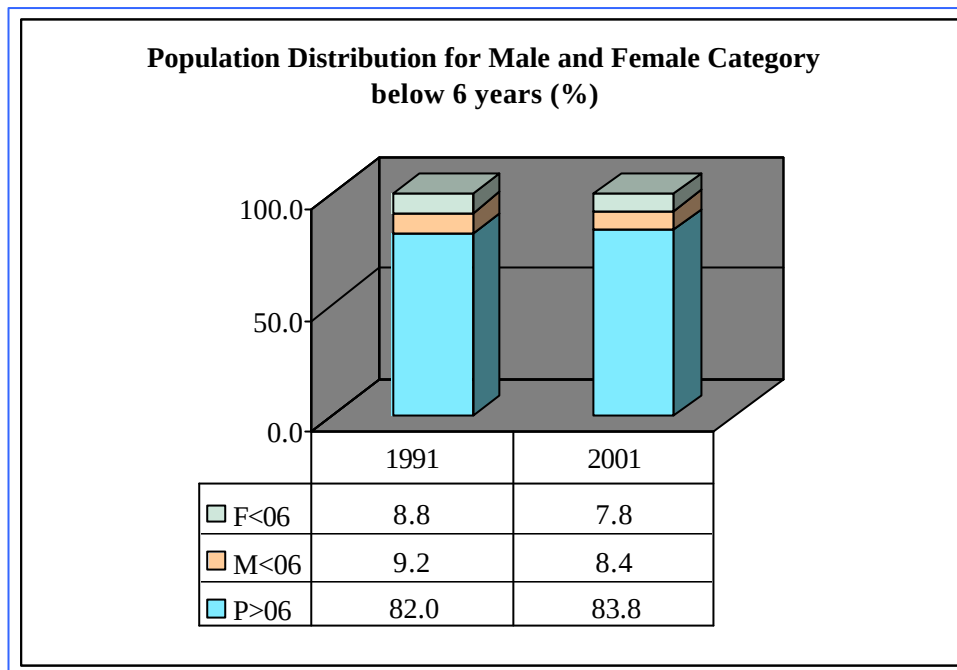


Figure No.5

Source: District Census Handbook 1991 and Census 2001

The contribution of 0-6 year children to over all population has reduced significantly from 18% (1991) to 16.2 % (2001) as shown in above Figure.

Table No.3
Scheduled Castes and Scheduled Tribes population (2001)

Name of Village	Persons (SC)	Males (SC)	Females (SC)	Persons (ST)	Males (ST)	Females (ST)
Mandvi Taluka						
Bag	0	0	0	32	15	17
Bidada	1374	709	665	321	159	162
Faradi	404	207	197	9	5	4
Gundiyali	444	217	227	164	73	91
Maska	211	109	102	117	65	52
Mota Bhadiya	380	193	187	15	8	7
Nana Bhadiya	330	160	170	43	26	17
Nani Khakhar	534	278	256	248	121	127
Pipari	58	28	30	6	4	2
Tragadi	0	0	0	0	0	0
Mundra Taluka						
Deshalpar	366	188	178	125	62	63
Jarpara	649	343	306	86	43	43
Kandagara Mota	317	171	146	144	70	74
Khakhar Moti	335	177	158	60	36	24
Moti Bhujpar	895	466	429	498	253	245
Nani Bhujpar	252	129	123	0	0	0

Navinal	189	99	90	98	57	41
Pratappar	0	0	0	0	0	0
Shiracha	463	222	241	59	30	29
Tunda	68	37	31	0	0	0
Sub Total	7269	3733	3536	2025	1027	998

Source: Census 2001

The study area within 10 Km radius is 36,489 Hectares. Total number of households in the study area is 10,161 as per Census 2001 (Table-4), which works out to a population density of 1.46 persons per Ha. Average family size in the area is 5.3. The percentage of males and females as per 2001 census is almost equal with 50.3% males and 49.7% females. Thus the sex ratio is 987 females per thousand males.

The percentage of scheduled caste and scheduled tribe population is 13.6% and 3.8% respectively. Total working population is about 39%. Among workers, 68% are males and 32% females. The literacy rate in the area is 54.2% as per 2001 Census.

Figure No.6

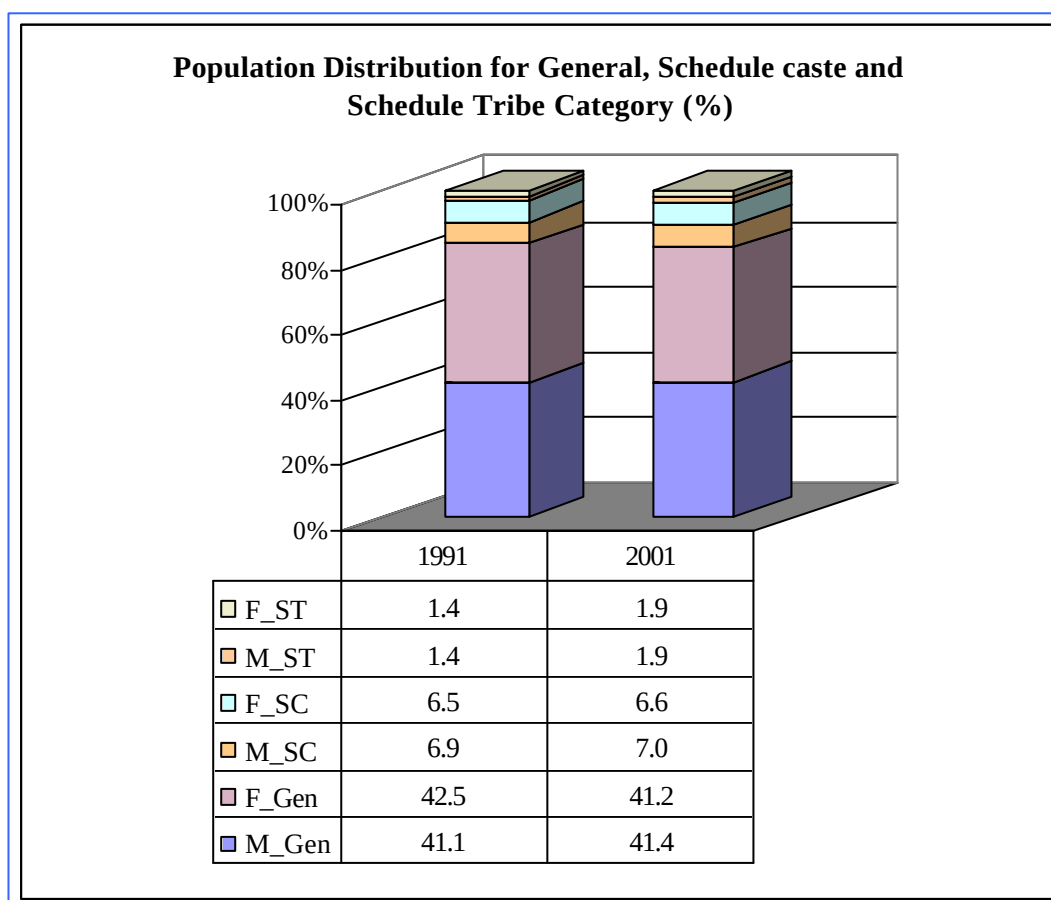


Figure No.7

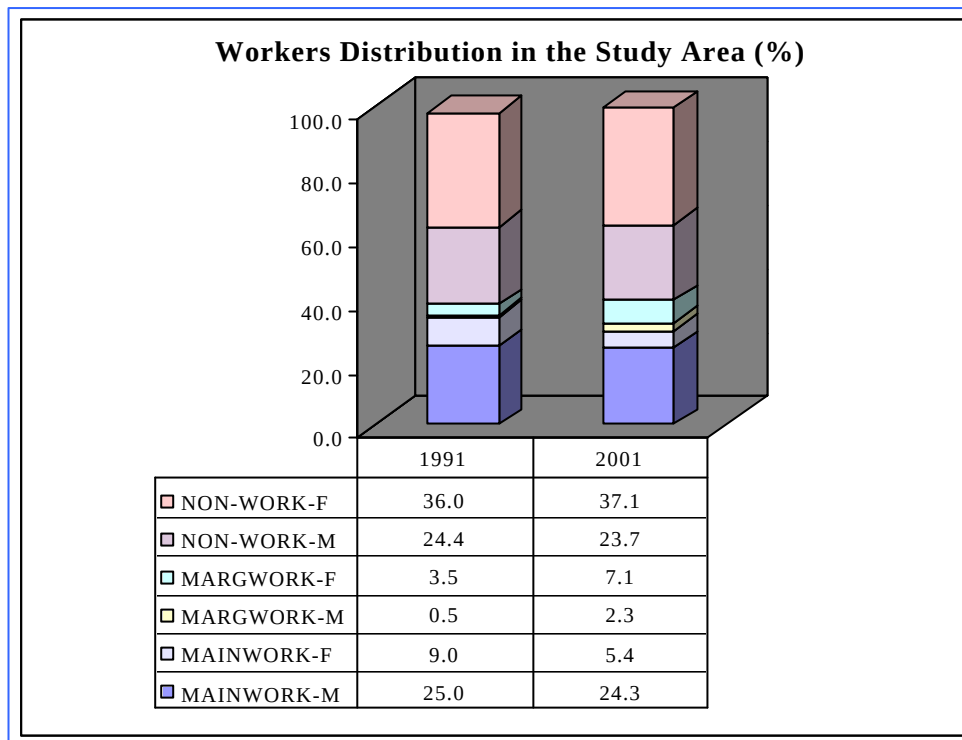
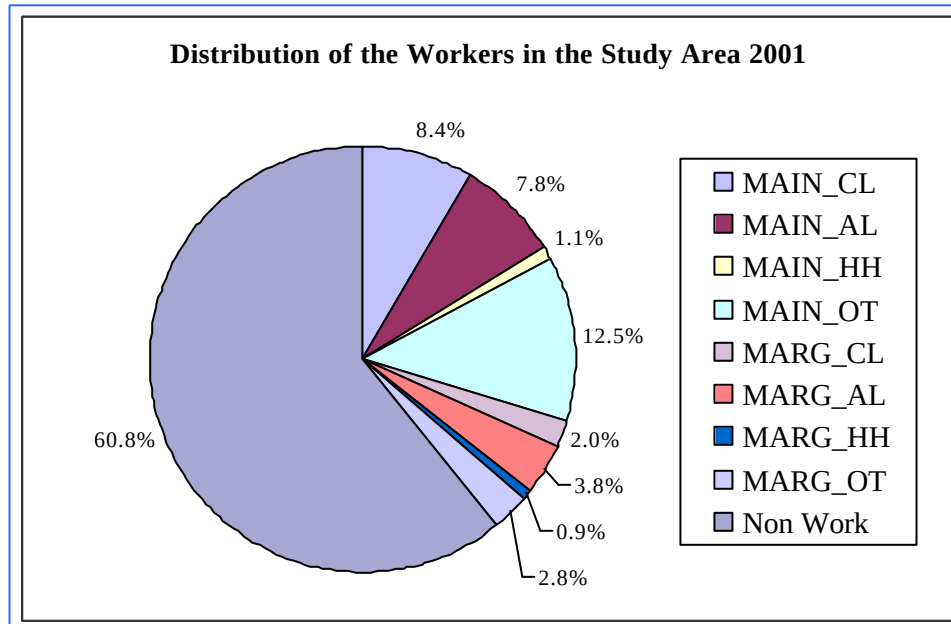


Figure No.8



Considerable portion about 39.2% of the total population falls under workers categories that population of non-workers was highest of 60.8% followed by 39.2% of total workers, 34.0 % main workers and 4.0 % marginal workers. Non worker population cover all persons, who are engaged in unpaid home duties and do not know

other work or have not done any work at all during the last one year. The main worker is a person, who works for major part of the year. Marginal worker is a person who works for a period of less than 6 months in a year.

