




Draft Environment Impact Assessment Report
For
Onshore Exploration and Development in 2PML Blocks in
Districts Cachar and Hailakandi, Assam



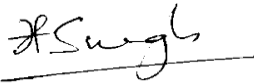
Submitted By

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12	RH*	Amlan Chakraborty	Risk Assessment and DMP studies (July,2017 till date)	
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Declaration by the Head of the accredited consultant organization/ authorized person

I, Harendra Singh, hereby, confirm that the above mentioned experts prepared the EIA "**Onshore Exploration and Development in Two (02) PML Blocks in Districts Cachar and Hailakandi, Assam**". I also confirm that the consultant organization shall be fully accountable for any misleading information mentioned in this statement.

Signature: 

Name: Harendra Singh

Designation: General Manager

Name of the EIA consultant organization: Oil & Natural Gas Corporation Ltd.

NABET Certificate No. & Issue Date: NABET/EIA/1518/RA0054, 14/06/2017



Quality Council of India

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CERTIFICATE OF ACCREDITATION

Oil & Natural Gas Corporation Limited (ONGC)
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Vasant Kunj, New Delhi- 110070

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Note: Names of approved EIA Coordinators and Functional Area Experts are mentioned in RA AC minutes dated May 12, 2017 posted on QCI-NABET website.

The Accreditation shall remain in force subject to continued compliance to the terms and conditions mentioned in NABET's letter of accreditation bearing no. QCI/NABET/ENV/ACO/17/0343 dated 14 June 2017. The accreditation needs to be renewed before the expiry date by Oil & Natural Gas Corporation Limited (ONGC) following due process of assessment.

C.E.O NABET
Dated: Jun.14, 2017

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Valid till Date
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Jun. 20, 2018

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(Kind Attention: Shri. J.S Sharma)

Sub: Validity of Accreditation as EIA Consultant organisation- Oil & Natural Gas Corporation Limited

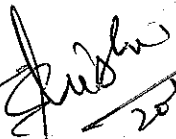
Dear Sir,

This has reference to the accreditation of your organization under QCI-NABET EIA Scheme, the validity of **Oil & Natural Gas Corporation Limited** is hereby extended till December 19, 2018 or completion of assessment process, whichever is earlier.

The above extension is subject to the submission of required information/documents related to assessment on time to NABET.

You are requested not to use this letter after expiry of the above stated date.

With best regards,

For 
20/06/2018

A.K Jha

Senior Director | NABET

NABET



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(02) PML Blocks in Districts Cachar and
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ABBREVIATIONS

BLEVE	Boiling Liquid Evaporating Vapour Explosion
BOD	Biological Oxygen Demand
BOP	Blow-out Preventer
CAGR	Compounded Annual Growth Rate
CC&A	Common Consent and Authorization (Consent to Operate (for water and air emissions) and Authorization (for management of hazardous wastes)
CGWA	Central Ground Water Authority
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
DG	Diesel Generator
DGH	Directorate General of Hydrocarbons
DMP	Disaster Management Plan
EC	Environmental Clearance
ECC	Emergency Control Centre
EHS	Environmental Health and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EOR	Enhanced oil Recovery
FAE	Functional Area Expert
GGs	Group Gathering Stations
GLC	Ground Level Concentration
GoI	Government of India
GPCB	Gujarat Pollution Control Board
HAZOP	Hazard and Operability Study
HDPE	High Density Polyethylene
HSD	High Speed Diesel
HSE	Health, Safety and Environment
IMD	Indian Meteorological Department
INR	Indian Rupees
KLD	Kilo Litre per Day
LU	Land Use
ML	Mining Lease
MoEF	Ministry of Environment and Forest
MSDS	Material Safety Data Sheet
MSL	Mean Sea Level
MT	Metric Tonnes
NABET	National Accreditation Board for Education and Training
NDT	Non Destructive Testing
NMHC	Non-Methane Hydrocarbons
NOC	No-Object Certificates (Consent to Establish)
NOx	Nitrogen Oxides
OOIP	original oil in-place
ONGC	Oil and Natural Gas Corporation Limited

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OMR	Oil Mines Regulation
PDCR	Plan, Do, Check and Review
PEL	Petroleum Exploration License
PM	Particulate Matter
PPE	Personal Protective Equipment
PSC	Production Sharing Contract
SAR	Sodium Absorption Ratio
SO2	Sulphur Dioxide
TDS	Total Dissolved Solids
TSDF	Treatment, Storage, and Disposal Facility
USEPA	United States Environment Protection Agency
VOCs	Volatile Organic Compounds

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GLOSSARY

ABANDONED WELL: A dry hole in which no producible oil or gas was present, or a well that has stopped producing. Abandoned wells must be plugged to prevent seepage of oil, gas, or water from one formation to another.

ACCIDENT: An accident may be defined as 'an undesirable and unplanned event with or without or major or minor damage consequence to life and/or property.'

ACTIVE WELL: A well in mechanical condition for production or service use (i.e., in active production or service use).

API: It is the short form of American Petroleum Institute. It is the oil industry's trade organization. API's research and engineering work provides a basis for establishing operating and safety standard issues; specifications for the manufacturing of oil field equipment; and furnishes statistical and other information to related agencies.


ASSOCIATED GAS: Gas combined with oil or dissolved in crude oil. Known also as cap gas and solution gas, it provides the drive mechanism needed to force oil to the surface of a well. Associated gas is normally present in an oil reservoir in the early stages of production.

BARREL: The standard unit of measure of liquids in the petroleum industry. It is equivalent to 42 U.S. standard gallons or 159 litres of oil.

BARREL OF OIL EQUIVALENT (BOE): The amount of energy resource that is equal to one barrel of oil on an energy basis. The conversion is based on the assumption that one barrel of oil produces the same amount of energy when burned as 5,620 cubic feet of natural gas.

BASIN: A depression of the earth's surface into which sediments are deposited, usually characterized by sediment accumulation over a long interval; a broad area of the earth beneath which layers of rock are inclined, usually from the sides toward the centre.

BED: A layer of rock, usually sediments, which is homogeneous (the same) in composition. One bed is separated from another by a bedding plane.

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BID: An offer for a lease submitted by a potential lessee in the form of a cash bonus dollar amount or other commitments as specified in the final notice of sale.

BLEVE: (BOILING LIQUID EXPANDING VAPOUR EXPLOSION): This is a type of explosion that can occur when a vessel containing a pressurized liquid is ruptured. Such explosions can be extremely hazardous.

BLOWOUT: An uncontrolled flow of gas, oil, or other fluids from a well to the atmosphere. A well may blow out when formation pressure exceeds the pressure overburden of a column of drilling fluid.

BLOWOUT PREVENTER: A special assembly of heavy-duty valves, commonly called the BOP stack, installed on top of a well which can be closed to prevent high-pressure oil or gas from escaping (a blowout) from the well hole during drilling operations.

BOREHOLE: The hole in the earth made by the drill; the uncased drill hole from the surface to the bottom of the well.

CASING: Steel pipe used in oil wells to seal off fluids in the rocks from the bore hole and to prevent the walls of the hole from caving.


CASING HEAD: The top of the casing set in a well; the part of the casing that protrudes above the surface and to which the control valves and flow pipes are attached.

CASING HEAD GAS: Gas produced from an oil well as distinguished from gas from a gas well. The casing head gas is taken off at the top of the well or at the separator.

COMMERCIAL WELL: A well of sufficient net production that it could be expected to pay out in a reasonable time and yield a profit from the operation.

COMPLETED WELL: A well that has been mechanically completed for production or service use. There may be more than one completed zone in the well.

CONDENSATE: A natural gas with a low vapour pressure compared with natural gasoline and liquefied petroleum gas. It is produced from a deep well where the temperature and pressure are high. Gas

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condenses as it rises up the well bore and reaches the surface as condensate. Similarly, condensate separates out naturally in pipelines or in a separation plant by the normal process of condensation.

DEVELOPMENT: Activities following exploration including the installation of facilities and the drilling and completion of wells for production purposes.

DIRECTIONAL DRILLING: The technique of drilling at an angle from the vertical by deflecting the drill bit. Directional wells are drilled to develop an offshore lease from one drilling platform; to reach a pay zone where drilling cannot be done, such as beneath a shipping lane.

DISASTER: Is a catastrophic consequence of a major emergency/accident that leads to, not only extensive damage to life and property but also disrupts all normal human activity for a long time and requires a major national and international effort for rescue and rehabilitation of those affected.

DISCOVERY: A find of significant quantity of gas or oil.


DRILL CUTTINGS: Chips and small fragments of drilled rock that are brought to the surface by the flow of the drilling mud as it is circulated.

DRILL PIPE: Heavy, thick walled, hollow steel pipe used in rotary drilling to turn the drill bit and to provide a conduit for the drilling mud.

DRILLING CONTRACTOR: A person or company whose business is drilling wells. Wells are drilled on several contract specifications: per foot, day rate, or turnkey (that is, upon completion). Most major oil companies do not own drilling rigs. Exploration and development drilling is contracted. Personnel manning the rigs work for the contractor.

DRILLING MUD: A special mixture of clay, water, or refined oil, and chemical additives pumped down through the drill pipe and drill bit. The mud cools the rapidly rotating bit; lubricates the drill pipe as it turns in the well bore; carries rock cuttings to the surface; serves as a plaster to prevent the wall of the borehole from crumbling or collapsing; and provides the weight or hydrostatic head to prevent extraneous fluids from entering the well bore and to control down hole pressures that may be encountered.

DRY HOLE: A well drilled to a certain depth without finding commercially exploitable hydrocarbons.

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DRY GAS: Natural gas from the well that is free of liquid hydrocarbons; gas that has been treated to remove all liquids; pipeline gas.

EMERGENCY: Is a situation of process deviation that if uncontrolled may lead to a major accident/disaster with potential short term and/or long term risk damage consequence to life and property in and/or around the facility.

ENVIRONMENTAL IMPACT ASSESSMENT: A statement required under the Environmental Impact Assessment Notification, 2006 or similar regulations by other bodies in relation to any action significantly affecting the environment, including certain exploration and drilling activities.

EXPLORATION: The process of searching for minerals preliminary to development. Exploration activities include (1) geophysical surveys, (2) drilling to locate an oil or gas reservoir, and (3) the drilling of additional wells after a discovery to delineate a reservoir. It enables the lessee to determine whether to proceed with development and production.


EXPLOSION: An explosion is a sudden increase in volume and release of energy in an extreme manner, usually with the generation of high temperatures and the release of gases.

FIELD: A geographical area in which one or more oil or gas wells produce. A field may refer to surface area only or to underground productive formation. A single field may include several reservoirs separated either horizontally or vertically.

FIREBALL: The burning of a flammable gas cloud on being immediately ignited at the edge before forming a flammable/explosive mixture.

FLAMMABLE LIMIT: Flammable limits refer to the conditions under which a mixture of a flammable material and air may catch fire or explode. When vapours of a flammable or combustible liquid are mixed with air in the proper proportions in the presence of a source of ignition, rapid combustion or an explosion can occur. The proper proportion is called the flammable range and is also often referred to as the explosive range. The flammable range includes all concentrations of flammable vapour or gas in air, in which a flash will occur or a flame will travel if the mixture is ignited.

FLASH FIRE: A flammable gas release getting ignited at the farthest edge resulting in flash-back fire.

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Gas Lost: Natural gas which is flared or vented (i.e., natural gas not retained in the production system for sale or use).

HAZARD: Is the potential of an Accident.

INCIDENT: Is an emergent situation of any critical deviation in the process control or otherwise that may lead to a major accident/potential emergency and disaster.

LEASE: A legal document executed between a landowner (as lessor) and a company or individual (as lessee) that conveys the right to exploit the premises for minerals or other products for a specified period of time over a given area.

INJURY ZONE: Zone of injury in any hazardous event.

MAJOR ACCIDENT HAZARD (MAH) INDUSTRY: If the quantity of any chemical as listed in MSIHC Rules' Schedule-2 or Schedule-3 is equal to or greater than the Threshold Quantity given therein.

MAJOR ACCIDENT: Loss of life or 10 or more injuries on-site or 1 or more injuries off-site (as defined in MSIHC Rules).


OIL LOST: Oil that is spilled or burned (i.e., oil not retained in the production system for sale).

OPERATOR: The individual, partnership, firm, or corporation having control or management of operations on a leased area or a portion thereof. The operator may be a lessee, designated agent of the lessee, holder of rights under an approved operation agreement, or an agent of an operating rights holder.

PLUGGED AND ABANDONED: Wells in which casings have been removed, and the well bore sealed with mechanical or cement plugs.

PLUMES: Plumes are continuous release of hazardous gases and vapours. Smoke from a chimney is an example. Plumes can cause Fires and Explosions as secondary scenarios, in case the gases are flammable & ignition occurs.

PRODUCIBLE LEASE: A lease where one well or several wells have discovered hydrocarbons in paying quantities, but for which there is no production during the reporting period.

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PRODUCIBLE ZONE COMPLETION: The interval in a well bore that has been mechanically prepared to produce oil, gas or sulphur. There can be more than one zone completed for production in a well bore.

PRODUCING LEASE: A lease that is producing oil, gas, or sulphur in quantities sufficient to generate royalties.

PRODUCTION: The phase of oil and gas operations involved with well fluids extraction, separation, treatment, measurement, etc.

PROVEN RESERVES (SOCIETY OF PETROLEUM ENGINEERS): Reserves that can be estimated with reasonable certainty to be recovered under current economic conditions. Current economic conditions include processing costs prevailing at the time of the estimate. Proved reserves must either have facilities that are operational at the time of the estimate to process and transport those reserves to market, or a commitment of reasonable expectation to install such facilities in the future. Proved reserves can be subdivided into undeveloped and developed Reserves.

PUFFS: Puffs are instantaneous release of hazardous gases and vapours. Puffs can give rise to FIRE BALLS and vapour cloud explosions (VCE). A special case of vapour cloud explosion is the Boiling Liquid Evaporating Vapour Explosion (BLEVE).


RENT: Periodic payments made by the holder of a lease, during the primary lease term for the right to use the land or resources for purposes established in the lease.

ROYALTY: Payment, in value (money) or in kind, of a stated proportionate interest in production from mineral deposits by the lessees to the Government.

SALES VALUE: The proceeds received for the sale of the mineral.

SERVICE ZONE COMPLETION: The interval in a well bore that has been mechanically prepared for service use, usually water or gas injection to stimulate production from other wells or for water or other waste disposal.

SESMIC SURVEY: The seismic survey is one form of geophysical survey that aims at measuring the earth's (geo-) properties by means of physical (-physics) principles such as magnetic, electric, gravitational, thermal, and elastic theories

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SPILLS: Spills are liquid pools created by leaking liquid chemicals. Spills may cause evaporation and dispersal of toxic gases and if the spilled liquid is flammable, then it can catch fire creating a pool fire, or the vapour can cause explosion.

SUSPENDED WELL: A well on which operations have been discontinued. The usual context is an uncompleted well in which operations ceased during drilling but which has not been plugged and abandoned permanently.


UPPER EXPLOSIVE LIMIT (UEL)/ UPPER FLAMMABLE LIMIT (UFL): Upper flammable limit (UEL) or the upper explosive limit is the maximum concentration of vapour or gas in air below which propagation of flame does not occur on contact with a source of ignition. The mixture is said to be too rich.

LOWER EXPLOSIVE LIMIT (LEL)/ LOWER FLAMMABLE LIMIT (LFL): Lower flammable limit (LEL) or the lower explosive limit is the minimum concentration of vapour or gas in air above which propagation of flame does not occur on contact with a source of ignition. The mixture is said to be too lean.

VCE: (VAPOUR CLOUD EXPLOSION); Explosion resulting from vapour clouds formed from flashing liquids or non-flashing liquids and gases. Sometimes also referred to as unconfined vapour cloud explosion.


VULNERABILITY ZONE: Zone of Exposure leading to Fatality or recoverable injury in any hazardous event.

WELL: A hole drilled or bored into the earth, usually cased with metal pipe, for the production of gas or oil. A hole for the injection under pressure of water or gas into a subsurface rock formation.


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TERMS OF REFERENCE AND ITS COMPLIANCES


Sr. No.	TOR Condition	Compliance
A	Specific and Additional TOR	
1.	Executive Summary of the Project	Executive Summary is given given at page no. ix
2.	No. of Exploratory wells for which environmental Clearance is accorded and No. of new Wells proposed during Expansion. Status and No. of the wells which are completed and closed.	The project proposal is a new proposal and not an expansion project. MoEFCC had earlier granted EC for fifteen exploratory wells in this area in 2008. Out of these 15 wells, 11 wells were drilled. Presently, the validity of EC has expired.
3.	Project description and project Benefits	Project description is given in Chapter-2 , and benefits of the project are given in Chapter-8 .
4.	Cost of project and period of completion	The total estimated cost of the proposed project is approximately Rs. 120 crores (each well Rs. 40 crores). Drilling activity generally takes 3-4 months for completion.
5.	Employment to be Generated	10 persons for 2 shifts/ 12 hours
6.	Distance from Coast line	Not applicable
7.	Details of Sensitive areas such as coral reef, marine water park, Sanctuary and any other eco-sensitive area	Barak river is flowing at a distance of 300 m, 2.5 KM and 5 KM from the wells location viz. BPAA, BPAB and WHRAA respectively. No coral reef, marine water park, Sanctuary and any other eco-sensitive area lies within 10 KM from the locations.

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8.	Recommendation of SCZMA/CRZ clearance as per CRZ Notification dated 6th January, 2011 (if applicable).	Not Applicable
9.	Details on support Infrastructure and vessel in the study area	Not Applicable
10.	Climatology and Meteorology including wind speed, wave and Currents, rainfall etc.	Climatology and Meteorological details are given in Section-3.7 and rainfall details in the section 3.7.3
11.	Details on establishment of baseline on the air quality of the areas immediately affected by the exploratory drilling and also particularly with reference to hydrogen sulphide , sulphur di oxide, NOx and background levels of hydrocarbons and VOCs	Details are given in Section 3.8 of Chapter-3
12.	Details on estimation and computation of air emissions (such as nitrogen oxides, sulphur oxides, carbon monoxide, hydrocarbons, VOC's etc.) resulting from flaring , DG sets, combustion etc. during all project phases	Details are given in section 4.2.1.2 of Chapter-4
13.	Baseline data collection for surface water for one season leaving the monsoon season within 1 km for each exploratory wells , particularly in respect of oil content in the water sample and sediments sample	Details are given in Section 3.10 of Chapter -3
14.	Fisheries study w.r.t benthos and marine organic material and coastal fisheries.	Not applicable
15.	Source of fresh water, detailed water balance, waste water generation and discharge	Water requirement details are given in Section-2.5.1 of Chapter-2 . Waste water generation details are given in Section-2.5.3 of Chapter-2 . and mode of treatment are given in Section-4.2.9.4 of Chapter-4 .
16.	Noise abatement measures and measures to minimize disturbance due to light and visual intrusions in case of project site closed to the coast.	Noise control measures are given in Section-4.2.2.9 of Chapter-4 .
17.	Procedure for handling oily water discharges from deck washing , drainage systems , bilges etc.	Details are given in Section 2.5.1 of Chapter-2
18.	Procedure for preventing spills and oil spill contingency plans	Oil spill emergency plan is given in Section-7.6.13 of Chapter-7 .
19.	Procedure for sewage treatment and disposal and also for kitchen waste disposal	Details are given in Section 10.7.12 of Chapter-10

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20.	Details on solid waste management for drill cuttings, drilling mud and oil sludge, produced sand, radioactive materials, other hazardous materials, etc. including its handling and disposal options during all project phases	Details are given in Section 10.7.11 of Chapter-10
21.	Storage of chemicals on site	Details are given in Section 2.5.1 of Chapter-2
22.	Commitment for the use of water based mud (WBM) and synthetic oil based mud in special case	Details are given in Section 2.5.3 of Chapter-2
23.	Details of blowout preventer Installation	Details are given in Section 7.6.1 of Chapter-7
24.	Risk assessment and mitigation measures including whether any independent reviews of well design, construction and proper cementing and casing practices will be followed	Details of Risk Assessment is given in Section 7.2 of Chapter-7
25.	Handling of spent oils and oil from well test operations	Management of used oil details are given in Section-2.5.5 of Chapter-2.
26.	H ₂ S emissions control plans, if required.	H ₂ S emission control details are given in Section-7.6.3 of Chapter-7.
27.	Details of all environment and safety related documentation within the company in the form of guidelines, manuals, monitoring programmes including Occupational Health Surveillance Program etc.	Occupational health and safety details are given in Section 7.9 of Chapter-7.
28.	Restoration plans and measures to be taken for decommissioning of the rig and restoration of on-shore support facilities on land.	Details of decommissioning and restoration plans are given in section-2.5.9 of chapter-2.
29.	Documentary proof for membership of common disposal facilities, if required	Not Applicable
30.	Any Litigation pending against the project or any directions /order passed by any court of law against the project. If SO, details thereof	NO
31.	Total Capital and recurring cost for environmental pollution control measures	Details given in section 9.2 of chapter-9
B	Standard TOR	
1.	Executive summary of a project.	Executive Summary has been enclosed given in EIA report.
2.	Project description, project objectives and project benefits.	Project description is given in Chapter-2 , project objectives are given in section-2.4 of

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		Chapter-2 and benefits of the project are given in Chapter-8 .
3.	Cost of project and period of completion.	<p>The total estimated cost of the proposed project is approximately Rs. 120 crores (each well Rs. 40 crores).</p> <p>Drilling activity generally takes 3-4 months for completion.</p>
4.	Site details within 1 km of the each proposed well, any habitation, any other installation/activity, flora and fauna, approachability to site, other activities including agriculture/land, satellite imagery for 10 km area. All the geological details shall be mentioned in the Topo sheet of 1:40000 scale, superimposing the well locations and other structures of the projects. Topography of the project site	<p>Environmental setting of block area is given in Table-1.3. The Topographic maps are shown in Figure-1.2 and Figure-1.3 of Chapter-1.</p> <p>Flora and fauna details are given in Section-3.9 of Chapter-3.</p> <p>Satellite imagery and land use pattern are given in Figure-3.3.1 and 3.3.2 of Chapter-3.</p>
5.	Details of sensitive areas such as National Park, Wildlife sanctuary and any other eco-sensitive area along with map indicating distance.	<p>Barak river is flowing at a distance of 300 m, 2.5 KM and 5 KM from the wells location viz. BPAA, BPAB and WHRAA respectively.</p> <p>National Park, Wildlife sanctuary and any other eco-sensitive area lies within 10 KM from the locations.</p>
6.	Approval for the forest land from the State/Central Govt. under Forest (Conservation) Act, 1980, if applicable.	No forest land is involved.
7.	Recommendation of SCZMA/CRZ clearance as per CRZ Notification dated 6th January, 2011 (if applicable).	Not Applicable
8.	Distance from nearby critically/severely polluted area as per Notification, if applicable. Status of moratorium imposed on the area.	Nil
9.	Does proposal involve rehabilitation and resettlement? If yes, details thereof.	No
10.	Environmental considerations in the selection of the drilling locations for which environmental clearance is being sought. Present any analysis suggested for	Details are given in Section 2.4.2 of Chapter-2

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	minimizing the foot print giving details of drilling and development options considered.	
11.	Baseline data collection for air, water and soil for one season leaving the monsoon season in an area of 10 km radius with centre of Oil Field as its centre covering the area of all proposed drilling wells.	The baseline studies were carried out from 27 th April 2018 to 27 th July 2018 during Pre-monsoon season. Details are given in Chapter-3 of EIA report.
12.	Climatology and Meteorology including wind speed, wind direction, temperature rainfall relative humidity etc.	Climatology and Meteorological details are given in Section-3.7 of Chapter-3 .
13.	Details of Ambient Air Quality monitoring at 8 locations for PM2.5, PM10, SO2, NOx, CO, VOCs, Methane and non-methane HC.	Results of Ambient Air Quality monitoring are given in Section-3.8 of Chapter-3 .
14.	Soil sample analysis (physical and chemical properties) at the areas located at 5 locations.	Details of Soil Sampling analysis are given in Section-3.11 of Chapter-3 .
15.	Ground and surface water quality in the vicinity of the proposed wells site.	Surface water and ground water quality have been monitored and results are given in Section 3.10 of Chapter-3 .
16.	Measurement of Noise levels within 1 km radius of the proposed wells.	Noise level survey results are given in Section-3.9 of Chapter-3 .
17.	Vegetation and land use; flora/fauna in the block area with details of endangered species, if any.	Details of flora and fauna are given in Section-3.12 of Chapter-3 .
18.	Incremental GLC as a result of DG set operation, flaring etc	Incremental GLC concentration results are mentioned in Section 4.2.1.3 of Chapter-4 .
19.	Potential environmental impact envisaged during various stages of project activities such as site activation, development, operation/ maintenance and decommissioning.	Impact assessment and mitigation measures for stage wise proposed project activities are given in Chapter-4 .
20.	Actual source of water and 'Permission' for the drawl of water from the Competent Authority. Detailed water balance, wastewater generation and discharge.	The water requirement will be met from the local sources through water tankers. Water requirement given in Section-2.5.1 of Chapter-2 . Waste water generation details and mode of treatment are given in Section-2.5.3 of Chapter-2 .
21.	Noise abatement measures and measures to minimize disturbance due to light and visual intrusions.	Noise control measures are given in Section-4.2.2.9 of Chapter-4 .

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22.	Details on wastewater generation, treatment and utilization /discharge for produced water/ formation water, cooling waters, other wastewaters, etc. during all project phases	Wastewater generation details and mode of treatment are given in Section-2.5.3 of Chapter-2 and Section-4.2.3 of Chapter-4 .
23.	Details on solid waste management for drill cuttings, drilling mud and oil sludge, produced sand, radioactive materials, other hazardous materials, etc. including its disposal options during all project phases.	Solid waste management details are given in Section-10.7.11 of Chapter-10 .
24.	Disposal of spent oil and lube	Management of used oil details are given in Section-2.5.5 of Chapter-2 .
25.	Storage of chemicals and diesel at site. Hazardous material usage, storage and accounting	Details for storage of chemicals are given in Section-2.5.1 of Chapter-2 .
26.	Commitment for the use of water based mud (WBM) only	Water Based Mud (WBM) waste from drilling details are given in Section-10.7.10 of Chapter-10 .
27.	Oil spill emergency plans for recovery/ reclamation.	Oil spill emergency plan is given in Section-7.6.13 of Chapter-7 .
28.	H ₂ S emissions control	H ₂ S emission control details are given in Section-7.6.3 of Chapter-7 .
29.	Produced oil/gas handling, processing and storage/transportation.	The proposal involves drilling of Exploratory wells only. No development/production shall be carried out.
30.	Details of control of air, water and noise pollution during production phase.	Not applicable
31.	Measures to protect ground water and shallow aquifers from contamination	Mitigation Measures to protect ground water and surface water are given in Section-4.2.3.3 & Section-4.2.3.4 of Chapter-4 .
32.	Whether any burn pits being utilized for well test operations.	Nil
33.	Risk assessment and disaster management plan for independent reviews of well-designed construction etc. for prevention of blow out. Blowout preventer installation.	Risk and disaster management plan details are given in Section-7.2 and Section-7.4 of Chapter-7 .

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		Blow out emergency Response procedure details are given in Section -7.6.1.
34.	Environmental management plan.	EMP details are given in chapter-10
35.	Total capital and recurring cost for environmental control measures	Details given in section 9.2 of chapter-9
36.	Emergency preparedness plan	Details are given in disaster management plan in section-7.6 of chapter-7.
37.	Decommissioning and restoration plans	Details of decommissioning and restoration plans section-2.5.9 of chapter-2.
38.	Documentary proof of membership of common disposal facilities, if any	Due to unavailability of any TSDF in Assam, any hazardous waste generated is either sent to authorize recyclers or treated through bio-remediation process.
39.	Details of environmental and safety related documentation within the company including documentation and proposed occupational health and safety Surveillance Safety Programme for all personnel at site. This shall also include monitoring programme for the environmental.	Occupational health and safety details are given in Section 7.9 of Chapter-7.
40.	A copy of Corporate Environment Policy of the company as per the Ministry's O.M. No. J-11013/41/2006-IA.II (I) dated 26 th April, 2011 available on the Ministry's website.	Corporate Environment Policy of ONGC given in Annexure-1
41.	Any litigation pending against the project and or any direction/order passed by any court of law against the project. If so details thereof.	Nil

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Executive Summary

Oil and Natural Gas Corporation Limited (ONGC) proposes to carry out onshore exploration, development and production of oil & gas in Three (03) wells in non-forest area in Assam and Assam Arakan Basin (A&AA Basin) for two locations BPAA and WHRAA in Cachar District PML and one location BPAB in Badarpur PML in Cachar and Hailakandi District respectively.

As per the Environment Impact Assessment (EIA) Notification dated 14th September 2006, the proposed project falls under 'Category A' of Activity Type 1(b).

Location Details of the Project

ONGC proposes onshore exploration, development and production of oil & gas in 2 blocks in Cachar and Hailakandi District, Assam.


Project Region	Block Title	Block Area (Sq. Km.)
Badarpur-Hilara	Badarpur PML & Cachar District PML	Badarpur: 2.3 Sq.KM and Cachar District PML: 732 Sq.KM

Importance of the Proposed Project

India is not among the major producers of crude oil, as it does not have much oil reserves. Therefore, India depends on imports of crude oil from other countries. There is a heavy imbalance between oil production and consumption in India. The Indian government is encouraging exploration and production of oil and gas to a great extent. This would primarily allow India to tap its own resources there by reducing its import bill. Discovery of viable hydrocarbon reserves in the state can boost the state's economic development to a great extent. The proposed project is therefore immensely significant for the state and nation.

Details of Proposed Project

The onshore exploration, development and production of oil & gas in the delineated area selected through seismic survey to identify and establish hydrocarbon potential.

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The site will be sized to contain all equipment and temporary camps, storage, workshops, etc. using distances between various rig components in line with existing rules and regulations for the area of operation and the approved standard operating procedures of the drilling contractor. Within the above constraints, the site shall be sized to minimize environmental impact. The approximate area of well site is dependent on the type of drilling equipment deployed, which in turn is dictated by the planned depth of drilling.

Land Requirement: The minimum land required at each well site will be 125 m x 125 m, i.e., 1.5-2.0 ha. Land requirement for the base camp will be about 0.5 ha. The land will be acquired on a temporary basis and if commercial quantity of oil or gas is found, the land will be taken on long lease and if oil and gas is not found in commercial quantities, the land will be returned to the owner by bringing back to its original status and adequate compensation as per the guidelines of local administration will be provided.

Power Requirement: The total power requirement at the well site will be 3000 KVA. The power requirement in the each well site will be catered through Diesel Generator (DG) sets. The power requirement will be met by 4 Nos of 750 KVA DG sets at well site. Stand by DG set arrangement of 750 KVA at well site will be made.


Water Requirement: Water is basically required for preparing drilling mud and for meeting domestic needs of the campsite. Typically, the water consumption for each well ranges from 25 m³/day for a period of 3-4 months. However, the drilling and domestic water requirement would depend on the time required to drill the well, which is primarily dependent on the proposed depth.

Manpower Requirement: The each well site construction would be done largely by employing local labour. At each well site construction, local employment will be generated for about 10 person/shift of 12 hrs in two shifts.

Baseline Environmental Status

Environmental monitoring has been carried within the entire onshore exploration, development and production of oil & gas in Cachar and Hailakandi districts, Assam. The baseline carried out during Pre-monsoon season.

Meteorology

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On-site monitoring was undertaken for various meteorological variables in order to generate the site-specific data. When the meteorological data generated at the monitoring site was compared with the data recorded at nearest IMD station, it was observed that the data generated at the site is broadly in comparison with regional meteorology, except for minor variations.

Ambient Air Quality

To establish the baseline status of the ambient air quality in the study area, the air quality was monitored at 8 locations during summer season 2018. Out of the 8 locations the minimum and maximum concentration for PM₁₀ ranges between 43.6 and 91.7 µg/m³ which are well within the NAAQ standards i.e 100 µg/m³.


The minimum and maximum concentration PM_{2.5} varies between 19.2 to 52.3 µg/m³ respectively during the study period which are well within the NAAQ standards i.e 60 µg/m³. The concentrations of SO₂ ranges between 5.1 to 8.8 µg/m³ which are well within the NAAQ standards i.e 80 µg/m³. The concentrations of NO₂ varied between 9.9 to 24.8 µg/ m³ respectively which are well within the NAAQ standard i.e. 80 µg/m³.

The concentration of CO ranges between 0.10 to 0.33 µg/m³. VOCs were observed well below detectable limit i.e.; <0.1 ppm. Methane hydrocarbon (CH₄ HC) was observed to be in the range of <0.1 ppm to 0.89 ppm. Non-methane hydrocarbon (Non-CH₄ HC) was observed to be in the range of <0.1 ppm to 0.73 ppm.

From the analysis of the monitored data, it infers that the air quality levels in the study area are of fairly good quality and comply with the National Ambient Air Quality Standards (NAAQ).

Ambient Noise Levels

The noise monitoring has been conducted at 12 locations, covering residential, commercial and silence zones in the study area. A review of this data indicates that at all the locations, the noise level was found within the permissible limits of CPCB.

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Water Quality


The baseline water quality status in the region is established by analysing about 5 ground water samples and 10 surface water samples during study period. The ground and surface water samples were analyzed and found that ground water quality is well within the drinking water quality limits.

The pH value of the collected ground water in the study area found to be in the range from 6.51 to 7.56 and conductivity observed in the range 140 μ S/cm to 460 μ S/cm. TDS values were observed to be in range from 83 mg/L to 254 mg/L. Total alkalinity is found to be the range from 12 mg/L to 196 mg/L and Total Hardness ranges from 42 to 216 mg/L. The chloride values of the samples were observed from 27 mg/L to 75 mg/L and sulphate values were observed from 3 mg/L to 10 mg/L. The Calcium and magnesium values were ranged from 7 mg/L to 61 mg/L and 4.8 mg/L to 15 mg/L respectively. Iron content observed in the range from 0.036 mg/l to 0.386 mg/l. Most of the metals are observed as below the detection limit.

The pH value of the collected surface water in the study area found to be in the range from 6.74 to 7.52 and conductivity observed in the range 80 μ S/cm to 184 μ S/cm. TDS values were observed to be in range from 44 mg/L to 105 mg/L. Total alkalinity is found to be the range from 20 mg/L to 60 mg/L and Total Hardness ranges from 20 to 70 mg/L. The chloride values of the samples were observed from 8 mg/L to 23 mg/L and Sulphate values were observed from 2 mg/L to 11 mg/L. The Calcium and magnesium values were ranged from 4 mg/L to 11 mg/L and 2 mg/L to 4.8 mg/L respectively. Iron content found in the range from 0.60 mg/L to 4.25 mg/l. COD values observed in the range from 18 mg/l to 34 mg/l. surface water has been found to be suitable for drinking after the conventional treatment followed by disinfection.

Land Use Studies

The land use pattern of the proposed project has been studied by District Census Hand Books and satellite images. The land use pattern of the study area is used by Forest (44021 hectare), agriculture purpose (23826 hectare), followed by water bodies (3432 hectare) and built up land (856 hectare) while the rest area includes waste lands (180 hectare) and others (160 hectare).

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Soil Quality

The soil samples were tested at 5 locations during pre-monsoon covering various land uses. It has been observed that the pH of the soil is ranging from 6.78 to 7.23 while the soil texture is shown in figure 3.25. Moisture found in the range from 9.7 to 16.6%. Conductivity of the soil ranges from 0.048 to 0.153 mS/cm. Texture of the soil in the selected locations of study area were found to be Clay in nature. The potassium content varies from 784 to 1332 kg/ ha. Exchangeable Sodium content varies from 4.68 to 6.43 m.eq/100g. Exchangeable calcium and Exchangeable magnesium were found in the range between 2.36 to 8.69 m.eq/100g & 3.74 to 9.71 m.eq/100g respectively.


Biological Environment

As per primary survey and secondary data referred, it can be concluded that the study area is ecologically rich and diverse. Common Langur, Mongoose and Palm Squirrel were observed during primary survey. The tree lizard and common garden lizards are also seen. Variety of butterflies (like common grass yellow, plain tiger) and insects (such as beetles, spiders, red ants, and flies) are spotted in abundance in the study zone. Livestock like cattle, buffalo, goat sheep, duck, and pig are reared for dairy products, meat, egg and for agriculture purpose. Majority of cattle and buffalo are of local variety. Backyard poultry farms are mostly common in this area; however, some commercial poultry farms are also recorded in the study area.

Socio-Economic Environment

The configuration of male and female indicates that the males constitute to about 51.24% and females to 48.76% of the total population as per 2011 census records. In the study area, as per 2011 census, 3.72% of the population belongs to Scheduled Castes (SC) and 6.92% to Scheduled Tribes (ST) in Hailakandi District.

The percentage of male literates to the total literates of the study area works out to be 54.69%. The percentage of female literates to the total literates, which is an important indicator for social change, is observed to be 45.31% in the study area as per 2011 census records in Cachar District.

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Impact Assessment

The identification and assessment of impacts over the various environmental attributes in the region due to the proposed project activities in the proposed blocks are discussed and mitigative measures and environmental management plan for the potential impacts have also been duly deliberated. Onshore exploration, development and production of oil & gas is a temporary activity which lasts for about 3-4 months at each well location.

Impact on Topography and Land Use

Onshore exploration, development and production of oil & gas project is a short duration activity at each well location, typically encompassing a period of 3-4 months from land acquisition to site abandonment. The impact would therefore be localized, temporary and minimal. Because of the above activities, the topographical structure may change locally. However, considering the small foot print area required during the drilling, only marginal impact due to change in land use is anticipated.


Impact on Climate

Impact on the climatic conditions due to drilling will not be significant. The maximum temperatures of the exit gas from the DG stack and flare stack will be around 300°C and 400°C respectively. In terms of total emission of greenhouse gases and consequent impact on global warming or on potential for local increase of ambient temperature, considering the quantum of exit gas and the total duration of flow, the impact on the local or global climate will be insignificant.

Impact on Air Quality

The potential sources of air emissions at the well sites will be as follows:

- Dust from earth works (during approach road and site preparation);
- Emissions from DG sets (including noise emission);
- Emissions from possible flaring during well testing; and
- Emissions from vehicles

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During the short period of site preparation mechanical shovels and earthmovers will be used for vegetation clearance, cut and fill and other site leveling activities. These activities could generate dust particles which will be mobilized by wind, and deteriorate the ambient air conditions. However, these activities will be only temporary and the impact to ambient air quality would be within the close proximity of well site.

The gaseous emissions from the DG set will be controlled by efficient combustion of fuel in the DG set. The flaring of oil and gas during well testing is a short duration activity (about 14 - 21 days) and will be done within a ground level enclosed pit. Wherever, required special precautions will be taken to minimize the impact on the local environment and habitat.


Impact on Surface Water and Groundwater Quality

Approximately 15 m³/day of wastewater would be generated from each well site. Water based non-toxic biodegradable fluids with inhibitive and encapsulate characteristics are proposed to be used as drilling mud for minimizing any long term impact on groundwater quality. Additionally, the drilling mud collection and recirculation pond is lined with impervious layer to prevent seepage and loss of drilling fluid into the subsoil. Further, proper casing installation and cementing the well will ensure least groundwater contact. The clarified wastewater will be treated in packaged treatment plant located at the well sites to meet norms specified by CPCB and ASPCB. The sewage will be discharged into septic tanks and then to subsoil through soak pits.