Table No.4
Summary of Demographic Details[§] (within 10 Km Study Area)

Parameters	Census 1991	Census 2001
No. of Households	7811	10161
Total Study Area in Ha	36489	36489
Total Population	43272	53452
Total Males	21429 (50.5%)	26897 (50.3%)
Total Females	21843 (49.5%)	26555 (49.7%)
Population Density (Persons/Ha)	1.19	1.46
Sex Ratio (Number of Females per 1000 Males)	1019	987
Average Family size	5.5	5.3
Percentage of Population below 6 Years	18.0%	16.2%
Total Schedule Caste population	5816 (13.4%)	7269 (13.6%)
Total Schedule Tribe population	1249 (2.9%)	2025 (3.8%)
No. of Literates (Percent Literacy)	18658 (43.1%)	28946 (54.2%)
No. of Illiterates (Percent Illiteracy)	24614 (56.9%)	24506 (45.8%)
No. of Literate Females(Percent Female Literacy)	7310 (33.5%)	12073 (45.5%)
Total Worker Population (% to total population)	16424 (39.6%)	20938 (39.2%)
Total Male workers	11025	14232 (68.0%)*
Total Female Workers	5399	6706 (32.0%)*
Main Workers	14860 (90.5%)*	15924 (76.1%)*
Marginal Workers	1744 (9.5%)*	5014 (23.9%)*
Non-Workers	26134 (60.4%)	32514 (60.8%)
Main Cultivator Population	5885 (35.8%)*	4496 (21.5%)*
Main Female cultivator Population	1451 (24.7%)*@	737 (16.4%)*@

[§]Source: District Census Handbook 1991 and Census 2001

* Percentage to Total workers

@ Percentage to Total Main Cultivators

Education Facilities

All the villages have primary schools within the village. Three villages have Secondary schools (up to X standard) and one village has a technical Institute. Looking at the number of students the enrollment of children in school is high.

Table No.5
Educational Institutions and No. of Students

S. No.	Taluka	Village	No. of Primary schools	No. of Students	Secondary Schools	No. of Students	Technical Institute	No. of Students
1	Mandvi	Faradi	1	300	0	0	0	0
2	Mandvi	Bidada	1	1000	1	400	0	0
3	Mandvi	Nani Khakhar	1	480	0	0	0	0
4	Mandvi	Nana Bhadiva	1	200	1	60	0	0
5	Mandvi	Pipari	1	300	0	0	0	0
6	Mandvi	Maska	1	400	1	400	1	70
7	Mandvi	Bag	1	600	0	0	0	0
8	Mandvi	Gundiyali	1	NR	0	0	0	0
9	Mandvi	Mota Bhadiva	1	500	0	0	0	0
10	Mandvi	Tragadi	1	161	0	0	0	0
11	Mundra	Tunda	1	103	0	0	0	0
12	Mundra	Shiracha	1	140	0	0	0	0
13	Mundra	Moti Bhuipar	1	1100	1	500	0	0
14	Mundra	Pratappar	1	100	0	0	0	0
15	Mundra	Nani Bhuipar	1	200	0	0	0	0
16	Mundra	Navinal	1	350	0	0	0	0

Source: Gram Panchayat Official

Figure No.9
Primary School at Navinal



Figure No.10
Technical Institute at Maska



Religion

The two major religions in the district including in the project area are Hindu and Muslim. Muslims in some villages forms a sizeable proportion of the population, e.g. in Tragadi and Tunda. Unlike other parts of Gujarat, there have been no Hindu-Muslim riots in this area. Each village has number of Temples and Mosques. The rich families contribute to the development of the village by constructing temples, schools, community centres, etc. in their own villages. Many villages have Gau-shalas/ gaucher land (charitable grazing sheds for cows), which are financed by village people.

Patel is a farming community whereas Baniya is a business community. Most of the villages in the project study area have some families of Baniya and Patel communities. As mentioned generally the families belonging to Baniya community stay away from the village in other towns and cities for business and come to village only during summer vacations and holy occasions/festivals.

Table No.6
Percentage Distribution of Population by Religion & Caste

S. No.	Taluka	Village	Hindu (%)	SC (%)	ST (%)	Muslim (%)	Patels (%)	Baniyas (%)	Other (%)
1	Mandvi	Faradi	70	10	1	30		10	
2	Mandvi	Bidada	80	25	2	20	25	25	3
3	Mandvi	Nani	80	15	5	20	5	20	

S. No.	Taluka	Village	Hindu (%)	SC (%)	ST (%)	Muslim (%)	Patels (%)	Baniyas (%)	Other (%)
		Khakhar							
4	Mandvi	Nana Bhadiya	80	60	10	20			
5	Mandvi	Pipari	95	5		5			4
6	Mandvi	Maska	80	30		20	10	10	
7	Mandvi	Bag	65			35			
8	Mandvi	Gundiyali	65			35	1		
9	Mandvi	Mota Bhadiya	95	60		5			
10	Mandvi	Tragadi	50		5	50		10	15
11	Mundra	Tunda	60	5		40		30	
12	Mundra	Shiracha	100	40	10				
13	Mundra	Moti Bhujpar	80	20		20	10	5	
14	Mundra	Pratappar	100						
15	Mundra	Nani Bhujpar	100	40	40		10		10
16	Mundra	Navinal	80	40		20		5	

Source: Gram Panchayat Official

Figure No.11
Statue of Lord Shiva at Faradi



Figure No.12
Mosque at Nana Bhadia



Figure No.13
Jain Temple at Kolapar (Mandvi)



Figure No.14
Mosque on sea beach near site of Power Plant



Agriculture

Agriculture is a major activity in the area but is mostly dependent on rains. The area has scanty rainfall. Land holdings are quite large because of low yield. Only few farmers have wells in their farm through which they can reap two crops. All others without wells can take only one crop i.e. Jowar and Bajra and that too if there are rains.

Table No.7
Important Commodities Grown

Name of the Village	Most important Commodity Grown-1	Most important Commodity Grown-2	Most important Commodity Grown-3
Mandvi Taluka			
Faradi	Pulses	Guvar	Wheat
Bidada	Bajri	Groundnut	Wheat
Nani Khakhar	Cotton	Wheat	Maize
Nana Bhadiya	Bajri	Jowar	Wheat
Pipari	Wheat	Bajri	Mung
Maska	Bajri	Groundnut	Jowar
Bag	Cotton	Bajri	
Gundiyali	Bajri	Cotton	Jowar
Mota Bhadiya	Bajri	Mung	Groundnut
Tragadi	Bajri	Jowar	
Mundra Taluka			

Name of the Village	Most important Commodity Grown-1	Most important Commodity Grown-2	Most important Commodity Grown-3
Deshalpar	Cotton	Castor Seeds	Isabgol
Khakhar Moti	Cotton	Wheat	Bajri
Kandagara Mota			
Tunda	Cotton	Guvar	Jowar
Shiracha	Wheat	Bajri	Mung
Moti Bhujpar	Groundnut	Bajri	Wheat
Pratappar	Wheat	Castor Seeds	Guvar
Nani Bhujpar	Groundnut	Castor Seeds	Guvar
Navinal	Cotton	Wheat	Bajri
Jarpara	Kharek	Chikoo	Coconut

Source: Census 2001

Figure No.15
Castor Crop at Faradi



Major crops in the area are Bajri and Jowar during rainy season. Those who have wells also grow wheat in winter. Other crops are Moong, Castor, Maize, Groundnut, Guvar and Cotton. Among plantations, the major ones are Kharik and Chikoo followed by Coconut. In the villages near Power Plant site i.e. Tunda and Wandh, there are not many plantations.

Figure No.16
Chikoo Plantation at Jarpara



Table No.8
Land Holding

S. No.	Taluka	Village	No. of households with land			No. of Households
			< 1acre	1-5 acre	> 5 Acre	
1	Mandvi	Faradi	50%	20%	30%	
2	Mandvi	Bidada	5%	20%	75%	
3	Mandvi	Nani Khakhar	40%	10%	50%	
4	Mandvi	Nana Bhadiya	10%	40%	50%	
5	Mandvi	Pipari	15%	50%	35%	350
6	Mandvi	Maska	15%	35%	50%	
7	Mandvi	Bag	70%	15%	15%	
8	Mandvi	Gundiyali	60%	20%	20%	
9	Mandvi	Mota Bhadiya	10%	40%	50%	
10	Mandvi	Tragadi	30%	20%	50%	
11	Mundra	Tunda	10%	40%	50%	
12	Mundra	Shiracha	25%	25%	50%	
13	Mundra	Moti Bhujpar	10%	40%	50%	
14	Mundra	Pratappar	0	50%	50%	
15	Mundra	Nani Bhujpar	5%	70%	25%	
16	Mundra	Navinal	10%	90%	0	

Source: Gram Panchayat Official

Figure No.17
Kharik Plantation at Bhojpar



Figure No.18
Coconut Plantation at Maska



Cattle

The area is rich in cattle wealth. Every village has plenty of bullocks, cows, buffalos, goats and sheep. Bullocks are used for farming and driving cart for farm products. The area also has a sizeable number of tractors. This shows the economic condition of farmers.

Figure No.20
Cows at Jarpara



Figure No.19
Buffaloes at Navinal



Table No.9
No. of Cattle by Villages

S. No	Taluka	Village	Bullocks (No.)	Tractors	Cows	Goats/ sheep	Other cattle	Milk Production per day	Rearing of cattle
1	Mandvi	Faradi	15	8	500	1000 / 200	100	1000	25
2	Mandvi	Bidada	150	10	6000	1500 / 500	200	2000	1000
3	Mandvi	Nani Khakhar	20	11	700	1000 / 2000	200	1000	1500
4	Mandvi	Nana Bhadiya	55	1	250	300 / 0	200	500	20
5	Mandvi	Pipari	25	12	300	300 / 70	100	1000	0
6	Mandvi	Maska	50	20	400	800 / 1500	150	1000	70
7	Mandvi	Bag	20	25	700	4000 / 0	150	2000	200
8	Mandvi	Gundiyali	200	20	600	3250 / 1000	50	500	200
9	Mandvi	Mota Bhadiya	100	13	300	350 / 100	100	1500	700
10	Mandvi	Tragadi	15	3	200	200 / 0	200	400	50
11	Mundra	Tunda	4	2	50	305 / 7	150	1000	65
12	Mundra	Shiracha	12	15	150	500 / 0	50	300	160
13	Mundra	Moti Bhujpar	20	70	300	1000 / 1000	500	2000	1000
14	Mundra	Pratappar	0	15	50	50 / 50	200	1500	20
15	Mundra	Nani Bhujpar	0	10	250	50 / 50	400	3000	100
16	Mundra	Navinal	4	4	1500	2000 / 0	400	800	200

Source: Gram Panchayat Official

Since rainfall in the region is scanty, cattle rearing, wool spinning and milk production is a major occupation after plantation and agriculture. The area produces plenty of milk. The milk is sold to dairies.

Figure No.21
Goats at Navinal



Figure No.22
Sheep at Nani Khakhar



Migration of Families for Livelihood

As seen above major sources of livelihood in the villages are Plantations (Kharik, Chikoo and Coconut), Cattle (milk production), Agriculture (mainly summer crop, if there is rain) and other occupations like trade, transport and services. Many families from these villages also work in towns like Ahmedabad, Vadodara, Surat and Mumbai. These families come to village only during summer vacations or on certain occasions. This is especially true of Jain families, which is a business community. Many streets in some of the villages, especially in the villages inhabited by Jain community, are deserted throughout the year because these families live in other cities for their livelihood. These families construct a descent house in the village and keep on contributing to the development of the village in some form or the other like constructing temple, school, community hall, dharamshala etc. Important elite families of the village also construct an entry gate to the village with their names inscribed on the gate. Such scenes are very common all-over the villages in the project area.

Table No.10
Migration of Families to Other Cities

S. No.	Taluka	Village	No. of families Migrated to Metropolitan cities	No. of Families migrated to Other Towns
1	Mandvi	Faradi	20%	10%
2	Mandvi	Bidada	10%	5%
3	Mandvi	Nani	20%	5%

S. No.	Taluka	Village	No. of families Migrated to Metropolitan cities	No. of Families migrated to Other Towns
		Khakhar		
4	Mandvi	Nana Bhadiya	20%	5%
5	Mandvi	Pipari	2%	1%
6	Mandvi	Maska	15%	5%
7	Mandvi	Bag	5%	2%
8	Mandvi	Gundiyali	20%	5%
9	Mandvi	Mota Bhadiya	1%	0
10	Mandvi	Tragadi	Not Known	Not Known
11	Mundra	Tunda	10%	5%
12	Mundra	Shiracha	10%	5%
13	Mundra	Moti Bhujpar	40%	10%
14	Mundra	Pratappar	75%	0
15	Mundra	Nani Bhujpar	0.5 %	1%
16	Mundra	Navinal	50%	10%

Source: Gram Panchayat Official

Figure No.23
A Deserted Street in Kandagra due to Migration of Families to Cities for Livelihood



Figure No.24
A Gate at Entry of Village in Nani Khakhar



Figure No.25
Fishermen near Tundawandh about 1½ kms from Power Plant



Table below gives sources of income from various activities.

Table No.11
Income from Various Occupations

			Annual Income Per Family (in thousand Rupees) from							
S. No.	Taluka	Village	Employment	Agriculture	Animal husbandry	Rearing of cattle	Fishing	Handicraft	Trading	Any other
1	Mandvi	Faradi		40		20			50	
2	Mandvi	Bidada	6	12		10		1.8	36	
3	Mandvi	Nani Khakhar		50						
4	Mandvi	Nana Bhadiya	36	20		30				
5	Mandvi	Pipari		250	360				600	
6	Mandvi	Maska	14	5		36		5	50	
7	Mandvi	Bag	10	50		50			40	
8	Mandvi	Gundiyali	20	40		20	40		35	
9	Mandvi	Mota Bhadiya		50		15			50	
10	Mandvi	Tragadi		20		10	20		50	
11	Mundra	Tunda		40					50	
12	Mundra	Shiracha		50		30		25		
13	Mundra	Moti Bhujpar		8000		2000		1000	1000	2000
14	Mundra	Pratappar		50		50				
15	Mundra	Nani Bhujpar		100		100				
16	Mundra	Navinal								

Source: Gram Panchayat Official

Water and Electricity

Drinking water in all the villages is supplied through bore-wells. Every village has over-head tank in which the water is filled by the Gram Panchayat and then supplied through pipeline to the houses at fixed time slots. Water is available at a depth of 200 feet but it is salty. The depth of the bore-wells for sweet water is more than 400 feet. Water is also stored in small dams (ponds) during rainy season. However, it depends on the rainfall, which is very scanty.

Since rainfall is scanty the villagers are more dependent on wells. The Table below gives the number of wells and the ones with and without pumps. In every village only one well is used for drinking water supply.

Table No.12
No. of Wells for Drinking and Irrigation

S. No.	Taluka	Village	No. of wells in village	No. of Wells for drinking	Wells for Irrigation without pump	Wells for Irrigation with pump
1	Mandvi	Faradi	40	1	25	14
2	Mandvi	Bidada	14	4	6	4
3	Mandvi	Nani Khakhar	252	2	0	250
4	Mandvi	Nana Bhadiya	32	25	0	7
5	Mandvi	Pipari	6	1	0	5
6	Mandvi	Maska	3	0	0	3
7	Mandvi	Bag	120	Narmada Water	0	120
8	Mandvi	Gundiyali	126	1	0	125
9	Mandvi	Mota Bhadiya	104	2	2	100
10	Mandvi	Tragadi	25	0	0	25
11	Mundra	Tunda	52	1	11	40
12	Mundra	Shiracha	100	1	49	50
13	Mundra	Moti Bhujpar	204	4	0	200
14	Mundra	Pratappar	31	1	0	30
15	Mundra	Nani Bhujpar	70	0	0	70
16	Mundra	Navinal	25	1	0	24

Source: Gram Panchayat Official.

All the villages in the area are electrified. There is no load shedding for the residential houses. However, agricultural farms have fixed time for supply of electricity.

Transport and Communication

Nearest airport to the Power Plant area is Bhuj, which is located at a distance of about 60 Kms from Mundra town and about 75 Kms from the site of CGPL. Nearest railway stations are Adipur, Bhuj and Gandhidham at about 57, 45 and 55 Kms respectively from Mundra town in opposite directions. A good motorable road in the area is National Highway NH-8A running from Gandhidham to Mandvi. The other roads a State Highway and other metal roads in the area are narrow and not in good condition. Local people travel by autorikshaws/chakkda, which carry 6-10 passengers. The villages are covered by State road transport buses but the frequency is limited and scanty in the villages. Mundra and Mandvi towns are well connected with other cities and towns of the State by State road transport buses. All the villages are covered by mobile telephone service provider. Most of the villages have Local and STD telephone booths. Newspapers are also available in the villages.

Figure No.26
Gandhidham – Mandvi Highway NH-8A



Figure No.27
Auto-Rickshaw stand at Bhojpar



Table No.13
Availability and Means of Transport

S. No.	Taluka	Village	Transport	No. of Bullock carts	No. of Auto Vehicles / Chhakda	Distance of bus stand	Nearest Railway station
1	Mandvi	Faradi	Road	5	12 / 5	In village	Bhuj
2	Mandvi	Bidada	Road	50	1000 / 45	1 Km	Bhuj
3	Mandvi	Nani Khakhar	Road	10	30 / 5	In village	Bhuj
4	Mandvi	Nana Bhadiya	Road	0	5 / 2	In village	Bhuj
5	Mandvi	Pipari	Road	10	30 / 6	1 Km	Bhuj
6	Mandvi	Maska	Road	30	400 / 7	In village	Bhuj
7	Mandvi	Bag	Road	10	7 / 3	In village	Bhuj
8	Mandvi	Gundiyali	Road	100	40 / 20	In village	Bhuj
9	Mandvi	Mota Bhadiya	Road	50	25 / 5	In village	Bhuj
10	Mandvi	Tragadi	Road	12	2	In village	Bhuj
11	Mundra	Tunda	Road	3	18 / 4	In village	Bhuj
12	Mundra	Shiracha	Road	3	1 / 3	In village	Bhuj
13	Mundra	Moti Bhujpar	Road	0	400 / 200	In village	Bhuj
14	Mundra	Pratappar	Road	0	3 / 3	In village	Bhuj
15	Mundra	Nani Bhujpar	Road	0	50 / 3	In village	Bhuj
16	Mundra	Navinal	Road	1	15 / 10	In village	Bhuj

Source: Gram Panchayat Official

Availability of number of auto-vehicles in the area shows the economic status of the villagers. All the milk-men use motor bikes for transporting milk from the village to selling point. The farmers also use motor-bikes for transport as for every need they can not depend on public transport.

Health and Sanitation

There are not many hospitals in the area. People have to travel 2 to 10 Kms for hospital services. Many villages do not have Private practitioners. They go to nearby villages for their needs. Though villagers prefer out-side open field for nature's call, many houses especially those migrated to urban towns and having their houses in the village have latrines inside the house as they are used to such facility in cities. Most of the houses in the area are pucca with either pucca roof or tiles. Tiles keep the house cool during summer. Out-migrants who have their business in cities and towns have constructed huge houses in the villages, which are furnished with all facilities inside the house.

Figure No.28
Soakpits at Gundiyali



Table No.14
Availability of Health Facilities and Sanitation

S. No.	Taluka	Village	Hospital	No. of doctors	Pvt practitioners	Health workers	General preventive diseases	Any family Wel. Scheme	Latrine	Soak pits
1	Mandvi	Faradi	7 km	0	0	No		No	200	2
2	Mandvi	Bidada	Yes	1	1	Yes2		No	1000	0
3	Mandvi	Nani Khakhar	6 km	6	0	Yes		No	65	0
4	Mandvi	Nana Bhadiya	8 km	0	Yes	No	Fever	No	500	5
5	Mandvi	Pipari	5 km	1	0	No		No	0	25
6	Mandvi	Maska	Yes	2	0	Yes	TB	No	24	5
7	Mandvi	Bag	6 km	0	Yes	Yes	Acidity	No	400	3
8	Mandvi	Gundiyali	8 km	0	Yes	Yes		Yes	200	1
9	Mandvi	Mota Bhadiya	5 km	0	0	Yes	Fever	No	4	1
10	Mandvi	Tragadi	13km	0	Yes	No		No	0	0
11	Mundra	Tunda	3 km	1	0	Yes	Gastro	No	50	3
12	Mundra	Shiracha	4 km	0	Yes	Yes		No	4	4
13	Mundra	Moti Bhujpar	Yes	1	Yes	Yes		Yes	1500	0
14	Mundra	Pratappar	6 km	0	0	No		No	100	2
15	Mundra	Nani	2 km	0	0	No		No	0	3

S. No.	Taluka	Village	Hospital	No. of doctors	Pvt practitioners	Health workers	General preventive diseases	Any family Wel. Scheme	Latrine	Soak pits
		Bhujpar								
16	Mundra	Navinal	10km	0	Yes	Yes		No	150	1

Source: Gram Panchayat Official

Facilities of Bank, Post Offices and Library

Most of the villages have post office in the village itself but the bank facility is rare and at times as far as 15 Km. away. A bank requires certain threshold of population to be viable for its existence and therefore it is understandable that the villages do not have banks.