Impact on Noise Levels

During the proposed project operation at the well sites, there would be various sources of noise in the area, viz., drilling draw works/rotors, mud pumps, power generators, Vehicular Movement and Cranes and material handling equipment.

The maximum predicted noise level at about 100 m from the boundary of the well site is about 52.0 dB (A). The ambient noise levels at most of the places in the region are within the CPCB standards. Since, the drilling operations last for only 3-4 months at each location, impact of the noise pollution due to the proposed exploratory drilling of wells project will be insignificant on the community.

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Ecological Impacts

Impact on the ecology of the study area will vary with the proximity of the habitats from the drilling locations. However, the impacts are of temporary nature, which will last only for few months at each drill location during the exploratory drilling activities and will thus allow subsequent recovery after the activities stops.

Demography and Socio-Economics

Although the level of existing communications and support services in the area are considered adequate based on the population density, establishment of the proposed project would further strengthen the road network and access to some of the remote areas with all-weather roads would be a distinct beneficial impact. The overall impact is considered to be positive.

Impact on health due to emissions and noise from proposed project activity has been assessed to be minimal. In addition employees working at the well site would be provided protective devices like ear plugs/ear muffs for ensuring minimum impact on human health.

The proposed project should be possible to avoid impact on existing arable land. By following the compensation procedures and by observing common courtesy, impacts on existing use and benefit rights holders can be minimized.


The proposed programme is expected to generate local employment in the order of about 30/shift 12 hrs. While this benefit is small by most standards, it is a significant employment opportunity in the block.

Environment Management Plan


The objective of the Environmental Management Plan (EMP) is to identify project specific actions that will be undertaken to mitigate and manage impacts associated with the proposed onshore exploration, development and production of oil & gas programme.

Environmental measures during well construction

1. As a preventive measure to avoid impacts the well site will be located based on the following consideration:

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- Located at least 300-500 m away from the nearest village habitat / sensitive receptors;
 - Located at least the height of the well must away from public road;
 - Located at least 300-500 m away from existing water bodies;
 - Ensure natural drainage channels are avoided or drainage channels rerouted to ensure unhindered flow of rain/flood water. Where necessary adequate erosion control measures will be provided; and
 - Located in a manner to avoid plantations of timber yielding trees
2. Construction activities will be coordinated in consultation with land owners and local authorities to reduce interference with agricultural activities.
 3. In dry weather conditions, water sprinkling during excavation, levelling and transportation will be implemented.
 4. Topsoil will be stripped below plough depth from the well site and stored on the site. The depth of stripping will be on the basis of site specific soil survey. Topsoil will also be stripped from and stored adjacent to the site.
 5. The well site ground level will be raised and hard standing provided. Drainage channels around the site area will be constructed to ensure no obstruction to flow pattern.
 6. The approach roads will be routed in a manner so that disturbance to existing activity and to the local community is minimized. Routing through village habitat areas will be avoided, as far as practical. The road surface will be maintained to minimize generation of vehicular movement dust in the local area.
 7. The well site would be provided with sufficient and suitable sanitary facilities and these will be connected to well designed and maintained septic tanks.
 8. Hazardous materials such as diesel, lubrication oil and paint materials required at the site during construction activities would be stored and disposed as per hazardous waste authorisation conditions.

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9. To ensure that the local inhabitants are not exposed to the hazards of construction the site would be secured by fencing and manned entry posts.
10. The chemical and diesel storage area will be paved and provided with spill containment walls. Pits for storage of water, drilling mud and drill cuttings will be provided with impervious liner. Sufficient free-board will be provided to prevent overflow.
11. It would be ensured that diesel powered construction vehicles are properly maintained. Vehicle maintenance would be carried out authorised service centres. Service centres will be so selected to ensure that these conform to statutory regulations.

Removal of Equipment and Materials


In the event if economic quantities of hydrocarbons are found, the well will be suspended with a wellhead in place for producing oil and gas, but all other equipment and materials will be removed from the site. All empty drums, wastes, used and unused drilling fluids, fuel and lubricants will be removed from the well site. Water supply and effluent discharge hoses and associated equipment will be removed. The access road(s) would be reinstated.

Decommissioning upon Abandonment

In the event that no economic quantities of hydrocarbons are found, a full abandonment plan will be implemented for the well sites in accordance with the applicable Indian petroleum regulations.

Atmospheric Emissions

The combustion of diesel for power generation for the proposed project operation results in atmospheric emissions of SO₂, NO₂, CO, Particulates and Hydrocarbons. Flaring during production and testing is of 14-21 days duration and atmospheric emissions are marginal. There will be no sensitive receptors to the emissions of combustion products in the vicinity of the proposed project operations apart from the crew of the drilling rig. The impacts caused are therefore, considered to be negligible. Measures to ensure minimal impacts include appropriate management of power generation source to achieve fuel efficiency and therefore reduce emissions and use of low sulphur diesel oil if available. Environmental monitoring is proposed during drilling and well testing to ensure maximum combustion efficiency. Flaring towards any standing vegetation will be avoided. In case if it is inevitable, a suitable barrier will be erected to

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prevent any vegetation scorching due to direct heat radiation; and prior to flaring, the critical equipment will be thoroughly tested.

Noise Environment

The modeling results show that the noise levels will attenuate to below permissible levels within the well site boundary. The Generators will be properly enclosed and the exhausts will be provided with silencers.


Management of Drilling Wastes

The major waste product of a drilling operation is the generation of rock cuttings with residual mud adhering to the drill cuttings and spent drilling fluid. About 408-430 m³ drill cuttings per well need to be disposed of. ONGC proposes to use internationally followed methodologies while drilling either with Water Based Muds (WBM). The volume of drilling fluids used will be optimizing at the design stage by selecting modern drilling engineering technology. The mud will be reused after its separation from the cuttings. A mud mixing tank will be set up at the well site with a collection system so that any spill of chemicals will be collected. The platform all around the tank on the pedestrian shall be of metal gratings to facilitate walkway as well as to permit the fluid to pass through so that it can be collected in the collection for further reuse / disposal. The spilled oil may be reused in the mud preparation. At the extent possible reuse the residual drilling fluids in the drilling campaign only the drilling fluid which is not further used can be discarded.

Management of the Solid Wastes

Small amounts of solid wastes will be generated during normal operation at the drilling rig. The wastes will be disposed of in compliance with local and national legislations. Spent waste oil to be stored in a secure paved area and disposed to MoEF&CC/ ASPCB approved waste oil recyclers. Drill cuttings and sludge from drilling mud to be buried within the impervious lined pit and covered with soil as part of the site abandonment plan. Biodegradable waste arising from kitchen and canteen activities to be scientifically composted and the bio-manure so generated to be used for green belt development.

Management of Waste Disposal sites within Well site

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The project proponent will dispose the drill cuttings, drill mud and wastewater generated during the proposed project operations into the lined pits of various sizes and undertaking plantation within the well site particularly on the reclaimed pits.

Management of Production Phase


During production of oil & gas will be collected through flow lines and processed in the Group Gathering Stations (GGS) in the ML areas. Once the drilling proves commercial viability, the well will be connected to GGS facilities through a flow line are regular inspection and monitoring will takes place to check equipment working capability and quality standards including compliance to HSE requirements.

Environmental Monitoring Program

A detailed pre-drilling and post-drilling phase monitoring in respect of air, water, soil, land use, occupational noise, etc. to assess the changes has been evolved covering various phases of project advancement. A network of sampling locations around the operational facilities will be established. The monitoring shall include compliances to legal and statutory controls imposed on the operation as well as other corporate commitment to responsible environment management. Systems for monitoring resources inputs (energy, chemical use, water, raw materials), equipment and plant performance and waste generations will also be set up. A detailed waste management plan with monitoring programme will be in place during various phases of activity.

Risk Assessment and Disaster Management Plan

The hazard potential of oil and gas and estimation of consequences in case of their accidental release during drilling has been identified and risk assessment has been carried out to quantify the extent of damage and suggest recommendations for safety improvement for the proposed facilities. Risk mitigation measures based on MCA analysis and engineering judgments are incorporated in order to improve overall system safety and mitigate the effects of major accidents. An effective Disaster Management Plan (DMP) to mitigate the risks involved has been prepared. This plan defines the responsibilities and resources available to respond to the different types of emergencies envisaged. Training exercises will be held to ensure that all personnel are familiar with their responsibilities and that communication links are functioning effectively.

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Project Benefits


The proposed program will establish hydrocarbons in the block. The development of the oil field will result in considerable growth of service sector and will also generate new industrial and business opportunities in the area. Small and medium scale industries may be developed as consequence. The major benefits of the project include reduction of the oil import bill of the nation as well as reduction of the imbalance in oil production and consumption. The commercial development will also lead to investment in Assam, bringing oil and gas revenues both to the State and to the Central Government. The presence of ONGC in the region will substantially improves the socio-economic conditions of the region. In operation phase ONGC requires significant work force of non-technical and technical persons. Migration of persons with better education and professional experience will result in increase of population and literacy in the surrounding villages.

Administrative Aspects

The basis of the operational philosophy is that the activities proposed in oil and gas processing shall be operated in complete compliance with all applicable Laws, Regulations, Standards and Permits, the Production Sharing Contract (PSC), ONGC corporate policies, procedures, specifications, rules, standards and guidelines. In order to achieve this, the proposed drilling sites will be maintained by technically qualified and experienced people. Detailed procedures and plans will be developed for each activity prior to operations start up. All persons on board the drilling rig will be an experienced crew with valid qualifications. ONGC has a well-defined Organization for Environment Management System. ONGC is committed to extend the EMS to its proposed facilities in Assam. The Director (Operations) of the project oversees the total environmental activity on a day-to-day basis. All individual departments are accountable for the environment in and around them and individual departments take prompt action in dealing with environmental issues. The HSE dept. is the nodal agency to coordinate and provide necessary services on environmental issues during construction and operation of the project.

Conclusions

The proposed project has certain level of marginal impacts on the local environment. However, the proposed project has significant beneficial impact/effects in terms of providing the employment

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opportunities and various CSR practices to be followed by ONGC. Growth and development, in harmony with the environment, has always been the approach of ONGC.

The conclusions of EIA are:

- The proposed project meets the compliance requirements of various environmental regulations;
- Adoption of environmental friendly Best Management Practices results in minimising the impacts on environment;
- Community impacts of the project will be beneficial, as the project will generate significant economic benefits for the region;
- The post drilling, commercial developmental activities of ONGC can reduce the import burdens of crude oil to the nation; and
- With the effective implementation of the Environment Management Plan (EMP) during the planning, design, construction and operation phases, the exploration, development and production project can proceed without significant negative impact on the environment.




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Chapter 1

Introduction

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1.0 Introduction


Oil and Natural Gas Corporation Limited (ONGC) is a Public Sector Undertaking (PSU) of the Government of India, under the administrative control of the Ministry of Petroleum and Natural Gas (MoPNG). It is India's largest oil and gas exploration and production company. It produces around 70% of India's crude oil (equivalent to around 25% of the country's total demand) and around 60% of its natural gas. This largest natural gas company ranks 11th among global energy majors (Platts). It is the only public sector Indian company to feature in Fortune's 'Most Admired Energy Companies' list. ONGC ranks 18th in 'Oil and Gas operations' and 183rd overall in Forbes Global 2000. Acclaimed for its Corporate Governance practices, Transparency International has ranked ONGC 26th among the biggest publicly traded global giants. It is involved in production of hydrocarbons in 26 sedimentary basins of India, and operates over 25,500 kilometres of pipelines in the country, including sub-sea lines.

1.1 Purpose of the Report

As per Environmental Impact Assessment EIA Notification dated 14th September, 2006, onshore exploration, development and production of oil & gas project falls under category 'A' of activity 1(b) requires prior Environmental Clearance (EC) to be obtained from MoEF&CC before the commencement of ground activity.

The application for obtaining TOR for the project proposal was submitted to MoEF&CC on 3rd August 2016 and same was reviewed by the Expert Appraisal Committee (Industry-II) meeting held during 26th-27th September 2016 in New Delhi to prescribe Terms of Reference (TORs) for the preparation of EIA/EMP report. TOR has been issued by MoEF&CC vide letter reference F.No. J-11011/172/2016-IA.II(I) dated 25th November 2016.

This EIA Report is prepared in line with the TOR issued by MoEF&CC and addresses the anticipated environmental impacts of the proposed project and proposes the mitigation measures for the same for obtaining Environmental Clearance (EC) from MoEF&CC, New Delhi. The report covers the primary data collected during 3 months of Pre Monsoon Season.

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1.2 Identification of Project and Project Proponent

1.2.1 Identification of Project

Three exploratory wells are proposed to be drilled to evaluate the hydrocarbon potential of the Badarpur-Hilara blocks. ONGC has firmed up two locations BPAA and WHRAA in Cachar District PML and one location BPAB in Badarpur PML.

1.2.2 Project Proponent

The Assam Arakan Fold Belt Block of A&AA Basin is engaged in exploration activities in Tripura, Cachar, South Assam and Mizoram. The Assam Arakan Fold Belt (AAFB) Block is situated in the South-Western part of Assam & Assam Arakan Basin in the North-Eastern part of India. The AAFB comprises of Two Acreages: Tripura Acreage covering the fold and thrust belt of Tripura State and Cachar Acreage covers the fold and thrust belt covering the districts of Cachar, Karimganj and Hailakandi of Assam.

1.2.3 Proposed Project


As per the proposed project, **Three (03)** of exploratory wells to be drilled in Badarpur-Hilara blocks i.e. two locations BPAA and WHRAA in Cachar District PML and one location BPAB in Badarpur PML blocks after 2D and 3D seismic data acquisition processing and interpretation. Targeted depths of proposed exploratory wells shall be up to 4100 mts. PML Blocks are with ONGC since 1965 with 100% operatorship. In support of the long term hydrocarbon exploration program, ONGC proposed to drill exploratory wells in the PML Blocks in deeper prospects. The blocks are located adjacent to other oil fields of ONGC and ONGC is operating these nearby oil fields since long time and are having proven hydrocarbon reserves.

1.3 Brief Description of the Project

1.3.1 Nature of the Project

The proposed project intends to identify the onshore exploration, development and production of oil & gas in three wells in Badarpur and Cachar PML Blocks located at Cachar and Hailakandi district, Assam.

1.3.2 Size of the Project

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ONGC has identified onshore 03 exploratory wells of oil & gas in non-forest area of 02 PML blocks in Cachar and Hailakandi district, Assam.

1.3.3 Project Site Details


Brief description of the project is given in Table 1.1. Details of block coordinates is given in Table 1.2. The study area map showing the block location are shown in **Figure-1.1**.

Table 1.1: Brief Description of the Project

S. No.	Item	Details
1.	Name of the Project	Exploratory drilling of Three (03) wells in Badarpur PML and Cachar District PML
2.	Project Sector	Badarpur PML and Cachar District PML
3.	Location of the Project	Hailakandi District and Cachar District
4.	Project Region	Badarpur-Hilara
5.	Block Area (Sq. Km.)	Badarpur: 2.3 Sq.KM and Cachar District PML: 722.4 Sq.KM
6.	Total Area of the Project	724.7 SqKM
7.	Total Cost of the Project	Rupees 120 Crores
8.	Remarks	PML validity: Badarpur PML: 01.08.2009 - 31.07.2019 Cachar District PML: 04.01.2013 - 03.01.2020

Table 1.2 Details of Block Coordinates

Sr. No.	ML Name	Boundary	Latitude			Longitude			Area (Sq. Km.)
			DEG	MIN	SEC	DEG	MIN	SEC	
1.	Badarpur block	A	24	52	17.320	092	35	22.232	2.3 Sq.Km
2.		B	24	52	12.950	092	35	47.512	
3.		C	24	51	47.819	092	35	52.802	
4.		D	24	50	47.816	092	35	22.092	
5.		E	24	50	46.816	092	35	09.802	
6.		F	24	51	15.947	092	35	01.372	
7.		G	24	52	12.950	092	35	20.512	
8.		A	24	52	17.320	092	35	22.232	

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9.	Cachar Block	A	25	03	56.598	092	28	06.798	722.4 Sq.Km
10.		B	25	00	11.588	092	28	00.799	
11.		C	24	57	34.933	092	35	02.020	
12.		D	24	58	48.096	092	35	36.420	
13.		E	24	57	43.884	092	39	00.590	
14.		F	24	58	30.566	092	39	19.240	
15.		G	24	57	08.284	092	44	14.001	
16.		H	24	53	46.525	092	42	53.042	
17.		I	24	55	40.039	092	38	07.701	
18.		J	24	52	03.169	092	36	40.222	
19.		K	24	52	20.090	092	34	20.561	
20.		L	24	52	24.179	092	29	17.621	
21.		M	25	01	44.822	092	25	21.499	
22.	A	25	03	56.598	092	28	06.798		
	Total Area of Block								724.7 Sq. Km

1.4 Importance of Project to Country and Region

India is highly dependent on import of crude oil. Net imports of crude oil is 202.85 MTs during 2015-16. Although more than 70% of its crude oil requirements and part of the petroleum product requirement is met from imports, India has developed sufficient processing capacity over the years to produce different petroleum products. As result, India is now a net exporter of petroleum products. The export of petroleum products increased to 60.53 MT during 2015-16.

Energy security has become one of the top three goals of the Indian Government. The Indian Government is encouraging exploration, development and production of oil and gas to a great extent. This would primarily allow India to tap its own resources there by reducing its import bill.

Discovery of viable hydrocarbon reserves in the state can boost the state's economic development to a great extent. It would also catalyse influx of industries in the state. The proposed exploration project is thus of immense significance for the Country.

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Extraction of hydrocarbons in this block will substantially improve the socio-economic conditions of the region. The proposed project will also help to discover the geological past to create the economic future for the region as well as to the country.


1.5 Scope of the Study

With a view to assess the environmental impacts arising due to the proposed exploratory drilling in block, ONGC has to prepare EIA Report for various environmental components including air, noise, water, land and biological components along with parameters of human interest which may be affected and to prepare an Environmental Management Plan (EMP) for mitigating adverse impacts.

Environmental baseline monitoring has been carried out during 3 months representing summer season and used to identify potential significant impacts. The scope of the present study is in line with the TOR as recommended by MoEFCC. The scope of study broadly includes:

- To undertake environmental monitoring so as to establish the baseline environmental status of the study area;
- To identify various existing pollution activities in the ambient levels;
- Establishing the relevant features of the proposed exploratory drilling that are likely to have an impact on the environment;
- Predicting the impacts on the environment due to exploratory drilling;
- To evaluate the predicted impacts on the various environmental attributes in the study area by using scientifically developed and widely accepted environmental impact assessment methodologies;
- To prepare a Disaster Management Plan (DMP) based on Risk Assessment, studies;
- To prepare an Environment Management Plan (EMP) outlining the measures for improving the environmental quality and scope for future drilling activities and Occupational Health and Safety for environmentally sustainable development; and
- To identify critical environmental attributes required to be monitored. The literature review includes identification of relevant articles from various publications, collection of data from various Government agencies and other sources.

1.7 Methodology of the Study

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A reconnaissance survey and sampling locations were identified on the basis of:

- Predominant wind directions in the study area as recorded by India Meteorological Department (IMD);
- Existing topography, location of surface water bodies like ponds, canals and rivers;
- Location of villages/towns/sensitive areas;
- Accessibility, power availability and security of monitoring equipment, pollution pockets in the area;
- Areas which represent baseline conditions; and
- Collection and analysis of baseline data for various environmental attributes viz ambient air quality, Water quality, Soil, Noise and Bio diversity etc.


Field studies have been conducted for a period of three months representing summer season to determine existing conditions of various environmental attributes as outlined in **Table-1.3**.

Table 1.3: Environmental Attributes and Frequency of Monitoring

Sr. No	Environmental Component	Sampling Locations	Sampling Parameters	Total Sampling Period	Sampling Frequency
1.	Geology	-	Geological history	Data collected from Primary sources	
2.	Hydrology	-	Drainage area and pattern, nature of streams, aquifer characteristics, recharge and discharge rates	Based on data collected from secondary sources	
3.	Meteorology	One central location	Temperature, Wind Speed, Wind Direction, Relative Humidity, Cloud Cover, Rainfall	One non monsoon season (Three months)	Continuous hourly recording


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4.	Ambient Air Quality	8 Locations	PM2.5, PM10, SO2, NOx, CO, VOC, THC CH4-HC and non CH4-HC	Two consecutive days per week for one non - monsoon season	24 hourly samples
5.	Water Quality	10 Locations of surface water & 5 locations of Ground water	As per IS: 10500:2012	Grab sampling	Once during study period
6.	Noise Monitoring	12 Locations	Sound Pressure Levels	Continuously for 24 hours	Once during study period
7.	Soil Analysis	5 Locations in Existing ecological resources within study area	Soil profile, Chemical constituents	Composite sample	Once during study period
8.	Ecology	3 locations within Existing ecological resources within study area	Flora and fauna	Field observations and secondary sources	Once in study period
9.	Demography and Socio-economic aspects	Total block area	Demographic profile	Based on Primary Data Survey and Census Handbook	
10.	Land Use	Total block area	Trend of land use change for different categories	Based on District Census Handbook and satellite images	

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1.7 Status & Stage of Regulatory Framework

As per the Schedule attached to the EIA Notification 2006, as amended till date, the proposed project is covered under Project or Activity, 1(b), namely Offshore and Onshore Oil and Gas Exploration, Development and Production. Such activities are also listed as Category A under the said Notification, requiring prior Environment Clearance (EC) from the Impact Assessment Authority (IAA), i.e. the Ministry of Environment, Forests & Climate Change (MoEF&CC), New Delhi.

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2.0 Project Description

2.1 Type of the Project


The exploratory drilling operation involves drilling of holes through various sub-surface layers (geological information) to predetermined depth of potential hydrocarbon reserves that are identified through interpretation of seismic data. Hence, in this project ONGC proposes drilling of 03 exploratory wells in 02 PML Blocks.

2.2. Need of the Project

India is heavily dependent on the imports to meet the rapidly growing demand of petroleum products. The rising population and the consequent increase in demands on petroleum have put lot of pressure on Indian economy. Despite its best efforts, India has to meet 80% of its total oil and gas demand from international market. Substantial efforts are therefore necessary to boost the exploration activities in the country so that level of crude oil and gas production can further significantly increase self-sufficiency in the years to come.

India imports over 1.5 million barrels of oil per day that place the country at the 9th position among the largest importers of the world. Though the Indian production has been increased in the recent times, the imports were also raised by 5% due to the raised Indian demand of around 4.2%. There is a heavy imbalance between hydrocarbon production and consumption in India. Growth in demand is expected to catapult the overall demand to 196-250 MT in 2024-25, at an annual growth rate of 3.6%. During the same period, domestic production is expected to grow at about 2.5% from current 0.8 million barrels per day. This shows a widening gap in domestic production and demand for hydrocarbon.

The energy demand is on rise with social and economic development in the country. Current hydrocarbon demand is much more than the domestic crude oil and natural gas production. In order to bridge the gap between energy supply and demand, it is imperative to accelerate the exploration and production activities in the country. Keeping in view the growing requirement of energy in the country, Government of India has adopted multi-pronged strategy for giving momentum to exploration and production in the country.

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2.3. Location of the Project


The 02 PML blocks are located in Cachar and Hailakandi District. Location Map showing general location is given in the **Figure 2.1 & 2.2**.

2.3.1 Typical Well Site Details

The site will be sized to contain all equipment and buildings, storage, workshops, etc. using distances between various rig components in line with existing rules and regulations for the area of operation and the approved standard operating procedures of the drilling contractor. Within the above constraints, the site shall be sized to minimize environmental impact. The approximate area of each well site is dependent on the type of drilling equipment deployed which in turn is dictated by the planned depth of drilling. Minimum land required at each well site during drilling will be 125 m x 125 m, i.e., 1.56 ha. On an average, the land requirement at each well site, including site facilities and camp site is considered as 1.5-2.0 ha.

Each well site will require the following facilities:

- Portable office cabins / rest rooms (container type cubicles);
- Drilling rig foundation and cellar;
- Foundation / pits for ancillary equipment;
- Space for drill rig equipment, working area and materials lay down area;
- Waste storage pits;
- Cutting disposal (impervious lined) pits;
- Waste storage pit;
- Septic tank with soak away pits;
- Paved and contained chemical storage area;
- Above ground diesel storage tanks with paved and bunded area;

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- Radio room;
- Storm water drainage system;
- Internal roads and fencing.

The proposed project each well sites will be restricted access area and fenced all round with round the clock watch and ward facility. Entry of vehicles into the drilling site area will be prohibited except for material movement. Adequate parking facilities will be provided outside the drilling location.

2.4 Drilling of Exploratory Wells

2.4.1. Overview

To exploit hydrocarbon in sub-surface, an oil well is drilled by deploying a drill rig. Drilling operations are conducted round-the-clock. The time taken to drill a well depends on the depth of the hydrocarbon bearing formation and the geological conditions. ONGC intends to drill wells to the depth up to 4100 m. This would typically take ~60-90 days for each well under normal conditions – however drilling period may change depending on well depth.

In the process of drilling, drilling fluid is used to lift the cutting from the hole to the surface. Drilling fluid is formulated by earth clay and barites. Various types of bio-degradable polymers are also added to maintain the specific parameters of the mud. After completion of production casing the well is tested to determine & analyze various parameters of producing fluid. Initial well tests are conducted to establish flow rates of oil & gas and formation pressure along with other reservoir parameters. These tests may then generate oil, gas and formation water. On completion of testing, the well would be declared oil / gas producer or dry.



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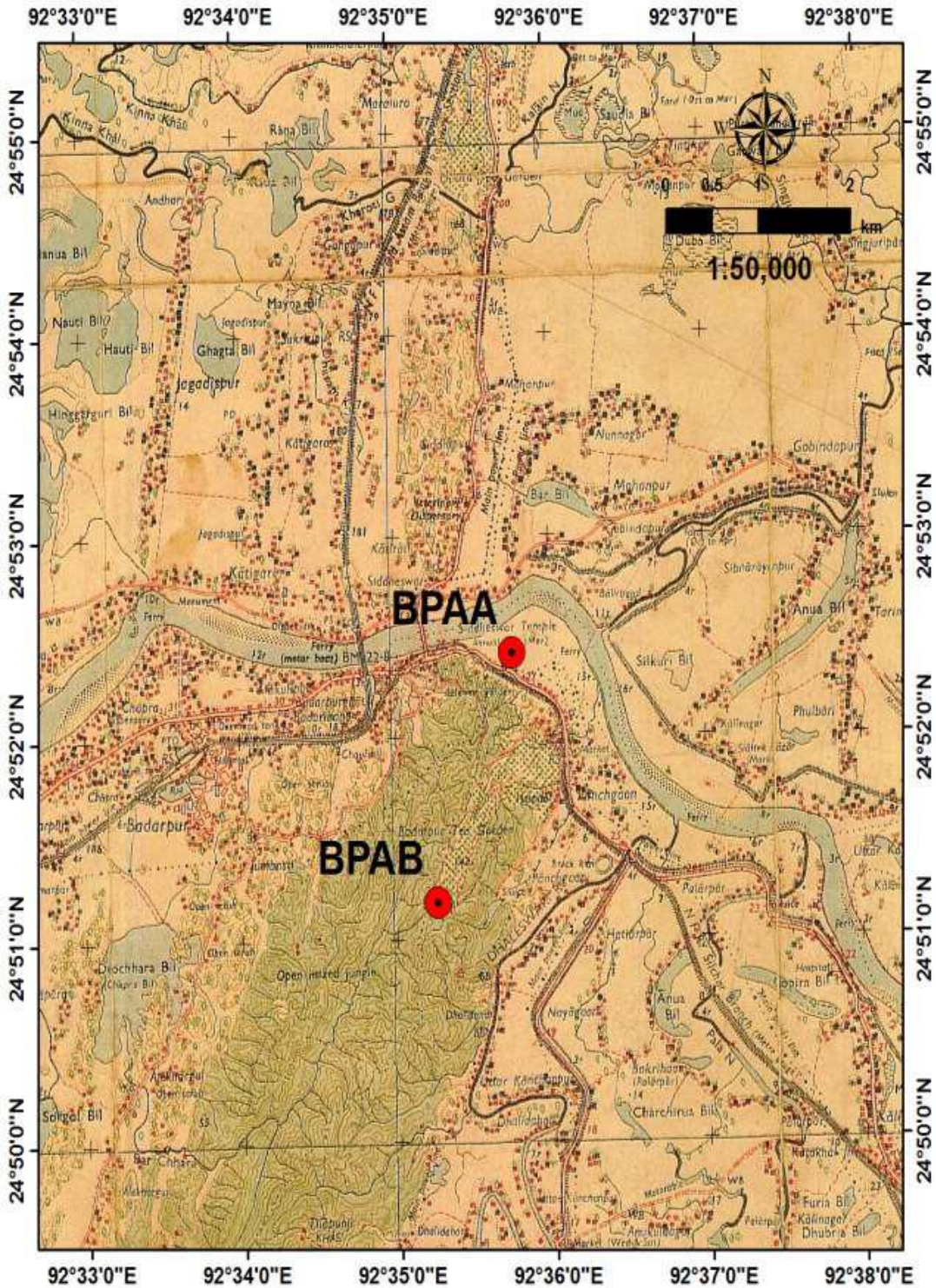


Figure 2.1 location of 2 Wells in the study area



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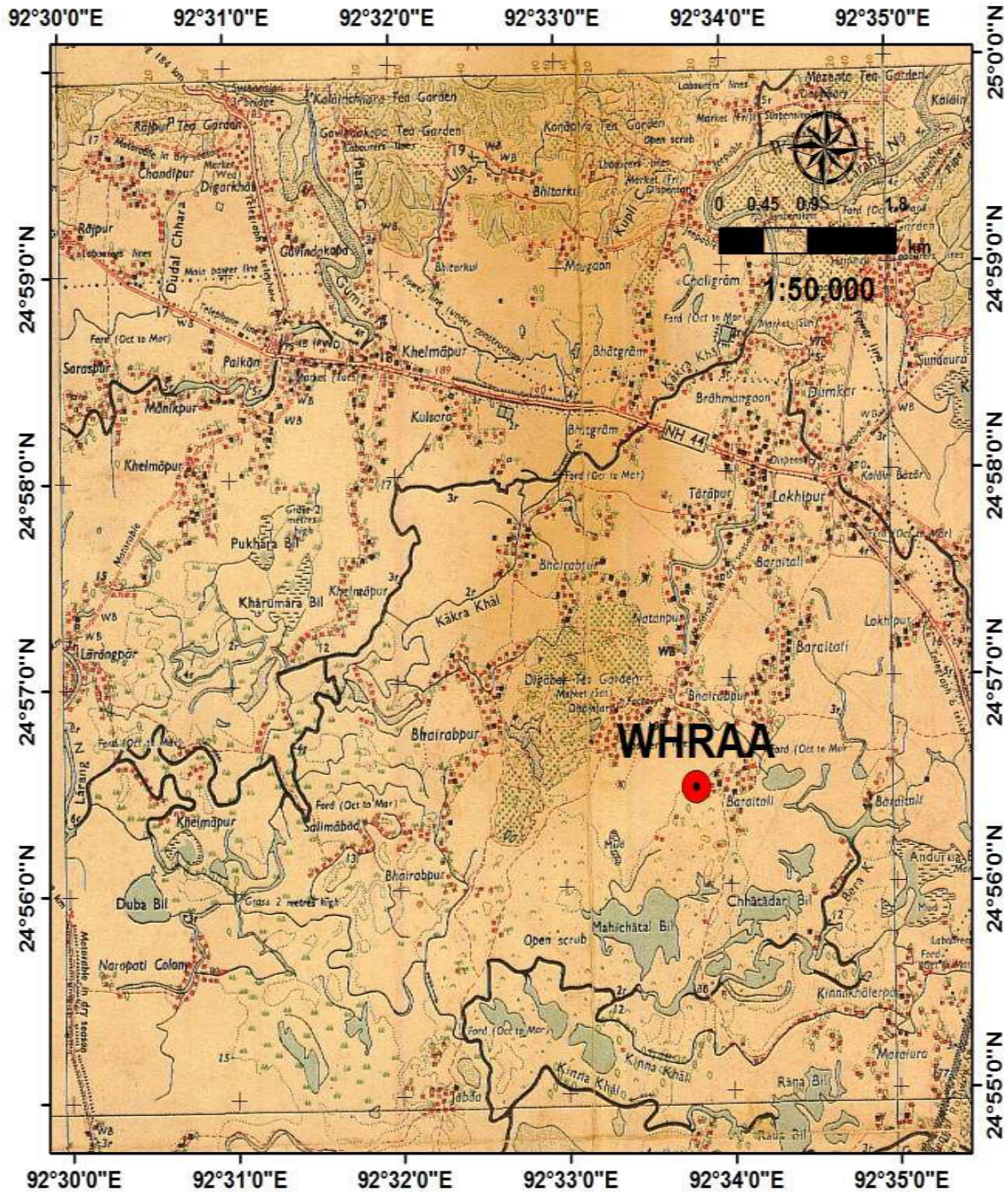



Figure 2.2: Location of Well in the study Area

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2.4.2. Drilling Site Selection

The proposed well locations will be selected based on the following considerations:

- Identified at a place so that drill site is located at a safe distance i.e. minimum 500m away from the nearest village habitat, hospitals, highways & existing rain water catchment tanks;
- All practicable means will be followed to avoid or minimize detrimental effects on the surrounding environment by virtue of the construction at the location or the operation of the drilling rig. Maximum care will be taken to avoid the cutting of the trees.

2.4.3. Site Clearance


The site selected for proposed drilling activity shall be first surveyed topographically and site boundaries shall be marked. Land clearance for site construction at each drilling site shall practicably be minimum in order to safely accommodate the facilities required for installation. The area of land required would be approximately of the order of 125 m x 125 m.

Earth moving equipment typically a bull dozer armed with a grader blade / ripper teeth and scoop bucket will be used for the leveling / grading and excavation work. The natural contours will be worked on to minimize off-site disposal of excavated earth. The site area (except the pit areas) will be provided with hard-standing by providing a layered base of coarse aggregate covered gravel. This is done to provide sufficient load-bearing capacity to enable all construction and drilling operations to be executed safely.

The earthwork to be carried typically involves approximately 450 m³ of excavation and about 1000 m³ of rolling and compaction of aggregate and gravel for the hard standing base. The civil works related to the construction of foundation, pits and paving would involve about 50 MT (for mobile rig site, mechanical rig) and 90 MT cement (for electrical rig site). During the construction phase approximately 6-7 truckloads per day of material movement would take place. The drill site construction would be done largely employing local labor.

2.4.4. Access and Transport

Access roads will be prepared to provide access to drilling site wherever required for movement of drilling machinery, equipment, supply vehicles etc. Existing infrastructure will be used to the extent possible,

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however where it is not possible ONGC may construct suitable route. These roads will be constructed as far as possible as overlays on existing roads, by strengthening and broadening the roads, and made with the consent of the local village administration and the concerned regulatory authorities. This would result in an added advantage to the local community, since the existing roads would be converted to heavy duty all weather roads. In case new roads are to be made, compensation for right of way will be provided. The choice to leave these newly constructed roads or to restore them back to original land use condition will depend on the requirements of the local authorities.

2.4.5 Proposed Schedule for the Project Approval and Implementation

The duration of various stages of the proposed project is given as under:

- The duration of construction works including site excavation, preparation and well pad construction is expected to last approximately thirty days for each well site.
- The duration of exploration and development of oil & gas will range from 3-4 months, depending on the target well depth.
- Well testing operation will be done over a period of 2-3 days.
- Abandonment and restoration of the each well site is expected to take about one month.

Thus, on an average, site preparation and drilling of one well is likely to take approximately 3-4 months under normal conditions. Working hours during the exploration and development operation will be 24 hours per day, seven days per week with 12 hours per shift.

2.5. Technology and Drilling Process Description

Entire gamut of Exploration drilling activities primarily involve geological studies, well logging, well completion, reservoir studies and laboratory services as exploration activities, drilling of oil and gas wells, casing and cementing of wells as drilling activities.




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Crude oil and natural gas resources are found in subsurface reservoirs. The drilling of oil and gas wells is necessary to produce these hydrocarbons. Drilling through the earth's crust is accomplished by using rigs to handle pipes to for drilling the well bore to allow fluids to flow to the surface for processing at production facilities. Thus, the purpose of oil /gas well drilling is to exploit oil and gas deposits in the reservoir from the surface. Rotary drilling is the most common process for this purpose. Major equipment used in drillings are- DG sets and PCR(Power control room),Mud pumps, Mud circulation system, Blow out prevention equipment, Choke and kill manifold, Kelly, kelly hose, rotary table, safety devices like chronometric and floriated devices, Escape line, cat head and cat lines, tongs and handling tools etc. Drilling of oil well is carried out through drilling rigs operating with rotary drilling technology in conformance to geotechnical order wherein casing policy and drilling parameters at various depths are explicitly defined.

Drilling of oil/gas wells employs mobile drilling rig. The drilling rig consists of a derrick at the top of which is mounted a crown block. A hoisting block having a hook is suspended from the crown block and a swivel is attached to the hoisting block by its shackle. From the swivel a tube of square section is suspended, which is called "Kelly stem". The Kelly stem is passed through a square hole in horizontal rotary table which is driven by electric motor. At the beginning of drilling operations, a round drill pipe at its end is screwed to the Kelly stem. The electric motor located near derrick rotates the rotary table through the Kelly stem rotations are transmitted to the drill pipe and finally to the bit. Kelly stem is needed to facilitate rotation, as round pipes are difficult to grip for rotating during drilling operations. As the hole is deepened, new sections are screwed to the drill pipe. Each section of drill pipe is about 9 to 10 meters in length and threaded at both ends. A string constitutes two/three drill pipes. Usually several such strings are kept ready at the derrick, so that they can be rapidly screwed with the help of special devices, as the well deepens.

The drill cuttings are removed by flushing the well and for doing so a hose is connected to stationary part of the swivel, through which a slush pump forces special drilling mud fluid also known as mud, down the string of drill pipes. The mud fluid is eco-friendly, non-toxic and non-hazardous in nature. The drilling mud then passes through the openings in bit to the bottom of the hole and back upwards between the walls of the well and drill pipes, thus bringing along with it the rock cuttings. The slush pump draws this mud fluid from special mud tanks. The diameter of the bit is always greater than that of a drill pipes, so as to ensure

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sufficient clearance between drill pipe and walls of the well along with which mud fluid returns to the surface after flushing the well.

The drilling mud fluid not only carries along with it crushed rock from the bottom hole but it also cools the bit which heats up during the drilling. Moreover, it reinforces the walls of the well by lining them with clay or pudding them thereby diminishing possibility of crumbling or caving in of the well walls. However, such pudding of the well walls is often ineffective and only in very hard rock the wells are free from danger of caving. It is for this reason, deep wells are usually reinforced by lowering casing pipes down their shafts. The mud fluid is discharged from well along a trough back into the mud tank and it is returned to the well after heavier particles of rock have been removed. In this way, it performs a continuous cycle. Mud fluids are prepared from particular types of clays capable of forming highly dispersed colloidal solutions. The most suitable clays for this purpose are bentonite clays. Drilling Mud fluid is prepared in tanks in nearby centrally located Mud Preparation Plant. The clay and water are fed to mud mixers and the resulting solution is filtered for separating un-dissolved lumps of clay and gravel. The volume of mud fluid in mud tank is always kept to about three times than that of entire mud circulating system. Before use, mud is always tested for its density, viscosity, water loss and put into drilling operations only if the test results are satisfactory.