Figure No.29
Post Office at Tunda



Table No.15
Availability of Post Office, Band and Library

S. No.	Taluka	Village	Post office	Bank	Library
1	Mandvi	Faradi	Yes	7 km	Yes
2	Mandvi	Bidada	Yes	Yes	Yes
3	Mandvi	Nani Khakhar	Yes	6 km	Yes

S. No.	Taluka	Village	Post office	Bank	Library
4	Mandvi	Nana Bhadiya	7 km	15km	Yes
5	Mandvi	Pipari	5 km	5 km	No
6	Mandvi	Maska	Yes	No	No
7	Mandvi	Bag	Yes	6 km	No
8	Mandvi	Gundiyali	Yes	8 km	8 km
9	Mandvi	Mota Bhadiya	Yes	5 km	No
10	Mandvi	Tragadi	2 km	11 km	No
11	Mundra	Tunda	Yes	3 km	3 km
12	Mundra	Shiracha	Yes	4 km	Yes
13	Mundra	Moti Bhujpar	Yes	Yes	Yes
14	Mundra	Pratappar	Yes	6 km	Yes
15	Mundra	Nani Bhujpar	2 km	2 km	2 km
16	Mundra	Navinal	Yes	5 km	Yes

Source: Gram Panchayat Official

Entertainment Facilities

Television is available to almost all the families in the villages of the project area. There are no cinema halls or sport like cattle race. Only two villages have some sports facility in the form of play-ground.

Table No.16
Availability of Entertainment Facilities

S. No.	Taluka	Village	No. of Radio sets	No. of TVs	Cinema Halls	Cattle Race	Sports
1	Mandvi	Faradi	325	140	None	None	None
2	Mandvi	Bidada	100	200	None	None	None
3	Mandvi	Nani Khakhar	100	350	None	None	None
4	Mandvi	Nana Bhadiya	120	120	None	None	None
5	Mandvi	Pipari	150	262	None	None	None
6	Mandvi	Maska	1050	720	None	None	Yes
7	Mandvi	Bag	55	165	None	None	None
8	Mandvi	Gundiyali	75	750	None	None	None
9	Mandvi	Mota Bhadiya	35	25	None	None	None
10	Mandvi	Tragadi	No	0	None	None	None
11	Mundra	Tunda	25	42	None	None	None
12	Mundra	Shiracha	120	120	None	None	None
13	Mundra	Moti Bhujpar	50	2500	None	None	Yes
14	Mundra	Pratappar	10	5	None	None	None
15	Mundra	Nani Bhujpar	15	40	None	None	None

S. No.	Taluka	Village	No. of Radio sets	No. of TVs	Cinema Halls	Cattle Race	Sports
16	Mundra	Navinal	10	80	None	None	None

Source: Gram Panchayat Official

Speciality of the Villages

The villages have very few specialities. The handicraft, temple and festivals were reported by investigators from the Gram Panchayat Officials. The household activities like spinning of woollen, thread and weaving of blankets by the shepherds were also recorded. Besides, Mundra is famous for its handicrafts especially tie -dye, block prints, Namda work by Mansoori people

Table No.17
Speciality of the Village

S.No.	Taluka	Village	Handicraft	Folk Art	Music	Temple/ Monument	Festival/ Market
1	Mandvi	Faradi	No	No	No	Yes	Yes
2	Mandvi	Bidada	No	No	No	Jain Derasar	
3	Mandvi	Nani Khakhar	No	No	No	No	No
4	Mandvi	Nana Bhadiya	No	No	No	Rama Peer	No
5	Mandvi	Pipari	No	No	No	No	No
6	Mandvi	Maska	No	No	No	No	No
7	Mandvi	Bag	No	No	No	No	No
8	Mandvi	Gundiyali	Yes	No	No	Yes	No
9	Mandvi	Mota Bhadiya	No	No	No	Baveswar Temple	
10	Mandvi	Tragadi	No	No	No	No	No
11	Mundra	Tunda	No	No	No	No	No
12	Mundra	Shiracha	No	No	No	Yes	No
13	Mundra	Moti Bhujpar	No	No	No	No	No
14	Mundra	Pratappar	No	No	No	No	No
15	Mundra	Nani Bhujpar	No	No	No	No	No
16	Mundra	Navinal	No	No	No	No	No

Source: Gram Panchayat Official

NGOs and Welfare Schemes

No major Non Government Organization (NGO) was found in the area. Some local community groups were functioning for the local needs mainly religious and community functions. The Gram Panchayats were given financial assistance from the State Government for certain activities like housing, drinking water and sanitation.

Table No.18
Availability of NGO and Welfare Schemes

S. No.	Taluka	Village	NGO Name	Welfare schemes	Funded Project
1	Mandvi	Faradi	No	No	No
2	Mandvi	Bidada	No	Sanitation	Indira Awas
3	Mandvi	Nani Khakhar	Kuchchh Jyoti Trust	No	No
4	Mandvi	Nana Bhadiya	No	No	No
5	Mandvi	Pipari	No	No	No
6	Mandvi	Maska	No	No	No
7	Mandvi	Bag	No	No	No
8	Mandvi	Gundiyali	No	No	No
9	Mandvi	Mota Bhadiya	No	No	No
10	Mandvi	Tragadi	No	No	No
11	Mundra	Tunda	No	No	No
12	Mundra	Shiracha	No	No	No
13	Mundra	Moti Bhujpar	VRTI	Yes	No
14	Mundra	Pratappar	No	No	No
15	Mundra	Nani Bhujpar	No	No	No
16	Mundra	Navinal	No	No	No

Source: Gram Panchayat Official

Figure No.30
Gram Panchayat Office, Mota Kandagra



Figure No.3
Gram Panchayat Office, Bhojpar



Difficulties Faced

The Gram Panchayat Officials have reported some common problems faced by the village. These are lack of good cultivable land, health facility in the village, higher level schools say up to X standard, water for drinking as well as irrigation and lack of grazing area for the live stock.

Table No.19
Difficulty Faced by the Villagers

S. No.	Taluka	Village	Lack of land	Health facility	School	Water	Lack of Grazing Area for Live Stock
1	Mandvi	Faradi	Yes	Yes	Yes	Yes	No
2	Mandvi	Bidada	Yes	No	No	Yes	Yes
3	Mandvi	Nani Khakhar	No	Yes	Yes	No	Yes
4	Mandvi	Nana Bhadiya	No	Yes	No	Yes	No
5	Mandvi	Pipari	No	Yes	Yes	Yes	Yes
6	Mandvi	Maska	No	No	No	Yes	No
7	Mandvi	Bag	Yes	Yes	No	No	Yes
8	Mandvi	Gundiyali	Yes	Yes	Yes	Yes	Yes

S. No.	Taluka	Village	Lack of land	Health facility	School	Water	Lack of Grazing Area for Live Stock
9	Mandvi	Mota Bhadiya	Yes	Yes	Yes	Yes	Yes
10	Mandvi	Tragadi	No	No	Yes	No	No
11	Mundra	Tunda	No	Yes	Yes	Yes	No
12	Mundra	Shiracha	No	Yes	No	Yes	Yes
13	Mundra	Moti Bhujpar	Yes	Yes	Yes	Yes	Yes
14	Mundra	Pratappar	Yes	Yes	Yes	Yes	Yes
15	Mundra	Nani Bhujpar	Yes	Yes	Yes	Yes	Yes
16	Mundra	Navinal	No	Yes	No	Yes	Yes

Source: Gram Panchayat Official

Awareness of Public about upcoming Ultra Mega Power Plant

During the visit to villages, some persons from general population, farmers and Gram Panchayat officials were contacted informally to find out their awareness about the power plant and attitude towards the proposed power plant. People in the study area are aware of the coming up of power plant. They are however not aware about its exact nature and capacity. And therefore, they are not able to fully assess its impact on the area. The similar perception was received from Gram Panchayat Officials also who were aware of the project but not about the likely impact on the local people, cattle and agriculture.

Table No.20
Awareness about Project

S. No.	Taluka	Village	Awareness about project	Disadvantages of project
1	Mandvi	Faradi	Aware	Not Aware
2	Mandvi	Bidada	Aware	Not Aware
3	Mandvi	Nani Khakhar	Aware	Not Aware
4	Mandvi	Nana Bhadiya	Aware	Not Aware
5	Mandvi	Pipari	Aware	Not Aware
6	Mandvi	Maska	Aware	Not Aware
7	Mandvi	Bag	Aware	Not Aware
8	Mandvi	Gundiyali	Aware	Not Aware
9	Mandvi	Mota Bhadiya	Aware	Not Aware
10	Mandvi	Tragadi	Aware	Not Aware
11	Mundra	Tunda	Aware	Not Aware
12	Mundra	Shiracha	Aware	Not Aware
13	Mundra	Moti Bhujpar	Aware	Not Aware
14	Mundra	Pratappar	Aware	Not Aware
15	Mundra	Nani Bhujpar	Aware	Not Aware
16	Mundra	Navinal	Aware	Not Aware

Source: Gram Panchayat Official

Kuchchhis are known to be progressive. They are hard working, business minded and believe in self-employment. Generally, all the people contacted welcomed the power plant though some of them feared some harm to plantations, land and agriculture due to ash pollution. They said that progress cannot come without any cost. People are thrilled about Narmada river/dam water coming to Kuchchh and they are aware that it has come at the cost of households whose houses and land got submerged in the dam. They therefore believe that the progress has its own cost for which they should be ready. They also said that in case there is any damage to the land and crop they will shift their livelihood from agricultural to some other activities. The residents in the area have seen rising prices of the land after coming of Mundra port. They had never seen such high price for their residential and agricultural land, which is more or less barren. The price for agricultural land in area is between 2 to 3 lakh per acre. They are therefore happy about the upcoming power plant, as it will fetch yet more money for the land owned by them, which they can use for some investment and alternative livelihood.

Likely Impact on People, Agriculture, Cattle and Plantation during construction

During construction of the plant heavy machinery and construction material will be brought to the plant site. The roads in the region are narrow that will be improved and designed to take care of required load bearing. Since the machinery will be heavy and if it happens to be brought by road transport, it may affect the movement of local people, local vehicles and cattle, if proper attention will not be given on existing roads. It may also spoil the roads and produce dust pollution. Public is in favour of power plant, this opinion may be retained by following good management practice during the construction and operational phase of the project. There will be movement of vehicles for construction of plant and housing colony in and around the villages and nearby towns. This will in some way or the other may affect smooth movement of local people, cattle and vehicles, if proper care would not be considered. There is no likelihood of any impact on agriculture and plantations during construction phase. Set up of the project will not affect the ground water table and existing water supply of the villages, as provision of thermal desalination plant/RO by using sea water will full fill complete water requirement of ultra mega power plant. Proper attention on existing infrastructures will not only minimise the impact but also will improve the existing infrastructure facilities.

Likely Impact on People, Agriculture, Cattle and Plantations after plant becomes operational

The plant is coming up on a barren land and therefore does not affect households, plantations, cattle grazing or agriculture. The only impact on the population, agriculture and plantations is likely to be the pollution due to coal ash, which will flow with the wind. Provision of green belt and plantation will help in reducing the fugitive dust emission. The discharge of the coal ash needs to be controlled and disposed off properly to minimise its adverse impact on the residential houses, people, cattle and plantations (Kharak, Chikoo and Coconut).

The disposal of balanced effluent and cooling water through out fall structure into the deep sea will have insignificant impact on marine life. The fish population of the study area will have insignificant impact as out fall structure will be properly designed that will not impact existing local marine life.

According to the proposal, the coal ash is to be stored at some distance away from the power plant, necessitating transporting the ash from plant to collection ground (ash depot). Transportation of ash to disposal area through wet system will not create inconvenience to local population and local traffic.

The power plant will need plenty of water that will be full filled from nearby sea. The area has severe scarcity of water. Therefore, under-ground water has not been proposed for use in power project. Water requirement of residential colony for the employees will have to be made available from their own facility from proposed thermal desalination plant/ RO plant. All the villages in the area have their own water supply through overhead tanks in which water is drawn from bore-wells. Therefore, existing water uses of the study area will have no impact due to set up of mega power plant.

Mitigation during Construction of Plant

The plant machinery and construction material should be brought by rail transport through a convenient port facility so that local people and cattle are not affected. Yet some road movement will be necessary between the plant site and some nearby villages and Mundra / Mandvi towns. It is therefore suggested that roads may be improved for smooth transportation without causing any inconvenience to the

locals. Improvement of roads will also generate favourable public opinion during construction and reduce resentment if any due to inconvenience caused. A sizeable amount of water will also be required during construction. Thermal desalination plant should be envisaged to meet the water requirement of plant during the start of construction.

Mitigation after Plant becomes Operational

The greatest impact that requires mitigation is the effect of pollution due to coal dust and ash on the people, cattle, plantations and agriculture land. Serious attention is required towards control of coal ash in the environment and heat generated during power generation. Even transport of coal ash from the plant to the collection depot will affect the local movement of traffic. It is advised to use railways or enclosed system for this purpose. Lifting of coal ash by the buyers from the ash depot will also have to be organized properly so that air pollution during lifting can be minimized and there should be minimum disturbance to local traffic during shipment from ash depot to buyers' warehouses. Disposal of treated effluent from desalination plant and cooling system will not have any impact on local ecology and marine life, if disposed to deep sea through a properly designed out fall structures. Therefore, the livelihood of fishermen will not be affected. It would be advisable to provide loan facilities to the needy fishermen for buying better mechanized boats so that the fishermen can go deeper in the sea for fishing.

**SUMMARY OF IMPACT AND MITIGATION MEASURES
DURING CONSTRUCTION**

S. No.	Activity	Likely Impact	Mitigation Measures
1.	Transportation of Plant Machinery and construction material to site of power plant	Damage to Roads and dust in atmosphere	Good construction management practices will Improve local roads connecting plant, ash depot and residential colony. Construction of Railway line will help in reducing transportation problems.
2.	Water required during construction of Power Plant, Ash Depot and Residential colony	Reduction of water table in the area	Thermal desalination desalination plant / RO plant envisaged will have no impact on ground water
3.	Drinking water for construction workers	Reduction of water table in the area	Thermal desalination desalination plant / RO plant envisaged, that will have no impact on ground water
4.	Unskilled labor required for construction	May create some some social problems like drinking	Employment of local labor would be less likely to fall prey to such activities
5.	Movement of staff between site, ash depot, residential colony and nearby towns in vehicles	Damage to roads and obstruction to local traffic	Good construction management practices will Improve local roads connecting plant, ash depot and residential colony

**SUMMARY OF IMPACT AND MITIGATION MEASURES
AFTER CONSTRUCTION**

S. No.	Activity	Likely Impact	Mitigation Measures
1.	Movement of coal from port to power plant	No adverse impact if railway is used	No mitigation required if railway is used
2.	Water required for Power Plant	No adverse impact if sea water is used	No mitigation required if sea water is used
	Dust emission from Coal and ash from power plant	Adverse effect likely on the health of the population, cattle, plantation and agricultural land	Proper dust suppression system and 100m wide green belt apart from the plantation in ash disposal and within the premises will minimize the dust emission problems. Health check-up facilities for the workers, cattle and villagers are the necessary measures to minimize the impacts.
3.	Transportation of coal and ash from power plant to Ash depot	Dust pollution	Use of closed system and water as dust suppression at transfer point will minimize the impacts.
4.	Disposal of ash from ash depot to buyers	Air pollution	Use closed containers, dust suppression system and preferred railways instead of road for transportation
5.	Water for residential colony	Water table in the area will go down	Use of sea water for desalinated water will have no impact on existing ground water table.
6.	Disposal of effluent into sea	Adverse impact on marine life (fish) and loss of livelihood of fishermen	Intake and outfall structures should be properly designed that should minimize the impacts on marine life. If fisherman requires any help, loan should be arranged for betterment of their livelihood.

APPENDIX

**SOCIO-ECONOMIC SURVEY
QUESTIONNAIRE FOR GRAM PANCHAYAT/GRAM SARAPANCH**

Date:

Village:

Name of interviewer:

Respondent:

Area of Village:

Population: as on

Total No. of House Holds:

1.	Population Breakup	%	SC	ST
	Hindu			
	Muslims		-	-
	Patels			
	Banias			
	Other		-	
2.	Land Breakup	Percentage of Households		
	Less than 1 acre			
	1-5 acre			
	More than 5 acre			
	No. of Households			
3.	School in Village	No. of Institutions / No. of Students		
	Primary	/		
	Secondary	/		
	Technical Institution	/		
	Collage	/		
	University			
	Adult literacy Centre			
	Training Institute			
4.	No. of Wells in village	Number		
	For drinking			
	For Irrigation without pumps			
	For Irrigation with pumps			

5.	Crop yield/acre/year	Yield/acre/year
	Crop 1:	
	Crop 2:	
	Crop 3:	
	Crop 4:	
	Crop.5:	
	Total Crops/acre/year	
	Major wadis (chikoo, dates, any other)	
6.	Agriculture	Number
	No. of bullocks	
	No. of tractors	
	No. of cows	
	No. of Goats/sheeps	
	Other Cattle	
	Milk production per day	
	No. of Rearing cattle	
7.	Source of Income in Rs.	Amount
	Through Employment	
	Agriculture	
	Animal Husbandry	
	Rearing of cattle	
	Fishing	
	Handicrafts	
	Trading	
	Any other	
8.	No. of persons working in factory	Number
	Directly	
	Indirectly	

9.	No. of Employees	Number		
	Govt. Employees			
	Private Employees			
10.	Education			
	Total No. of Educated persons			
		%	Employed	Unemployed
	Upto High School			
	Upto graduation			
11.	No. of Electrified Houses	Number (%)		
	TV			
	Radio			
	Fan			
	Other			
12.	Consumption of fuel per day	Number of Households (%)		
	Wood / Weed			
	Coal			
	Gas			
13.	Medical facilities	If not available / distance from village		
	Hospitals			
	No. of Doctors			
	Private Practitioners			
	Health Workers/Midwives			
	General prevalent diseases			
	Any family welfare schemes			
14.	No. of Latrines			
15.	No. of Soakpits			
16.	Means of Transport	Road / Navigation - River		
17.	No. of Bullock Carts			
18.	No. of Auto-vehicles/Chhakada			

19.	Distance of bus stand from village	
20.	Distance of nearest railway station from village	
21.	Amenities	If not available/ distance from village
	Post Office/Telegraph Office	
	Bank	
	Library	
22.	No. of drinking water sources	Number
	Wells	
	River Ghats	
	Hand Pump	
	Ponds/Springs	
23.	Any specific problem related to drinking water (scarcity /taste/ odor/long distance from source/ other	
24.	Is there a place of tourist attraction in your village	
25.	Is there any religious place	Names:
26.	Historical/Monuments/Sanctuary	Names:
27.	Is there weekly market in a week	
28.	If no, how far persons going for market	
29.	No. of persons visiting the market	
30.	What are the facilities for entertainment	Number
	Radio	
	TV	
	Cinema	
	Cattle race	
	Sports	
	Other	

31.	Main specialty of the village	
	Handicraft	
	Folk art/Dance	
	Music	
	Temple/Monuments	
	Festival/Market	
32.	Are there any specific revenue earning facilities? (Temple, Mela, etc.)	
33.	Migration of population towards cities	Number (%) migrating
	Metropolitan Cities	
	Other	
34.	Any NGO working in the village.	Name:
	Any welfare scheme	
	Any funded project	
35.	Village levels specific problem.	
	Lack of land	
	Lack of health facilities	
	Lack of schools	
	Accessibility to water	
	No grazing area for live stock	
	Any other (specify)	
36.	Awareness about the project	Aware / Not aware
	Advantages of the project	
	Disadvantages of the project	

TCE Consulting Engineers Limited

A **TATA** Enterprise



Ecological Study Report **for** **MGR System**

of
4000 MW Imported COAL Fired
Mundra Ultra Mega Thermal Power Project

Coastal Gujarat Power Limited, New Delhi

(A wholly owned subsidiary of Power Finance Corporation Limited)

Chandralok Building, 36, Janpath, New Delhi-110001

December 2006

INTRODUCTION

1. The Government of India has envisaged capacity addition of 100, 000 MW by 2012 to meet its Mission of Power to All. Achievement of this target also requires the development of large capacity projects at the national level to meet the requirements of a number of States.
2. Recognizing the fact that economies of scale leading to cheaper power can be secured through development of large size power projects, Ministry of Power, Central Electricity Authority (CEA), and Power Finance Corporation are working together for development of five ultra mega power projects under tariff based competitive bidding route. These projects will be awarded to developers on Build, Own Operate (BOO) basis. The ultra mega power projects each with a capacity of 4000MW would also have scope for further expansion.
3. CGPL proposed to set up a power plant near South of Tundawand village in Mundra taluka of Kutch district of Gujarat Coastal area with a capacity of 4000 MW. Proposed site is located at 22° 49' 48" N latitude and 69° 30' 58" E longitudes. The site is well connected with State Highways No. SH-50 (Via Anjar) and No. SH-6 (Via Gandhigram) and would be nearer to the proposed NH-8A (Delhi- Kandala). The nearest railway station is Adipur, which is 57 km away from the proposed site. Adipur railway station is well connected to multi terminal Mundra port through broad gauge railway system privately owned by M/s. Adani Group.
4. Coal for the project would be imported, sourced from countries like China, Indonesia, Australia and South Africa through cargo vessels of capacity of 125,000 MT to the nearest Mundra port.
5. Secondary and start up fuels are HFO and LDO which would be obtained from Jamnagar/ Vadodara by rail/ road.
6. However, the existing facilities at Mundra port for storage and handling of coal would not be adequate. Hence, the facilities at the port are being proposed to be augmented to meet UMPP requirement. MGR rail link has been indicated to the developer for transportation of coal from the Mundra port to proposed power project site.
7. RITES feasibility study carried out for proposed transportation of coal to Mundra has been considered for present study. Seven to eleven train loads per day (depending upon rake type) is expected to meet the fuel requirement of UMPP.
8. The topography from Mundra port to proposed site is plain and flat terrain. Most of the land is barren. Some of the land is marshy also. The distance from Mundra coal yard area and project site is 21 km. Small *Prosopis juliflora* (Ganda bawal), other shrubby plants and very few of the commercial crops at Navinal, Siracha and Jarpara are the main habitation on the route of proposed MGR line.
9. Following are the objectives of the study:
 - a) Reconnaissance survey along the proposed MGR system
 - b) To study the proposed activities along 21 Km long MGR (Merry Go Round) railway system.
 - c) Survey of flora and fauna falling along 21 km MGR stretch
 - d) Determine the impact of the proposed activities on existing ecology
 - e) Management plan for restoring the existing ecology