2.5.1. General Requirements of Drilling

a. Drilling muds

Drilling of wells requires specially formulated muds which basically comprise inert earth materials like bentonite and barite in water with several additives to give mud weight, fluidity and filter cake characteristics while drilling. The drilling muds have several functions like lubrication and cooling of the drill bit, balancing subsurface formation, bringing out the drill cuttings from the well bore, thixotropic property to hold cuttings during non-operations, formation of thin cake to prevent liquid loss along well bore etc. Several additives are mixed into the mud system to give the required properties. Water based mud will be used to the possible extent in exploratory drilling but use of synthetic based mud may require due to complexities associated with the geological formations and associated hole stability problems. The constituents of water based mud (WBM) are given in **Table 2.1**. The special additives and their functions in WBM are shown in **Table 2.2**.


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Table 2.1: Ingredients of Water Based Drilling Fluid

S. No	Chemicals	S. No	Chemicals
1	Barite	6	Spotting Fluid
2	Bentonite	7	EP Lube
3	Carboxy Methyl Cellulose	8	Caustic Soda
4	Mud Thinner / Conditioner	9	Potassium Chloride
5	Resinated Lignite	10	Soda Ash

Table 2.2: Additives and their functions in Drilling Fluids

Sl no.	Additive	Functions
1	Sodium bicarbonate	Eliminate excess calcium ions due contamination
2	Sodium chloride	Minimize borehole washout in salt zone
3	Groundnut shells and mica flakes	Minimize loss of drilling mud to formation
4	Cellulose polymers or starch	Forms thin, sticky filter cake on the well bore to decrease filtrate loss to formation
5	Aluminium stearate	Minimize foaming
6	Vegetable oil lubricant	Reduce torque and drag on drill string

7	Pill of oil-based mud spotting fluid	Counter differential pressure sticking of drilling string; Pill is placed down hole opposite contact zone to free pipe
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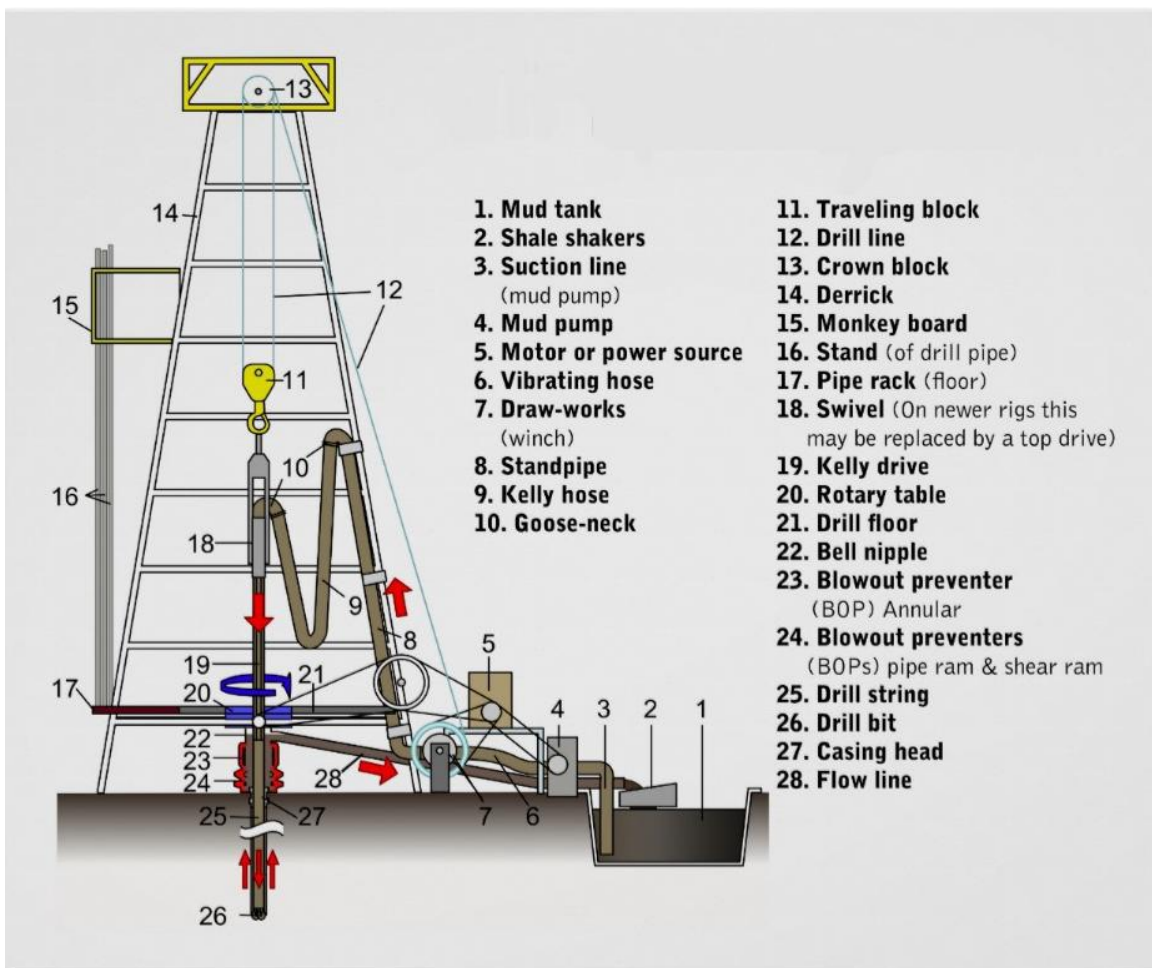



Figure2.1: Anatomy of Drilling Rig

b. Power Generation

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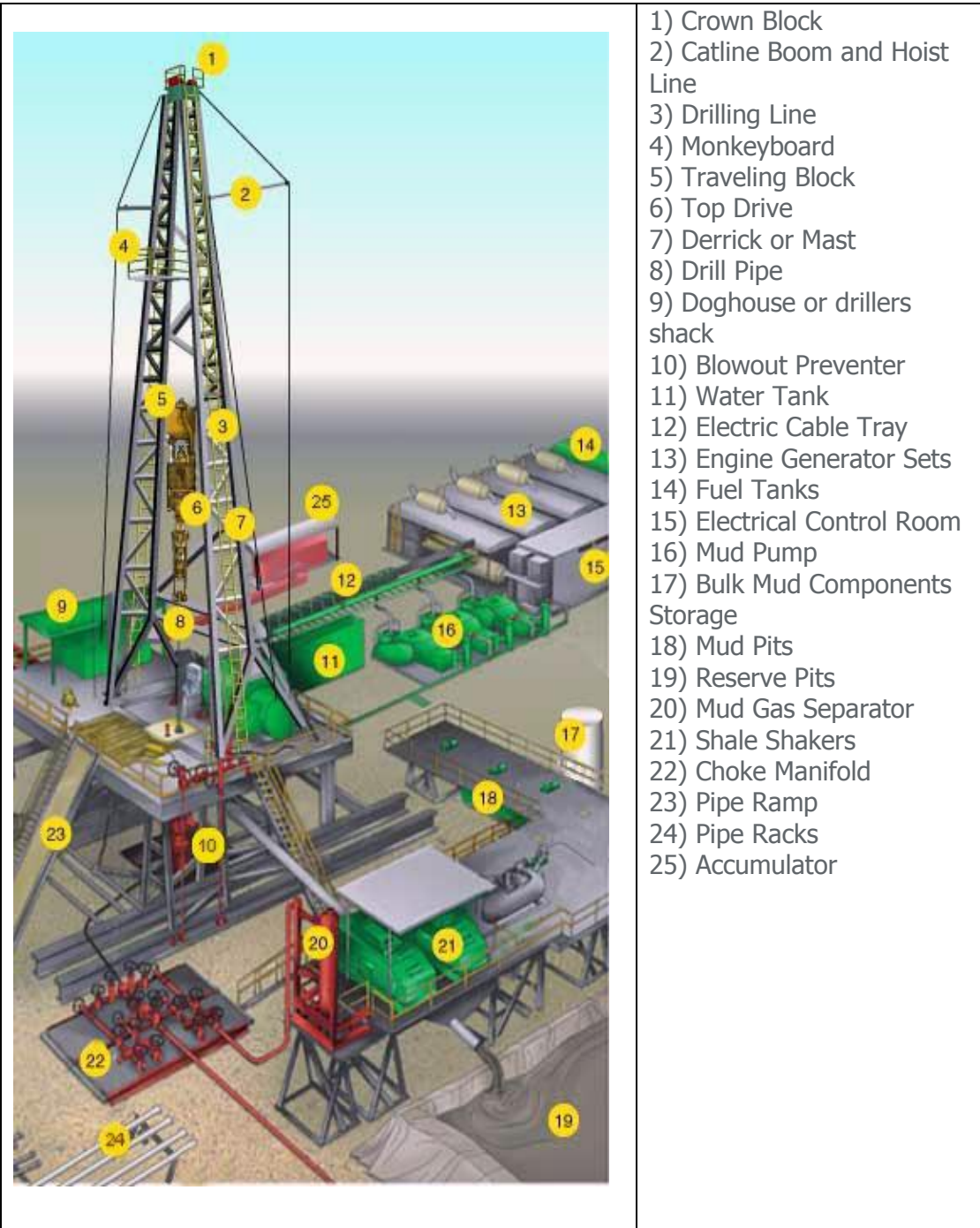
The drilling process requires movement of drill bit through the draw works which require power. The power requirement of the drilling rig will be met by using the 3 Diesel Generator sets (2 running and 1 standby) with a diesel consumption of about 2-3 Kl/day.

c. Water requirements

The drilling operation and maintenance of the drill site facilities have various water requirements. The most significant of these requirements in terms of quantity is that for mud preparation. The other requirements would be for engine cooling, floor / equipment / string washing, sanitation, fire-fighting storage / make-up and drinking. Water for emergency fire-fighting would be stored in a pit of 200 m³ capacity and make-up of the same will have to be made on a regular basis. For this project, it is anticipated that a total requirement of ~35m³/day/well will be required for drilling purposes, out of which 10 m³/day will be recycled. Thus a fresh water requirement of ~25 m³/day.

The requirement of water expected for sanitation and drinking purposes of the workers shall be insignificantly low in terms of quantity. ONGC has planned to meet the requirement of water at the drilling site through water supplied by tankers and sourced from nearest ONGC installation. Since, there is no quality criterion for usage of raw water for the various uses mentioned above (other than drinking), the tanker water shall be directly used without any treatment. The potable water requirements shall be met by procuring adequately treated water from off-site locations.

The potable water requirement shall be met by procuring adequately treated water from off-site. **Table 2.3** gives a quantitative break-up of the peak water requirement on daily basis for the drilling period at each site. Actual consumption figures if averaged on daily basis are likely to be lower.



- 1) Crown Block
- 2) Catline Boom and Hoist Line
- 3) Drilling Line
- 4) Monkeyboard
- 5) Traveling Block
- 6) Top Drive
- 7) Derrick or Mast
- 8) Drill Pipe
- 9) Doghouse or drillers shack
- 10) Blowout Preventer
- 11) Water Tank
- 12) Electric Cable Tray
- 13) Engine Generator Sets
- 14) Fuel Tanks
- 15) Electrical Control Room
- 16) Mud Pump
- 17) Bulk Mud Components Storage
- 18) Mud Pits
- 19) Reserve Pits
- 20) Mud Gas Separator
- 21) Shale Shakers
- 22) Choke Manifold
- 23) Pipe Ramp
- 24) Pipe Racks
- 25) Accumulator

Figure2.2: Typical Onshore Drilling Rig


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Table 2.3 Water Requirement


S. No.	Purpose	Peak water required during Drilling period (KLD) per well
Drilling Operation		
1	Mud preparation	18
2	Drill cutting washing	05
	Derrick floor Washing	
3	Desander	05
	Desilter	
4	Domestic requirement	05
5	Mud Pump	02
Total Water requirement for Drilling (KLD)		35
Actual Requirement of fresh water (KLD)		25

d. Domestic wastewater

The operating personnel in the drilling rigs will operate from drill site accommodation (DSA) in the vicinity of the location. Suitable soak pits will be available at the DSA.

e. Solids removal

The rock cuttings and fragments of shale, sand and silt associated with the return drilling fluid during well drilling will be separated using shale shakers and other solids removal equipment like desanders and

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desilters. The recovered mud will be reused while the rejected solids will be collected and discharged into the waste pit.

f. Testing

Testing facilities will be available at drilling rig for separation of liquid phase and burning of gaseous hydrocarbons during testing. The test flare boom will be located at a safe distance from the drilling rig.

g. Storage of chemicals and other materials

The drilling rig will have normal storage facilities for fuel oil, required chemicals and the necessary tubular and equipment. The storage places will be clearly marked with safe operating facilities and practices.

h. Logistics

Crew transfers to and from the drilling rig, materials, diesel and chemicals will be through light vehicles, trucks and trailers.

i. Manpower Arrangement


During the drilling operations, about 10 persons may be working in 8/12 hour shifts at site. Workers will be able to return to their camp/homes during duty – off period. Once drilling is over no person is required at site, except security cover through a contractor.

j. Land Requirement

ONGC shall acquire the land approx. 125m x 125m per well on temporarily basis for the purpose of preparation of the drill site and drilling operations. The site may require temporary approach road from an existing one for transportation of rig and other equipment necessary for drilling work. The site shall be fenced in the event the well is successful.

k. Surface Drainage

Drilling sites will have an adequate drainage and wastewater conveyance system, so that all wastewater are contained and can be disposed as per the CPCB discharge norms. The drilling rig location will be connected with paved drains to the lined drilling fluid collection pits. Storm water flows will be conveyed

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through surface drainage system. Surface drains will be adequately graded and maintained and kept debris free to ensure quick disposal of their contents.

I. Waste Oil Collection, Storage & Disposal System

Waste oil from pumps or other machinery will be trapped and manually collected and stored in a paved waste oil storage area. The storage area will be provided with paved flooring, containment binding and covered roofing. The storage facility shall be designed based on the CPCB guidelines for hazardous waste storage. The waste oil will be recycled as per CPCB & MoEF&CC authorized waste oil recyclers at the end of the drilling operations.

2.5.2 Spill Containment System


Containment systems and oil traps will be provided to trap any escape of oil before it can leave the drilling site. All potential sources of spillage will be equipped with drainage facilities or drip pans in order to contain spills.

2.5.3. Waste Water Storage Pit

The waste water storage pit of approx. 3000 to 4000 m³ (depending on well depth) will be available at drill site to collect waste water, which come from the drilling operations. The waste water present in the waste pits will be recycled and reused during drilling phase. Water based drilling fluids, which are of an environmentally acceptable nature with regards to current Indian legislation and which are non-hazardous, will be used. The residual wastewater and the drilling fluid from the drilling operation will be collected in waste pits for solar drying. The pit will be lined with HDPE sheet and the overlaps welded together with the edges brought over the rim and tucked into the soil. At the end of the drilling phase, the liquid fraction of the waste drilling fluid will be allowed to evaporate and the pit is filled with thick layer of native top-soil. Typical Sectional view of the drill cutting and drilling mud collection pit is presented in Figure 2.3.

2.5.4 Drill Cuttings Disposal Pit

The drilling rig system to be employed for drilling will be equipped for the separation of drill cuttings and solid materials from the drilling fluid. The drill cuttings, cut by the drill bit, will be removed from the fluid

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by the shale shakers (vibrating screens) and centrifuges and transferred to the cuttings containment area. Once the drilling fluid / mud have been cleaned it will be returned to the fluid tank and pumped down the drill string again.

Drill Cutting and drilling mud will be disposed off in accordance with Notification dated 30th August 2005 - G.S.R 546 (E) point no C “Guidelines for Disposal of Solid Waste, Drill Cutting and Drilling Fluids for Offshore and Onshore Drilling Operation”.

2.5.5. Domestic Sewage Treatment and Disposal System

The domestic sewage generated from the drill site operations will be treated in a septic tank–soak pit system. The septic tank would be adequately sized so as to cater to a volumetric capacity of 4–5 m³ per day.

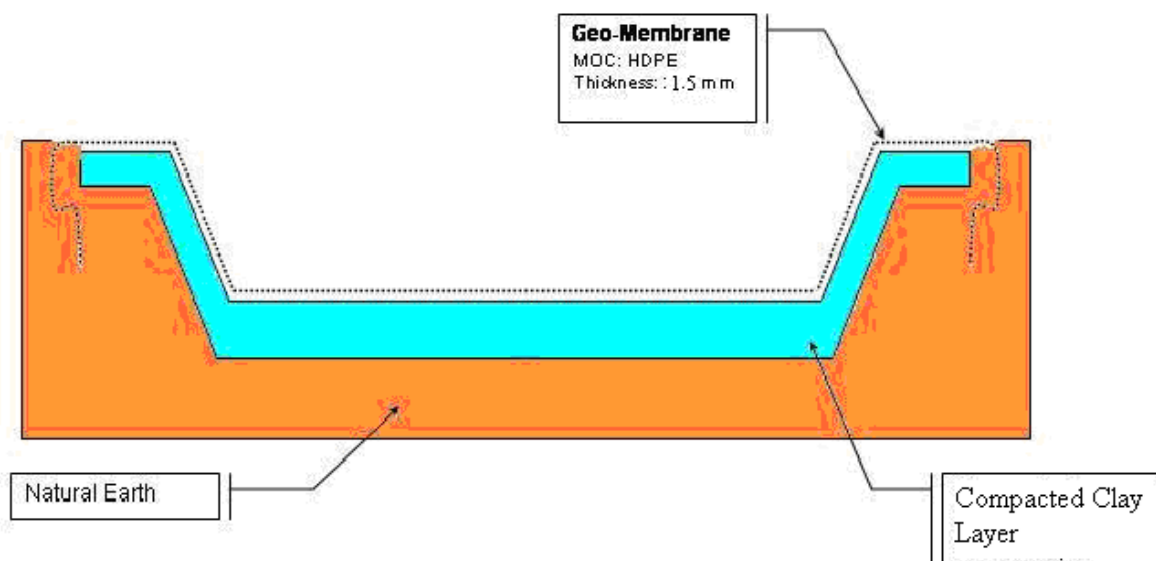



Figure 2.3 Typical section view of drilling cut and drilling mud collection pit

The top layer of soil shall be stacked at site for reuse after completion of drilling operations. The solid waste generated from drilling operation will be disposed in following manner.

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- a. **Drill Cuttings** – 150-800 MT / well will be generated, which are mainly inert solids. Drill cuttings shall be water washed and then solar dried at site in HDPE lined pit at site. Drill cuttings are collected dried and disposed of as per GSR 546(E) dated 30th August 2005 guidelines for disposal of solid waste, drill cuttings and drilling fluids for Onshore drilling process. Dry cuttings shall be covered with top layer of soil.
- b. **Spent Oil** – During the drilling approx. 200 litres of spent oil shall be generated. This oil shall be sent to authorize recyclers, as per CPCB guidelines and Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016.
- c. **Oil Sludge/ Hazardous waste** – The proposed drilling is temporary activity and exploratory in nature, no hazardous waste shall be generated. In case of any Oil Sludge/ Hazardous waste is generated during the drilling activities, same shall be sent for incineration to a TSDF site.
- d. **Drilling Mud** – Water base drilling mud shall be used, approx. 200m³ -600 m³ drilling mud per well is required.

2.5.6. Air Emissions


The Emissions to the atmosphere from the drilling operations shall be from the DG sets and temporary from flaring activity (during testing).

2.5.7. Noise Generation

The source of noise generation during this phase of operations would be the operation of rig and diesel generating sets. The expected noise generation at source, due to operation of rig is 101 dBA (Source: "Control of Noise Pollution from Diesel Generator Sets", Programme Objective Series; Probes/71/1998-99, Central Pollution Control Board). Besides certain pumps are expected to be in operations during this phase, for mud circulation. The noise generation work however is transient and limited to the drilling period only.

Noise levels were measured near various noise generating equipment and at site boundary. The noise levels were observed as follows (based on earlier site visit of typical drilling site)

- Near well head – 80 to 85 dB (A)
- Near Mud Pump- 80- 85 dB (A)

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- Near DG set – 70-75 dB (A)
- Near Shale Shaker- 70 to 75 dB (A)
- Near Site Boundary- 55 to 60 dB (A)

2.5.7. Safety and Environment

Adequate safety measures such as fire-fighting equipment shall be provided at the site in accordance with the norms of OISD 189. A high-pressure influx of formation fluids (water and/or gas) into the well bore is commonly known as a 'kick'. Well control is aimed at preventing the kick and a possible blowout. The function of well control can be conveniently sub-divided into two main categories, namely primary well control and secondary well control. These categories are briefly described below.


a. Primary Well Control

This is the maintenance of sufficient hydrostatic head of fluid in the well bore to balance the pressure exerted by the fluids in the formation being drilled. This means that the pressure exerted by the density of the drilling fluid should be greater than the pressure of the formation fluids. It should be noted that balancing formation pressure is a theoretical minimum requirement; good drilling practice dictates that a sufficient excess of hydrostatic head over the formation pressure be maintained at all times to allow for contingencies.

b. Secondary Well Control

If, for any reason, the effective hydrostatic head in the well bore should fall below formation pressure, an influx of formation fluids (kick) into the well bore would occur. If this situation occurs, the Blowout preventer (BOP's) must be closed to prevent the loss of fluid from the well. The purpose of secondary well control is to rectify the situation by closing the well in and circulating the invading fluid out of the well, while at the same time increasing the fluid weight to prevent any further influx.

The drilling personnel of the selected contractor are expected to be experienced in the above procedures and the key personnel will be required to hold certificates to prove competence in well control procedures. They will be trained and regular drills held to ensure that they will know how to act in such events. Furthermore, they will be aware of the safety aspects associated with the drilling operation, through

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training and experience. It must be also noted that blowouts are rare events during exploratory drilling operations conducted by experienced operators.

2.5.8. Decommissioning and Restoration

At the conclusion of the drilling program at each drilling site, an orderly withdrawal of all personnel and the removal of all drilling and testing equipment and non-fixed items from the drilling site will be undertaken.

Broadly, there are two such scenarios:

- In case that the well is completed when economic quantities of hydrocarbons are found, the well will be left with a wellhead in place, but all other equipment and materials will be removed from the site. The well site will be fenced and will be reduced to 30m X 30 m for the production phase and all non-essential area will be fully reclaimed.
- In any other case the site will be cleared and refurbished to permit recovery to as near as possible the pre-existing local environment as per ONGC's Standard Operating Procedure (SOP) of Restoration.


2.5.8.1 Temporary Suspension of Activities

- In the event that economic quantities of hydrocarbons are found, all empty drums, wastes, used and unused drilling fluids, fuel and lubricants will be removed from the drilling site. Water supply and effluent discharge hoses and associated equipment will be removed.

2.5.8.2 Decommissioning upon Abandonment

In the event that no economic quantities of hydrocarbons are found, a full abandonment plan will be implemented for the drilling sites in accordance with the applicable Oil Mines Regulation, 2017. The activities mentioned in the above section would apply to decommissioning upon abandonment as well, but abandonment would be more permanent.

The overriding principle being that the environment should, with time, be reinstated to broadly its original condition. Until such time as this is achieved, ONGC would actively manage the

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reinstatement process. All concrete or steel installations would be removed to at least 1 m below ground level, so as to ensure that there are no protruding surface structures. In the unlikely event that soil is found to be contaminated, measures would be taken to remove or treat appropriately all contaminated topsoil to promote its remediation.

- All concrete structures will be broken up, and the debris disposed of as per the regulatory requirements.
- All other waste products, solid and liquid, will be disposed of in accordance with the requirements of the EIA and will be treated to render them harmless.
- All fencing and access gates will be removed.
- All pits whose contents will show regulatory compliance for on-site disposal, at the time of site closure, will be backfilled and closed out as per the legal requirements.
- Restoration of unusable portion of the access track, removal of pilings and landscaping.
- In case of abandoned wells, where there are no indications of oil/gas, the site will be restored by ONGC to its original condition as per ONGC's policy on site restoration, and land handed over to the land owner.




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Chapter 3

Description of Environment

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3.0 Description of the Environment

3.1 Introduction


This chapter illustrates the description of the existing environmental status of the study area with reference to the prominent environment attributes to assess environmental impacts from the proposed project activity.

3.2 Baseline environmental Study

The study area was determined through collection of samples followed by quantifying environmental indicators of air, noise, water, land, ecology and socio-economic status. The baseline environmental quality has been determined for Summer Season by following guidelines prescribed in MoEF & CC, EIA notification and ToR issued to the ONGC.

The baseline environmental qualities for the proposed exploratory drilling locations have been assessed for the following environmental components, which are most likely to be influenced by the drilling activity:

- Geology
- Seismicity and flood
- Hydrogeology
- Land Environment
- Ambient Air Quality
- Meteorological conditions
- Noise levels
- Water quality (Surface +Ground water)
- Soil quality

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- Biological and
- Socio-economic studies.

The primary baseline environmental quality for the EIA is assessed through field studies within the impact zone for various components of the environment, viz. air, noise, water, Soil and socio-economic.

3.3. Geology

Badarpur-Hilara structures are located in the Narayanchara-Hilara-Badarpur-Chandipur Anticlinal trend of Cachar area. This anticlinal trend formed due to EW compression adjacent to face of subduction and in the northern part trend rotated in NE direction due to strike slip movement of Dauki Fault. The anticlinal trend is traversed by cross faults which produced separate structures like Chandipur, Badarpur, Hilara, Narayanchara etc. Badarpur structure is a doubly plunging asymmetrical anticline with gentle western limb and steeper eastern limb. Lower Bhuban Formation is exposed in the core of the structure and succeeded by Middle and Upper Bhubans, Bokabil, Tipam and Dupitila formations towards the west flank of the structure. The subsequent reactivation of thrusts gave rise to the configuration of up-thrust and sub-thrust blocks. Hence Badarpur structure formed through combined effect of both folding and faulting. As the faulting episode is younger and stronger, the structure is more of fault related and the HC pools are also more fault governed with limited areal extend.

Geologically, the district of Cachar can be divided into two major groups, i.e. unconsolidated deposits comprising alluvial deposits of Sub-Recent to Recent age and semi-consolidated Tertiary deposits of Bhaban, Bokabil, Girujan/ Tipam, Dupitila and Dihing formations of Miocene to Pliocene age. The alluvial deposits containing in the central parts mainly comprises of sand, silt and clay with gravel and occasional coal bands. The semi consolidated rocks are exposed in the form of hillocks comprising shale, sandstone, ferruginous sandstone, mottle clay, pebble bed and boulder beds etc.

The Cachar area comprises a part of the frontal thrust and folded belt of the Assam-Arakan Basin. The area exposes a series of sub-parallel, acute, elongated, doubly plunging folds arranged in an echelon pattern trending N-E in the north to N-S in the central part than swings to NW-SE in the south, with convexity towards west. The structures are tight and affected by thrust either on one side or both limbs. The crustal parts of the structures are exposed by older Tertiary sediments while the flanks are covered

by younger sediments. The intervening synclines are relatively broad and covered by younger, softer sediments and alluvium.

3.4 Seismicity and Floods:

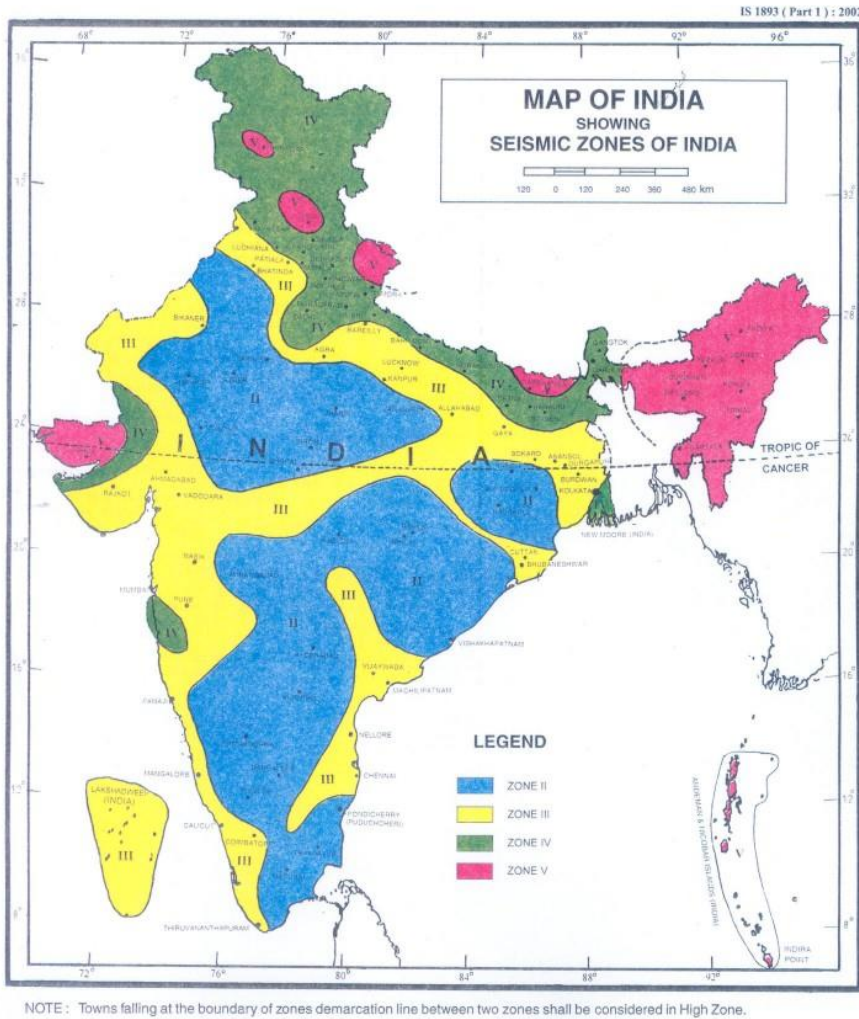


Figure 3.1: Seismic Zone Map of India.

3.4.1 Seismicity: Geo-morphologically, Assam falls within in an earthquake prone zone (BIS Seismic Zone IV and V) of the Indian subcontinent. Refer Figure 3.2 for Seismic zone map of Assam. As per the seismic hazard map, Cachar district falls in the high hazard zone with Seismic Zone V category.

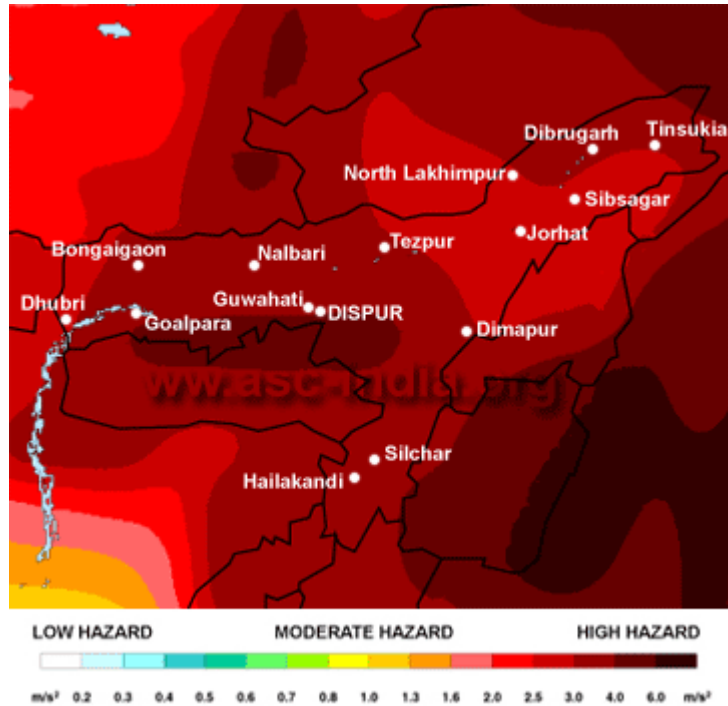



Figure 3.2: Seismic Zone map of Assam

3.4.2 Floods: Being on the south eastern part of Assam, Cachar district is highly prone to flooding due to Barak River with varying magnitude. Silchar town experiences urban flooding and severe water logging particularly during the rainy season,. Silchar is inundated frequently due to excessive rainfall and flooding by the Barak River and its flashy flowing tributaries. In the last three decades, Silchar and the Barak Valley have been ravaged by three major floods in 1986, followed by 1991 and in 2004. Floods in Silchar and Cachar district are inevitable, considering the topography and the intricate river system. Being on the south eastern part of Assam, Cachar district are highly prone to flooding due to Perennial Barak River with varying magnitude. The frequent flood in the district spoils the quality of soil resulting water logging. Presently, this problem of water logging in the district creates hazards for irrigation of land during cultivation.

3.5 Hydrogeology

The entire area of Cachar district is represented by i) unconsolidated, ii) semi-consolidated and iii) consolidated (Compact formation of Tertiary) formations and these units are as follows. 1. Very compact formations comprising the Surma and Dihing series of rocks, 2. Semi-consolidated rocks comprising Tipam and Dupitila formations, and 3. Unconsolidated formation of alluvial deposits. The semi-

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consolidated Tipam sandstones form good repository in the area. The depth to water level varies from a few metres to 4 m bgl in alluvial sediments particularly in north and south of Silchar and in western parts while it varies from a few metres to 2 m bgl in the central parts. The hydraulic gradient of ground water is from North to South in northern parts and ground water flows from South to North-West in southern parts. The static water level in shallow aquifers (within 5 m) is within 1.3 to 4.0 m bgl in the North of the Barak River and it varies from 1.8 to 2.22 m bgl in southern parts. Discharge of tube well water is varies from 5.5 to 8 m³ /hr with the drawdown of 6.0 m.

In the deeper aquifer, the granular zone occurs below a confining layer of clay, thus it is a confined aquifer. The static water level ranges from 1.92 to 6.88 m bgl in northern parts and from 0.50 to 8.50 m bgl in the southern parts of the River Barak. The yield of the tube well is varies from 33 to 88 m³ /hr with drawdown varying between 9.9 to 32.65 m. The ground water levels measured in the study area during the primary survey is as given in Table 3.2.

- i) Major water bearing formations : Sand of various grades and other river borne aquifer materials
- ii) Pre-monsoon water level: 1.62 m bgl
- iii) Post-monsoon water level : 1.05 m bgl

The water level fluctuation, in general, is less than 1 m, however, in places like Mohanpur, Srikona, Kashipur, Rajabazar etc. it is from 4.52 to 7.0 m. In the central parts of the district around Dholai, Palanghat etc. it is only 0.20 m indicating low fluctuation in fine grained deposits.

Ground water resource is mainly utilized for drinking purposes. Dug well of 8 to 10 m depth and shallow tube well (STW) can be constructed along the fringe area of the district for a potential source of water.

3.6 Land Environment

3.6.1 Topography

Physiographically, the study area consists of plain terrain in the most of the eastern part, except southwest & west where the terrain is hilly. The main river system is perennial Barak River (Perennial) with its tributaries in the North and South flowing from east to northwest direction. Other tributaries/streams which join main Barak River are Barnal Khal, Gujari Khal, Mathura Khal, Baraputhi



Khal and Salganga Nadi. The other water bodies in the study region are village ponds & water logs in low lying areas, which are predominantly located towards west of study area. The main drainage of the 10 km study area is dendritic and all the 1st order and 2nd order drains connect to the main drainage which is ultimately joining to Barak River.

3.6.2 Land Use Studies

Studies on land use aspects of eco-system play important roles for identifying sensitive issues, if any, and taking appropriate actions for maintaining the ecological balance in the development of the region.






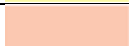





The objectives of land use studies are:


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





Methodology

The various steps involved in the study are preparatory field work, field survey and post field work. The present land use/land cover maps were prepared based on the classification system of National standards. For explanation of each of the land use category the details as given in **Table-3.1** were considered.

Table: 3.1 Land use classification of the study area

S. No	Level - 1		Level - 2
1	Built-up		Built-up, Urban
			Built-up, Mining
			Builtup, Rural
2	Agriculture		Agriculture, Plantation
			Agriculture, Crop land
			Agriculture, Current Shifting Cultivation
3	Forest		Forest, Evergreen/Semi evergreen
			Forest, Scrub Forest
			Forest, Deciduous
4	Wastelands		Barren/unculturable/Wastelands , Scrub land
			Barren/unculturable /wastelands, Barren rocky

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5	Water Bodies		Wetlands/Water Bodies, Inland Wetland
			Wetlands/Water bodies, Reservoir/Lakes /Ponds
			Wetlands/Water bodies, River/Stream /Canals
6	Others		Grass / Grazing

Mapping of Land use and land cover of the area falling within the 10 km radius of study area is being prepared with the help of topographical data, Satellite data and Field studies. The land use and land cover (LULC) map of study area is given in the **Figure 3.3** has been prepared by adopting the interpretation techniques of the image in conjunction with collateral data such as Survey of India topographical maps, census records, LANDSAT Imagery and ground truth.

Table 3.2: Land Use of Block area

S.No.	Land Use	Area Sq.km	Area in Hectare
1.	Agriculture Land	238.26	23826
2.	Built –Up land	8.56	856
3.	Forest	440.21	44021
4.	Wastelands	1.8	180
5.	Water bodies	34.32	3432
6.	Others	1.6	160
	Total Area	724.75	72475

The above table indicates that, the majority of land is used by Forest (44021 hectare), agriculture purpose (23826 hectare), followed by water bodies (3432 hectare) and built up land (856 hectare) while the rest area includes waste lands (180 hectare) and others (160 hectare).

3.5 Meteorology

The meteorological data recorded during the study period is very useful for proper interpretation of the baseline information as well as for input to prediction models for air quality dispersion.

On site monitoring was undertaken for various meteorological parameters in order to generate the site specific data. The central monitoring station (CMS), equipped with continuous monitoring equipment to record wind speed, wind direction, temperature, Relative humidity and rain fall was set up at the top of the building at a height of ~ 5.0m above the ground level. The methodology adopted for monitoring

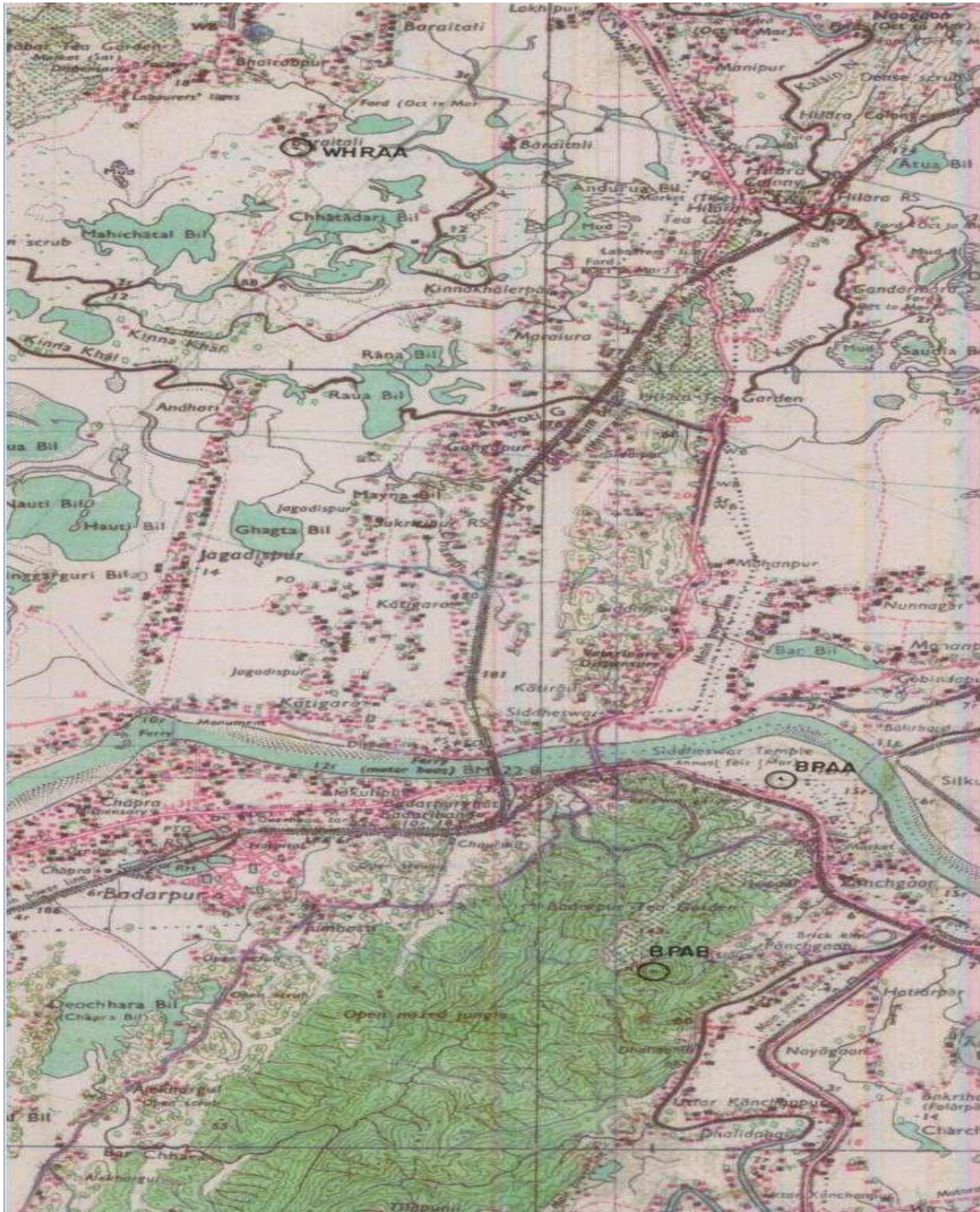



Figure 3.3 Land use of the study area

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surface observations was as per the Standard norms laid down by the Bureau of Indian Standards (IS: 8829:1978) and IMD.