- f) To prepare a report on ecological impact

METHODOLOGY

10. The field survey was carried out in the last week of November'2006 to evaluate the ecological condition along MGR (Merry Go Round) system. The stretch of 21 km from the Mundra Port to proposed UMPP plant site was surveyed for existing ecological conditions. Surveyed route is shown in Drawing No. RITES/PFC-Mundra-plan/01 sheet 1 of1 Plan of the proposed MGR route.
11. Literature reviewed for collection of secondary data from Forest Working Plan of Kutch Forest Division and a study report on Sustainable Development Plan for Environmental Protection of Kutch by Gujarat Institute of Desert Ecology.
12. Satellite Imagery data has been used to derive the land use pattern of the study area.
13. Local public were also contacted for the existing flora and fauna and awareness of the proposed development
14. Impact has been assessed qualitatively

GENERAL FEATURE OF THE REGION

15. The great Rann of Kachchh consists of a vast expanse of tidal flats with saline efflorescence. Strata of northern strip of Kachchh belong to the Jurassic with recent alluvium of the low land and the Banni tract.
16. The soil is mostly sandy or sandy loam on the coastal tract where as in the other area of the district it is alluvial, sandy, swampy or black clay or loam.
17. The Rann of Kachchh remain flooded for about four months in rainy season with sea water driven up by the strong south west monsoon and fresh water brought down by the river Rann consists of a vast expanse of tidal mudflats with saline efflorescence

TOPOGRAPHY OF THE STUDY AREA

18. The present study area falls in Kutchch peninsula. The topography of the area is such that the central portion forms the table land sloping on all sides. It is practically an undulating rocky area with small hills and with Rann of Kutch lying on the northern end, consisting of vast expanse of tidal mud flats with salt-encrusted mud. The soil varies a great deal from place to place, along the coastline, there are alluvial soils and in some parts they are saline. Soil type indicates that area has high erodability. Elevation of the route varies from 10 m to 21m MSL . A typical topographic feature and vegetation of the route is shown in the following Figure – 1:

Figure -1
General Topography and Vegetation



LAND USE PATTERN OF THE STUDY AREA

19. Satellite image analysis was carried out for the generation of land use/ land cover map of the study region. The approach for satellite data analysis adopted the well-proven Image processing procedures. The analysis was preceded with a ground survey, which comprised of data collection of ground features along with the respective geographical position in terms of latitudes and longitudes.
20. The satellite data used has the below specifications:
 - ? Satellite and Sensor: IRS P-6, LIS III (L-3)
 - ? Date on which the image was taken: 26-November-05
21. In order to understand the land use and land features covering the entire study region, both False Composite and classified images have been derived. An FCC image depicts the land features such as the coastal boundaries, while the classified images show different land use classes listed above. The coverage statistics, the area covered by each land use class, are also derived for 5 km ,10km and 30 km through satellite data analysis and shown in following Tables and Figures:

Table - 1

LAND USE CLASSES WITHIN 5 KM RADIUS

Classes	Area (Km²)
Scrub forest	1.326274637
Salt Pan	8.319278704
Mangrove	0.054819352
Built up area	14.78530965
Fallow land	18.88261409
Nallah	7.241459516

Agricultural land	5.15743997
Water Bodies	5.406779602
Barren hill	5.210490956
Marshy Land	12.89581038
Total	79.28027686

Table -2
LAND USE CLASSESS WITHIN 10 KM RADIUS

Classes	Area (Km²)
Scrub forest	2.829385891
Salt Pan	13.23445251
Mangrove	0.719725036
Built up area	44.29934123
Fallow land	70.77974062
Nallah	15.3839016
Agricultural land	33.14890827
Water Bodies	63.53651274
Barren hill	25.53697604
Marshy Land	46.71581362
Total	316.1847575

Table - 3
LAND USE CLASSESS WITHIN 30 KM RADIUS

Classes	Area (Km²)
Scrub forest	53.16239253
Salt Pan	32.66260757
Mangrove	6.764000647
Built up area	280.4018678
Fallow land	443.8271969
Nallah	84.7790115
Agricultural land	158.2316376
Water Bodies	515.5998752
Barren hill	414.0859303
Marshy Land	120.9942667
Total	2110.508787