3.5.1 Meteorological data recorded at study area

The meteorological parameters were recorded at the study area on hourly basis during the Summer season from the month of 27th April 2018 to 27th July 2018 consist of parameters like Wind speed, Wind direction, Relative Humidity, Temperature and total rainfall. The maximum and minimum values for Temperature & Humidity are presented in **Table 3.3**

Table 3.3: WEATHER DATA FROM IMD, SILCHAR (1971-2000)

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max-Temp (C)	24.5	26.4	29.6	30.5	31.0	31.5	31.4	31.9	31.5	30.9	29.1	26.1
Min Temp (c)	12.1	14.1	17.7	21.0	23.0	24.6	25.1	25.2	24.6	22.9	18.6	13.9
RH (%)	76	70	68	75	79	85	85	83	83	81	76	77
Rainfall (mm)	12.1	44.2	229	258	460	612	503	428	367	169	33	13

Source: IMD, Silchar

3.5.2 Temperature

The monthly mean maximum temperature varied from 23.5°C in January to 30.8°C in August while monthly mean minimum varied from 12 °C in January to 24.9°C in August indicating January as the coldest while August as hottest month as shown in **figure 3.3**.

3.5.3 Rainfall

The rainfall occurred maximum in June (612 mm) followed by July (503 mm). The total annual rainfall is 3128.3 mm. Total rainy days observed are 132.6 days. The monsoon sets in the month of June and continues till September and sometime extends up to mid-October as shown in **figure 3.4**.

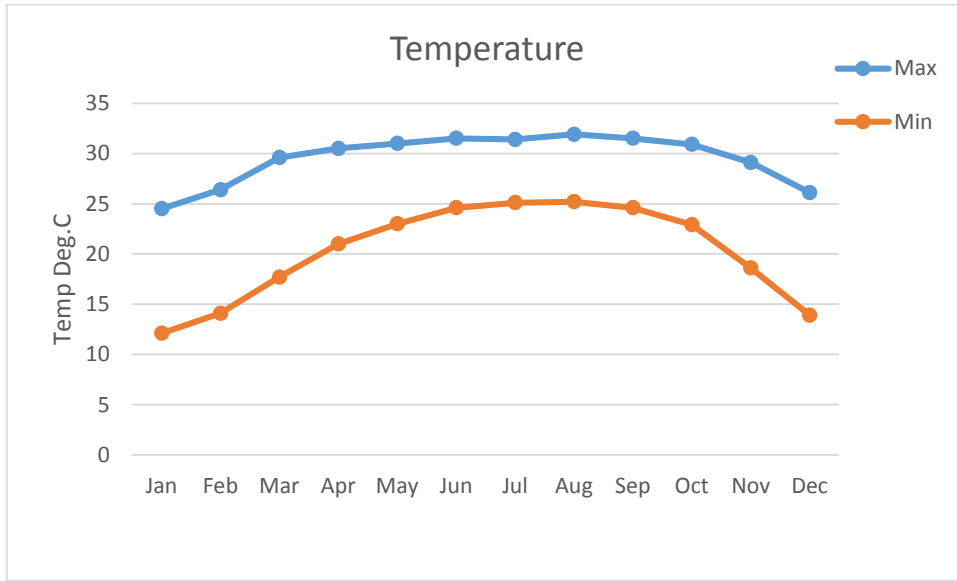


Figure 3.4: Monthly Average Maximum and Minimum Temperature in °C

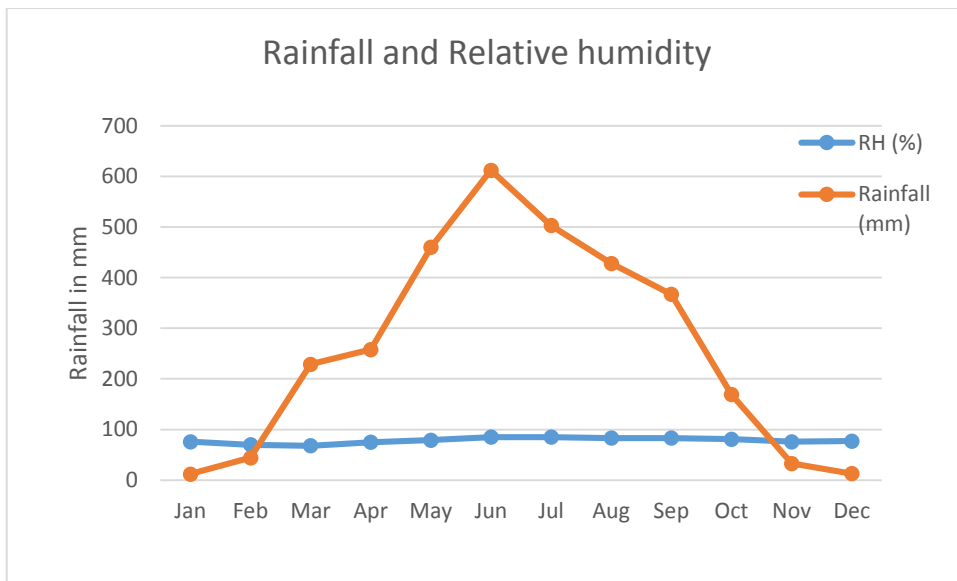


Figure 3.5: Monthly Average Rainfall in mm and Relative humidity in %


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TABLE –3.4: Summary of the Meteorological Data Generated in Study Area

Period	Temperature (°C)		Relative Humidity (%)		Rainfall (mm)
	Max	Min	Max	Min	
April 2018(27 th to 30 th)	32.2	22.1	84	66	13
May 2018	33.5	23.0	98	45	99.5
June 2018	35.8	22.4	99	42	1119
July 2018(1 st to 27 th)	35.9	24.1	94	51	152
27 th April 2018 to 27 th July 2018	35.9	22.1	99	42	1383.5

Source: ABC Techno Labs India Private Limited

The summary of the wind pattern for the study period is listed in **Table-3.24**. The graphical presentation of the same illustrated from **Figure- 3.6 to 3.10**

TABLE – 3.5: Summary of Wind Pattern in the Study Area

Period	First Predominant Wind Direction	Second Predominant Wind Direction	Average Wind Speed (m/s)
April 2018(27 th to 30 th)	NW	W	0.8
May 2018	W	NW	0.8
June 2018	W	S	0.6
July 2018(1 st to 27 th)	S	W	0.6
27 th April 2018 to 27 th July 2018	W	S	0.7

Source: ABC Techno Labs India Private Limited

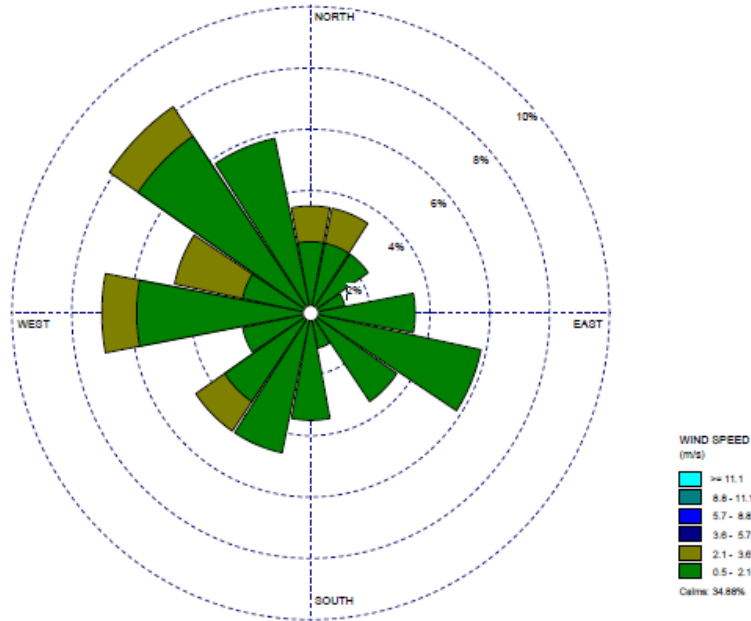


FIGURE: 3.6: Wind rose Diagram for April, 2018 (27th to 30th)

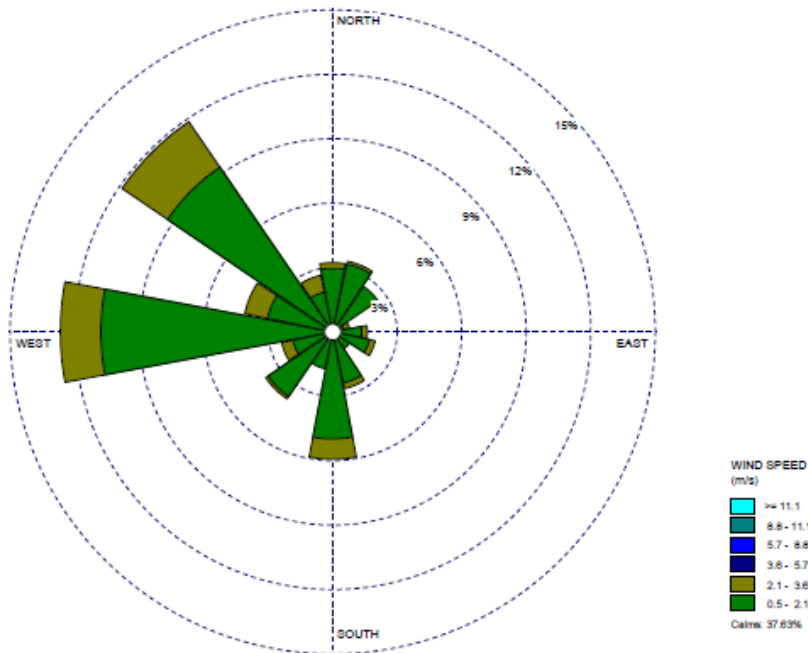


FIGURE : 3.7 : Wind rose Diagram for May, 2018

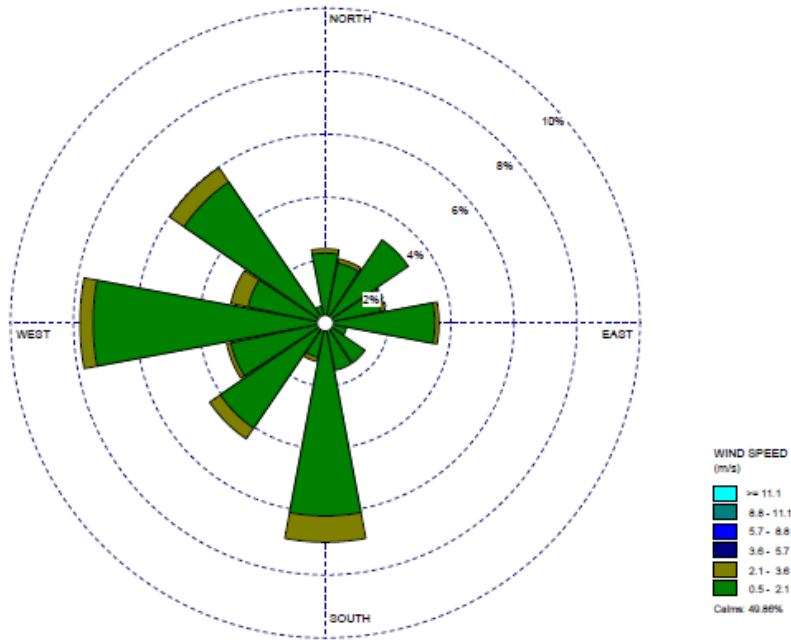


FIGURE – 3.8: Wind rose Diagram for June, 2018

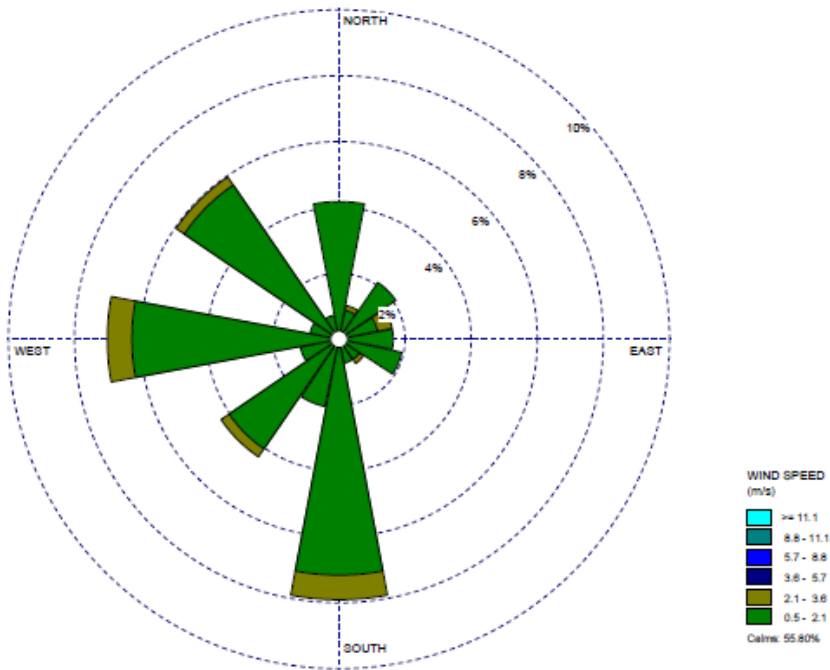


FIGURE – 3.9: Wind rose Diagram for July, 2018 (1st to 27th)

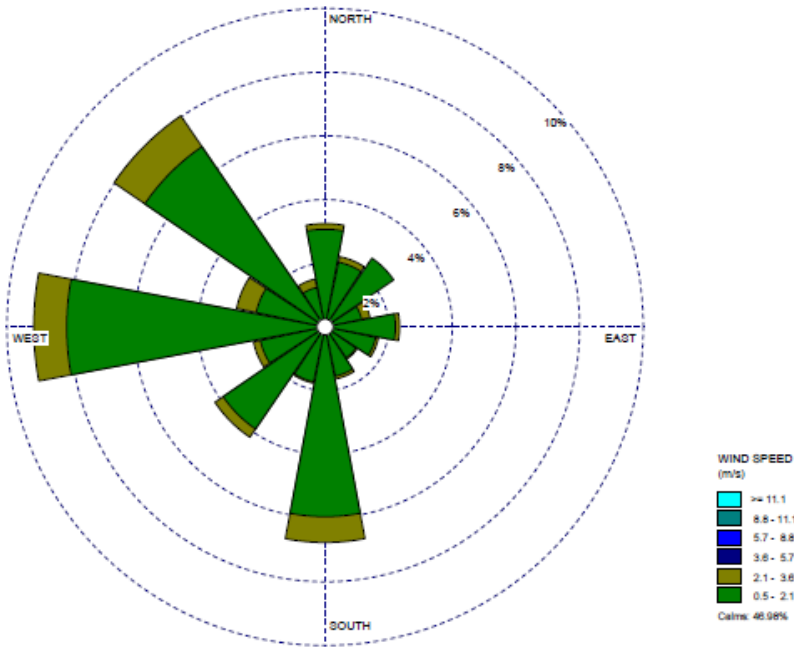
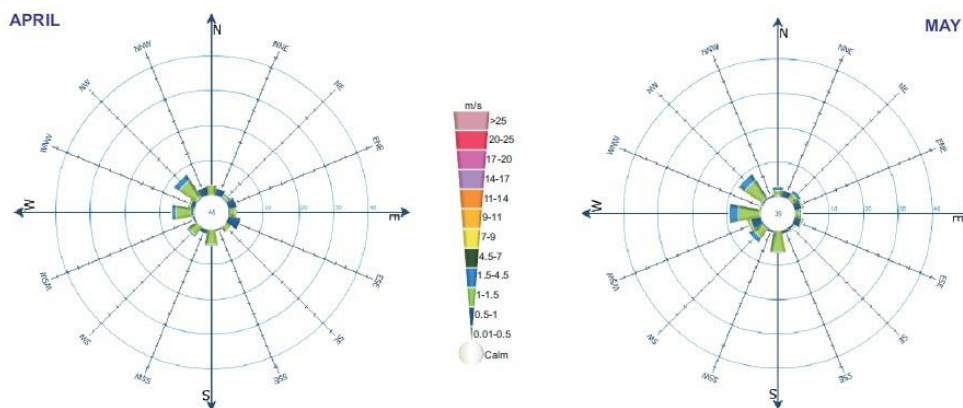


FIGURE – 3.10: Wind rose Diagram for the period from 27th, April-18 – 27th July-18

3.7.4 Secondary Data from Indian Meteorological Dept., (IMD), Silchar

The nearby India Meteorological Department station that is generating meteorological data is 20 km from the project site i.e. IMD, Silchar. Hence, secondary information on meteorological conditions has been collected from Silchar IMD station.

Indian Meteorological Department at Silchar regularly monitors wind direction, wind speed, relative humidity, temperature and rainfall at 08.30 hours and 17.30 hours every day. Wind rose diagrams (1971-2000) collected from IMD and the same is shown in **Figure – 3.11 & 3.12**



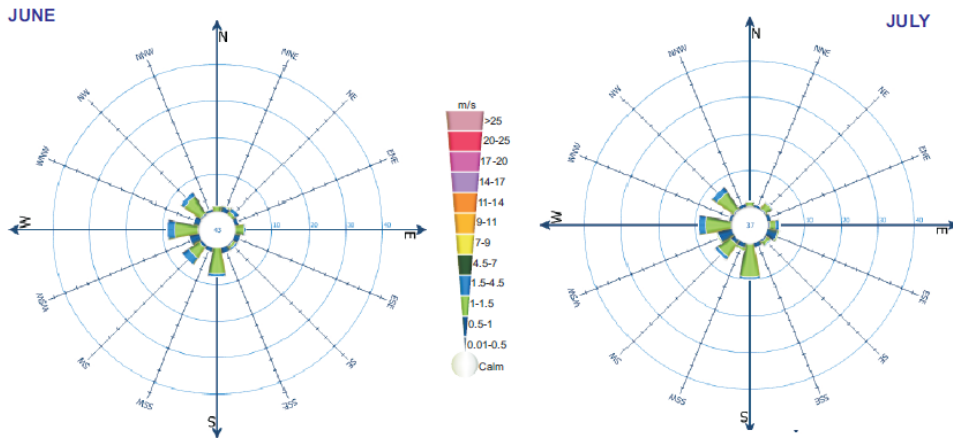


Figure 3.11: Wind rose diagrams for the month of April, May, June & July - IMD, Silchar (1971-2000)

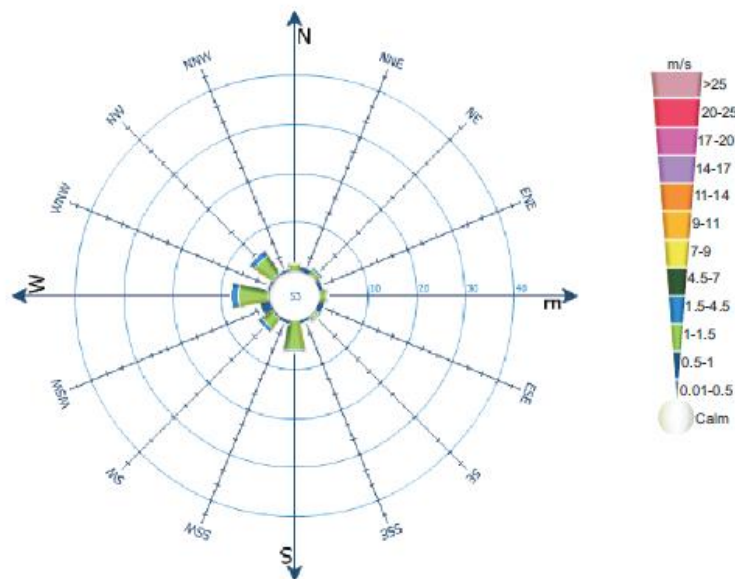



Figure 3.12: Annual Wind rose diagrams from IMD, Silchar (1971-2000)

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3.8 Ambient Air Quality

A reconnaissance survey was undertaken to identify the sampling locations to establish baseline status of Ambient Air quality in the study area. The sampling stations were selected based on guidelines of air monitoring network siting criteria such as:

- Topography of the study area
- Persistence of wind direction and speed
- Representation of regional background
- Populated and sensitive areas
- Location of industries and their emission magnitude
- Screening of maximum ground level concentrations and distances of their likely occurrences as per climatological normal
- Representation of valid cross-sectional distribution in down-wind direction.


3.8.1 Ambient Air Quality Monitoring Network and Analytical Methods

The ambient air quality around the location within 10 km radius was monitored at Eight (08) stations. To establish the baseline monitoring of air quality in the study area during summer season; Ambient Air Quality Monitoring stations eight (08) were selected using network design criteria and monitored as per CPCB guidelines.

As per NAAQS (2009) the pollutants viz., particulate matters (PM₁₀ and PM_{2.5}), sulphur dioxide (SO₂), nitrogen dioxide (NO₂), carbon monoxide (CO) and ammonia (NH₃) were stipulated parameters for air quality monitoring. All the parameters were monitored on 24 hourly while CO was monitored on hourly basis. Standard analytical procedures were used for analysis and quantification of air quality parameters and the details are given in **Table 3.5**. The photographs show in sampling stations/locations are given in the **Figure 3.13**.

3.8.2 Frequency and Parameters for Sampling

Ambient air quality monitoring was carried out at a frequency of two days per week at each location for continuous three months. The baseline data of air environment was generated for the parameters namely Particulate Matter size less than 10 µm (PM₁₀), Particulate Matter size less than 2.5 µm (PM_{2.5}), Sulphur

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dioxide (SO₂), Oxides of Nitrogen (NO_x), Carbon Monoxide (CO), Volatile Organic Compounds (VOCs), Hydrocarbon (Methane & Non-Methane) and Hydrogen Sulphide (H₂S).

3.8.3 Instruments used for Sampling

Respirable Dust Samplers APM 460 BL of Envirotech, Fine Particulate Samplers APM 550 of Envirotech & Combo PM₁₀ & PM_{2.5} sampler AAS 271 of Envirotech were used for monitoring the Particulate matter PM₁₀ & PM_{2.5}. The Gaseous pollutant samplers AAS 109 of Ecotech or APM 411 along with APM 460 Envirotech were used for sampling of gaseous parameters like SO₂, NO_x, H₂S, VOCs & HC. Carbon Monoxide was measured using electro chemical sensor method. The instruments used for monitoring are periodically calibrated every year or after in case of any repair.

3.8.4 Sampling and Analytical Techniques

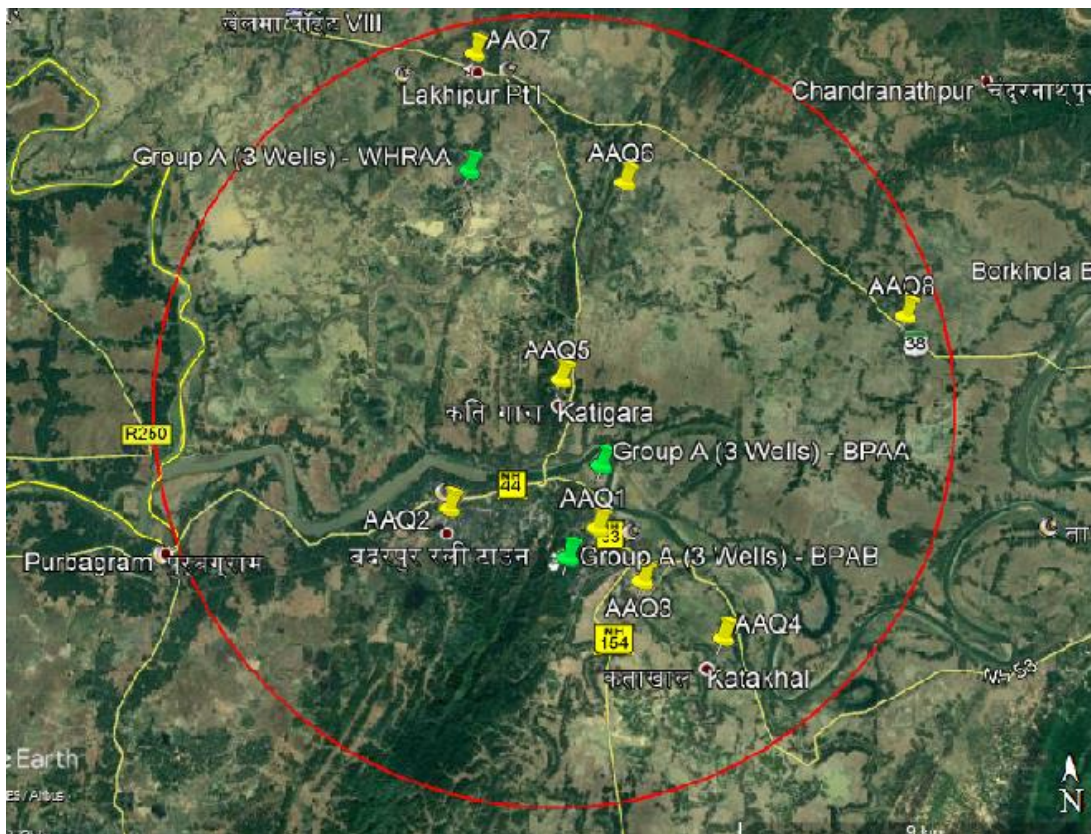
The sampling and analytical techniques used for the monitoring of Ambient Air quality is given in **Table 3.6**. The power supply for the operation of AAQ instruments were utilized from either residential or commercial buildings nearest to each AAQ station.

TABLE – 3.6: Techniques used for Ambient Air Quality Monitoring

S.No	Parameter	Technique	Technical Protocol	Detectable Limit
1	Particulate Matter of size less than 10 µm (PM ₁₀)	Gravimetric method	IS 5182 Pt.23 : 2006 (Reaff. 2017)	5 µg/m ³
2	Particulate Matter of size less than 2.5 µm (PM _{2.5})	Gravimetric method	EPA- 40 Appendix L To CFR PART 50	5 µg/m ³
3	Sulphur dioxide (SO ₂)	Improved West and Gaeke	IS 5182: Part 2:2001 (Reaff. 2017)	5 µg/m ³
4	Oxides of Nitrogen (NO _x)	Modified Jacob & Hochheiser	IS 5182: Part 6:2006 (Reaff. 2017)	5 µg/m ³
5	Carbon monoxide (CO)	Non Dispersive Infra Red (NDIR) Spectroscopy	IS 5182:Part 10 :1999 (Reaff. 2014)	0.1 mg/m ³
6	Hydrogen Sulphide (H ₂ S)	Colorimetry Method	IS 5182: Part 7:1973 (Reaff.2014)	5 µg/m ³
7	VOCs & BTX	GC-MS/MS	ABCTL/INS/SOP/035	1 µg/m ³

8	Methane HC	GC FID	ABCTL/INS/SOP/038	0.1 µg/m ³
9	Non-Methane HC	GC FID	ABCTL/INS/SOP/038	0.1 µg/m ³

Figure – 3.13: Map showing Ambient Air Quality Monitoring Stations



Proposed Well



AAQ Monitoring Stations



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3.8.5 Summary of Ambient Air Quality Results

Summary of ambient air quality results of PM₁₀, PM_{2.5}, Sulphur Dioxide, Oxides of Nitrogen, Carbon Monoxide, Methane and Non-Methane Hydrocarbon are summarized in **Table 3.7**. Hydrogen Sulphide, Volatile Organic Compounds and BTX (Benzene, Toluene and Xylene) was not observed in the study Area.

TABLE 3.7:- Summary of Ambient Air Quality Monitoring Results

AAQ Location	PM10 µg/m ³				PM2.5 µg/m ³				SO ₂ µg/m ³				NO _x µg/m ³				CO mg/m ³				Methane HC µg/m ³			Non methane HC µg/m ³		
	Min	Max	Mean	98 th %le	Min	Max	Mean	98 th %le	Min	Max	Mean	98 th %le	Min	Max	Mean	98 th %le	Min	Max	Mean	98 th %le	Min	Max	98 th %le	Min	Max	98 th %le
Near Panchgram	54.1	76.0	63.5	75.0	24.8	48.5	33.1	45.8	5.6	8.6	6.7	8.3	11.8	20.4	15.1	20.0	0.11	0.28	0.19	0.28	< 0.1	0.88	0.87	< 0.1	0.56	0.55
Badarpur Town	59.4	91.7	71.8	89.6	28.9	52.3	37.5	51.4	5.5	8.8	6.5	8.5	12.9	24.8	18.0	23.7	0.12	0.33	0.20	0.32	< 0.1	0.89	0.86	< 0.1	0.67	0.65
Bakori Hawar	44.9	58.7	51.1	58.2	20.2	28.7	24.8	28.7	5.2	6.9	6.0	6.9	10.8	21.5	16.1	20.9	0.11	0.25	0.18	0.24	< 0.1	0.77	0.77	< 0.1	0.55	0.55
Katakhal Rly Stn	43.9	57.3	50.4	56.6	21.2	29.4	25.5	29.0	5.1	7.4	6.0	7.1	10.4	19.6	14.1	19.5	0.11	0.21	0.16	0.20	< 0.1	0.86	0.72	< 0.1	0.73	0.72
Katigara	43.6	58.7	49.8	58.0	19.2	32.9	25.0	32.8	5.4	6.8	6.0	6.8	10.4	20.9	14.3	19.8	0.12	0.22	0.18	0.22	< 0.1	0.80	0.79	< 0.1	0.64	0.62
Hilara Rly Stn	44.2	72.1	54.5	66.7	31.7	22.8	26.0	31.0	5.2	6.9	5.8	6.8	10.4	18.6	13.9	18.1	0.11	0.24	0.16	0.23	< 0.1	0.79	0.79	< 0.1	0.58	0.57
Lakhipur	45.8	63.2	54.9	61.8	20.7	38.3	28.2	37.0	5.4	6.7	6.0	6.7	9.9	19.8	15.0	19.3	0.12	0.25	0.17	0.24	< 0.1	0.80	0.80	< 0.1	0.62	0.62
Chandpur Pt III	49.0	70.1	60.7	69.8	25.7	34.7	29.9	34.7	5.5	6.9	6.2	6.9	10.8	23.5	16.3	23.5	0.10	0.27	0.18	0.27	< 0.1	0.80	0.80	< 0.1	0.68	0.67
NAAQ Standards	100				60				80				80				2				--			--		

Source: ABC Techno Labs India Private Limited

3.8.6 Baseline Air Quality Status

The data collected was subjected to statistical analysis like minimum, maximum, average and standard deviation. The observed ambient air quality data within the study area from the project site is reported in **Table 3.6** and described briefly:

3.8.7 Observations

PM₁₀: The maximum and minimum concentrations for PM₁₀ were recorded as 91.7 µg/m³ and 43.6 µg/m³ respectively. The maximum concentration was recorded at the Badarpur. and the minimum concentration was recorded at Katigara, such variation would be due to wind-blown dust and unpaved roads. The average concentrations were ranged between 49.8 – 71.8 µg/m³ as described in figure 3.14

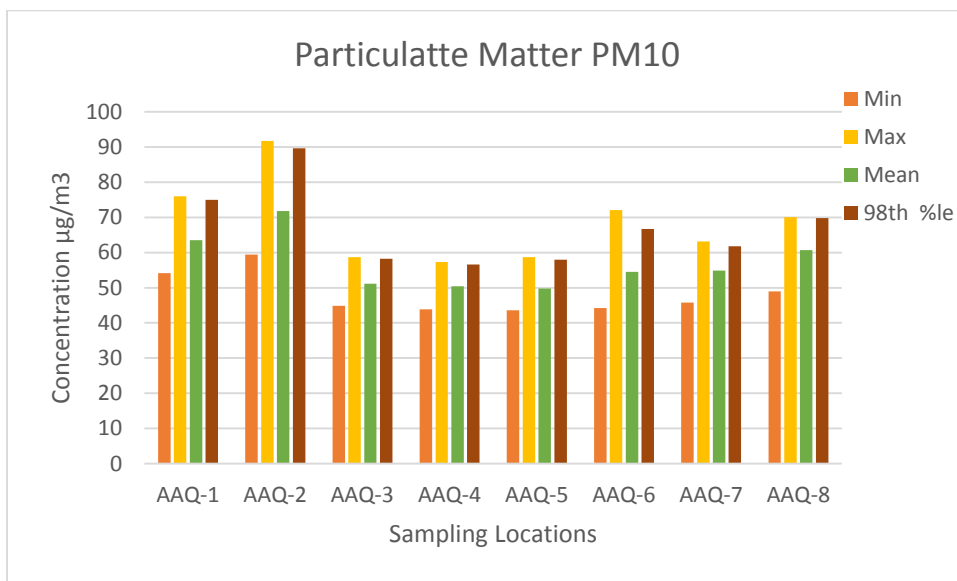


Figure 3.14: Variation of Particulate Matter PM10 in the study area

PM_{2.5}: The maximum and minimum concentrations for PM_{2.5} were recorded as 52.3 µg/m³ and 19.2 µg/m³ respectively. The maximum concentration was recorded at Badarpur and the minimum concentration was recorded at Katigara. The average values were observed to be in the range of 24.8– 37.5 µg/m³. The concentration of particulate matter both PM10 and PM2.5 are well within the stipulated standards set by CPCB as described in figure 3.14

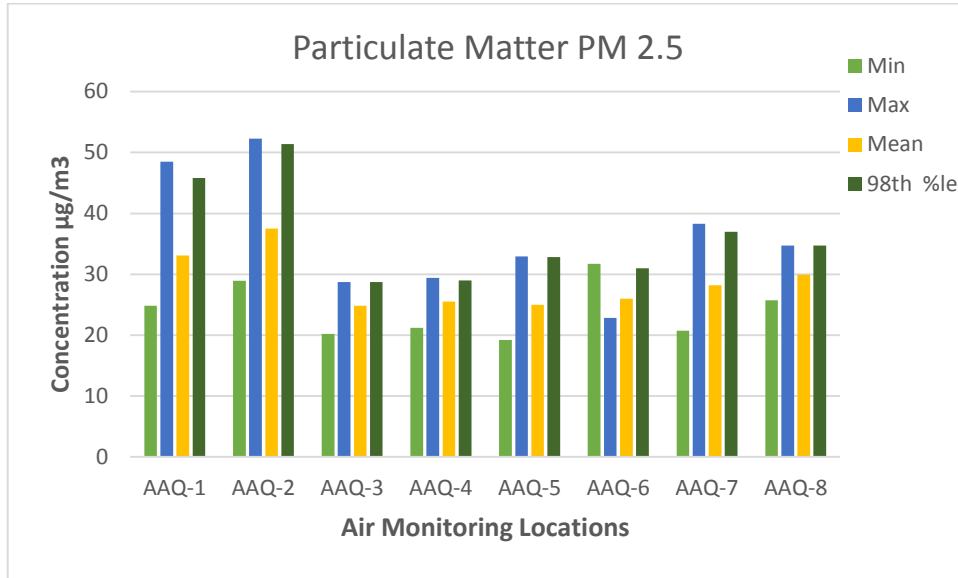


Figure 3.15: Variation of Particulate Matter PM2.5 in the study area

SO₂: The maximum and minimum SO₂ concentrations were recorded as 8.8 µg/m³ and 5.1 µg/m³. The maximum concentration was recorded at Badarpur and the minimum concentration was recorded at Katakhal. The average values were observed to be in the range of 5.8 -6.7 µg/m³ as described in figure 3.16

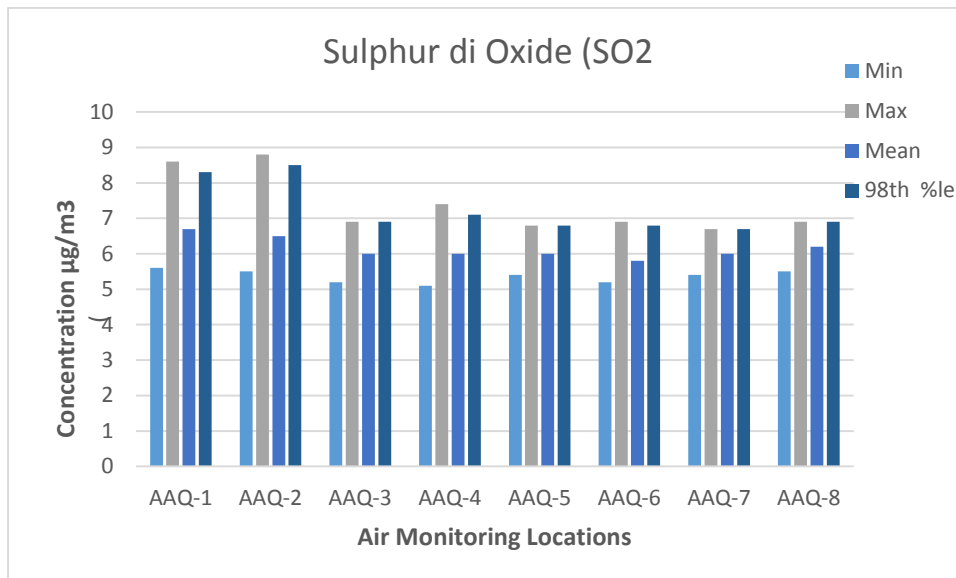


Figure 3.16: Variation of Sulphur di oxide (SO₂) in the study area

NO_x: The maximum and minimum NO_x concentrations were recorded as 24.8 µg/m³ and 9.9 µg/m³. The maximum concentration was recorded at Badarpur and the minimum concentration was recorded at Lakhipur. The average values were observed to be in the range of 13.9 – 18.0 µg/m³. The concentrations of SO₂ and NO_x were observed below the stipulated standards of NAAQS, 2009; i.e., 80 µg/m³ as described in **figure 3.17**

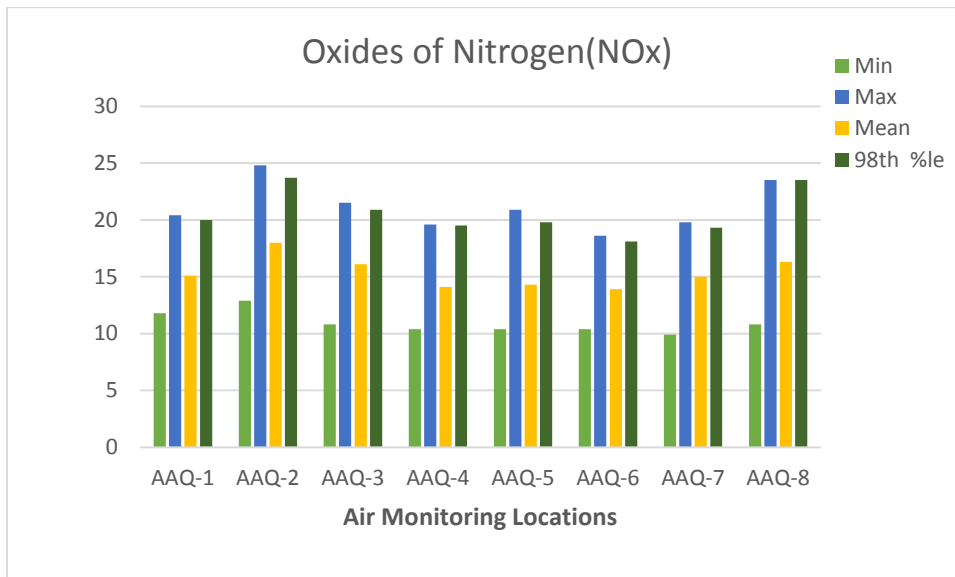


Figure 3.17: Variation of Oxides of Nitrogen (NO_x) in the study area

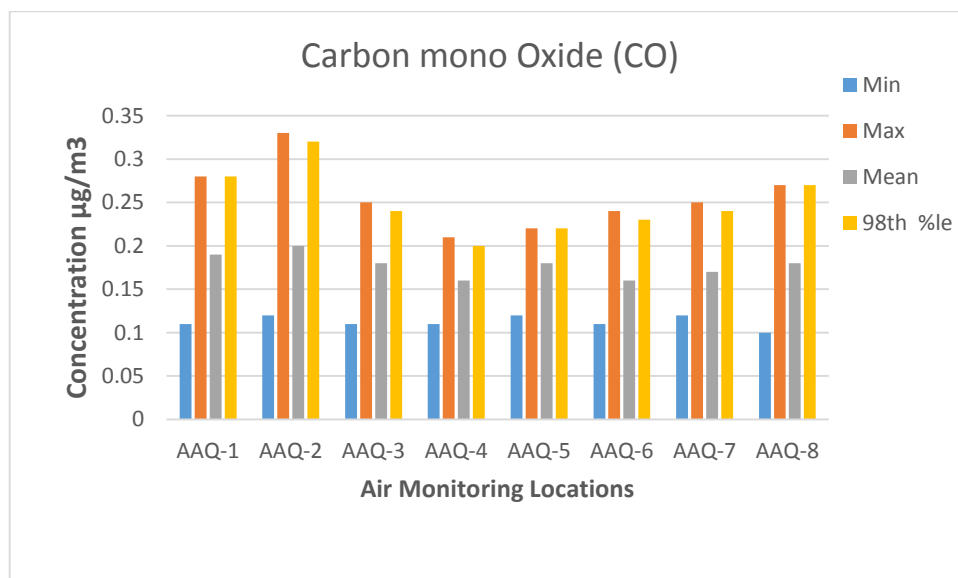



Figure 3.18: Variation of Carbon mono oxide (CO) in the study area

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CO: The maximum and minimum CO concentrations were recorded as 0.33 mg/m³ and 0.10 mg/m³. The maximum concentration was recorded at Badarpur and the minimum concentration was recorded at Chandpur Pt III. The average values were observed to be in the range between 0.16 mg/m³ to 0.20 mg/m³ and concentrations would be due to vehicular traffic, woods used for cooking activities and industrial emissions in the study area. The values are within the permissible limit 2.0 mg/m³ of National Ambient Air Quality Monitoring (NAAQM) standards for the respective designated areas as described in **figure 3.18**

H₂S: The H₂S concentrations at all station in the study area were observed below the detection limit of 5 µg/m³


VOCs & BTX: The VOCs & BTX concentrations at all station in the study area were observed below the detection limit of 1 µg/m³.