Figure – 2
FCC Image around 5 Km. Radius from the Project site

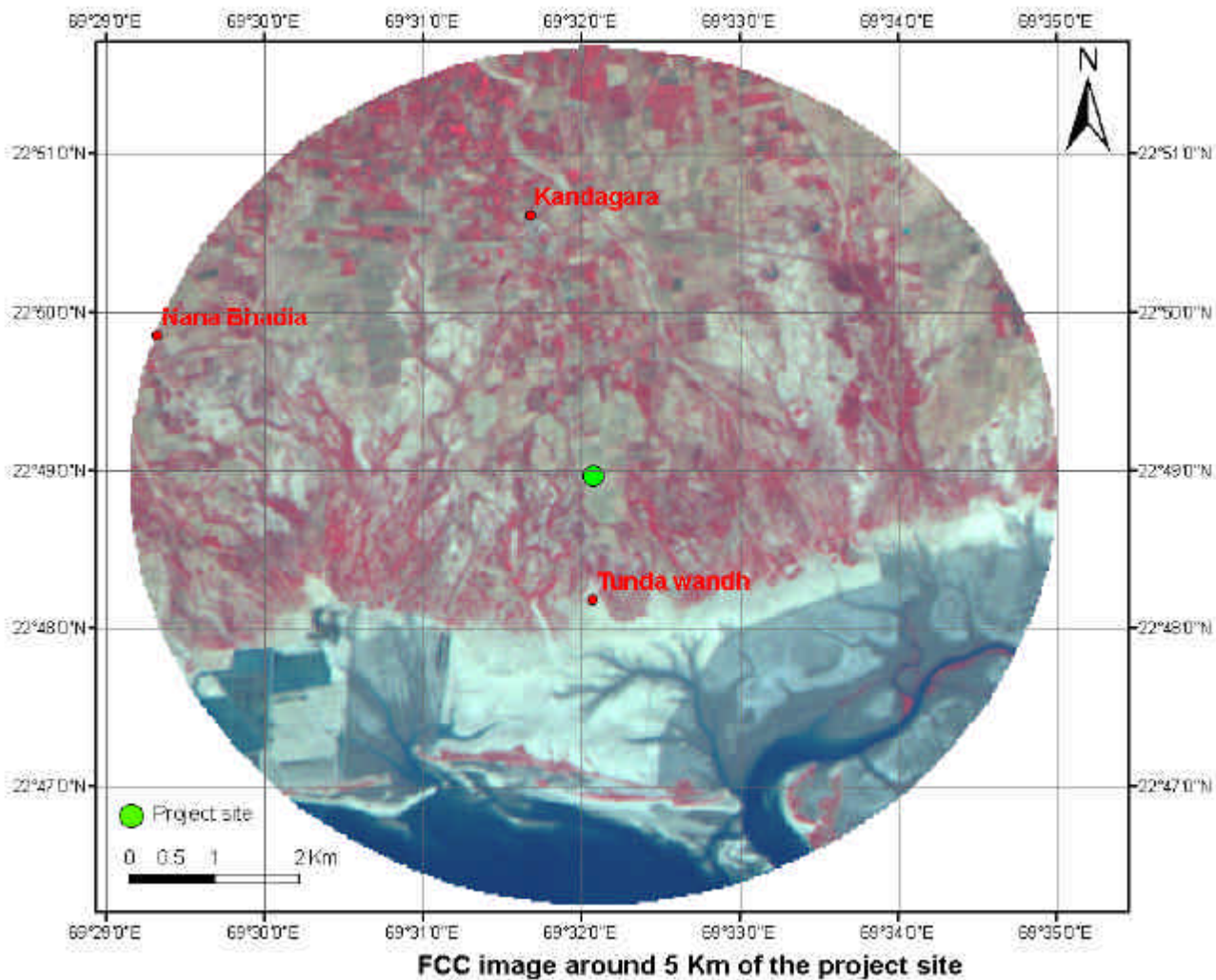


Figure – 3
FCC Image around 10 Km. Radius from the Project site

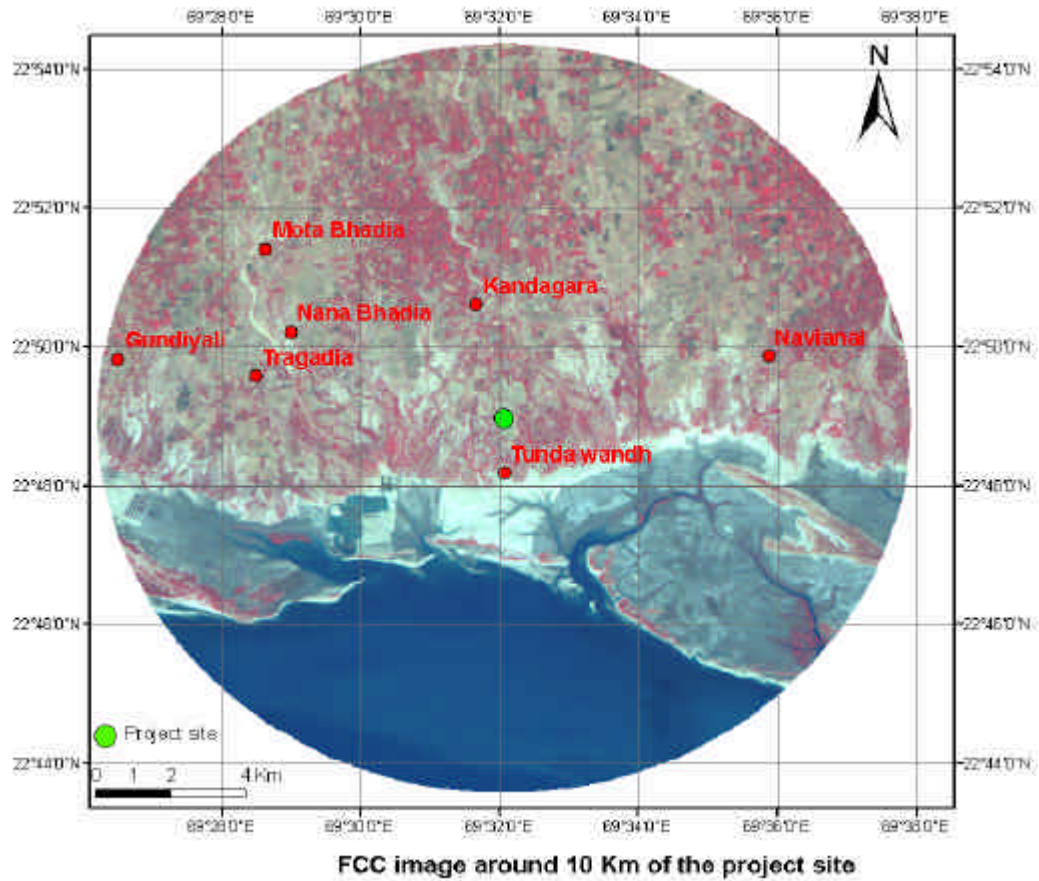
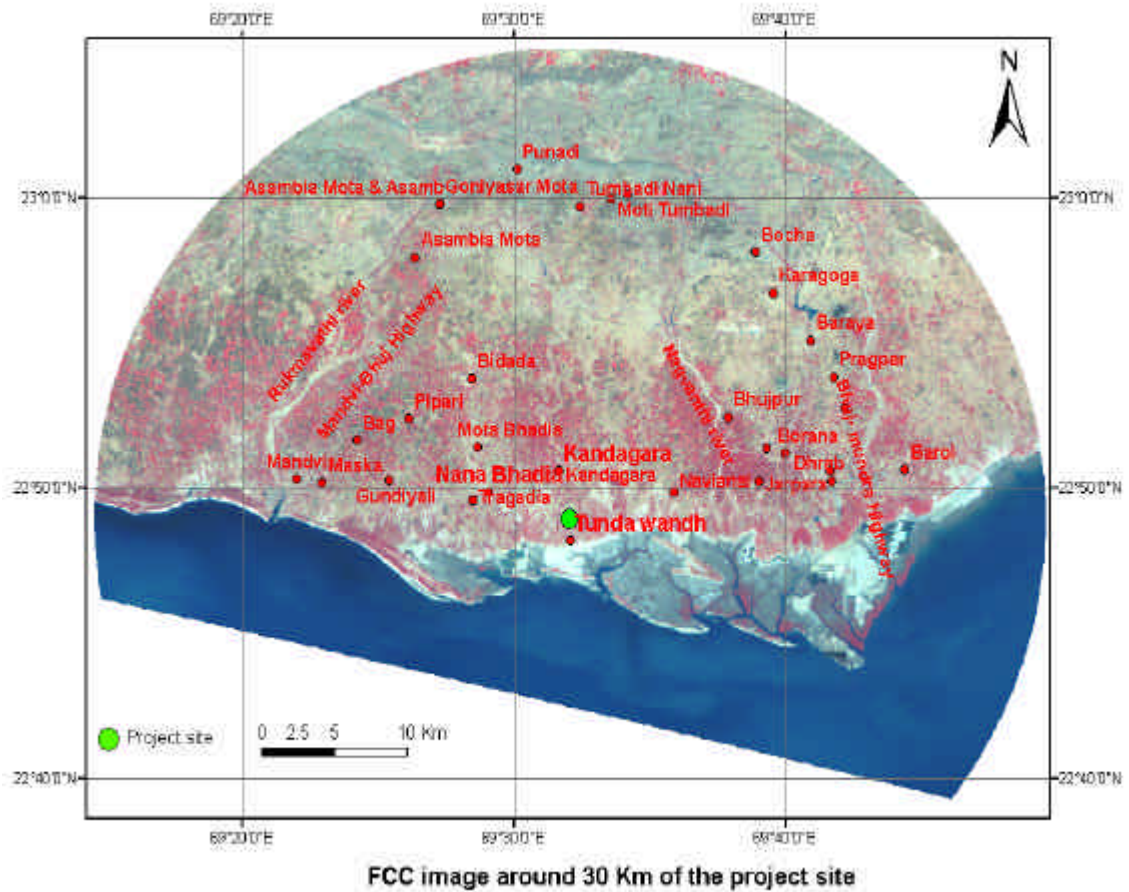


Figure –4
FCC Image around 30 Km. Radius from the Project site



FLORA OF THE STUDY AREA

22. The forest type of the area falls under scrub forest as per the classification of Champion and Seth (1968). These forests are typical of arid and semi-arid zones of the earth where the total rainfall ranges from 25-100Cm. The vegetation presents a very open appearance so that the trees and shrubs are widely spaced. The bulk of the vegetation consist of co-dominant, spiny shrubs and trees capable of drought resistance.
23. The typical species found in these areas are shown in the following figure:

Figure – 5
***Prosopis juliflora* - A Dominant Species of the Area**



Figure – 6

Dichrostachys cinerea



Capparis decidua



24. Detailed information's on ecological condition has been collected, which includes information on both flora and fauna communities. In present study, information has been collected on existing plant and animal species through survey and field studies. The information on distribution pattern of tree species has been collected to establish the interrelationship between species for prevailing environmental factors for post-development monitoring and management.

25. Plant communities are not static but always a dynamic entity. The vegetation cover may reflect the changes, which occurs in its structure, density, and composition. The most important characteristics of a community are its quantitative relationship between abundant and rare species. Characteristics of community in any ecosystem include the composition, structure, species diversity and growth trend of succession and other characteristics of the community, which is applied for the concept and realization of land management. To meet the objective of bio-diversity conservation with temporal & spatial changes, the monitoring of vegetation of an area is a necessary step.
26. A reconnaissance survey of the study area was planned during the study period November 2006 to establish the existing ecological condition of the study area. The information about forestland area of the villages was collected from District Census Hand Book Part II – Land use also. *Prosopis juliflora* is the dominant species of the terrestrial ecosystem of the study area.
27. Vegetation of the study area falls under “VI – B Northern Tropical Forest “ – sub – type C-I Desert Thorn Forest - (VI – Kachchh, Saurashtra, Gujarat).
28. The major agricultural crops cultivated in the area are Jowar (*Sorghum bicolor*), Bajara (*Pennisetum typhoides*) wheat, cotton, castor etc. Fruit trees like sapota, mango, are also cultivated in some part of the district. The most dominant species which is found growing in almost all parts of the district is **Phoenix robusta** (Bell.) Bell. & Hook. f. locally known as **Kharik**. It is a commercial crop cultivated for its edible fruits.
29. There happens to be a significant diversity of crops in the study area. Among cereals, Bajra (*Pennisetum typhoides*) and Jowar (*Sorghum bicolor*) are mainly cultivated in this region. Proportionately Wheat (*Triticum vulgare*) is cultivated in lesser quantity. In pulses Mung and Mungphali (*Arachis hypogaea*) and cotton were observed.
30. The most dominant species which is found growing in almost all parts of the district is **Phoenix robusta** (Bell.) Bell. & Hook. f. locally known as **Kharik**. It is a export quality commercial crop cultivated for its edible fruits. Kharik Palm (*Pheonix dactylifera*), Chiku (*Achrus sapota*), Coconut (*Cocos nucifera*) Mango (*Mangifera indica* var). Kesar were the main cash crops cultivated in orchards. Of these Kharik Palm, Chiku were also reported in the coastal villages.

Figure – 7

***Phoenix robusta* (Bell.) Bell& Hookf**

***Acrus sapota* plantation**



Photo No.:7 *Phoenix robusta* (Bell.) Bell& Hookf



Photo No.:8 *Acrus sapota* plantation

31. However in inner villages the Coconut and Mango has reduced their majority significantly. Papita or Papaya (*Carica papaya*) was also observed in few orchards. Erand (*Ricinus*

communis) was observed to be cultivated for its oil yielding seeds. In vegetable crops Dudhi, and members of Cucurbitaceae family were observed along with Brinjal. In homestead areas Khatti and Mithi imli (*Tamarindus indicus* and *Pithecolobium dulce*), Jamun (*Syzygium cumini*) and Ber (*Zizyphus mauritiana*) were very common. Very few numbers of *Artocarpus heterophyllus* were also been observed.

MANGROVE VEGETATION

32. The intertidal region in the study area is though under influence of tide, possesses sandy substratum and hence is devoid of mangrove vegetation. Mangroves show a very dwarf appearance in the creeklets such as “kutri”(local name creek, which is at least 2.5 Km. away from the actual project site. *Avicennia marina* is the dominant species with *Suaeda* as a majour associate mangrove. *Denis indica* and *Salvadora persica* are the other associated species were recorded during the study period.
33. Mangroves, locally famous as “Cheriya” in this region and the mangrove areas are called “Cheriya vistar”. *Avicennia marina*, *Salvadora perciaca*, *Seuda* were very common in this area. According to information available from local forest office, few years back, *Rhizophora mucronata* and *Cerriops tagal* had been introduced in this region. The mangrove vegetation is seen from Mundra port up to Tunda-Vandh coast. However, in Tunda-Vandh, the *Prosopis* and *Acacia* spp. were predominantly observed just above the high tide line.

Figure – 8
Natural Vegetation of the study area



VEGETATION DENSITY:

34. Mangrove plant density varies considerably between creek and island in study area. Density of mangrove trees ranges from minimum of 525/ ha at Jarpara to a maximum of 1666/ha at Navinal Creek -1. *Mangrove species were not reported along the proposed MGR rail route.*
35. Highest mangrove tree density of 1666 per ha was recored at Navinal creek. Details of the vegetation characterstics falling alongthe route are given below.

Station	Tree Density/Ha	Height (m)		GBH (m)	
		Mean	Range	Mean	Range
Adani	500	1.34	1- 4.5	0.32	0.2-0.59
Navinal cr-1	1666	3.28	1-6	0.53	0.1-1.05
Navinal cr-2	860	2.46	1-5.5	0.36	0.15-0.93

Station	Tree Density/Ha	Height (m)		GBH (m)	
		Mean	Range	Mean	Range
Jarpara	525	1.85	1-2.5	0.26	0.2-0.36

Source: Gujarat Institute of Desert Ecology

36. This region receives very small amount of rain, in addition the soil texture is also sandy. Hence, the vegetation in this region is typically “scrub” type vegetation. The trees and shrubs of *Prosopis* and *Acacia* are predominantly reported in non-cultivated lands. Also members of Euphorbiaceae namely *E. nivula* and *E. tirucalli* were very commonly observed. *Aloe vera* was also observed at few places. The profusely grown *Ficus benghlensis* were observed near a dry water tank in Navinal village. Among the evergreen species Neem (*Azadirachta indica*) is the only species observed in significant number in the study area. Among shrubs- *Cassia auriculiformis*, locally called “Avar” is also observed predominantly along with *Calotropis*. In tress species, *Eucalyptus*, *Casuarina*, *Delonix*, *Peltophorum*, *Nerium*, *Polyalthia*, *Thevetia* were observed to be cultivated in homestead areas. A list of flora recorded in the study area is shown in the following Table:

Table - 4
List Of Flora Recorded In The Study Region

No.	Name of Plant	Family	Habit	Vernacular Name
1.	<i>Acacia auriculiformis</i>	Mimosaceae	T	
2.	<i>Acacia leucociphala</i>	Mimosaceae	T	Hermo baval
3.	<i>Acacia nilotica sub-species indica</i>	Mimosaceae	T	Babhul
4.	<i>Acacia senagal</i>	Mimosaceae	T	Gorad
5.	<i>Acrus sapota</i>	Sapotaceae	T	Chiku
6.	<i>Agave ingens</i>	Agavaceae	H	
7.	<i>Aloe vera</i>		H	
8.	<i>Arachis hypogaea</i>	Papilionaceae	H	Mungphali
9.	<i>Artocarpus heterophyllus</i>	Moraceae	T	
10.	<i>Avicennia marina</i>	Avicenniaceae	T	Cheriyā
11.	<i>Azadirachta indica</i>	Meliaceae	T	Nimda, Limdo, Neem
12.	<i>Bougainvillea spectabilis</i>	Nyctaginaceae	C	
13.	<i>Butea monosperma</i>	Fabaceae	T	Kesudo
14.	<i>Calotropis gigentia</i>	Asclepiadaceae	S	Dholo Akado
15.	<i>Calotropis procera</i>	Asclepiadaceae	S	Nano Akado
16.	<i>Carica papaya</i>	Carricaceae	T	Papita, Papaya
17.	<i>Cassia auriculiformis</i>	Caesalpiniaceae	S	Avar
18.	<i>Casuarina equisetifolia</i>	Casuarinaceae	T	Suru
19.	<i>Cocos nucifera</i>	Arecaceae	T	Nariyal
20.	<i>Cordia dichotoma</i>	Boraginaceae	T	Moto Gundo

No.	Name of Plant	Family	Habit	Vernacular Name
21.	<i>Cordia gharaf</i>	Boraginaceae	S	Liyar, Gundi,
22.	<i>Cynodon dactylon.</i>	Poaceae	HG	
23.	<i>Cyperous spp.</i>	Cypereceae	H	
24.	<i>Delonix regia</i>	Caesalpinaceae	T	Gul Mohar
25.	<i>Derris indica</i>	Fabaceae	T	
26.	<i>Eucalyptus Spp.</i>	Myrtaceae	T	Nilgiri
27.	<i>Euphorbia nivulia</i>	Euphorbiaceae	S	Thor
28.	<i>Euphorbia tirucalli</i>	Euphorbiaceae	T	Kharsani, Thor
29.	<i>Ficus benghalensis</i>	Moraceae	T	vad
30.	<i>Ficus recemosa L.</i>	Moraceae	T	
31.	<i>Ficus religiosa L.</i>	Moraceae	T	Pipal
32.	<i>Ipomea fistulosa</i>	Convolvulaceae	S	Akari
33.	<i>Ipomoea sp.</i>	Convolvulaceae	C	
34.	<i>Leptadenia pyrotechnica</i>	Asclepiadaceae	S	Khip
35.	<i>Leucaena leucocephala</i>	Mimosaceae	T	
36.	<i>Mangifera indica L</i>	Anacardiaceae	T	Aam
37.	<i>Mimosops hexandra</i>	Sapotaceae	T	Rayan
38.	<i>Nerium odoratum</i>	Apocynaceae	S	Kanher
39.	<i>Peltophorum pterocarpum</i>	Caesalpinaceae	T	
40.	<i>Pennisetum typhoides</i>	Poaceae	HG	Bajra
41.	<i>Phaseolus aureus</i>	Fabaceae	H	Mung
42.	<i>Pheonix dactylifera</i>	Arecaceae	T	Kharik Palm
43.	<i>Pithecolobium dulce</i>	Mimosaceae	T	
44.	<i>Polyalthia longifolia</i>	Annonaceae	T	
45.	<i>Portulaca indica</i>	Portulacaceae	H	
46.	<i>Prosopis chilensis</i>	Mimosaceae	S	Gando Baval
47.	<i>Prosopis chilensis</i>	Mimosaceae	T	Khijdo
48.	<i>Prosopis stephaniana</i>	Mimosaceae	S	Khijdi
49.	<i>Ricinus communis L.</i>	Euphorbiaceae	S	Erاند
50.	<i>Samanea saman</i>	Mimosaceae	T	
51.	<i>Solanum melanogena</i>	Solanaceae	H	Baingan
52.	<i>Sorghum bicolor</i>	Poaceae	HG	Jowar

No.	Name of Plant	Family	Habit	Vernacular Name
53.	<i>Syzygium cumini</i>	Myrtaceae	T	Jamun
54.	<i>Tamarindus indicus L.</i>	Caesalpiniaceae	T	
55.	<i>Terminalia catapa</i>	Combretaceae	T	
56.	<i>Thevetia peruviana</i>	Apocynaceae	S	
57.	<i>Typha angustata</i>		H	Panj
58.	<i>Zizyphus mauritiana</i>	Rhamnaceae	S	Ber

FAUNA OF THE STUDY AREA

37. Old records reveal that at the beginning of the 18th century Lion, Tiger and other animals relating to cat family was plentiful in Kachchh, but villages observed that most of these animals are not seen in the area.
38. Some of the common animals found in the study area are Fox, Mongoose, Nilgai (in Mundra forest) Rabbit etc,
39. In reptile's cobra, monitor lizard, rat snake is reported by surrounding villagers at rare occasions.
40. A recent study reveals high avifaunal diversity at Mundra region and 140 species have been documented. Some of the birds sighted during the present study are Grey herons, Pond herons, large and small Egrets, Black Ibis etc. Following figures indicate about the presence of avifauna of the area.

Figure – 9
Avifaun of The Study Area



LIVESTOCK POPULATION

41. Cattle wealth occupies a pivotal place in the rural economy of any of the area. Bullocks & cows, buffalo, sheep, goats, horses, mules, donkeys, camels, pigs and poultry are the livestock reported. Livestock density of the area varies from 50 to 75 per square kilometer. Average density (per square kilometer) for buffalo, cattle, goat, and sheep varies from 10 –

20, 30 – 50, 10 – 20, and below 5, respectively. The cattle's (cow and buffaloes) are normally taken to open land for natural manuring of the land. There are various dairy farms (Gau shalas) in the study region that are also important source of earning for village people. Following Table and Figures shows the livestock population of the study area

Livestock	Average Density/sq km
Buffalo	<10
Cattle	20-30
Goat	20-30
Sheep	20-30

Source: ENVIS website, 2006

42. Herds of goat were reported during the study period, which is shown in following figure:

Figure – 10
Livestocks of the Study Area



Figure – 11
Livestocks of the Study Area



MGR RAILWAY SYSTEM AND VEGETATION DESCRIPTION.

43. To describe the MGR railway route, MGR line is divided into four segments viz. A) Unloading bulb B) MGR load alignment Loading C) Loading and D) Loading terminal station @ Adani R & D railway yard. Proposed MGR railway route is shown in Drawing No. RITES/PFC-Mundra-plan/01 sheet 1 of1.
44. For the purpose of description of rail alignment, the starting point proposed at the entrance of unloading bulb is assumed as km 0.00. For in motion of coal rakes for unloading in the track hopper the train will have forward movement. Therefore a bulb type arrangement has been proposed in the unloading terminal. Unloading terminal station is partially on straight and curve and ends at km 5/692.
45. After unloading terminal station at km 5/692 the alignment is straight up to km 8/208. after this the alignment takes a the curve (no.6)with a curve of radius 500k meters up to km 8/477 and then the alignment is straight up to km 11/709, there after the alignment take a left hand curve (no.7) with curve of radius 500 meters up to km 11/798 and then straight up to km 13/641. after this the alignment takes right hand curve (no.8) with a curve of radius 500 meters up to km 13/657 after that the alignment takes is straight unto km 15/434 and takes a right hand curve (No.9) with curve of radius 500 meters up to km 15/685. Thereafter the alignment is straight up to km 18/590 and takes right hand curve (no.10) with a curve of radius of 500 meters up to km 18/634 and than straight up to km 21/424. After this the alignment takes right hand curve (no.11) with a curve radius of 500 meters up to km 21/951 and then straight up to km 25/110. After this the alignment takes a left hand curve (no.12) with a curve of radius 500 meters up to km 25/507 where the alignment enters in to the loading bulb.
46. The alignment enters into a loading bulb with a curve (no.12) at km 25/110 with a curve radius of 500 meters up to km 25/507. There after the alignment Is straight up to km 25/784. After this the alignment takes a left hand curve (no.13) with a curve of radius 500 meters up to km 25/874 and than straight up to 26/595. After this the alignment takes a right hand curve (no.14) with a curve of radius 300 meters up to km 27/128 and than alignment straight up to 27/141. After this the alignment takes a right hand curve (no.15) with a curve of radius 300 meters up to km 27/670 and than alignment straight up to 28/372 and takes right hand curve (no. 16) with a radius of curve 500 meters up to km 28/489 and than the alignment straight up to 28/993. After this the alignment takes a right hand curve (no.17) with a curve of radius 500 meters up to km 29/164 and meets the MGR bulb.
47. Existing Adani's R & D rail yard has 5 lines for handling port traffic. It is proposed to bring the UMP POL rakes from Adipur station to Adani R & D rail yard for handling. Unloading line No. 1 and 2 shall be used for handling the loading and unloading coal rakes.
48. The proposed railway yard near Adani railway yard doesn't have any vegetation. The Adani railway yard and vacant place for the MGR railway yard is shown in following photographs.

Adani railway yard



Figure – 12

**Place For Proposed Railway
Route Near Adani Railway Yard**



49. Ideally in MGR system, the train needs not to be physically stopped as both loading and unloading operations are in motion. The proposed MGR system is envisaged not to disturb village habitations, village roads, and ecology along the MGR line.
50. Photograph showing typical Vegetation near the MGR route near Adani railway yard at Mundra.

Figure – 13

Vegetation Along The MGR Route. Near Adani Railway Yard



51. There are 18 bridges proposed on the MGR route. One of them is planned over Nagavantahi Nadi also. Typical feature and vegetation under the proposed bridges is shown in following figure.

Figure – 14
Proposed Bridge At Nagvanthi Nadi



52. Proposed coal stack yard area was also surveyed during the study. *Prosopis juliflora* is the predominate species at the proposed project site coal stack yard. Existing features of the area is shown in following figure :

Figure – 15
Coal Stacking Yard



IMPACTS AND MANAGEMENT PLAN

53. Mangrove or other forested areas are not falling along the 100 wide route of MGR system. There may be cutting of some vegetation at certain stretches; the exact number can be ascertained after the finalization of the route. However, effort will be done to minimize the minimum shrub/trees felling.
54. Plantation is planned all along the available corridor of railway route. This will help in restoring the existing ecology of the route.

55. The above plantation will attenuate the noise generated due to operation of rail route.

CONCLUSION:

- a) Predominant species along the route is reported to be *Prosopis juliflora* (Ganda bawal).
- b) Mangrove species were not reported along the proposed MGR route.
- c) No National park, wild life sanctuary, Biosphere Reserves, Bird sanctuary are falling along the rail route of proposed MGR system.
- d) There is no Lakes, Reservoir, Dams coming in the way of MGR line. A small Bridge will be constructed on Nagvanthi Nadi.
- e) Study area does not have Sensitive monuments and, Historical Places.
- f) Mostly domestic and pet animals were reported during the study. However, wild animals are also noticed by villagers at some of the occasions.
- g) No significant wild life habitat disturbance is expected due to proposed MGR route and its activities.
- h) During the lay down of MGR line, mainly local shrub plantation and some of the commercial species of **Phoenix robusta** locally known as **Kharik**, Chiku (*Achras sapota*), Coconut (*Cocos nucifera*) Mango (*Mangifera indica* var) will be disturbed. However, proposed plantation along the MGR route will be helpful in compensating the loss of flora.
- i) Plantation will be done all along the MGR route in consultation with local forest department.
- j) Plant species native of the area shall be introduced. The preferred plant species will be heterogeneous in nature. Monocultures will be discouraged as much possible.