Methane HC: The maximum Methane HC concentrations were recorded as 0.89 µg/m³ and the minimum concentration of <0.1 µg/m³ was observed at all locations. The maximum concentration was recorded at Badarpur.

Non Methane HC: The maximum Non Methane HC concentrations were recorded as 0.73 µg/m³ and 0 and the minimum concentration of <0.1 µg/m³ was observed at all locations. The maximum concentration was recorded at Katakhal.

3.9 Noise Environment

Noise can be defined as unwanted sound or any sound that is undesirable because it interferes with speech and hearing, is intense enough to damage hearing or is otherwise annoying. From the noise source, natural or man-made barriers between the source and the impacted population, weather conditions which could potentially absorb, reflect, or focus sound (such as wind speed, direction, temperature inversions), and the scale of industrial activity. The environmental impact of noise can vary from noise induced hearing loss (NIHL) to annoyance depending on the loudness of noise levels and tolerance levels of individual.

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3.9.1 Methodology for Noise Monitoring

The sound level meter of HTC was used for measuring the Sound Pressure Level (SPL). Sound Pressure Level (SPL) measurements were recorded at the specified locations continuously for 24 hours. The day noise levels were recorded between 6 and 10 pm and night noise levels were recorded between 10 pm and 6 am at all locations.

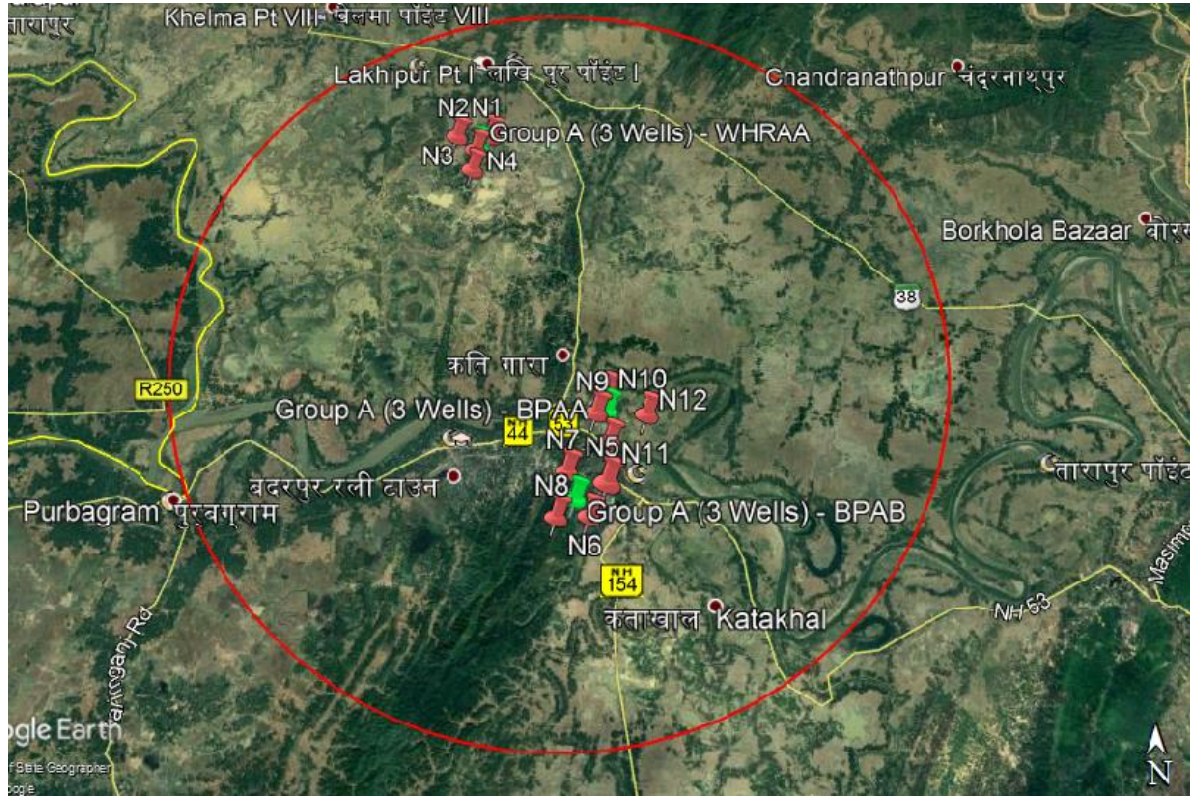
3.9.2 Details of Noise Monitoring Locations & Presentation of Results

To quantify noise levels in the study area i.e., 10 km radius from the location, the following criteria was followed to select sampling stations during field reconnaissance.

- Human settlements near the location, which can be affected
- Locations of Industrial, residential, commercial, and silence zones in the study area, as per the CPCB guidelines.

Based on the reconnaissance, the noise quality monitoring stations were identified within the study area outside the location as shown in **Figure 3.19**; the details of the locations are given in **Table 3.8**.

Figure – 3.20: Map showing Noise Monitoring Stations



Proposed Well



Noise Monitoring Stations



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Table 3.8: Noise level Monitoring of locations

Location	Date of Sampling	Name of the Location	Co-ordinates		Classification of Location	Noise Level Results			Standards	
			Latitude	Longitude		Lday [dB(A)]	LNight [dB(A)]	Leq [dB(A)]	Lday [dB(A)]	LNight [dB(A)]
N1	25.06.2018	Baraitoli pt II (Well WHRAA)	24°56'38.50"N	92°33'59.31"E	Residential Area	48.8	38.8	47.3	55	45
N2	25.06.2018	Bharirabpur (Well WHRAA)	24°56'38.52"N	92°33'26.79"E	Residential Area	52.1	40.4	50.5	55	45
N3	26.06.2018	Baraitoli pt IV (Well WHRAA)	24°56'6.11"N	92°33'42.04"E	Residential Area	50.4	42.6	49.0	55	45
N4	26.06.2018	Well WHRAA	24°56'25.42"N	92°33'45.15"E	Residential Area	51.2	39.9	49.6	55	45
N5	27.06.2018	Panchgram (Well BPAB)	24°51'21.50"N	92°35'48.95"E	Commercial Area	55.8	46.7	54.3	65	55
N6	27.06.2018	Well BPAB	24°50'57.16"N	92°35'28.28"E	Industrial Area	58.2	47.7	56.6	75	70
N7	28.06.2018	NW of Well BPAB	24°51'34.25"N	92°35'9.33"E	Residential Area	51.0	42.6	49.5	55	45
N8	28.06.2018	South of Well BPAB	24°50'56.49"N	92°34'59.28"E	Residential Area	50.9	39.4	49.3	55	45
N9	29.06.2018	Karimganj Silchar Road - Well BPAA	24°52'23.42"N	92°35'36.29"E	Residential Area	52.5	43.0	51.0	55	45



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N10	29.06.2018	Balirbond (Well BPAA)	24°52'39.74"N	92°35'46.04"E	Residential Area	51.9	41.8	50.3	55	45
N11	30.06.2018	Uttar Kanchanpur (Well BPAA)	24°51'59.21"N	92°35'47.75"E	Residential Area	50.6	40.6	49.1	55	45
N12	30.06.2018	Kalinagar Road (Well BPAA)	24°52'21.37"N	92°36'21.66"E	Residential Area	53.7	42.0	52.1	55	45

Standard as per Environmental Protection Act 1986, the principle rules published for Ambient Noise Level Standard (Area Category: Industrial/Residential/Commercial Area).

3.9.3 Observations

Day time Noise Levels

Noise levels during day time were found to be in the average range of 48.8 to 58.2 dB (A). The maximum noise level was observed as 58.2dB (A) at Well BPAB and a minimum of 48.8 dB (A) was observed at Baraitoli pt II (Well WHRAA) as described in figure 3.20

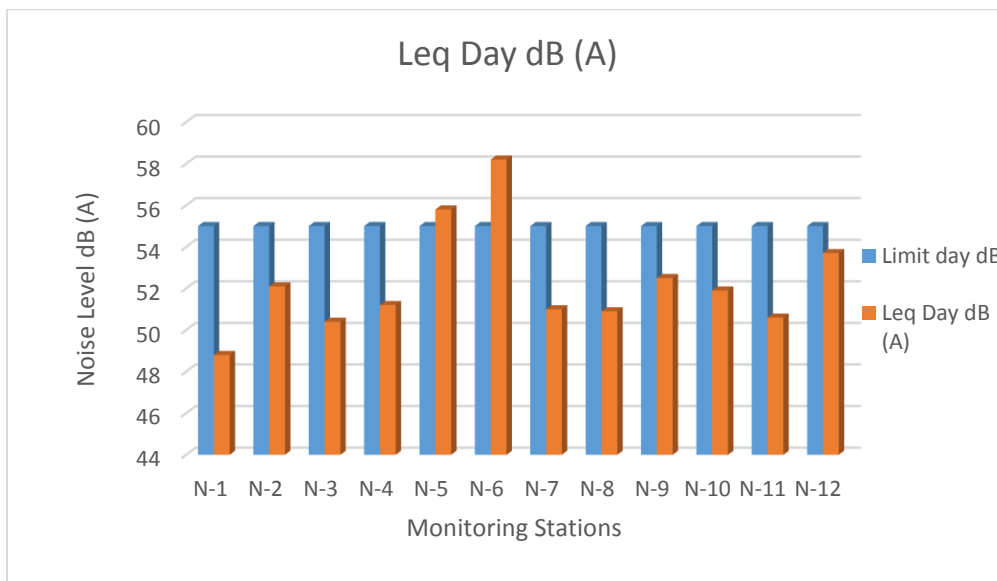


Figure 3.20.: Ambient Noise Levels Monitored in the Study Area (Day time)

Night time Noise Levels

Noise levels observed to fall in the range 38.8 to 47.7 dB (A) during the night time. A maximum of 47.7 dB (A) was observed at Well BPAB and a minimum of 38.8 dB (A) was observed at Baraitoli pt II (Well WHRAA) as described in figure 3.21

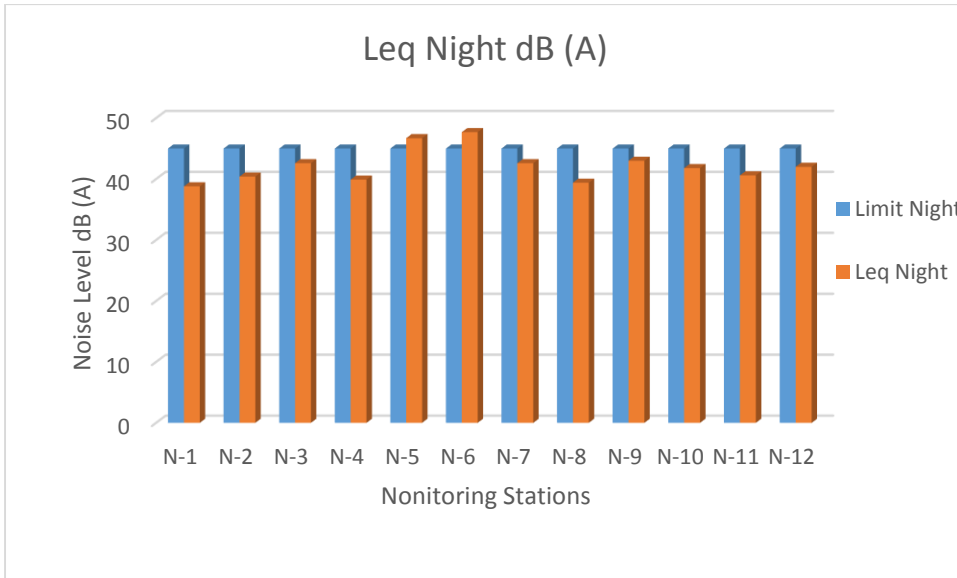


Figure 3.21 : Ambient Noise Levels monitored in the Study area (Night Time)

In residential zone the noise levels were found to meet the Ambient Air Quality Standards in respect of Noise (henceforth Noise Standards 2000) as given in Noise Rules 2000, except at near well BPAB during day and night time. The exceedance of noise levels would be due to traffic and human activity near the monitoring stations.

Within the proposed location, the noise levels were within the OSHA damage risk criteria for hearing. The area which is located at a lower elevation and has dense vegetation, which would prevent noise propagation to nearby villages. Many of the activities such as construction, bus/auto station and traffic causing noise are temporary in nature.

Figure 3.22: Noise Monitoring Locations

N1 – Baraitoli pt II (Well WHRAA)



N2 - Bharirabpur (Well WHRAA)



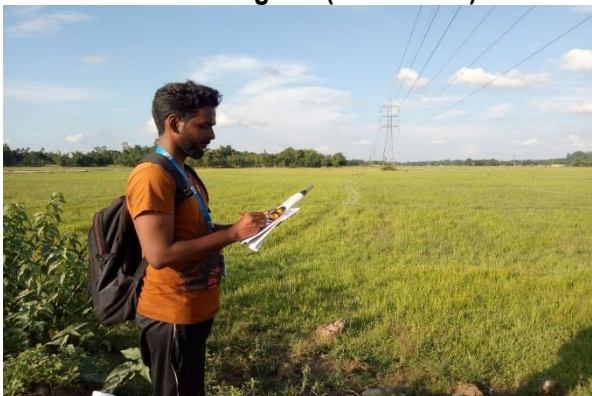
N3 - Baraitoli pt IV (Well WHRAA)



N4 - Well WHRAA



N5: Panchgram (Well BPAB)



N6: Well BPAB





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N9- Karimganj Silchar Road (Well BPAA)


N10- Balirbond (Well BPAA)



N11: Uttar Kanchanpur (Well BPAA)

N12: Kalinagar Road (Well BPAA)



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3.10 Water Environment

3.10.1 Reconnaissance

A reconnaissance survey was undertaken to identify the sampling locations to establish baseline status of water quality in the study area. Based on the reconnaissance survey, the type of water bodies and their relative importance with the project site and environmental issues within study area; surface and ground water sampling locations were identified and water samples were collected in summer season.

3.10.2 Water Quality Monitoring

Selected water quality parameters of the Ground water resources within the project area have been studied for assessing the water environment. Water samples were examined for Physico-chemical, Heavy metals and Bacteriological parameters in order to assess the effect of industrial, vehicular and other activities on ground or surface water.

3.10.3. Sampling and Analysis Techniques

Samples for chemical analysis were collected in polyethylene carboys. Samples collected for metal content were acidified with 1 ml HNO₃. Samples for bacteriological analysis were collected in sterilized bottles. The samples were analyzed as per the procedures specified in IS methods and 'Standard Methods for the Examination of Water and Wastewater' published by American Public Health Association (APHA).

3.10.4 Details of Water Sampling Locations

Five Ground Water and Ten Surface water samples were collected to establish baseline water quality of the study area. The Ground water sampling locations are listed in the **Table-3.9** & locations for Surface water samples are listed in the **Table 3.10**

TABLE 3.9– GROUND WATER SAMPLING LOCATIONS

Location Code	Name of the Location	Co-ordinates		Direction & Distance from the Nearest Well
		Latitude	Longitude	
GW1	Baraitoli Pt II	24°56'39.10"N	92°33'57.63"E	North East – 0.5 km w.r.t. WHRAA well
GW2	Hilara	24°55'27.47"N	92°35'8.77"E	South East – 2.8 km w.r.t. WHRAA well
GW3	Katigara	24°53'17.93"N	92°35'13.76"E	North West – 1.8 km w.r.t. BPAA well
GW4	Badarpur Town	24°51'54.54"N	92°33'41.90"E	North West - 3.0 km w.r.t. BPAB well
GW5	Panchgram	24°51'36.03"N	92°36'15.23"E	South East 1.9 km w.r.t. BPAB well

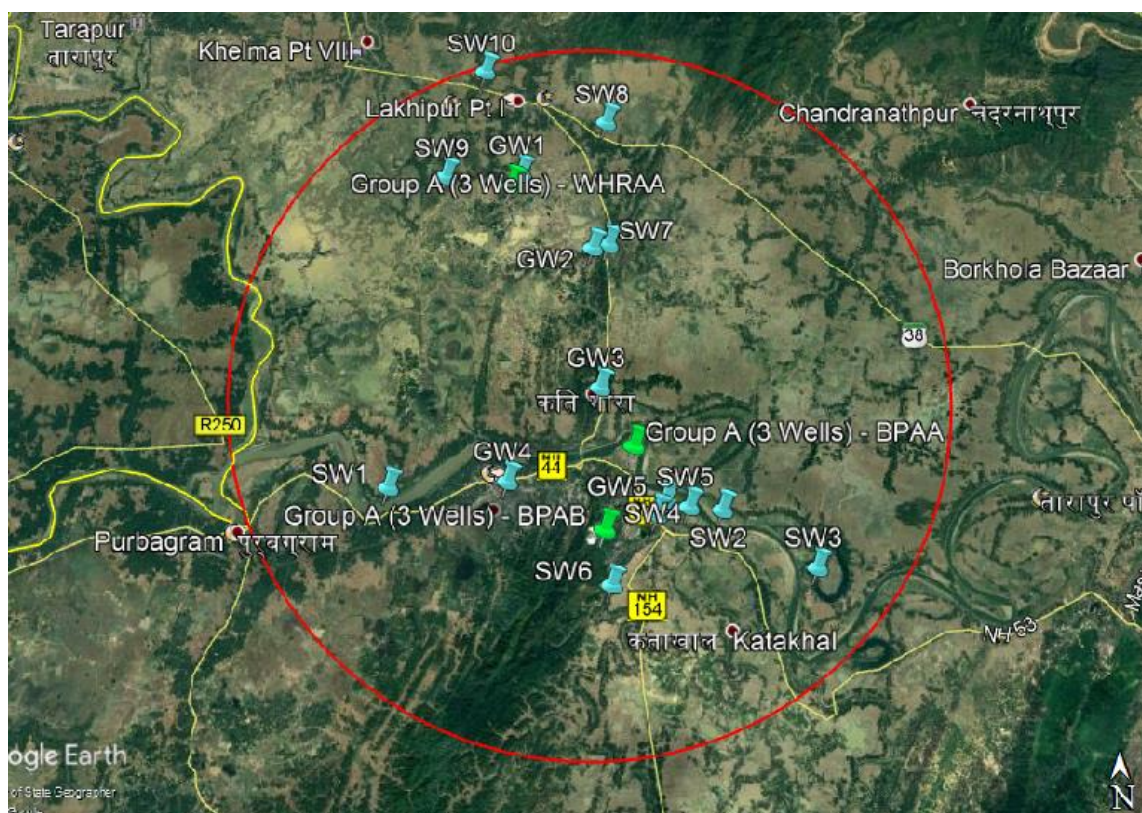
TABLE 3.10 – SURFACE WATER SAMPLING LOCATIONS

Location Code	Source/ Location	Co-ordinates		Direction & Distance from the Nearest Well
		Latitude	Longitude	
SW1	Barak River – Upstream	24°51'50.51"N	92°31'46.13"E	West- 6.6 km w.r.t. BPAB well
SW2	Barak River – Downstream	24°51'28.25"N	92°37'10.84"E	East – 2.5 km w.r.t. BPAB well
SW3	Lake - Near Salchapara	24°50'35.38"N	92°38'39.30"E	South East 5.8 km w.r.t. BPAB well
SW4	Pond - Near HPC Road	24°51'23.79"N	92°36'6.63"E	South East 5.6 km w.r.t. BPAB well
SW5	Dolasor River – Upstream	24°51'29.97"N	92°36'37.85"E	South – 2.4 km w.r.t. BPAA well
SW6	Dolasor River – Downstream	24°50'22.68"N	92°35'21.34"E	West - 1.36 km w.r.t. BPAB well

SW7	Lake - Near Hilara	24°55'30.69"N	92°35'24.49"E	South East – 3.1 km w.r.t. WHRAA well
SW8	Pond - Near Manipur Pt 1	24°57'28.23"N	92°35'24.71"E	North East 3.5 km w.r.t. WHRAA well
SW9	Lake - Near Bhairabpur Py III	24°56'37.42"N	92°32'40.93"E	West – 1.8 km w.r.t. WHRAA well
SW10	Cannal - Near Kakrakhand	24°58'19.93"N	92°33'21.47"E	North West 3.3 km w.r.t. WHRAA well

The study area map covering the Water sampling Locations is enclosed as Figure – 3.23, while the ground water sampling locations are given in figure 3.24 while surface water sampling locations are shown in figure 3.25


Figure – 3.23: Map showing Water Sampling Stations



Proposed Well



Water Sampling Stations

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3.10.5 Presentation of Results

The sampling results for the ground water and surface water samples were tabulated in **Table – 3.11 & Table 3.12 (a) &(b)** respectively. The analysed results are compared with the Acceptable Drinking water standard as per IS: 10500:2012 for both Ground water and Surface water.



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Table 3.11: Results of Ground Water sampling locations

S.No	Parameters	Unit	Procedure	GW1	GW2	GW3	GW4	GW5	Acceptable Limit as per IS 10500:2012
1	Colour	Hazen	APHA 22nd Edition (Reaff:2012)	1	Nil	2	1	1	5
2	Temperature	°C	APHA 22nd Edition (Reaff:2012)	24.9	24.8	24.8	25.1	25.1	Not Specified
3	pH at 25°C	-	IS : 3025 Part 11- 1983 (Reaff:2012)	6.88	6.53	6.62	7.56	6.51	6.5-8.5
4	Electrical Conductivity	µS/cm	IS : 3025 Part 14- 1984 (Reaff: 2012)	294	232	330	460	140	Not Specified
5	Turbidity	NTU	IS : 3025 Part 10-1984 (Reaff: 2012)	1.3	0.8	1.6	BDL(< 0.5)	BDL(< 0.5)	1
6	Total Dissolved Solids	mg/l	IS : 3025 Part 16-1984 (Reaff: 2012)	174	135	202	254	83	500
7	Total Hardness as CaCO ₃	mg/l	IS : 3025 Part 21-2009 (Reaff: 2014)	70	60	90	216	42	200
8	Total Alkalinity as CaCO ₃	mg/l	IS : 3025 Part 23- 1986 (Reaff:2012)	38	30	32	196	12	200
9	Chloride as Cl	mg/l	IS : 3025 Part 32-1988 (Reaff: 2014)	75	59	63	38	27	250
10	Sulphate as SO ₄	mg/l	APHA 22nd Edition -4500- SO ₄ 2- E	10	6	12	3	10	200
11	Fluoride as F	mg/l	APHA 22nd Edition-4500-F B&D	0.18	0.44	0.14	0.2	0.23	1
12	Nitrate as NO ₃	mg/l	APHA 22nd Edition -4500- NO ₃ - B	2	6	41	6	11	45
13	Ammonical Nitrogen	mg/l	APHA 22nd Edition -4500- NH ₃ B&C	0.12	BDL(< 0.05)	BDL(<0.05)	BDL(< 0.05)	BDL(< 0.05)	Not Specified
14	Total Nitrogen as N	mg/l	APHA 22nd Edition -4500- N&C,NO ₃ E	3.37	7.3	10.1	7.5	12.1	Not Specified
15	Total Phosphorous	mg/l	IS : 3025 Part 31-1988 (Reaff:2014)	0.16	0.15	0.08	0.11	0.2	Not Specified
16	Sodium as Na	mg/l	IS : 3025 Part 45-1993 (Reaff:2014)	37	25	30	15	13	Not Specified



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17	Potassium as K	mg/l	IS : 3025 Part 45-1993 (Reaff:2014)	2	8	9	12	2	Not Specified
18	Calcium as Ca	mg/l	IS : 3025 Part 40-1991 (Reaff:2014)	14	9	15	61	7	75
19	Magnesium as Mg	mg/l	APHA 22nd Edition-3500 Mg-B	9	9	12.5	15	4.8	30
20	Iron as Fe	mg/l	IS : 3025 Part 53-2003	0.197	0.176	0.386	0.036	0.09	1
21	Manganese as Mn	mg/l	APHA 22nd EDN -3500-Mn D	0.08	BDL(< 0.02)	0.05	BDL(< 0.02)	BDL(< 0.02)	0.10
22	Dissolved Oxygen as O2	mg/l	IS:3025:Part-38:1989 (Reaff:2003)	5.5	5.9	5.3	5.8	5.7	Not Specified
23	Chemical Oxygen Demand	mg/l	IS:3025:Part-58:2006 (Reaff:2012)	4.8	7.7	8.2	BDL (< 4)	6.0	Not Specified
24	Bio-Chemical Oxygen Demand @ 27°C for 3 days	mg/l	IS:3025:Part-44:1993 (Reaff:2014)	< 2	< 2	< 2	< 2	< 2	Not Specified
25	Copper as Cu	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.03)	BDL(< 0.03)	BDL(< 0.03)	BDL(< 0.03)	BDL(< 0.03)	0.05
26	Mercury as Hg	mg/l	APHA 22nd Edition -3112 B	BDL(< 0.001)	BDL(< 0.001)	BDL(< 0.001)	BDL(< 0.001)	BDL(< 0.001)	0.001
27	Cadmium as Cd	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.003)	BDL(< 0.003)	BDL(< 0.003)	BDL(< 0.003)	BDL(< 0.003)	0.003
28	Total Arsenic as As	mg/l	APHA 22nd Edition -3114 B	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	0.01
29	Cyanide as CN	mg/l	APHA 22nd Edition -4500 CN	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	0.05
30	Lead as Pd	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	0.01
31	Zinc as Zn	mg/l	APHA 22nd Edition -3111 B	0.025	BDL(<0.02)	0.123	0.041	BDL(<0.02)	5



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32	Hexavalent Chromium as Cr6+	mg/l	APHA 22nd Edition -3500 Cr B	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	Not Specified
33	Total Chromium as Cr	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	0.05
34	Nickel as Ni	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	0.02
35	Sodium Absorption Ratio	-	Calculation	1.90	1.4	1.38	0.45	0.93	Not Specified
36	Salinity	%0	APHA 22nd Edition -2520 B	0.2	0.2	0.2	0.3	0.1	Not Specified
37	Calcium Hardness as CaCO3	mg/l	IS:3025:Part-40:(Reaff:2014)	35	22	38	152	18	Not Specified
38	Magnesium Hardness as CaCO3	mg/l	APHA 22nd Edition -3500 Mg B	34	38	41	64	24	Not Specified
39	Molybdenum as Mo	mg/l	APHA 22nd Edition -3111 D	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	0.07
40	Total Coliform	MPN/100ml	IS :1622 (1981)	7	9	7	4	6	Absent
41	Faecal coliform	MPN/100ml	IS:1622 (1981)	< 2	< 2	< 2	< 2	< 2	Absent
42.	Total Suspended Solids	mg/l	IS:3025 Part 17	1	<1	1	<1	<1	Not Specified



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TABLE –3.12 (a): SURFACE WATER ANALYSIS RESULTS

S.No	Parameters	Unit	Procedure	SW1	SW2	SW3	SW4	SW5	Acceptable Limit as per IS 10500:2012
1	Colour	Hazen	APHA 22nd Edition (Reaff:2012)	10	15	4	15	20	5
2	Temperature	°C	APHA 22nd Edition (Reaff:2012)	26.3	26.1	24.8	26.3	26	Not Specified
3	pH at 25°C	-	IS : 3025 Part 11- 1983 (Reaff:2012)	7.52	7.39	7.31	7.06	7.10	6.5-8.5
4	Electrical Conductivity	µS/cm	IS : 3025 Part 14- 1984 (Reaff: 2012)	118	136	144	184	136	Not Specified
5	Turbidity	NTU	IS : 3025 Part 10-1984 (Reaff: 2012)	4.6	5.9	2.4	6.4	7.6	1
6	Total Dissolved Solids	mg/l	IS : 3025 Part 16-1984 (Reaff: 2012)	65	78	84	105	74	500
7	Total Hardness as CaCO ₃	mg/l	IS : 3025 Part 21-2009 (Reaff: 2014)	30	32	26	44	28	200
8	Total Alkalinity as CaCO ₃	mg/l	IS : 3025 Part 23- 1986 (Reaff:2012)	40	40	50	60	40	200
9	Chloride as Cl	mg/l	IS : 3025 Part 32-1988 (Reaff: 2014)	8	15	15	23	10	250
10	Sulphate as SO ₄	mg/l	APHA 22nd Edition -4500- SO ₄ 2- E	4	4	2	5	8	200
11	Fluoride as F	mg/l	APHA 22nd Edition-4500-F B&D	0.1	0.11	0.12	0.14	0.15	1
12	Nitrate as NO ₃	mg/l	APHA 22nd Edition -4500- NO ₃ - B	3	2	1	1.6	5	45
13	Ammonical Nitrogen	mg/l	APHA 22nd Edition -4500- NH ₃ B&C	0.06	0.07	0.14	0.18	0.16	Not Specified
14	Total Nitrogen as N	mg/l	APHA 22nd Edition -4500- N&C,NO ₃ E	2.21	2.74	1.05	1.77	3.78	Not Specified



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15	Total Phosphorous	mg/l	IS : 3025 Part 31-1988 (Reaff:2014)	0.14	0.15	0.21	0.11	0.21	Not Specified
16	Sodium as Na	mg/l	IS : 3025 Part 45-1993 (Reaff:2014)	10	11	12	18	15	Not Specified
17	Potassium as K	mg/l	IS : 3025 Part 45-1993 (Reaff:2014)	3	3.3	3	6	4	Not Specified
18	Calcium as Ca	mg/l	IS : 3025 Part 40-1991 (Reaff:2014)	9	11	10	11	6	75
19	Magnesium as Mg	mg/l	APHA 22nd Edition-3500 Mg-B	2	2.6	4.5	4	3	30
20	Iron as Fe	mg/l	IS : 3025 Part 53-2003	0.91	1.21	0.60	1.25	1.92	1
21	Manganese as Mn	mg/l	APHA 22nd EDN -3500-Mn D	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	0.07	BDL(< 0.02)	0.10
22	Dissolved Oxygen as O2	mg/l	IS:3025:Part-38:1989 (Reaff:2003)	6.9	6.7	6.5	5.1	6.3	Not Specified
23	Chemical Oxygen Demand	mg/l	IS:3025:Part-58:2006 (Reaff:2012)	18	21	24	22	30	Not Specified
24	Bio-Chemical Oxygen Demand @ 27°C for 3 days	mg/l	IS:3025:Part-44:1993 (Reaff:2014)	2.4	2.8	3.1	2.8	3.8	Not Specified
25	Copper as Cu	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.03)	0.1	0.09	0.12	0.11	0.05
26	Mercury as Hg	mg/l	APHA 22nd Edition -3112 B	BDL(< 0.001)	BDL(<0.001)	BDL(<0.001)	BDL(< 0.001)	BDL(< 0.001)	0.001
27	Cadmium as Cd	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.003)	BDL(<0.003)	BDL(<0.003)	BDL(< 0.003)	BDL(< 0.003)	0.003
28	Total Arsenic as As	mg/l	APHA 22nd Edition -3114 B	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	0.01
29	Cyanide as CN	mg/l	APHA 22nd Edition -4500 CN	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	0.05
30	Lead as Pd	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	0.01



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31	Zinc as Zn	mg/l	APHA 22nd Edition -3111 B	0.214	0.236	0.141	BDL(< 0.02)	0.145	5
32	Hexavalent Chromium as Cr6+	mg/l	APHA 22nd Edition -3500 Cr B	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	Not Specified
33	Total Chromium as Cr	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	0.05
34	Nickel as Ni	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	0.02
35	Sodium Absorption Ratio	—	Calculation	0.78	0.77	0.79	1.18	1.24	Not Specified
36	Salinity	%0	APHA 22nd Edition -2520 B	0.1	0.1	0.1	0.1	0.1	Not Specified
37	Calcium Hardness as CaCO3	mg/l	IS:3025:Part-40:(Reaff:2014)	22	25	25	28	14	Not Specified
38	Magnesium Hardness as CaCO3	mg/l	APHA 22nd Edition -3500 Mg B	8	11	18	16	14	Not Specified
39	Molybdenum as Mo	mg/l	APHA 22nd Edition -3111 D	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	0.07
40	Total Coliform	MPN/100ml	IS :1622 (1981)	170	220	500	140	350	Absent
41	Faecal coliform	MPN/100ml	IS:1622 (1981)	11	17	24	21	26	Absent



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TABLE – 3.12 (b): SURFACE WATER ANALYSIS RESULTS

S. No	Parameters	Unit	Procedure	SW6	SW7	SW8	SW9	SW10	Acceptable Limit as per IS 10500:2012
1	Colour	Haze n	APHA 22nd Edition (Reaff:2012)	60	3	2	7	5	5
2	Temperature	°C	APHA 22nd Edition (Reaff:2012)	25.8	25.2	24.9	24.9	25	Not Specified
3	pH at 25°C	-	IS : 3025 Part 11- 1983 (Reaff:2012)	6.96	6.78	6.74	7.11	7.03	6.5-8.5
4	Electrical Conductivity	µS/cm	IS : 3025 Part 14- 1984 (Reaff: 2012)	162	98	145	172	80	Not Specified
5	Turbidity	NTU	IS : 3025 Part 10-1984 (Reaff: 2012)	36.9	2.4	1.3	3	4.1	1
6	Total Dissolved Solids	mg/l	IS : 3025 Part 16-1984 (Reaff: 2012)	85	56	82	94	44	500
7	Total Hardness as CaCO ₃	mg/l	IS : 3025 Part 21-2009 (Reaff: 2014)	30	40	50	70	20	200
8	Total Alkalinity as CaCO ₃	mg/l	IS : 3025 Part 23- 1986 (Reaff:2012)	42	24	58	50	20	200
9	Chloride as Cl	mg/l	IS : 3025 Part 32-1988 (Reaff: 2014)	16	20	15	13	8	250
10	Sulphate as SO ₄	mg/l	APHA 22nd Edition -4500- SO42- E	11	6	2	4	4	200
11	Fluoride as F	mg/l	APHA 22nd Edition-4500-F B&D	0.19	0.11	0.51	0.33	0.31	1
12	Nitrate as NO ₃	mg/l	APHA 22nd Edition -4500- NO3- B	1.2	1	2	1.2	2.6	45
13	Ammonical Nitrogen	mg/l	APHA 22nd Edition -4500- NH ₃ B&C	0.24	0.1	0.1	0.05	0.13	Not Specified
14	Total Nitrogen as N	mg/l	APHA 22nd Edition -4500- N&C,NO ₃ E	1.92	1.63	1.06	1.68	2.1	Not Specified



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15	Total Phosphorous	mg/l	IS : 3025 Part 31-1988 (Reaff:2014)	0.16	0.045	0.05	0.11	0.14	Not Specified
16	Sodium as Na	mg/l	IS : 3025 Part 45-1993 (Reaff:2014)	19	12	18	13	8	Not Specified
17	Potassium as K	mg/l	IS : 3025 Part 45-1993 (Reaff:2014)	1	1.2	2.6	2.4	2	Not Specified
18	Calcium as Ca	mg/l	IS : 3025 Part 40-1991 (Reaff:2014)	8	8	10	10	4	75
19	Magnesium as Mg	mg/l	APHA 22nd Edition-3500 Mg-B	2.4	4.8	7.2	6.3	2.4	30
20	Iron as Fe	mg/l	IS : 3025 Part 53-2003	4.25	0.71	0.5	1.42	0.72	1
21	Manganese as Mn	mg/l	APHA 22nd EDN -3500-Mn D	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	0.06	BDL(< 0.02)	0.10
22	Dissolved Oxygen as O2	mg/l	IS:3025:Part-38:1989 (Reaff:2003)	6.3	5.7	6.1	6.2	5.8	Not Specified
23	Chemical Oxygen Demand	mg/l	IS:3025:Part-58:2006 (Reaff:2012)	34	18	28	30	34	Not Specified
24	Bio-Chemical Oxygen Demand @ 27°C for 3 days	mg/l	IS:3025:Part-44:1993 (Reaff:2014)	4.1	2.3	4.1	3.7	4.6	Not Specified
25	Copper as Cu	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.03)	BDL(<0.03)	BDL(<0.03)	0.135	0.115	0.05
26	Mercury as Hg	mg/l	APHA 22nd Edition -3112 B	BDL(< 0.001)	BDL(<0.001)	BDL(<0.001)	BDL(<0.001)	BDL(<0.001)	0.001
27	Cadmium as Cd	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.003)	BDL(<0.003)	BDL(<0.003)	BDL(<0.003)	BDL(<0.003)	0.003
28	Total Arsenic as As	mg/l	APHA 22nd Edition -3114 B	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	0.01
29	Cyanide as CN	mg/l	APHA 22nd Edition -4500 CN	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	0.05
30	Lead as Pd	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	BDL(< 0.01)	0.01
31	Zinc as Zn	mg/l	APHA 22nd Edition -3111 B	0.214	BDL(<0.02)	BDL(<0.02)	0.236	BDL(<0.02)	5



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32	Hexavalent Chromium as Cr6+	mg/l	APHA 22nd Edition -3500 Cr B	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)	BDL(<0.01)	Not Specified
33	Total Chromium as Cr	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	0.05
34	Nickel as Ni	mg/l	APHA 22nd Edition -3111 B	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	BDL(< 0.02)	0.02
35	Sodium Absorption Ratio	–	Calculation	1.51	0.83	1.05	0.79	0.78	Not Specified
36	Salinity	%0	APHA 22nd Edition -2520 B	0.1	0.1	0.1	0.1	0.1	Not Specified
37	Calcium Hardness as CaCO3	mg/l	IS:3025:Part-40:(Reaff:2014)	20	20	28	20	10	Not Specified
38	Magnesium Hardness as CaCO3	mg/l	APHA 22nd Edition -3500 Mg B	10	20	67	30	10	Not Specified
39	Molybdenum as Mo	mg/l	APHA 22nd Edition -3111 D	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	BDL(< 0.05)	0.07
40	Total Coliform	MPN/ 100ml	IS :1622 (1981)	220	110	90	500	140	Absent
41	Faecal coliform	MPN/ 100ml	IS:1622 (1981)	14	9	7	26	14	Absent

Figure 3.24 Ground Water Sampling locations

GW1 : Badarpur



GW2: Hilara



GW3: Katigorah



GW4 : Panchgram



GW5: Hilara



Figure 3.25 Surface water sampling locations
SW1: Barak River - Up Stream



SW2: Barak River - Down Stream



SW3 : Salchapara



SW4: Pond Near HPC Road



SW5:Dolosar River Upstream



SW6:Dolosar River Down stream



SW7: Lake - Near Hila

SW8: Pond Near Manipur PT I




SW9: Lake Near Bhairabpur Py III



SW10: Kakarahand (Canal)



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3.10.6 Observations

Ground Water


The pH value of the collected ground water in the study area found to be in the range from 6.51 to 7.56 and conductivity observed in the range 140 μ S/cm to 460 μ S/cm. TDS values were observed to be in range from 83 mg/L to 254 mg/L. Total alkalinity is found to be the range from 12 mg/L to 196 mg/L and Total Hardness ranges from 42 to 216 mg/L. The chloride values of the samples were observed from 27 mg/L to 75 mg/L and Sulphate values were observed from 3 mg/L to 10 mg/L. The Calcium and magnesium values were ranged from 7 mg/L to 61 mg/L and 4.8 mg/L to 15 mg/L respectively. Iron content observed in the range from 0.036 mg/l to 0.386 mg/l. Most of the metals are observed as below the detection limit. Total Coliforms were observed up to 9 MPN/100ml and Fecal Coliforms were observed <2 MPN/100ml at all locations.

Surface Water

The pH value of the collected surface water in the study area found to be in the range from 6.74 to 7.52 and conductivity observed in the range 80 μ S/cm to 184 μ S/cm. TDS values were observed to be in range from 44 mg/L to 105 mg/L. Total alkalinity is found to be the range from 20 mg/L to 60 mg/L and Total Hardness ranges from 20 to 70 mg/L. The chloride values of the samples were observed from 8 mg/L to 23 mg/L and Sulphate values were observed from 2 mg/L to 11 mg/L. The Calcium and magnesium values were ranged from 4 mg/L to 11 mg/L and 2 mg/L to 4.8 mg/L respectively. Iron content found in the range from 0.60 mg/L to 4.25 mg/l. COD values observed in the range from 18 mg/l to 34 mg/l. Most of the metals are observed to be within the detection limit. Total Coliforms were observed from 90 MPN/100ml to 500 MPN/100ml and Fecal Coliforms were observed from 7 MPN/100ml to 26 MPN/100ml.

3.11 Soil Quality Monitoring

To study the soil quality of the region, sampling locations were selected to assess the existing soil conditions in and around the project area representing various land use conditions. The physical and chemical concentrations were determined.

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The present study of the soil quality establishes the baseline characteristics of soil and this will help in future in identifying the incremental concentration changes if any, due to the operation in the proposed project.

3.11.1 Sampling and Analysis Techniques

Soil samples were collected from three different depths viz., 30cm, 60cm, and 100cm below the surface. The samples were analyzed for physical and chemical characteristics. The samples have been analyzed as per the established scientific methods for physio-chemical parameters.

3.11.2 Details of Soil Sampling Locations

Soil samples were collected at 5 locations as tabulated in **Table 3.13**. The sampling locations were identified with the following objectives;

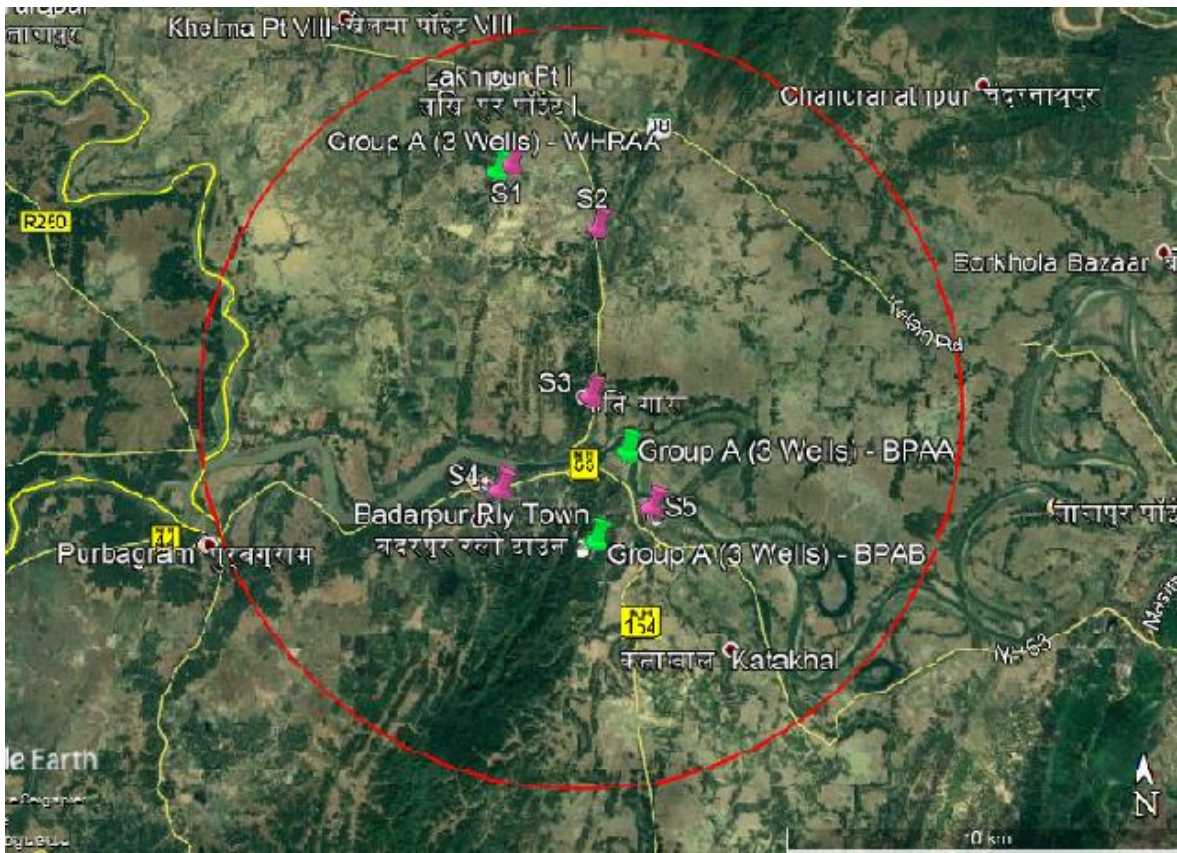
- To determine the baseline soil characteristics of the study area and
- To determine the impact of proposed project on soil characteristics

TABLE 3.13: SOIL SAMPLING LOCATIONS

Location Code	Name of the Location	Co-ordinates		Description of location
		Latitude	Longitude	
S1	Baraitoli Py II	24°56'39.10"N	92°33'57.63"E	Rural Settlement
S2	Hilara	24°55'27.47"N	92°35'8.77"E	Rural Settlement
S3	Katigara	24°53'17.93"N	92°35'13.76"E	Agriculture land
S4	Badarpur Town	24°51'54.54"N	92°33'41.90"E	Urban settlement
S5	Pachgram	24°51'36.03"N	92°36'15.23"E	Rural Settlement

The study area map covering the Soil Sampling Locations is enclosed as **Figure - 3.26**

Figure – 3.26: Map showing Soil Sampling Stations



Proposed Well



Soil Monitoring Stations



3.11.3 Presentation of Results

The soil quality at the specified location during the study period is tabulated as **Table-3.14**

TABLE 3.14 - Soil Analysis Results

S.No	Parameters	Test Method	S1	S2	S3	S4	S5
1	pH (1:5 Suspension)	IS -2720(Part 26) 1987 (RA 2016)	7.13	7.21	7.23	6.78	6.92
2	Moisture, %	IS -2720(Part 2) 1987(RA 2015)	16.6	13.8	12.8	9.7	15.1
3	Porosity, %	IS -2720 (Part 36)	28.2	33.5	27.4	32.8	24.7
4	Water Holding Capacity,%	Soil Chemical Analysis By M. L. Jackson	23.6	21.8	25.1	26.9	20.6
5	Permeability, cm/hr	Soil Chemical Analysis By M. L. Jackson	0.18	0.13	0.11	0.10	0.17
6	Cation Exchange Capacity, m.eq/100g	IS -2720(Part 24) (RA 2015)	27.6	26.5	32.8	30.5	25.8
7	Electrical conductivity, mS/cm (1:5 Suspension)	IS -14767:2000 (RA 2016)	0.084	0.126	0.096	0.048	0.153
8	Exchangeable Calcium as Ca, m.eq/100g	FAO Chapter 3, ABCTL/SOIL/SOP 4	2.36	2.97	2.52	3.05	8.69
9	Exchangeable Magnesium as Mg, m.eq/100g	FAO Chapter 3, ABCTL/SOIL/SOP 5	7.76	5.79	3.74	9.71	7.54
10	Exchangeable Sodium as Na, m.eq/100g	FAO Chapter 3, ABCTL/SOIL/SOP 6	5.72	5.95	6.08	6.43	4.68
11	Potassium as K, Kg/ha	FAO Chapter 3, ABCTL/SOIL/SOP 7	1296	808	900	1332	784
12	Texture Classification	IS -2720(Part 26) 1987(RA 2011)	Clay	Clay	Clay	Clay	Clay
13	Sand (%)	Robinson Pipette Method	21.4	26.4	18.2	17.3	35.2
14	Clay (%)		63.8	58.7	66.5	71.4	48.6

15	Silt (%)		14.8	14.9	15.3	11.3	16.2
16	Sodium Absorbtion ratio	Calculation	8.05	9.00	10.88	8.06	5.20
17	Available phosphorus as P, kg/ha	FAO Chapter 3, ABCTL/SOIL/SOP2	41.8	32.9	28.8	42.5	51.6
18	Available Nitrogen as N, kg/ha	FAO Chapter 3, ABCTL/SOIL/SOP11	296	214	236	307	254
19	Total Nitrogen as N, kg/ha	IS-14684:1999, Reaff.2008	356	302	318	412	356

Source: ABC Techno Labs India Private Limited

3.11.4 Observations:

It has been observed that the pH of the soil is ranging from 6.78 to 7.23 while the soil texture is shown in figure 3.27. Moisture found in the range from 9.7 to 16.6%. Conductivity of the soil ranges from 0.048 to 0.153 mS/cm. Texture of the soil in the selected locations of study area were found to be Clay in nature. The potassium content varies from 784 to 1332 kg/ ha. Exchangeable Sodium content varies from 4.68 to 6.43 m.eq/100g. Exchangeable calcium and Exchangeable magnesium were found in the range between 2.36 to 8.69 m.eq/100g & 3.74 to 9.71 m.eq/100g respectively.

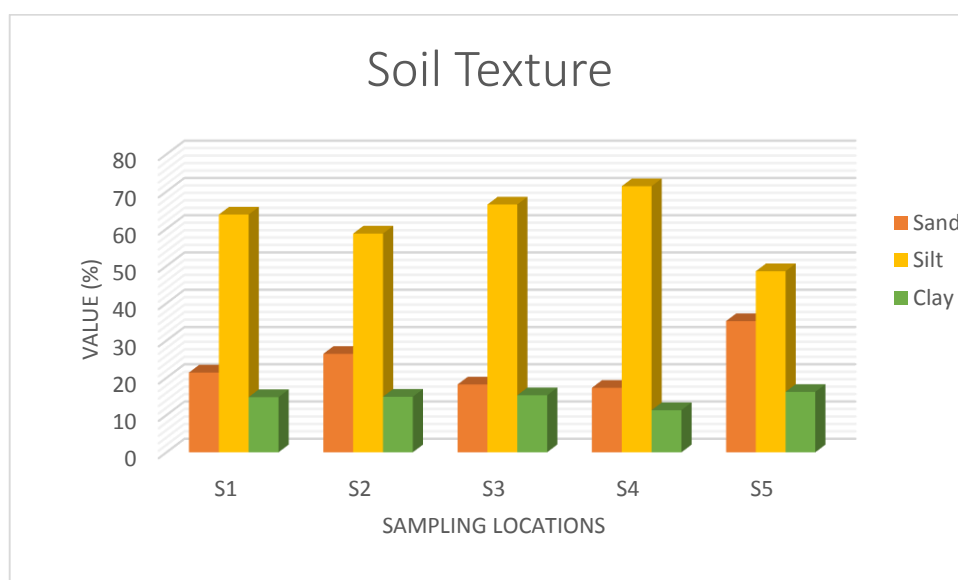


Figure 3.27: Particle Size distribution of soil samples

Figure 3.28 Soil Sampling locations

Baraitoli Py II



Hilara




Katigara



Badarpur Town



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3.12 Biological Environment

Onsite Ecological investigations were carried out of three wells (3 No.s) to meet the following objectives:

- To establish the present status of ecological conditions surrounding all the well locations
- To study the existing anthropogenic stresses on the prevailing ecosystem.
- To identify and predict the likely impacts on the local ecosystem from the proposed activities;
- To list out floral species, terrestrial vertebrate and aquatic flora and fauna present within the study area, and significance status under The Wildlife (Protection) Act, 1972;
- To define ecological/conservation status of each species as per IUCN categories (Red Data List).
- To list out the species used as medicinal.
- To formulate mitigatory measures and a sustainable Environmental Management Plan (EMP) basing upon the likely impacts.

During survey, following aspects were considered for study:

- Assessment of present status of flora and fauna;
- Identification of rare and endangered species of plants and animals (if any);
- Identification of ecologically sensitive areas within the study area;
- Assessment of migratory route of wildlife (if any); and
- Assessment of Aquatic Ecology with specific reference to aquatic birds and fishery resources.

3.12.1 Methodology:


This study has been carried out during the during Summer Season for the purpose of providing an independent and comprehensive baseline assessment of the flora and terrestrial vertebrate and aquatic fauna and associated habitat values within study area as shown in figure 3.29.



Figure 3.29: Sample collection during the study area

Terrestrial investigations for flora and fauna records were collected by random field survey around each identified exploratory well and a checklist was prepared. During field survey, discussions with the local people were made for getting the information related to local biodiversity in and around the villages. The ecological status of the study area has been assessed based on the following methodology:

- Primary field surveys to establish primary baseline of the study area;
- Compilation of secondary information available in published literatures/working plan was referred from State Forest Department and other secondary sources

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3.12.2 Floral Study

The assessment of the flora of the study area is done by an extensive field survey of the area.

- Plants are identified based on their specific diagnostic characters of Family, Genus and Species using available floral, other related literature and herbarium Botanical Survey of India.
- Besides the identification of plant species, information is collected on the vernacular names and uses of plants made by local inhabitants.
- Qualitative analysis of vegetation is made by floristic analysis (by simple studying various genera and species of various plant groups i.e. herbs, shrubs, trees etc).

3.12.3 Faunal Study

3.12.3.1 Terrestrial Fauna

Ground surveys are carried out by trekking the study area for identification of important animal groups such as birds, mammals and reptiles for sampling of animals through the following methods.

- For sampling birds/ avifauna 'point sampling' along the fixed transects (foot trails) were done to record all the species of birds with the help of binoculars; field guides and photography for more than 1 hour.
- For sampling mammals, information on recent sightings/records of mammals by the locals are also collected from the study areas.
- Secondary information collected from local villagers, published government data etc.

List of the endangered and endemic species as per the schedule of The Wildlife Protection Act, 1972 Emphasis is given to identify avifauna and mammals to determine the presence and absence of Schedule-1 species, listed in The Wildlife Protection Act 1972, as well as in Red List of IUCN.

3.12.3.2 Ecological Status of Blocks

The forests in Cachar district can be classified into 2 types as per available record as shown in figure 3.30


1B/C3 – Cachar tropical evergreen



Figure 3.30 Ecological diversity in the study area

2B/C2 – Cachar tropical semi evergreen

These 2 types of forests do not occur in compact blocks over extensive areas. These forests are largely composed of evergreen species. The upper storey is comprised of Cham (*Artocarpus chapiasha*), Bon am (*Mangifera spp.*), Sutrong (*Lophopetolum fibriatum*), Morica sundi (*Alscodophene owdenii*). The middle storey is represented by Jam (*Eugenia fruticosa*), Kurta (*Calophyllum polyanthum*), Karol (*Kayea floribunda*), Dhuna (*Canarium resinifrum*) etc. In the lower storey Agar (*Aquilaria agolocha*), Chalmugra (*Synocardia odorata*) are important. Bamboos are found in abundance at many places within Cachar block.

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Cachar Dist. PML block area consists about 47% of agricultural land, Open mixed jungle of about 11% and reserved forest area of about 15%. Sonai reserved forest situated near Cachar dist. PML block. Several tea estates also situated within this PML block like Badarpur TE, Jalalpur TE, Palai TE, Maniarkhal TE etc. Some important tree species are *Alistonia scholaris*, *Anthrocephalus sinensis*, *Azadirachta indica*, *Acacia auriculiformis*, *Artocarpus heterophyllus*, *Delonix regia*, *Phyllanthus embilica*, *Ficus religiosa*, *Mangifera indica*, *Lagerstroemia speciosa*, *Dalbergia sisso*, *Terminalia arjuna*, *Salix tetrasperma*, *Terminalia belerica*, *Ficus cunia*, *Azadirachta indica*, *Acacia nilotica*, *Anthocephalus kadamba*, *Saraca indica*, *Tamarindus indica*

Badarpur PML block shows that majority of the land (57.63%) within the Block is used for agriculture purpose followed by homestead plantation/vegetation about 21.92%. Several bamboo patches were found and principal species of Bamboos are *Dendrocalamus hamiltonii* (Kako) and *Bambusa tulda* (Jati). However, other bamboo species are also found. In places where the soil is wet over a long period and is in ill drained clay, rich in humus, various species of canes are found. They form an impenetrable thorny thicket sometimes with a few trees standing over them. Vegetation are also recorded in the non-forest area of the block. Tree species in these sites are mostly planted and few are natural. Some important tree species are *Mangifera indica*, *Aegle mermelos*, *Salmalia malabarica*, *Delonix regia*, *Dalbergia sisso*, *Ficus religiosa*, *Ficus bengalensis*, *Alstonia scholaris*, and *Areca catechu*.

3.12.3.3 Floristic Compositions at well sites

The survey was conducted within the 1 km radius of each identified location of well within 2 blocks as shown in figure 3.31. It is observed that human settlements present near each well and many of villages have moderate ranges of plantations. Most of the wells are in agricultural fields and some wells are found to be near tea garden and hilly area. During site assessment several floral species encountered within the 2 blocks. The Wildlife (Protection) Act 1972 prohibits picking, uprooting, damaging, destroying, acquiring or collecting six species of plants from forest land and any area specified, by notification, by the Central Government [Clause 17A of Chapter IIIA (Protection of Specified Plants), page 346 of Handbook Vol. 1]. The six species are: Beddome's cycad (*Cycas beddomei*), Blue Vanda (*Vanda coerulea*), Kuth (*Sassurea lappa*), Ladies slipper orchids (*Paphiopedilum* sp.), Pitcher plant (*Nepenthes khasiana*), Red Vanda (*Rananthera*



Figure 3.31: Vegetation of the study area

imshootiana). None of these species is recorded in the forests of the study area. The Following species were enlisted from the well locations during the field visits as given in Table 3.13

3.12.3.4 Floristic Diversity in the Study area

The floristic diversity includes various species of trees, shrubs, herbs and climbers as shown in figure 3.32 .

Table 3.15: Floristic diversity of the study area

Sl.No	Scientific Name	Common name	Family
Trees			
1.	<i>Terminalia arjuna</i>	Arjun	Combretaceae
2.	<i>Salix tetrasperma</i>	Indian Willow	Salicaceae
3.	<i>Terminalia belerica</i>	Baera	Combretaceae
4.	<i>Ficus benghalensis</i>	Bot	Moraceae
5.	<i>Dillenia indica</i>	Chalta	Dilleniaceae
6.	<i>Podocarpus neriiifolius</i>	Brown Pine	Podocarpaceae
7.	<i>Grewia glabra</i>	Dhamon	Tiliaceae
8.	<i>Syzygium cumini</i>	Jaman	Myrtaceae
9.	<i>Ficus cunia</i>	Dumur	Moraceae
10.	<i>Anthocephalus kadamba</i>	Kadam	Rubiaceae
11.	<i>Diospyros melanoxyton</i>	Kendu	Ebenaceae
12.	<i>Aegle marmelos</i>	Bel	Rutaceae
13.	<i>Azadirachta indica</i>	Neem	Meliaceae
14.	<i>Acacia nilotica</i>	Babla	Mimosaceae
15.	<i>Annona squamosa</i>	Ata	Annonaceae
16.	<i>Borassus flabellifer</i>	Taal	Arecaceae
17.	<i>Albizia lebbeck</i>	Sirish	Fabaceae
18.	<i>Bursera serrata</i>	Nour	Burseraceae
19.	<i>Saraca indica</i>	Asoka	Leguminosae
20.	<i>Tamarindus indica</i>	Tetul	Leguminosae
21.	<i>Ficus mysorensis</i>	Dhopabar	Moraceae
22.	<i>Premna bengalensis</i>	Gohora	Lamiaceae
23.	<i>Adina cordifolia</i>	Haldu	Rubiaceae
24.	<i>Toona ciliata</i>	Poma	Poma
25.	<i>Elaeocarpus robustus</i>	Helok	Elaeocarpaceae
26.	<i>Terminalia chebula</i>	Harida	Combretaceae
27.	<i>Randia fasciculata</i>	Harumoin	Rubiaceae
28.	<i>Aquilaria agallocha</i>	Agar	Thymeleaceae
29.	<i>Amoora wallichii</i>	Atari	Meliaceae
30.	<i>Alstonia scholaris</i>	Chatim	Apocynaceae
31.	<i>Areca catechu</i>	Supari	Piperaceae
32.	<i>Artocarpus heterophyllus</i>	Kanthal	Moraceae
33.	<i>Salmalia malabarica</i>	Simul	Malvaceae
34.	<i>Shorea robusta</i>	Sal	Dipterocarpaceae
35.	<i>Ficus religiosa</i>	Pipal	Moraceae
36.	<i>Sapindus detergens</i>	Ritha	Sapindaceae
37.	<i>Stereospermum chelonoides</i>	Missi	Bignoniaceae
38.	<i>Sterculia villosa</i>	Udal	Sterculiaceae
39.	<i>Sterculia foetida</i>	Jangli Badam	Malvaceae
40.	<i>Schima wallichii</i>	Usoi	Theaceae
41.	<i>Pongamia glabra</i>	Karach	Fabaceae

Shrubs			
1.	<i>Bambusa balcooa</i>	Boro bans	Poaceae
2.	<i>Bambusa rutans</i>	Malka bans	Poaceae
3.	<i>Bambusa tulda</i>	Jati bans	Poaceae
4.	<i>Bambusa arundinacea</i>	Kata bans	Poaceae
5.	<i>Lantana camara</i>	Wild Sage	Verbenaceae
6.	<i>Asparagus racemosus</i>	Satamul	Asparagaceae
7.	<i>Acalypha indica</i>	Bishohory	Euphorbiaceae
8.	<i>Calamus gracilis</i>	Chuli beth	Poaceae
9.	<i>Calamus erectus</i>	Beth	Poaceae
10.	<i>Plectiomia assamica</i>	Cane	Poaceae
11.	<i>Bambusa pallida</i>	Makal	Poaceae
12.	<i>Jatropha curcas</i>	Bongali Ara	Euphorbiaceae
13.	<i>Ipomoea fistulosa</i>	Morning Glory	Convolvulaceae
14.	<i>Dendrocalamus hamiltonii</i>	Kako bans	Poaceae
15.	<i>Hymenodictyon excelsum</i>	Ban kadam	Rubiaceae
16.	<i>Hyptis suaveolens</i>	Buno tulusi	Lamiaceae
17.	<i>Calotropis procera</i>	Aakanda	Asclepiadaceae
18.	<i>Adhatoda vasica</i>	Basuti	Acanthaceae
19.	<i>Musa paradisiaca</i>	Kela	Musaceae
20.	<i>Xanthium stromarium</i>	Gokru	Tiliaceae
21.	<i>Hibiscus rosa-sinensis</i>	Jaba Phool	Malvaceae
22.	<i>Camellia chinensis</i>	Tea	Theaceae
23.	<i>Smilax macrophylla</i>	Chopchini	Smilacaceae
Herbs			
1.	<i>Bacopa monnieri</i>	Brahmi	Scrophulariaceae
2.	<i>Acacia catechu</i>	Khair	Mimosaceae
3.	<i>Cannabis sativa</i>	Bhang	Cannabinaceae
4.	<i>Crotalaria albida</i>	Ban-methi	Fabaceae
5.	<i>Croton caudatus</i>	Lata-mahudi	Euphorbiaceae
6.	<i>Microlepia speluncae</i>	Lace Fern	Dennstaedtiaceae
7.	<i>Datura metal</i>	Dhutra	Solanaceae
8.	<i>Michelia champaca</i>	Golden Champa	Magnoliaceae
9.	<i>Amaranthus spinosus</i>	Khutura	Amaranthaceae
10.	<i>Mimosa pudica</i>	Lajjabati	Fabaceae
11.	<i>Datura fastuosa</i>	Dhatura	Solanaceae
12.	<i>Saccharum spontaneum</i>	Khagra	Coramineae
13.	<i>Andropegon squarrous</i>	Binna	Coramineae
14.	<i>Dioscorea bulbifera</i>	Kathalu	Dioscoreaceae
15.	<i>Gmelina arborea</i>	Gomari	Verbenaceae
16.	<i>Elsholtzia blanda</i>	Bon-tulasi	Lamiaceae
Climbers			
1.	<i>Vitis adnata</i>	Bhatia Lata	Vitaceae
2.	<i>Smilax ovalifolia</i>	Kumari Lata	Smilacaceae
3.	<i>Coccinia cordifolia</i>	Telakucha	Cucurbitaceae
4.	<i>Saccharum spontaneum</i>	Khagra	Poaceae


5.	<i>Phragmites karka</i>	Nal-khagra	Poaceae
6.	<i>Mikania scandens</i>	Tara Lata	Asteraceae
7.	<i>Luffa cylindrica</i>	Dhundul	Cucurbitaceae
8.	<i>Ipomea pes tigridis</i>	Langali Lata	Convolvulaceae



Figure 3.30: Plants found in the study area

3.12.3.5 Economically important Flora of the study area

Agricultural crops: Paddy (Khariff, Rabi, Jait) is the main crop. Also Pulses (Lathyrus, Blackgram, Greengram), Oilseeds are other important crops. Different fruits like Banana, papaya, mangoes and

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vegetables like Potatoe, chili, brinjal, cauliflower and capsicum also grown by the local people. Most of the cultivable land remains fallow in winter due to lack of irrigation facilities. The consultation with local people reveals that the farmers are cultivating the improved varieties in the field.

Rare and endangered floral species: During the survey in the study area species which are endangered or threatened under IUCN (International Union for Conservation of Nature and Natural resources) guidelines have not been observed.

Medicinal plant species: The nearby area is also endowed with the several medicinal plants which are commonly available in the shrub forest and waste lands. The common medicinal plants of the region are *Asparagus racemosus*, *Aegle marmelos* (Bel), *Azadirachta indica* (Neem), *Alstonia scholaris* (Chhatim) etc.

3.12.4 Faunal Communities

The Cachar PML Block falls in the Cachar Paper Mill. The well locations within Badarpur PML are mainly on agricultural land. Both direct (sighting) and indirect (evidences) observation methods were used to survey the faunal species around the study area. Additionally reference of relevant literatures (published/unpublished) and dialogues with local villagers were also carried out to consolidate the presence of faunal distribution in the area given in the **Figure 3.33**





Figure: 3.33 Faunal Diversity of the Study Area

Mammals: No wild mammalian species was directly sighted during the field survey. Dialogue with local villagers located around the study area also could not confirm presence of any wild animal in that area. Common Langur, Mongoose and Palm Squirrel were observed during primary survey. Primate diversity are shown in **figure 3.34**.

Avifauna: Since birds are considered to be the indicators for monitoring and understanding human impacts on ecological systems (Lawton, 1996) attempt was made to gather quantitative data on the avifauna by walk through survey within the entire study area and surrounding area. From the primary survey, various species of avifauna were identified and recorded from the 2 block area. The diversity of avifauna from this region was found to be quite high and encouraging as shown in **figure 3.35**



Figure 3.34: Primate Diversity in the study area

The tree lizard and common garden lizards are also seen. Variety of butterflies (like common grass yellow, plain tiger) as shown in **figure 3.36** and insects (such as beetles, spiders, red ants, and flies) are spotted in abundance in the study zone as shown in table 3.16

TABLE 3.16: Fauna Recorded from the Primary Survey in the study area and their conservation status

SI.No	Scientific name	English Name	Schedule of Wildlife Protection Act	Status as per IUCN Red Data List
Mammals				
1.	<i>Bandicota bengalensis</i>	Common Indian Rat	V	Not assessed
2.	<i>Muntiacus muntjak</i>	Barking deer	III	Least Concern
3.	<i>Cervus unicolor</i>	Sambar deer	III	Vulnerable

4.	<i>Axis porcinus</i>	Hog Deer	III	Endangered
5.	<i>Funambulus pennanti</i>	Common five Stripped Squirrel	IV	Not assessed
6.	<i>Hystra indica</i>	Porcupine	II	Least Concern
7.	<i>Axis axis</i>	Cheetal	III	Least Concern
8.	<i>Panthera pardus</i>	Leopard	I	Near Threatened
9.	<i>Mus musculus</i>	Common mouse	V	Least Concern
10.	<i>Nycticebus coucang</i>	Slow loris	I	Not assessed
11.	<i>Viverricula indica</i>	Small Indian Civet	I	Least Concern
12.	<i>Macaca assamensis</i>	Assamese Macaque	II	Near Threatened
13.	<i>Prionailurus viverrinus</i>	Fishing Cat	I	Not assessed
14.	<i>Leporidae sp.</i>	Rabbit	IV	Not assessed
15.	<i>Tamios mcclllandii</i>	Himalayan Stripped Squirrel	IV	Not assessed
16.	<i>Felis silvestris</i>	Wild cat	II	Vulnerable
17.	<i>Felis chaus</i>	Jungle cat	II	Least Concern
18.	<i>Felis bengalensis</i>	Leopard cat	I	Not assessed
19.	<i>Macaca mulatta</i>	Rhesus Monkey	II	Least Concern
20.	<i>Crocidura caerulea</i>	Grey musk shrew	-	Not assessed
21.	<i>Presbytis pileatus</i>	Langur	I	Not assessed
22.	<i>Bubalus arnee</i>	Wild Buffalo	I	Endangered
23.	<i>Sus scrofa</i>	Wild pig	III	Not assessed
24.	<i>Herpestes edwardsii</i>	Common Indian Mongoose	II	Least Concern
Birds				
1.	<i>Corvus splendens</i>	common house crow	V	Least Concern
2.	<i>Corvus macrorhynchos</i>	Jungle Crow	IV	Least Concern
3.	<i>Pycnonotus cafer</i>	The red Vented Bulbul	IV	Least Concern
4.	<i>Pynonotus jocosus</i>	The red whiskered Bulbul	IV	Least Concern
5.	<i>Dicrurus adsimilis</i>	Common Drongo	IV	Least Concern
6.	<i>Acridotheris tristis</i>	Common House Myna	IV	Least Concern
7.	<i>Sturnus contra</i>	The pied Myna	IV	Least Concern
8.	<i>Passer domesticus</i>	House sparrow	IV	Least Concern
9.	<i>Dendrocitta vagabunda</i>	Indian Tree pie	IV	Least Concern
10.	<i>Turdoides caudatus</i>	Common Babbler	IV	Least Concern
11.	<i>Dicrurus paradiseus</i>	Great Racket tailed Drongo	IV	Least Concern
12.	<i>Chloropsis jerdoni</i>	Jerdons Chloropsis	IV	Least Concern
13.	<i>Ploceus phillippinus</i>	Striated Green Bulbul	IV	Least Concern


14.	<i>Copsychus malabaricus</i>	shama	IV	Least Concern
15.	<i>Prinia subflava</i>	Indian Wren Warbler	IV	Least Concern
16.	<i>Cisticola juncidis</i>	streaked fantail warbler	IV	Least Concern
17.	<i>Orthotomus sutorius</i>	Tailor bird	IV	Least Concern
18.	<i>Acredotheres fuscus</i>	jungle Myna	IV	Least Concern
19.	<i>Gracula religiosa</i>	Hill Myna	IV	Least Concern
20.	<i>Oriolus xanthornus</i>	black headed oriole	IV	Least Concern
21.	<i>Ploceus philippinus</i>	Baya weaver Bird	IV	Least Concern
22.	<i>Motacilla alba</i>	white Wagtail	IV	Least Concern
23.	<i>Motacila citreola</i>	yellowheaded wagtail	IV	Least Concern
24.	<i>Motacila cinerea</i>	Grey Wagtail	IV	Least Concern
25.	<i>Lonchura punctulata</i>	Spotted Munia	IV	Least Concern
26.	<i>Amandava amandava</i>	Red-Munia	IV	Least Concern
27.	<i>Lonchura striata</i>	white Munia	IV	Least Concern
28.	<i>Nectarinia asiatica</i>	purple sunbird	IV	Least Concern
29.	<i>Nectarina zeylonica</i>	purple rumped sunbird	IV	Least Concern
30.	<i>Aethopyga siparaja</i>	Indian Yellow backed sunbird	IV	Least Concern
31.	<i>Pericrocotus flammeus</i>	scarlet Minivet	IV	Least Concern
32.	<i>Coracias benghalensis</i>	Indian Roller or the blue jay	IV	Least Concern
33.	<i>Merops orientalis</i>	common Bee Eater	IV	Least Concern
34.	<i>Halcyon smyrnensis</i>	White breasted king fisher	IV	Least Concern
35.	<i>Alcedo atthis</i>	common king fisher	IV	Least Concern
36.	<i>Halcyon pileata</i>	black capped king fisher	IV	Least Concern
37.	<i>Upupa epops</i>	Indian Hoopoe	IV	Least Concern
38.	<i>Cuculus micropterus</i>	Indian cuckoo	IV	Least Concern
39.	<i>Clamator jacobinus</i>	ped crested cuckoo	IV	Least Concern
40.	<i>Centropus sinensis</i>	Crow Pheasant	IV	Least Concern
41.	<i>Eudynamis scolopacea</i>	common Koel	IV	Least Concern
42.	<i>Psittacula cyanocephala</i>	Blossom-headed parakeet	IV	Least Concern
43.	<i>Psittacula fasciatus</i>	Indian Red breasted Parakeet	IV	Least Concern
44.	<i>Psittacula krameri</i>	Eastern Rose Ringed parakeet	IV	Least Concern

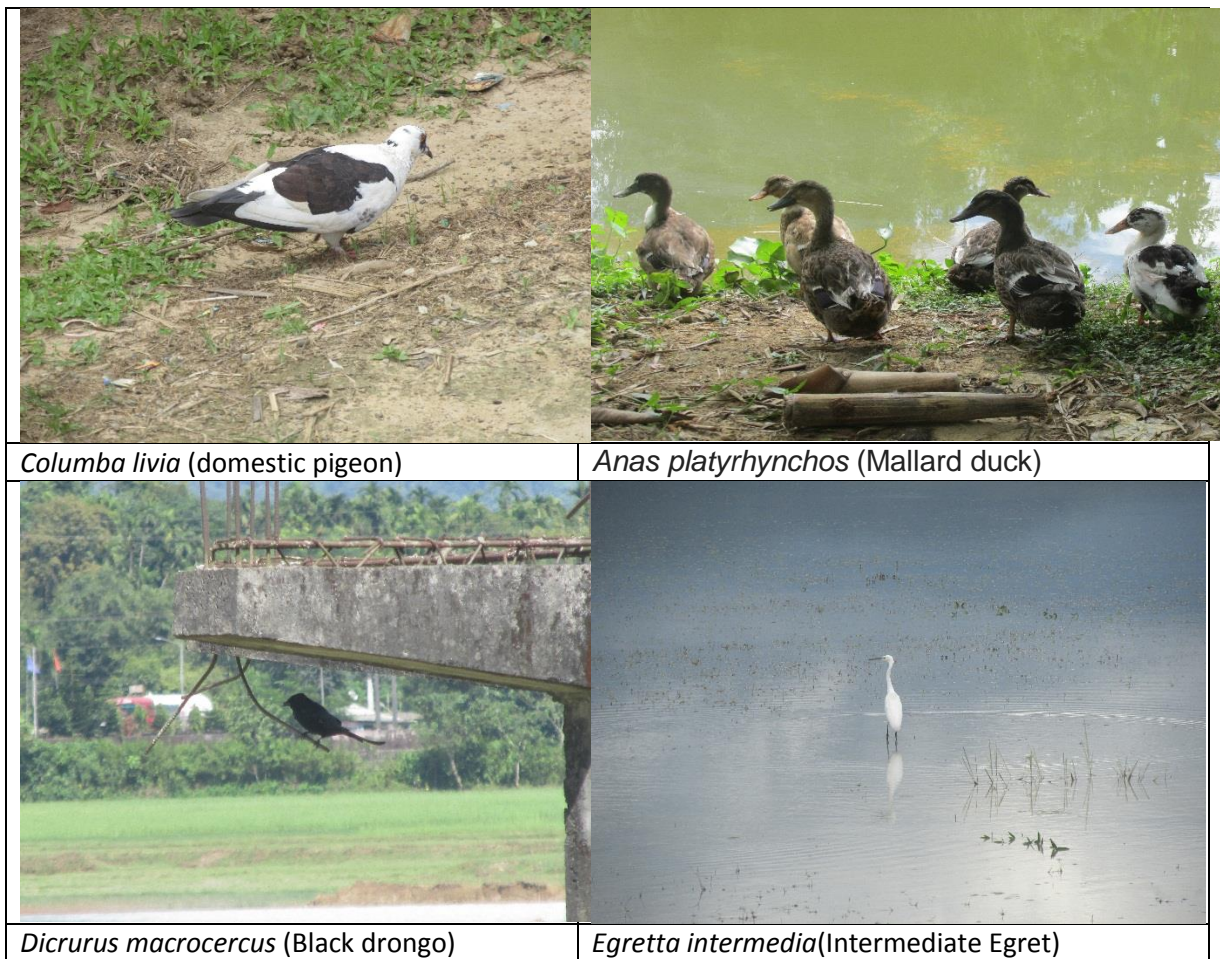
45.	<i>Ketupa zeylonensis</i>	Brown fish owl	IV	Least Concern
46.	<i>Otus scops</i>	scops owl	IV	Least Concern
47.	<i>Spilopelia chinensis</i>	Indian Spotted Dove	IV	Least Concern
48.	<i>Gallus gallus</i>	Red jungle fowl	IV	Least Concern
49.	<i>Gallicrex cinera</i>	Water cocks	IV	Least Concern
50.	<i>Grus antigone</i>	Sarus Crane	IV	Least Concern
51.	<i>Metopidius indicus</i>	Bronze winged jacana	IV	Least Concern
52.	<i>Hydrophasianus chirurgus</i>	pheasant tailed jacana	IV	Least Concern
53.	<i>Burhinus oedicephalus</i>	Stone Curlew	IV	Least Concern
54.	<i>Vanellus indicus</i>	Red Wattled Lapping	IV	Least Concern
55.	<i>Ciconia episcopus</i>	white necked stork	IV	Least Concern
56.	<i>Bulbulcus ibis</i>	Cattle Egret	IV	Least Concern
57.	<i>Ardeola grayii</i>	paddy Bird or the pond Heron	IV	Least Concern
58.	<i>Nycticorax nycticorax</i>	Night Heron	IV	Least Concern
59.	<i>Ixobrychus cinnamomeus</i>	Chestnut Bittern	IV	Least Concern
60.	<i>Ixobrychus minutus</i>	Little Green Bittern	IV	Least Concern
61.	<i>Anas clypeata</i>	Shovellers	IV	Least Concern
62.	<i>Anas crecca</i>	Common Teal	IV	Least Concern
63.	<i>Nettapus coromandelianus</i>	Cotton Teal	IV	Least Concern
64.	<i>Dinopium benghalense</i>	Lesser Golden Backed Woodpecker	IV	Least Concern
65.	<i>Fulica atra</i>	Common Coot	IV	Least Concern
66.	<i>Anhinga melanogaster</i>	Indian Darter	IV	Least Concern
67.	<i>Himantopus himantopus</i>	Black Winged Stilts	IV	Least Concern
68.	<i>Anastomus ocitans</i>	Openbilled Stork	IV	Least Concern
69.	<i>Gyps himalayensis</i>	Himalayan Griffon Vulture	I	Critically Endangered
70.	<i>Gyps bengalensis</i>	White Rumped Vulture	I	Critically Endangered
71.	<i>Gyps indicus</i>	Slender Billed Vulture	I	Critically Endangered
72.	<i>Haliaeetus leucoryphus</i>	Palla's Fish Eagle	I	Critically Endangered
73.	<i>Anser indicus</i>	Bar Headed Goose	IV	Least Concern
74.	<i>Leptoptilos javaicus</i>	Lesser Adjutant Stork	IV	Least Concern
75.	<i>Leptoptilos dubius</i>	Greater Adjutant Stork	I	Least Concern

76.	<i>Netta rufina</i>	Red Crested Pochard	IV	Least Concern
77.	<i>Anas Penelope</i>	Eurasian Wigeon	IV	Least Concern
78.	<i>Anas cypeata</i>	Northern Shoveller	IV	Least Concern
79.	<i>Anas acuta</i>	Garganey	IV	Least Concern
80.	<i>Anser anser</i>	Greylagloose	IV	Least Concern
81.	<i>Anas poecilorhyncha</i>	Spot Billed Duck	IV	Least Concern
82.	<i>Anas platyrhynchos</i>	Mallard	IV	Least Concern
83.	<i>Tyto alba</i>	Barn Owl	IV	Least Concern
84.	<i>Pelicanus phillipensis</i>	Spot billed Pelican/Grey Pelican	IV	Least Concern
Reptiles				
1.	<i>Naja naja</i>	Cobra	II	Least Concern
2.	<i>Ptyas mucosus</i>	Rat snake	II	Least Concern
3.	<i>Bungarus coeruleus</i>	Common Krait	II	Least Concern
4.	<i>Vipera russellii</i>	Russell's viper	II	Least Concern
5.	<i>Calotes versicolor</i>	Garden lizard	IV	Least Concern
6.	<i>Chameleon zeyalanicus</i>	Indian Chameleon	II	Least Concern
7.	<i>Pangshura sylhetensis</i>	Assam Roofed Turtle	I	Endangered
8.	<i>Geocelmys hamiltonii</i>	Spotted Pond Turtle	I	Near Threatened
9.	<i>Cycelmys gemelli</i>	Asian Leaf Turtle	I	Near Threatened
10.	<i>Aspideres gangeticus</i>	Gangetic Softshell Turtle	I	Near Threatened
11.	<i>Batagur kachuga</i>	Red Crown Roof Turtle	I	Near Threatened
12.	<i>Batagur baska</i>	River Terrapin	I	Near Threatened
Amphibians				
1.	<i>Fejervarya limnocharis</i>	Cricket Frog	IV	Least Concern
2.	<i>Hoplobatrachus tigerinus</i>	Indian Bull Frog	IV	Least Concern
Butterfly				
1.	<i>Junonia hierta</i>	Yellow pansy	IV	Least Concern
2.	<i>Danaus chrysippus</i>	plain	IV	Least Concern
3.	<i>Precis iphita</i>	Chocolate Pansy	IV	Least Concern
4.	<i>Junonia atlites</i>	Grey pansy	IV	Least Concern

Livestock like cattle, buffalo, goat sheep, duck, and pig are reared for dairy products, meat, egg and for agriculture purpose. Majority of cattle and buffalo are of local variety. Backyard poultry farms are mostly common in this area; however, some commercial poultry farms are also recorded in the study area.

The study area is marked with moderate population of fauna. With reference to the Wildlife Protection Act 1972 total number of wildlife tabulated in this study can be characterized as given in the table 3.16

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Columba livia (domestic pigeon)

Anas platyrhynchos (Mallard duck)

Dicrurus macrocercus (Black drongo)

Egretta intermedia(Intermediate Egret)

Figure 3.35: Birds found in the study area

Table 3.17: Characterization of Fauna in the Study Area (as Wild life protection Act 1972)

Sl.No	Schedule of Wildlife Protection Act 1972	No. of species
1.	Schedule I	18
2.	Schedule II	11
3.	Schedule III	5
4.	Schedule IV	98
5.	Schedule V	2
6.	Schedule VI	0



Figure 3.36: Butterfly found in the study area

3.12.5 AQUATIC ECOSYSTEM

Primary Survey

The impact of pollution on aquatic ecosystem manifests itself first on the biotic aquatic communities. The species composition of aquatic organisms in natural communities is directly influenced by ambient water quality. The responses of plants to pollutants, when measured quantitatively give an insight about the conditions of existing aquatic ecosystem.


Plankton Study



Figure: 3.37 Aquatic locations sampling in the study area

Protecting the environment and making efficient use of natural resources are two of the most pressing demands in the present stage of social development. The task of preserving the purity of the atmosphere and water basins is of both national and global significance since there are no boundaries to the propagation of anthropogenic contaminants in the water. An essential pre requisite for the successful solution to these problems is to evaluate ecological impacts from the baseline information and undertake effective management plan as shown in **figure 3.37**. So the objective of aquatic ecological study may be outlined as follows:

- To characterize water bodies like fresh waters;
- To understand their present biological status;

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- To characterize water bodies with the help of biota;
- To understand the impact of industrial and urbanization activities; and
- To suggest recommendations to counter adverse impacts, if any on the ecosystem.

To meet these objectives following methods were followed:

- Generating data by actual field sampling and analysis in these areas through field visits during study period; and
- Discussion with local people to get the information for aquatic plants and aquatic animals.

To fulfill these objectives and to understand the present status of aquatic ecosystem, samples were collected from different fresh water system (river) under investigation. In order to get a clear picture and to assess the various parameters of water, three sampling locations were identified for sampling. Samples were collected during study period.

The sampling locations are presented in Table-3.17

Table 3.18: DETAILS OF AQUATIC SAMPLING LOCATIONS

Sr. No.	Code	Locations
1.	AE-1	Near WHRAA well
2.	AE-2	Barak river Near BPAA well
3.	AE-3	Pond Near BPAB well

Methodology Adopted for Aquatic Studies

The biological species specific for a particular environmental conditions are the best indicators of environmental quality. This includes different biological species such as phytoplankton, zooplankton and bacteria. Diatoms, desmids and dinophyceae members are indicative of clean water conditions. Increasing dominance of diatoms, ciliates, flagellates, chlorophycean and cyanophycean species indicates progressively increasing trophic conditions. Presence of Euglenophyceae indicates high eutrophic conditions.

Planktonic rotifers are usually more abundant in fresh water than estuarine waters. It is believed that when crustacean and insect out number other groups the situation reflects the enriched organic

conditions of water. Thus, of certain organisms help in classifying water body in trophic levels on knowing its physico-chemical characteristics. The most dominant macrophytes are *Phragmites karka*, *Arundo donax*, *Altermantha sessilis*, *Cyperus iria*, *Hydrilla verticillata* and *Nymphoides cristat*.

The plankton samples were collected by using plankton net. The filamentous algae and debris were avoided by filtering through the plankton net. The collected sample was condensed to 100 ml by filtration and the samples were preserved using pinch of Rose Bengal and 10 ml of 4% formaldehyde solution. For the measurement of frequencies of various forms of Phytoplankton and Zooplankton, one drop of the sedimented plankton was mounted on a micro-slide, as many as 20 different microscopic fields situated at more or less even distances from each other were examined, and numbers of individual organisms are counted. It should also be noted that diversity is also susceptible to other parameters such as turbidity, colour, nutrients and flow rates etc., particularly in hilly rivers. A widely accepted ecological concept is that community with larger number of species i.e. with high diversity will have high stability that can resist adverse environmental factors.

Phytoplankton group reported from three locations having dominance of bacillariophyceae and cyanophyceae followed by chlorophyceae and euglenophyceae members. About 10 species of phytoplankton were reported from three locations as shown in table 3.18.

Zooplankton about 6 zooplankton species are recorded from all the sampling locations. The list of plankton recorded in fresh water bodies in study area during study period as given in table 3.19

TABLE 3.19 - List of Phytoplankton species found in the study area

S.No.	Family	Phytoplankton Species
1.	Bacillariophyceae	<i>Navicula sp</i>
		<i>Diatoma sp</i>
		<i>Synedra sp</i>
		<i>Cyclotella sp</i>
		<i>Gomphonema sp</i>
		<i>Nitischia sp</i>
2.	Cyanophyceae	<i>Chlorella sp</i>
		<i>Scenedesmus sp</i>
		<i>Nostoc Sp</i>
3.	Chlorophyceae	<i>Merismopidia sp</i>
4.	Euglenophyceae	<i>Euglena sp</i>

TABLE 3.20 - List of Zooplankton species found in the study area

Sl.No.	Family	Zooplankton Species
1.	Rotifera	<i>Brachinous sp</i>
2.	Arthropoda	<i>Nauplius sp</i>
		<i>Acroperus sp</i>
		<i>Macrothrix sp</i>
		<i>Ceriodaphnia sp</i>
		<i>Simocephalus sp</i>

Table 3.21: Shannon diversity Index of Phytoplankton and Zooplankton

Sl. No.	Location	Phytoplankton		Zooplankton	
		Count No/Lit	Shannon Wiener Diversity Index	Count No/Lit	Shannon Wiener Diversity Index
1.	AE-1	710	1.82	766	1.01
2.	AE-2	560	1.34	433	1.14
3.	AE-3	420	1.58	836	0.91

*Ranges of Shannon-Wiener Diversity Index:

0<1: Indicate maximum impact of pollution

1-2: Indicate medium impact of pollution

>2: Indicate minimum impact of pollution

Diversity:

Diversity of plankton depends on physico-chemical characteristics of water especially on trophic levels. In oligotrophic water, diversity of plankton is high. While with increasing levels of pollution such as mesotrophic and eutrophic condition diversity of plankton decreases. Shannon Wiener Index is a measure of diversity of plankton, which takes into account the total count, and individual species count in a water sample.

$$d = - \sum (ni/n) \log_2 (ni/n)$$

Where,

d = Shannon Wiener Diversity Index

n_i = Number of individual of each individual species in a sample

n = Total number of individual of all species in the sample

It should also be noted that the diversity is also susceptible to other parameters such as turbidity, colour and flow rate particularly in hilly rivers. Thus the results should be interpreted with caution. A widely accepted ecological concept is that communities with large number of species (i.e., with high diversity) will have high stability that can resist adverse environmental factors. The maximum value of Shannon Wiener Index of Phytoplankton for clean waters has been reported to be around 1.82, though it may differ slightly in different locations given in table 3.20. Decrease in the value of index may thus be taken as indicator of pollution. As shown in the table 3.18 and in figure of each plankton i.e phyto and zooplankton is given in **figure 3.38**

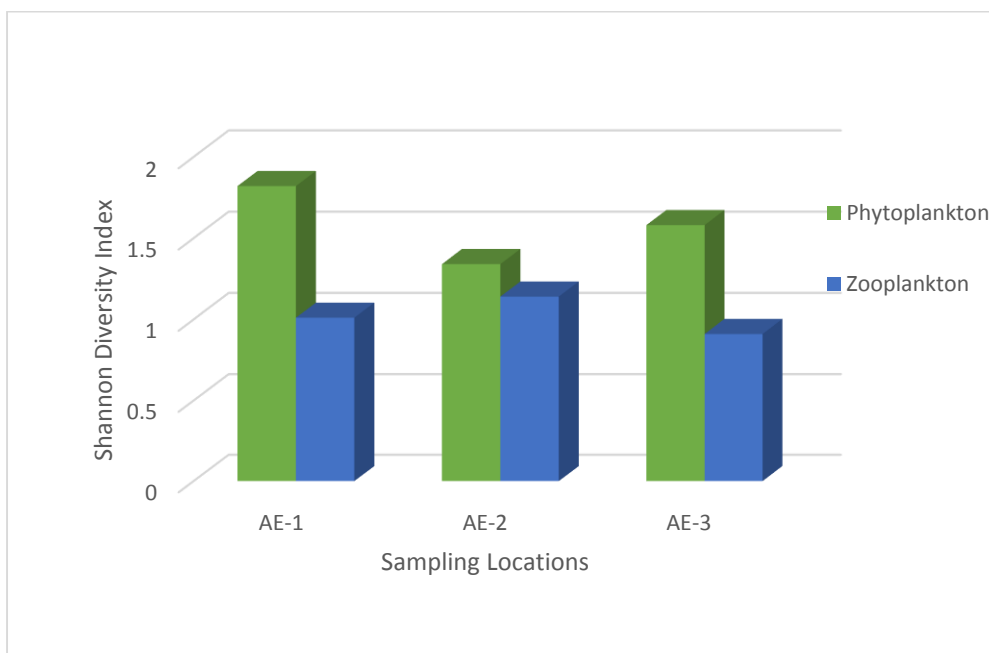


Figure 3.38: Shannon diversity Index of planktons

Fish is widely available in the still (Bills / Ponds) and flowing water bodies (Rivers/Nalas) of the study area. Freshwater fish species within the study area (2 block area) have been identified and given in the table 3.21. Major fish fauna of fresh water bodies include catla, rohu, mrigala, bata, punti, titpunti,


maurala, chela, boal, lata, shole, kholse, pancal, baan, tangra, etc. A total of 15 species of fishes were recorded from these aquatic ecosystems.

Table 3.22: List of Species of Fishes found in the study area

Sr. No.	Scientific Name	Local Name	English Name
1	<i>Catla catla</i>	Katal / Catla	Katla
2	<i>Labeo rohita</i>	Rui	Rohu
3	<i>Labeo calbasu</i>	Baush kalibaush	Calbasu / Black rohit
4	<i>Labeo gonius</i>	Goinya	Goania
5	<i>Cirrhinus mrigala</i>	Mrigal / mikra	Mrigal
6	<i>Labeo bata</i>	Bata	Bata
7	<i>Cirrhinus reba</i>	Bhagna	Reba
8	<i>Hilsa ilisha</i>	Ilish	Indian shad
9	<i>Rhinomugil corsula</i>	Corsula / Nadir bata	Corsula mullet
10	<i>Hypophthalmichthys molitrix</i>	Silver carp	Silver carp
11	<i>Hypophthalmichthys nobilis</i>	Big head	Big head
12	<i>Ctenopharyngodon idellus</i>	Grass carp	Grass carp
13	<i>Cyprinus carpio var communis</i>	Carpio / Japani rui	Common carp / Scale carp.
14	<i>Puntius javanicus</i>	Japani Puti	Java Puti
15	<i>Oreochromis mossambica</i>	Tilapia	Tilapia / Mozambique cichlid

Source: Directorate of Fisheries, Silchar district, Assam

Conclusion As per primary survey and secondary data referred, it can be concluded that the study area is ecologically rich and diverse. The terrain is undulating with the presence of hillocks are observed in the study area. Upon detailed survey of the study area, there are no endangered and endemic fauna or flora found near the well locations.

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3.13 Socio-economic Aspects

3.13.1 Baseline Status

The study of socio-economic aspects deals with social and cultural conditions, and economic status in the study area. The socio-economic study provide information such as demographic structure, population dynamics, infrastructure resources, status of human health and economic attributes like employment, per-capita income, agriculture, trade, and industrial development in the study area. The aesthetics in the study area represents tourist attraction and wildlife, historic and cultural monuments. The study of these attributes helps in identification, prediction and evaluation of impacts on socio-economic and parameters of human interest due to proposed project developments.

To assess impact of the project activity on socio-economic aspects, recent primary data collected from field studies and Government agencies has been compiled to delineate the baseline socio-economic profile in study area. The data generated in this study is classified as follows:

- Administrative setup
- Demographic structure
- Infrastructure base
- Economic attributes
- Health status
- Fisheries Resources
- Cultural attributes
- Awareness and opinion of people about the proposed project

Based on the primary and secondary data collected from villages and towns, the existing socio-economic status have been analysed and details are appended below. The secondary data is collected from Census Record (2011), District Census Handbook 2011 and Town Directory 2011.

3.13.2 Methodology for Primary Data Collection


For the primary data collection, structured questionnaires will be used by survey team. This format will include all type of village information like demographic details, infrastructure details etc. For household survey, surveyor will visit to household's house as shown in **figure 3.39**.



Figure 3.39 Socioeconomic survey of the study area

For focus group discussion male, female group were interviewed in open spaces like community hall, school ground, temple, panchayat hall etc. For the selection of respondents random sampling used by surveyor. Direct observation during transit walk in villages, telephonic calls to peruse information is also comes under the primary data collection, these methods also a part of primary data collection.

For survey purpose, selection of villages was performed in 10 km radial study area map. Proportionate and purposive sampling methods were used for selecting villages as shown in **figure 3.40**

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House near study Area	Shop near study area
	
School near study area	Saraswati Shishu Vatika near study area

Figure 3.40: locations near the study area

3.13.3 Demographic Structure

The Primary Census Abstract 2011 was used to prepared demographic structure of Cachar and Hailakandi district; and the details of demography such as number of persons per household, total area, population density, sex ratio, SC and ST population, and literacy rate and employment pattern are given in **Table 3.20**. The salient observations from the demographic structure are as follows

Population Structure:

- As per 2011 census, total population of the Hailakandi District was 6,59,296 out of which male population was 3,37,890 and female population was 3,21,406 while as per 2011 census, total population of the Cachar area was 17,36,617 out of which male population was 8,86,284 and female population was 8,50,333. As shown in figure 3.41

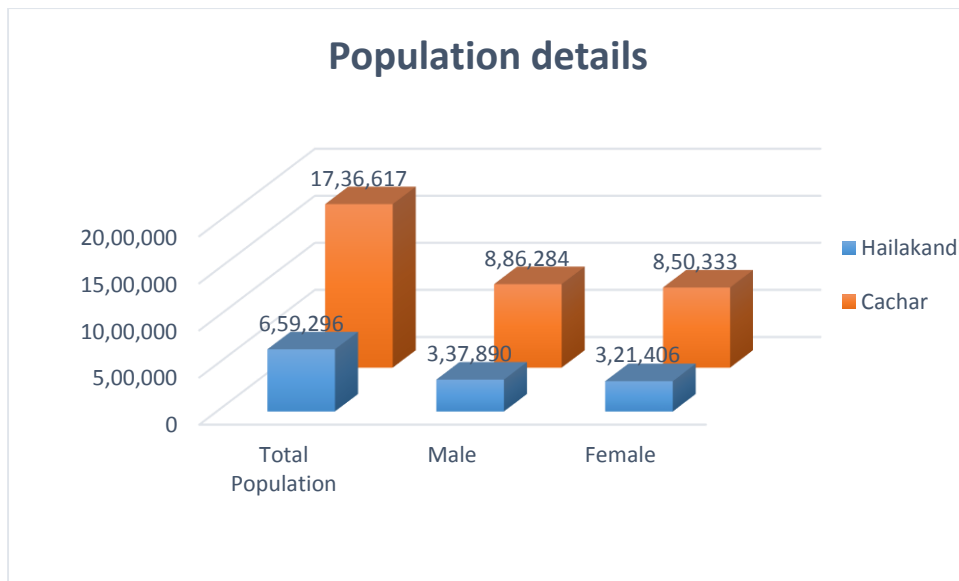


Figure 3.41: Population details of Cachar and Hailakandi District

- Overall population density was 497 persons/ km² of Hailakandi District while the 459 persons/ km² of Cachar district as shown in figure 3.42.

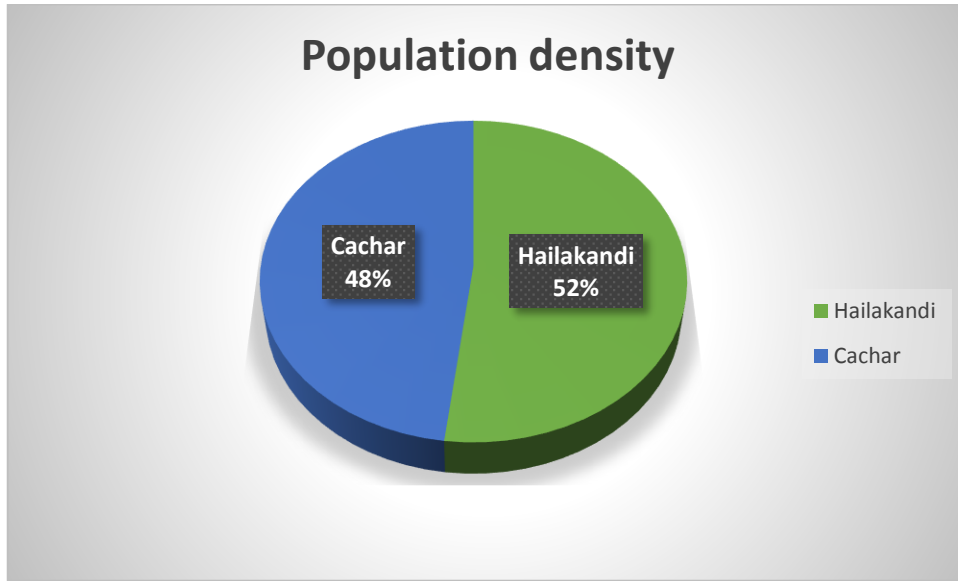


Figure 3.42: Population density of Cachar and Hailakandi district

- Total child (below 6 years of age) population was 111,278 out of which male population was 56,936 and female population was 54,342 in Hailakandi District while in Cachar District Total child (below 6 years of age) population was 256,774 out of which male population was 131,417 and female population was 125,357 as shown in figure 3.43

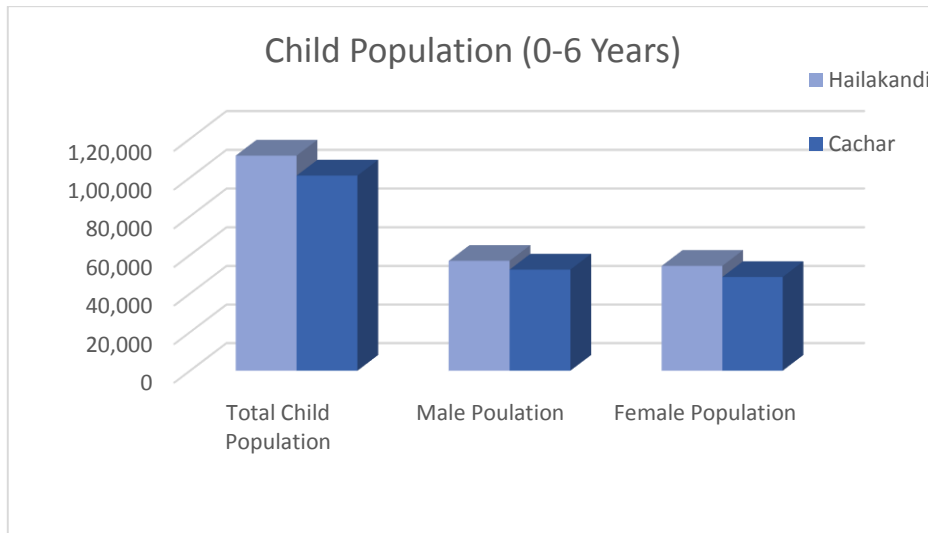


Figure 3.43: Child population below 6 years of Age in Cachar and Hailakandi District

Literacy rate:

The Average literacy of Hailakandi district is 74.33 while male literacy is 80.74 and female literacy is 67.60. In Cachar District Average literacy is 79.34 while male literacy is 84.78 and female literacy is 73.68 as shown in **figure 3.44**

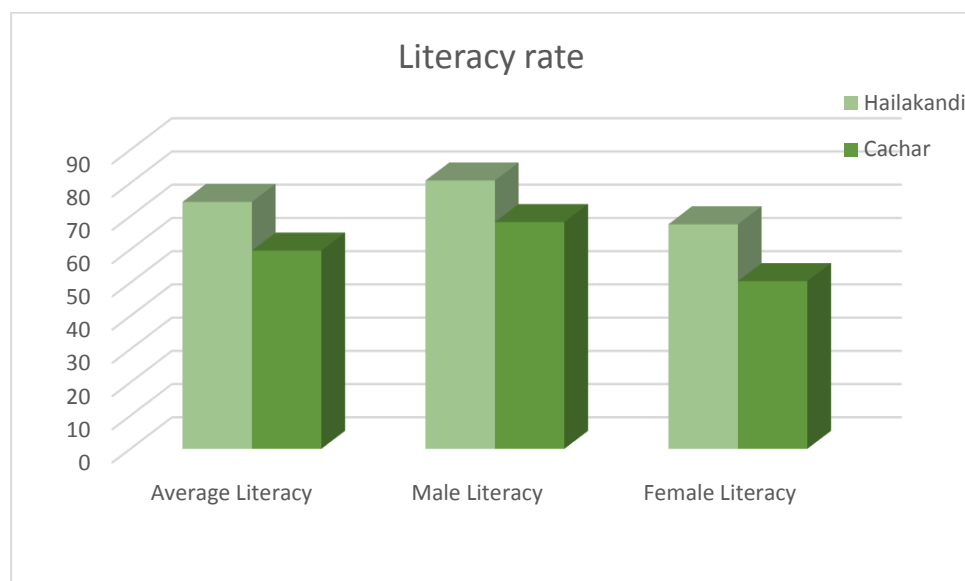


Figure 3.44: Literacy rate of Hailakandi and Cachar District


Table 3.23: Social Profile of the Study Area

S.No.	Description	District	
		Hailakandi	Cachar
1.	Actual population	659,296	1,736,617
2.	Male	337,890	886,284
3.	Female	321,406	850,333
4.	Population growth	21.45%	20.19%
5.	Area sq.km	1327	3786
6.	Density/km2	497	459
7.	Prportion to assam population	2.11%	5.57%
8.	Sex ratio (per 1000)	951	959
9.	Child sex ratio (0-6Age)	954	954
10.	Average literacy	74.33	79.34
11.	Male literacy	80.74	84.78
12.	Female literacy	67.60	73.68
13.	Total child population (0-6 age)	111,278	256,774
14.	Male population (0-6 age)	56,936	131,417

15.	Female population (0-6 age)	54,342	125,357
16.	Literates	407,366	1,174,128
17.	Male literates	226,836	639,946
18.	Female literates	180,530	534,182
19.	Child population (0-6 age)	16.88%	14.79%
20.	Boys population (0-6 age)	16.85%	14.83%
21.	Girls population (0-6 age)	16.91%	14.74%

3.13.4 Salient Observations of the Survey:

- **House pattern:** It is notable that nearly 90% of the houses were pakka with good construction.
- **Employment:** Main occupation of the people in the study area is agriculture and labour work. The labours are getting daily wage in the range of Rs. 100-250, depending on type of work they involved.
- **Fuel:** The primary source of cooking fuel is LPG and coal is alternative fuel.
- **Main Crops:** The principal crops grown in agricultural farm are paddy,. Average crop productivity of paddy was 8-10 quintal per acre. Water from dug well and bore well were used for irrigation purpose.
- **Language:** Official language is () and mother tongue of the people is () Hindi and English languages are understood by population.
- **Migration:** During survey, it was found that local population migrate for employment in Gulf Countries.
- **Sanitation:** Toilet facility is one of the most basic facilities required in a house. The findings of the survey show that more than 90% of the households were having toilet facilities in their houses. There was no proper drainage line in the villages, but soak-pit facilities were observed in most of the villages surveyed. The overall condition of cleanliness was satisfactory.
- **Drinking Water Facilities:** Ground water is the major source of drinking water in the villages wherein hand pumps, tap water and dug wells are installed. In some villages organized piped water supply is also in operation.
- **Education Facilities:** Most of the villages had education facilities in the form of Anganwadi and Primary Schools. Higher education facilities were available in the range of 5-10 km. Colleges and other diploma courses were available at Mangalore district place at a distance of 10- 20 km.

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- **Transportation Facility:** The public transport is primarily by public and private buses and auto-rickshaws. Well established transportation is noticed between villages cities. Private vehicles like bicycles and motor cycles are mostly used by villagers for transportation purpose.
- **Road Connectivity:** Most of the roads are pucca and connecting to all villages with towns and cities. Tar & Concrete roads were commonly seen inside the villages.
- **Communication Facilities:** For communication purpose mainly mobile phones, newspaper & post offices were seen in the villages.
- **Medical Facilities:** There are few healthcare facilities available in the study area. In some of the villages, primary health sub centres are available. Hospitals and other better medical facilities are available in the range of 10-20 km at town/city place.
- **Electricity:** Electricity is available in all the study villages and do not have frequent problem of load shedding.
- **Market Facility:** Study area is predominantly semi urban type. In villages, small shops are available for daily needs. Weekly market facility is available in some villages. Wholesale markets are available at town place.
- **Recreation Facilities:** Temples, Samaj Bhawan, Television and Radios are the main recreation facilities in the study area. Newspaper/Magazine facilities were also used by villagers.

3.13.5 Economic Resource Base:

3.13.5.1 Agriculture and Horticulture of Cachar and Hailakandi District

The farming system of Cachar and Hailakandi district is mainly agriculture and agri-based allied activities. Rice is the main cereal crop of the district. Rice is grown as a double crop, in sequence with vegetables/mustard/oilseeds. Rape and mustard is the important oilseed crop, though sesamum and linseed are also grown to a limited extent. Rajmah, black gram and pea are the main pulse crops. Different vegetables are grown particularly on riverine tracts. Homestead garden is common farming system of the district Pineapple, arecanut, coconut, banana, jackfruit and citrus are the important horticultural crops. Pineapple is specialty of zone for its sweetness and is grown on a commercial scale in certain regions of Cachar and Hailakandi district.

3.13.5.2 Livelihood in the Surveyed Villages

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As per discussion with village Panchayat President and local people majority of households are involved in agriculture and its allied activities as a source of livelihood which is evident from the land use classification where agricultural land is predominant and same also is in line with the details given in the census handbook 2011. These households are mostly depending upon rain water to carry out agriculture activities. The main crop is rice. Green vegetables and fruits are also grown in Homestead gardens. These gardens are characterized by high density haphazard planting without maintaining proper spacing. The villagers sell these products in weekly haat and main market. Apart from this, people are also engaged as government servants, teachers, plantation workers, small business, construction labours etc. A small proportion of households are engaged as permanent and casual tea garden working labours in the surrounding tea gardens.

3.13.6 CULTURAL AND AESTHETIC ATTRIBUTES

Study area of 10km from centre of proposed exploratory well does not involve any major place with religious, archaeological and historical importance.


3.13.6.1 Festival Celebrated in the Study Area

Bihu: The Bihus are the national festivals of Assam and have been celebrated from ancient times. There are three such festivals: in the months of Bohaag (Baisakh, the middle of April), Maagh (the middle of January), and Kaati (Kartik, the middle of October). Each Bihu coincides with a distinctive phase in the farming calendar. The Bohaag Bihu marks the New Year at the advent of seeding time, the Kaati Bihu marks the completion of sowing and transplanting of paddies, and the Maagh Bihu marks the end of the harvesting period.

Durga Puja and Deul Mahotshav (Holi) is widely celebrated in the study area and all parts of Assam.

3.13.6.2 Medical & public Health Facilities

During consultation, it was revealed that the existing health infrastructure and services in the study area comprises of Primary Health Centre (PHC) and Health Clinics run by Private Practitioners. PHC exists in only one village which is staffed with a medical officer supported by a pharmacist, a senior clerk and helper (midwife) and caters to a population of only nearby villages. However, Maternity and Child Welfare (MCW) Centre is available in three villages. Allopathic Hospital and Dispensary is not available in any of the village. Hospital with surgical facilities is available. It was also informed that

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doctors and staff of PHCs organizes general health check-up and awareness programme on maternal and child care, eye care and immunization camps in the surrounding villages.

3.13.6.3 Existing Health Conditions and Concerns

During discussion, except routine cough, cold and fever, diarrhoea were reported common amongst villagers in the study area which is due to open excreta and flies all around. Presidents of village panchayat stated that due to lack of equipments, infrastructure as well as inadequate and poor coverage of the existing health services, the people have to travel long distance which is time consuming and expensive also. The analysis of secondary data based on census 2011 also revealed that people from 95% villages in the study area are availing health facility within 5kms, 5-10kms and more than 10kms distance from their village. There is a good awareness about pulse polio and vaccination among people in the area. The private hospitals are equipped with better facilities than the PHC exist in the study area. These private clinics mostly cater to the affluent class residents i.e., mostly belonging to middle income group in the area and hence people are expecting health infrastructure with adequate staff shall be provided by project authorities under welfare scheme/CSR plan on priority basis.

3.13.7 During Socioeconomic survey:

The salient observations arising out of survey are:

- The average family size in the study area is 5 per family. However, joint families are ranging from 5-10 members per household.
- A household belongs to both Hindu and Muslim religion with caste-hierarchy OBC, General, Schedule caste and Scheduled tribes etc.
- The houses are made largely using wood based materials. Wooden plank flooring is adopted in stilted houses and mud plaster flooring in rural area. Roofing is made of weed, leaves with boundary wall of Ikaria reed. Other common type of flooring include cement flooring have also seen in few houses belongs to middle class family in the area. Pitched/corrugated/galvanized iron sheet roofing is the most common form of roofing system used in modern buildings. Open space in front (chital) and back side (bare) of the house is common in majority of households in the area.

- Among surveyed villages, primary education facility (1st to 5th standard) is available. Students travel 5-10kms distance to avail middle, secondary and senior secondary education. For higher education like degree, diploma, polytechnic and engineering, students travel Silchar and Lakhimpur town.
- Source of potable water in the surveyed villages comprises of hand pump and open well. Tap water supply through Public Health Engineering Department (PHED) exists in few very households. People informed during survey that due to erratic power supply, people don't get sufficient water for domestic purpose.
- Only 20% households have individual toilet facility in the form of soak pit. Toilets are constructed away from the main house near the periphery of the plot. Unhygienic kachha toilet and Open defecation is common in the study area which leads to diarrhoea and other related ailments.
- The predominant crop cultivated in the area is paddy. Black gram and pea are the main pulse crops. Horticultural crops (Fruits) viz. Guava, Banana, Papaya is also grown in the study area. Few households grow green vegetables potato, brinjal, pumpkin and cauliflower which are sold in weekly bazaar (haat) in the surrounding villages or in main market of nearby town.
- Homestead garden is common farming system in the study area. In few households it was found that presence of small pond is common meant for drinking, washing and fishing etc.
- As a source of livelihood, small population from each surveyed village is engaged as seasonal and permanent workers in the surrounding tea gardens. Majority of the workers are leaf pluckers in the tea garden and they are mostly female.
- The traditional handicraft activity (weaving) is also one of the earning sources of very few households in the study area.
- Bamboo has played an important part in the lives of the people of Assam It grows in natural forests, and is cultivated in homesteads and on private plantations. It is utilized in many ways, for housing, fencing, functional articles, agricultural implements, basketry and even as a fuel.
- The approach road and internal road network in all surveyed villages are kachha and few existing pucca roads were also found in very bad condition. State transport bus service up to the village is not available. Besides, people use two wheeler and auto rickshaw for their routine household chores. The nearest railway station is Silchar.

- Rice, wheat, sugar and kerosene are being distributed to those families who are having valid ration cards under public distribution system (PDS) run by the government.
- The communication facility is unsatisfactory in terms of post office but majority of villages are privilege with coverage of mobile phones.
- Recreational facilities like television and radio are available in households having good economic status.

3.13.8 Awareness and Opinion of People about the Project

- An attempt has been made to know the awareness and opinion of the people about proposed location of ONGC as shown in **figure 3.45**.






Figure 3.45 : Public consultation during the Survey

- The respondents were happy to know about the project and they opined positively because any industrial activity would definitely contribute to development towards improvement in the local as well as regional economy and creation of job opportunities.
- Respondent asked for better health services and better transportation facilities.
- Respondents added that due to non-availability of technical education most of the local educated youth are not offered jobs in company so would promote professional educational and training facilities in the region.
- According to the respondent air pollution was increased due to upcoming industries and directly affecting health of surrounding villagers.

3.13.9 Community Consultation:

Interaction with different village Sarpanch/Society Heads/ villagers was done to understand the socio-economic issues of the region and their needs. It will be of profound importance to study the perception as well as reaction of the community people towards the proposed project activity. In-depth interview with President of selected Village Panchayat, discussion with Members and local people was done to gather the existing baseline socio-economic information on a various parameters of Quality of Life. During discussion, issues related to employment generation, information flow, health and safety, social welfare activity, temporary and permanent land requirement etc. were discussed.


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Chapter 4

Anticipated Environmental Impacts

&

Mitigation Measures

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4.0 Anticipated Environmental Impacts & Mitigation Measures

4.1 Introduction:

The objective of the impact identification is to formulate Environmental Management Plan (EMP) to mitigate the probable negative impacts that might arise during the project activities to the maximum possible extent. Therefore, in order to come to a strategic EMP it is imperative to identify the possibilities at various project stages, impact type and affected environmental component, extent and severity. EIA is an activity designed to identify and predict the impact on the environment, on human health and ecology, taking into account the requirements of legislative proposals, policies, programs, operational procedures and to communicate information about the impact. The identification of the potential impacts during the exploratory drilling activity on various environmental components namely Air, Water, Soil etc., are discussed below:

Table 4.1 Key Potential Impacts of Exploration Activities

Potential impacts	Potential Environment Impacts for onshore activities
Potential Physical Environmental Impacts	<ul style="list-style-type: none"> ➤ Sedimentation ➤ Erosion ➤ Disturbance of sensitive areas ➤ Soil compaction and disturbance ➤ Groundwater disturbance ➤ Drainage alteration, surface seepage, drainage lines and creek disturbance ➤ Hydrocarbon contamination ➤ Fire
Potential Biological Environmental Impacts	<ul style="list-style-type: none"> ➤ Disturbance to fauna including breeding seasons or migration paths ➤ Noise and light disturbance ➤ Disturbance of rare and endangered flora and fauna and threatened ecological communities ➤ Introduction of noxious weeds and vermin, exotic species, flora and animal diseases ➤ Encroachment into quarantine areas ➤ Disturbance to habitats and vegetation communities


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Potential Social Environmental Impacts	<ul style="list-style-type: none"> ➤ Disturbance to heritage sites ➤ Disturbance to archaeological sites ➤ Disturbance to scientific study sites ➤ Disturbance to tourism ➤ Public disruption ➤ Disturbance to pastoral or farming activities ➤ Disturbance to horticultural activities ➤ Disturbance to aesthetics (visual impact) ➤ Disturbance to ethnographic sites ➤ Third party access denial or creation
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Table 4.2 Impact Significance Criteria

Impact Significance	Criteria
Major Adverse	<i>When the impact is of:</i> <ul style="list-style-type: none"> • high intensity • high spread (regional) or moderate spread • high or moderate duration
Moderate Adverse	<i>When the impact is of:</i> <ul style="list-style-type: none"> • moderate intensity • high or moderate or low spread • <i>high or moderate or low duration</i>
Minor Adverse	<i>When the impact is of:</i> <ul style="list-style-type: none"> • moderate or low intensity • low spread • moderate or low duration
Insignificant Adverse	<i>When the impact is of:</i> <ul style="list-style-type: none"> • low intensity • low spread • low duration
Beneficial	<i>When the impact are positive</i>

A Number of techniques are available for identification of impacts. In the present case “Network Method” has been adopted for understanding the “cause-condition-effect” relationship between an activity and environmental parameters. Various activities and their likely impacts due to exploratory drilling have been identified and shown in the Table 4.3. The detailed list of activities and actions described earlier in this report has been taken into consideration for generation of cause-condition-effect network (i.e. chain of

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events). The idea was to account for the project activity and identify the types of impacts, which would initially occur. The next was to select each impact and identify the secondary and tertiary impacts, which induced as a result. This process was repeated until all possible impacts were identified. While identifying the impact networks for drilling operations in the study area all significant activities such as land acquisition, road/site clearance, drill site preparation and diesel generation set operation have been considered the availability of energy resource (oil/gas) the end product has been considered for the purpose of economic benefits.

The identified impacts for various components of environment viz. air, noise, water, land, biological and socio-economic are described respectively.

4.2 Impact assessment and mitigation measures


This section discusses the possible impacts of the project activities on the existing environmental receptors, particularly on the environmental sensitivities of the area which get effected by the project. It discusses probable impacts during various phases of the project life cycle to the environmental receptors. Identification of impacts would help in delineating appropriate mitigation measures to reduce the adverse impact



Table-4.3: Activities – Impacts/Risks Interaction Environmental Sensitivities

Impacts/ Risk	Environmental Sensitivities													
	Physical			Biological			Socio-economic							
Activities	Soil & Sediments	Water Resource & Quality	Air Quality	Flora	Fauna	Reserve Forest/ Protected Forest	Living Condition	Local Economy	Existing Oil and Gas Business	Traffic Hazards	Onsite Risks (Occupational Exposure)	Culture/ Archaeological places	Tourism / Leisure	Land Use (Mudflats/ Agriculture)
Drilling Site Preparation														
Physical Presence including Land acquisition/ Lease							√	√						√
Site Clearance	√			√	√			√						
Site Preparation		√	√											
Equipment Transportation	√			√				√						√
Campsite	√	√	√					√						√
Drilling Operation														
Atmospheric emissions			√								√			
Noise & Vibrations			√		√		√				√			
Waste generation	√	√												√
Storage of Flammables	√		√								√			
Well kick			√								√			

√ - Shows Impact

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4.2.1 Air Environment:

The potential sources of air emissions at the well sites will be as follows:

- Dust from earth works (during approach road and site preparation);
- Emissions from DG sets;
- Emissions from vehicles.

During the short period of site preparation mechanical shovels and earthmovers will be used for vegetation clearance, cut & fill and other site levelling activities. These activities could generate dust particles which will be mobilized by wind and could impact the ambient air conditions. However, these activities will be only temporary and with the clay nature of the soil, the impact to ambient air quality would be within the close proximity of well site.

All the anticipated air emissions other than dust arise from combustion of hydrocarbons. The pollutants of concerns are NO_x, SO₂, CO and Particulate Matter.

4.2.1.1 Potential Impacts


Ambient air quality effects are normally assessed in relation to their potential to cause:

- Health deterioration and nuisance in local communities;
- Health deterioration amongst on-site workers; and
- Damage to vegetation.

The gaseous emissions from the DG set will be controlled by efficient combustion of fuel in the DG set.

The impact on ambient air quality is assessed hereunder considering the following:

- The air quality impacts have been predicted for the proposed drilling; and
- Site-specific meteorological parameters have been recorded. Short-term 24 hourly GLC's incremental values were estimated using the site-specific meteorological data.

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4.2.1.2 Fugitive Emissions

Air pollution during construction would be primarily due to fugitive emissions from vehicular movement, site preparation activities and material handling. Weathering of soil would take place as a result of clearing of vegetation, excavation and movement of heavy vehicles. The weathered soil generates dust due to re-entrainment during vehicular movement and equipment mobilization. Such dust emissions as experienced in other similar construction activities are of larger than 10μ (more than respirable range) and propagates to short distances. These emissions only have nuisance factor affecting workers at site. Use of dust masks would be adequate to mitigate impacts on workers.

Fugitive emissions in the form of material dust is expected during drilling operations (loading, unloading, handling of drilling fluid, chemical additives, cement and cement additives). Some fugitive emissions are also anticipated from storages of volatile chemicals and fuel at the site, if the storages are not properly capped or are handled without due care. However, such emissions will not disperse widely and can only affect workers and people at site. Fugitive emissions during drilling operations are however not as significant as during site preparation. Fugitive emissions during drilling are not expected to travel beyond project boundaries. Workers working near fugitive emission sources are only susceptible which would be mitigated through use of PPEs in these areas.


4.2.1.3 Air Pollution Modelling

Prediction of impacts on air environment has been carried out employing mathematical model based on a steady state Gaussian plume dispersion model designed for multiple point sources for short term. In the present case, **AERMOD** dispersion model based on steady state gaussian plume dispersion, designed for multiple point sources for short term and developed by United States Environmental Protection Agency [USEPA] has been used for simulations from point sources.

4.2.1.4 Model Input data

- **Emission from DG sets:**

The power requirements for the operation of the drilling will be met by using diesel generator sets. Four generators of 1430 KVA each are installed at the site. The cumulative power generating capacity of the 4 units is 5720 KVA of power at peak periods. The DG sets are primary contributor to air pollution at the

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drill site. The pollutants emitted by a DG set consists of Particulate Matter (PM), Sulphur-di-oxide (SO₂), Nitrogen Oxides (NO_x) and Carbon Monoxide (CO). Combustion of fuel in a DG set typically happens at high temperatures resulting in generation of considerable amounts of NO_x. The SO₂ concentration in emissions is dependent on the Sulphur content in fuel burnt and particulate matter consists of unburnt Carbon particles.

The emission from each of the power generator sets in the drilling rig will be due to combustion of diesel. For a particular drilling site during drilling operation, there will be 04 operating DG sets, as detailed in **Table-4.4**.

TABLE-4.4 Details of DG Sets

Location	DG Capacity	Operational	Stand by	Fuel Requirement
Drilling Site	1430 kVA	03	01	58 L/Hrs


The operational DG sources are considered as source for the modelling. The emission from each of these diesel generators will be due to combustion of diesel.

- **Modelling Scenarios**

Emissions from diesel generator sets will be continuous throughout the drilling operations. The main pollutants from diesel generator sets include Particulate Matter (PM), Sulphur-di-oxide (SO₂), Nitrogen Oxides (NO_x) and Carbon Monoxide (CO). As the fuel used is low sulphur HSD, insignificant amount of particulate emissions and gaseous emissions are envisaged. The emission characteristics considered for the modelling exercise from DG generator sets are given in the **Table-4.5**

TABLE-4.5 Emission Characteristics- Model Inputs

Sr. No	Particulars	DG Set (4 x 1430 kVA)
1.	No. of engines and stacks	04

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2.	Height above ground level (m)	7
3.	Diameter (m)	0.25
4.	Gas temperature (°C)	188
5.	Gas velocity (m/s)	13.4
6.	Emission rate (g/s)	0.0075 (PM), 0.0098 (SO ₂), 0.041 (NO _x) & 0.16 (CO)
7.	PM10 (mg/Nm ³)	17
8.	SO ₂ (mg/Nm ³)	22.4
9.	NO _x (mg/Nm ³)	93.3
10.	CO (%v/v)	0.19

4.2.1.5 Presentation of Results

The Maximum GLC's results for PM, CO, SO₂ and NO_x are presented in **Table-4.6** the isopleths for PM, CO, SO₂ and NO_x concentrations are depicted as given below:



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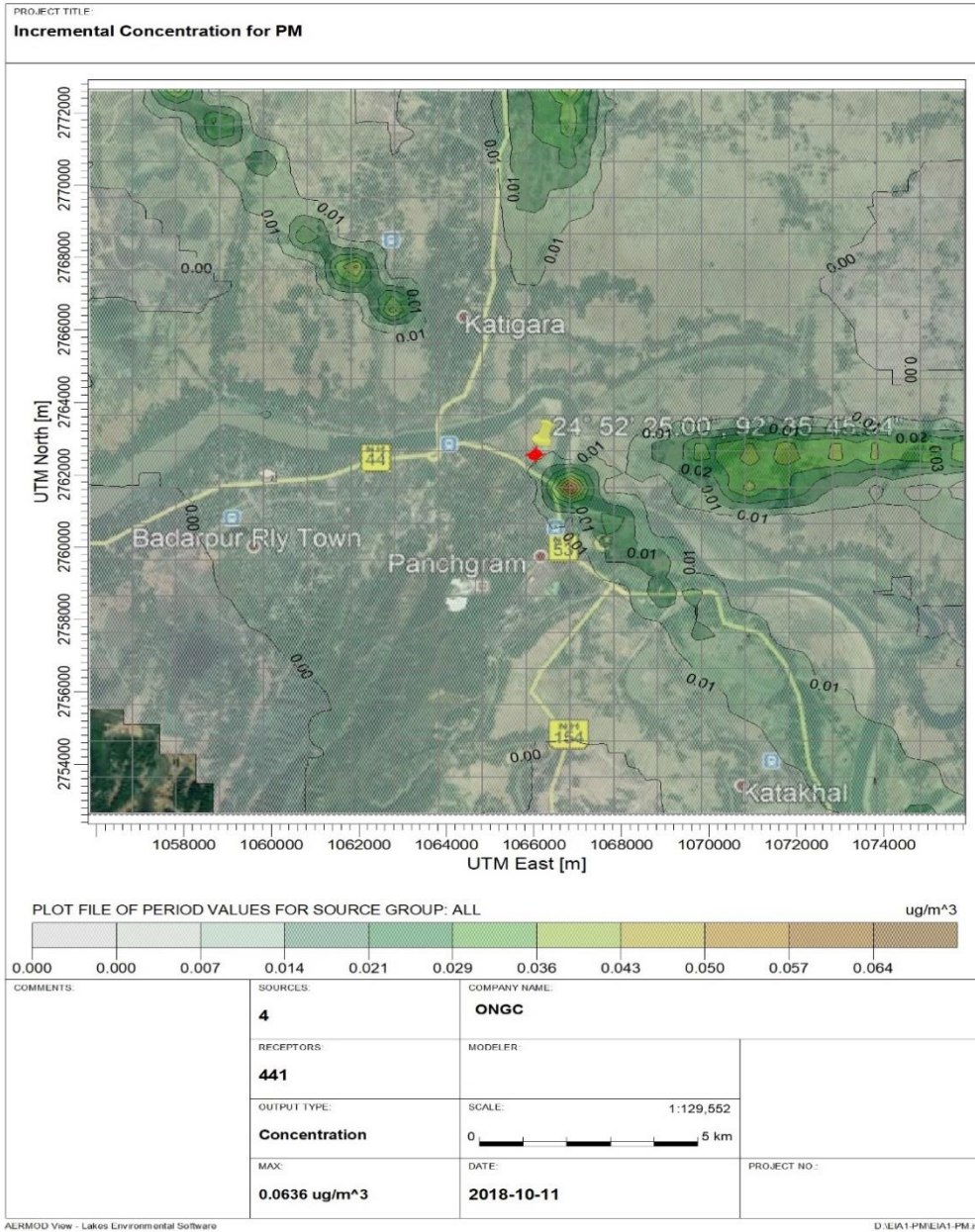


Fig-4.1: Output Model- Particulate Matter

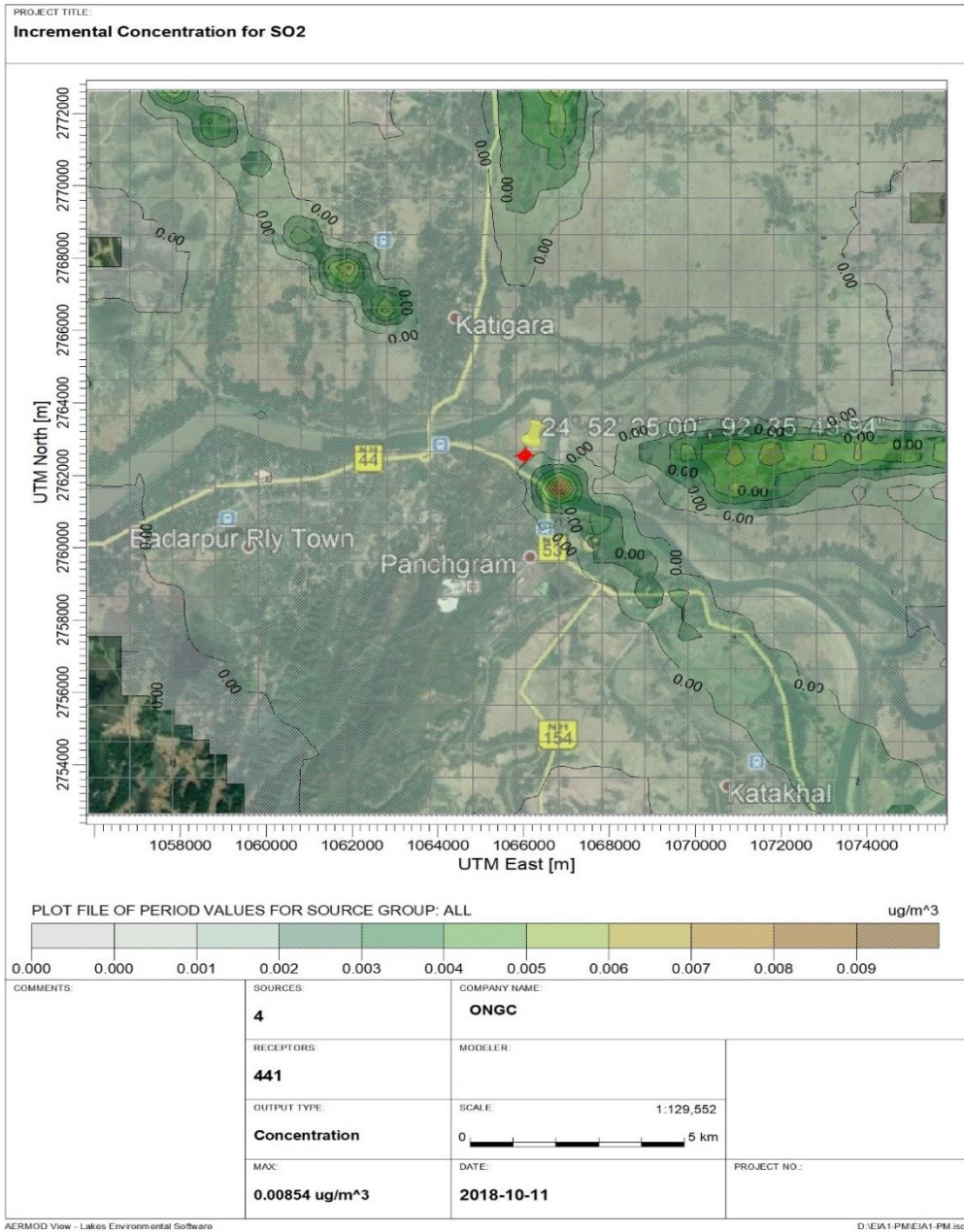
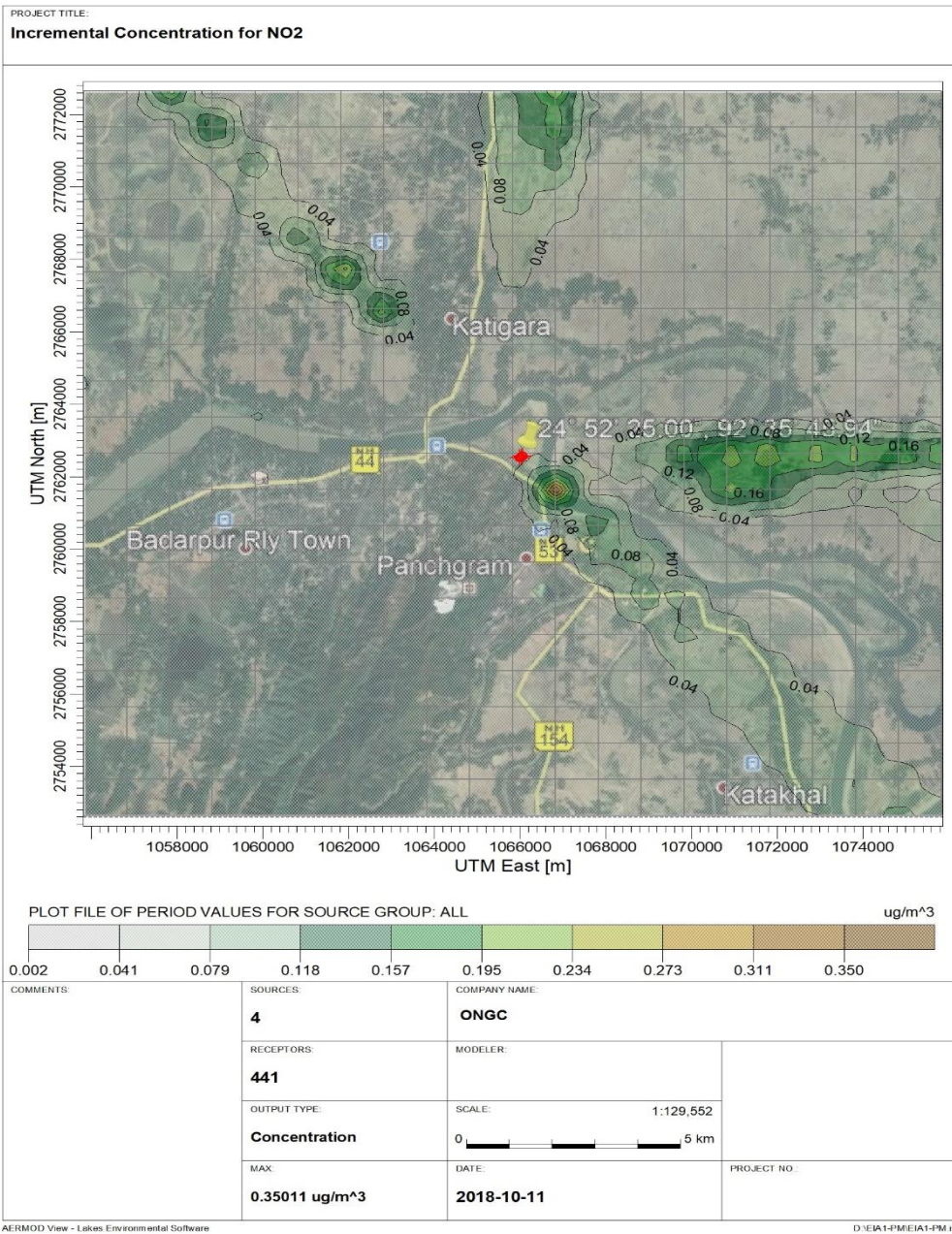


Fig-4.2: Output Model- Sulphur-di-Oxide (SO₂)



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Fig-4.3 Output Model- Nitrogen Oxides (NOx)

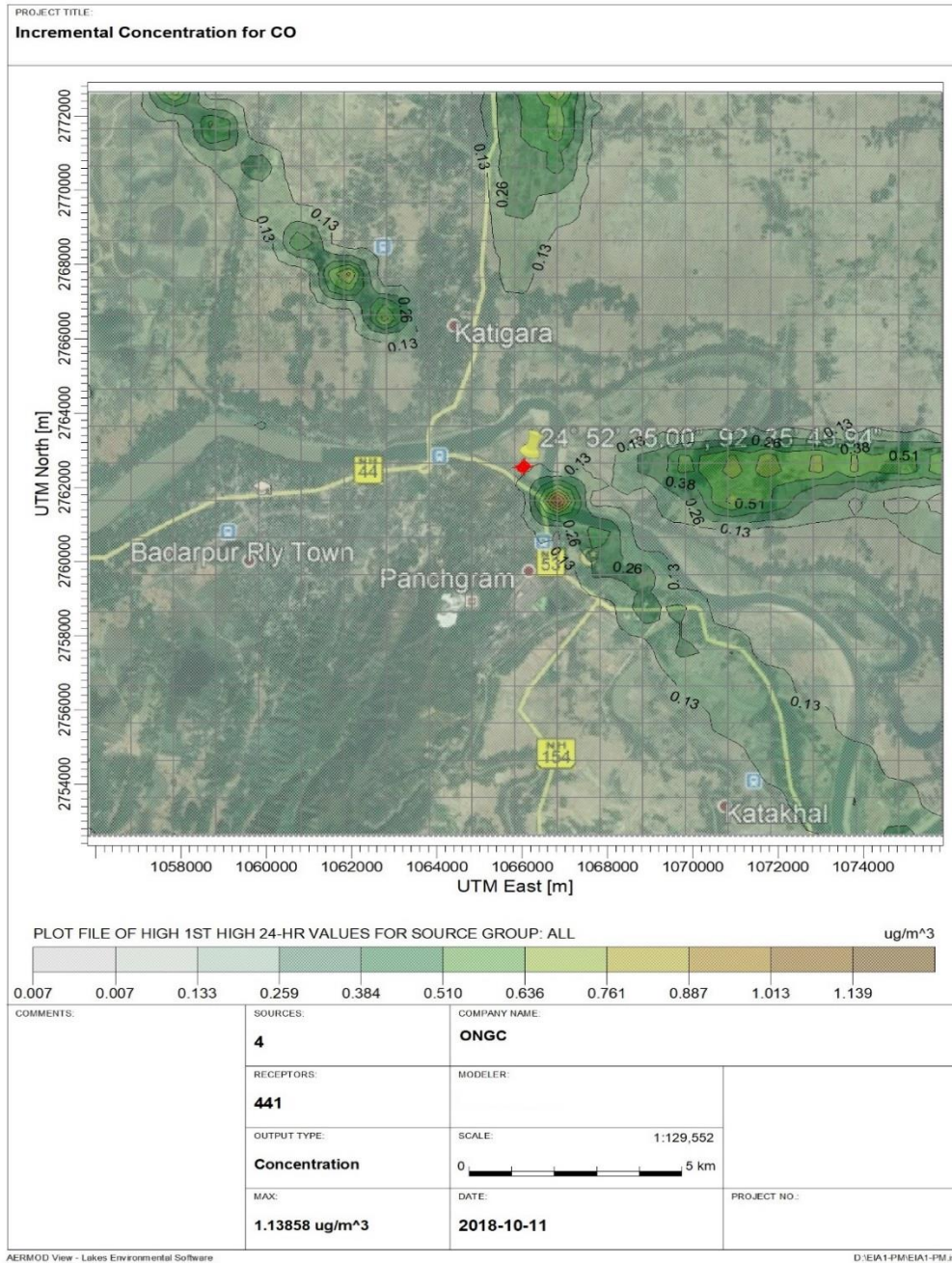


Fig-4.4 Output Model- Carbon Monoxide (CO)


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TABLE-4.6 Predicted 24 Hourly Short Term Incremental Concentrations

Pollutants	Maximum Incremental Conc. ($\mu\text{g}/\text{m}^3$)	Distance (km)/ Direction
Particulate Matter (PM)	0.06360	1.3 km SE
Sulphur-di-Oxide (SO ₂)	0.00854	1.3 km SE
Nitrogen Oxides (NO _x)	0.35011	1.3 km SE
Carbon Monoxide (CO)	1.13858	1.3 km SE

4.2.1.6 Comments on predicted concentrations


A perusal of **Table-4.6** reveals that the maximum incremental short term 24 hourly ground level concentrations for PM, CO, SO₂ and NO_x likely to be encountered due to DG sets are 0.06360 $\mu\text{g}/\text{m}^3$, 1.13858 $\mu\text{g}/\text{m}^3$, 0.00854 $\mu\text{g}/\text{m}^3$ and 0.35011 $\mu\text{g}/\text{m}^3$ occurring at a distance of 1.3 km in SE direction.

4.2.1.7 Resultant Concentrations after Implementation of the Project

The maximum incremental GLCs due to the proposed project for PM, CO, SO₂ and NO_x are superimposed on the maximum baseline PM, CO, SO₂ and NO_x concentrations recorded during the study to arrive at the likely resultant concentrations after commissioning of the proposed drilling. The cumulative concentrations (baseline + incremental) after implementation of the project are tabulated below in **Table-4.7**.

TABLE-4.7 Resultant Concentrations due to Incremental GLC's

Pollutant	Maximum AAQ Concentration Recorded During the Study	Incremental Concentration due to drilling	Resultant Concentration	AAQ Standard(CPCB)
Particulate Matter (PM)	91.7	0.06360	91.7636	100

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Sulphur-di-Oxide (SO ₂)	8.8	0.00854	8.8085	80
Nitrogen Oxides (NO _x)	24.8	0.35011	25.1501	80
Carbon Monoxide (CO)	0.33	0.001138	0.3311	2

The maximum GLCs for PM, CO, SO₂ and NO_x after implementation of the proposed project are likely to be within the prescribed standards for rural and residential areas. Further considering that the (maximum or minimum) GLCs occur at about 1.3 km, which is in the vicinity of the site boundary, therefore no impact on outside environment is envisaged. Based on the above details, it can be inferred that the ambient air quality in the study area is unlikely to be affected due to the proposed activity. The above air quality data reveals that even after considering incremental concentration in to baseline air quality from various operations, Ground Level Concentration (GLC) does not exceeds limits as prescribed by CPCB's National Ambient Air Quality Standards (NAAQS). It may be concluded that impact of proposed activities will be of insignificant.


4.2.1.8 Mitigation Measures

Measures proposed to mitigate the effects of air emissions are as follows:

- The exhaust of the DG sets will be at sufficient height to allow dispersions of the pollutants and periodical maintenance of DG sets so that emissions will be under limits.
- Use of Low sulphur diesel to reduce emissions of pollutant SO₂.
- Most of the equipment, machinery and vehicles have inbuilt pollution control devices.
- The storage and handling of top soils and materials will be carefully managed to minimize the windblown material and dust.

4.2.2 Noise Environment

The proposed drilling operations and related activities will lead to considerable emission of noise that may have significant impact on the surrounding communities in terms of increase in noise levels and associated disturbances. The potential impacts on noise level may arise out of the following:

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4.2.2.1 Noise from the drilling rig:

Driller Rotors, Power Generators and Pumps would be the main sources of Noise Pollution during the drilling activity. Noise due to vehicular movement will be intermittent, but will also add to the background noise levels. Typically, the noise generating sources for the onshore drilling activity are provided below: (in the immediate vicinity)

- Diesel Generator : 90 to 95 dB(A)
- Pumps: 85 to 90 dB(A)
- Miscellaneous : 80 to 85 dB(A)
- Control Room & Quarters : 50 to 60 dB(A)

In order to predict ambient noise levels due to the proposed drilling the preparative modelling has been done. For computing the noise levels at various distances with respect to the plant site, noise levels are predicted using an user friendly model the details of which is elaborated below:


4.2.2.2. Mathematical Model for Sound Wave Propagation during Operation

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

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

$$Lp2=Lp1-20 \log(r2/r1) \quad (1)$$

Where Lp2 and Lp1 are Sound Pressure Levels (SPLs) at points located at distances r2 and r1 from the source. The combined effect of all the sources then can be determined at various locations by the following equation:

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$$L_{p(\text{total})} = 10 \log(10^{(L_{p1}/10)} + 10^{(L_{p2}/10)} + 10^{(L_{p3}/10)}) \quad (2)$$

Where, L_{p1} , L_{p2} , L_{p3} are noise pressure levels at a point due to different sources.

Based on the above equations a user friendly model has been developed. The details of the model are as follows:

- Maximum number of sources is limited to 200;
- Noise levels can be predicted at any distance specified from the source;
- Model is designed to take topography or flat terrain;
- Coordinates of the sources in meters;
- Maximum and Minimum levels are calculated by the model;
- Environmental attenuation factors and machine corrections have not been incorporated in the model but corrections are made for the measured L_{eq} levels.


4.2.2.3 Input for the Model

The incremental increase in noise levels due to the operation phase of the exploratory drilling has been done. Noise levels are mainly generated from DG sets, Air Compressors and Pumps. The noise sources have been defined with respect to centre of drill site. The input data pertaining to corresponding noise level are tabulated below in **Table-4.8**.

TABLE-4.8 Input Data for Noise Modelling

Sr. No.	Location	Noise Levels dB(A)
1.	Diesel Generator sets	90 to 95
2.	Pumps	85 to 90
3.	Miscellaneous	80 to 85
4.	Control Room and Quarters	50 to 60

4.2.2.4 Presentation of Results

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The predicted noise level at 100 m distance from the boundary of well site is 52.0 dB (A) and are tabulated in **Table-4.9**.

Table 4.9 Predicted Noise Levels

Sr. No.	Distance from well site boundary	Noise Levels dB(A)
1.	25 m	58
2.	50 m	55
3.	75 m	54
4.	100 m	52


On the basis of expected noise levels calculated through standard attenuation model, it is observed that the noise levels in the region would be within the standard limits (IS: 4954). The increase will only be marginal in comparison to the existing noise levels. The impact of the noise on general population is therefore expected to be insignificant.

4.2.2.5 Occupational Health Hazards from Noise Pollution

Exposure to noise levels, above Threshold Limit Value (TLV), has been reported to have detrimental effect on the workers' health. Personnel's working for more than 4 to 4.5 hours per shift near the sound pressure level of 90 dB(A) will be greatly affected, unless suitable mitigation measures are taken. The adverse effects of high noise levels on exposed workers may result in:

- Annoyance;
- Fatigue;
- Temporary shift of threshold limit of hearing;
- Permanent loss of hearing; and
- Hypertension and high blood cholesterol, etc.

Noise pollution poses a major health risk to the workers near high noise source. If the magnitude of noise exceeds the tolerance limits, it is manifested in the form of discomfort leading to annoyance and in extreme cases to loss of hearing. Detrimental effects of noise pollution are not only related to sound pressure level and frequency, but also on the total duration of exposure and the age of the person. **Table-4.10** below gives noise levels and associated mental and physical response of humans.

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During drilling operation, the personnel required to continually present in high noise source like DG is remote. All personnel working on rig are given noise abatement personnel protective equipment's like earmuffs etc.


Table 4.10 Noise Exposure Levels & its Effects

Noise Levels dB(A)	Exposure Time	Effects
85	Continuous	Safe
85-90	Continuous	Annoyance and irritation
90-100	Short term	Temporary shift in hearing threshold, generally with complete recovery
Above 100	Continuous	Permanent loss of hearing
	Short term	Permanent hearing loss can be avoided
100-110	Several years	Permanent deafness
110-120	Few months	Permanent deafness
120	Short term	Extreme discomfort
140	Short term	Discomfort with actual pain
150 and above	Single Exposure	Mechanical damage to the ear

Source: OSHA

4.2.2.6 Community Noise Level

The maximum predicted noise level at about 100 m from the boundary of the drill site is about 52 dB(A). The ambient noise levels at most of the places in the region are within the CPCB standards. Since, the drilling operations last for only 4-5 months at each location, impact of the noise pollution due to the proposed exploratory drilling will be insignificant on the community. It can be concluded that the impact

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due to elevated noise is confined only up to a distance of 100 m from the drilling point and in areas beyond this distance, the ambient noise levels are within the stipulated ambient noise quality norms.

4.2.2.7 Noise emanated by Machinery and Equipment

In addition to the drilling activity, site preparation/closure related activities will also involve the operation of heavy equipment like pile drivers, loaders, tippers and bulldozers etc. Such heavy equipment are noted to emit considerable noise emissions which will get dispersed in the nearby communities thus resulting in a decrease in noise quality in the immediately adjacent settlement area. Most equipment and machinery will have noise control devices to reduce the emission levels.

4.2.2.8 Noise from vehicular traffic

Vehicles used for procuring goods, and manpower to the drill site and the subsequent transportation of rig/equipment and debris during decommissioning will use the site approach road and village roads. This will result in increase in traffic density to the site access road which will cause increase in noise levels in the nearby settlement and other sensitive receptors like schools, hospitals etc. located near the drill site. This may cause considerable noise disturbances to few residents living in the nearby areas as they were not very used to with such noise exposure. However this is a temporary in nature hence the impact may be considered insignificant.


4.2.2.9 Noise Control Measures

Typical mitigation measures for noise will include the following:

Sufficient engineering control during installation of equipment and machineries is ensured

- Acoustic enclosures for the DG sets
- All noise generating operations except drilling is restricted to daytime to the extent possible
- Personnel Protective Equipment like ear plugs/muffs will be provided to the workers at the site
- Undertake preventive maintenance of vehicles and machinery to reduce noise levels.

4.2.3 Surface Water and Groundwater Quality

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The daily water consumption at the proposed exploratory drilling will be 25 M³ per day. Out of this 15 M³ will be consumed for mud preparation and 10 M³ for domestic consumption (Personnel & Kitchen). The waste water from the cuttings washings, derrick floor cleaning, de-silter and de-sander will be collected in the HDPE lined waste pits and will be recycled & re-used after treatment with mobile Effluent Treatment Plant (ETP). No waste water is discharged to the outside water bodies.

Drilling fluid or mud is basically a mixture of water, clay, polymers and weighting material with all individual components being Environmentally friendly. The mud circulation is a closed loop with the return mud going back to the mud tanks. At the end of drilling operations, the residual (unusable) water based mud is discharged in to the waste pit. Since, lined pits will be used for solar evaporation of the unusable mud, the chances of run off or leaching is very low. Therefore, no significant impacts on surface water quality is envisaged due to the proposed drilling activity.


4.2.3.1 Sources of Water Pollution

In general circumstances, the surface water impacts that could be potentially caused from the drilling activities are as follows:

- Potential wastewater discharges may arise from the following sources:
 - ✓ Treated domestic effluent (sewage and kitchen waste);
 - ✓ Spent drilling muds, cuttings and completion fluids disposal;
 - ✓ (Potentially) contaminated storm water drainage from the derrick floor and other systems;
 - ✓ Seepage of drilling mud fluid into subsoil from mud collection & recirculation pond;
 - ✓ (Potentially) high sediment loads in runoff from unpaved well site areas during heavy shower; and
 - ✓ Any produced water and liquid hydrocarbon fractions collected in the test separator during well testing.
- Potential accidental spills of fuel, lubricants or chemicals and leaks from engines (i.e. power generators, vehicles) and liquid hydrocarbons during testing; and

4.2.3.2 Potential Surface and Groundwater Impacts

Based on the above-mentioned activities, the following potential impacts have been identified:

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- Potential for water logging during monsoon in the site;
- Potential for adverse impact on the surface water quality;
- Potential for adverse impact on the groundwater quality; and

4.2.3.3 Impact to Surface Water Quality

The probability of contamination of surface water bodies and sub-surface water bodies was discussed above. The impact to the surface water bodies could arise from discharge from the site, disposal practice of spent drilling mud, cuttings, completion fluids, handling of liquid hydrocarbons, fuels etc. With the proposed concrete pavement and secondary containment provisions, the surface water quality contamination will be negligible. Noticeable impacts to water quality in nearby watercourses are more likely to occur as a result of increased suspended particle load. During the well site preparation the extent of impact to nearby watercourses will be function of:

- Area cleared;
- Amount of rainfall from the period between site construction and drilling;
- Distance of the watercourse from the well site; and
- Mitigation measures to prevent any soil erosion within well site.

However, if the site preparation activities were conducted in dry season, the above impact would be negligible or insignificant. Overall, with the appropriate measures to protect the well site and prevent discharges, installation of soil erosion control measures, prevention of spillages while handling and management of chemicals, the likely chances of impact on surface water will be minor.

4.2.3.4. Impact on Groundwater Regime

The water requirement for drilling is proposed to be met from the local sources through water tankers. Since the drilling activity being temporary and water requirement is meagre, no adverse impact on ground water resources is envisaged.

ONGC proposes to use water based non-toxic biodegradable fluids with inhibitive and encapsulative characteristics as drilling mud. Additionally, the drilling mud collection and recirculation pond is lined with impervious layer to prevent seepage and loss of drilling fluid into the subsoil. Further, proper casing installation and cementing will ensure least groundwater contact.




Apart from the mud characteristics, the waste and spent mud would be disposed in polyethylene propylene lined pits. The mud components during the storage form a Bentonite (clay) lining along the pit wall preventing the seepage of water to the underground strata. Any hydrocarbons contamination will be skimmed off from site before proceeding to the next site so as to ensure that no leaching or sub-surface contamination finally reaches the groundwater table. The waste oils and the skimmed oils collected from the drill site will be sent to the authorized recyclers.

Overall, with the appropriate management practices in place impacts on groundwater quality at the site is likely to be insignificant. The summary of impacts on water resources is given in **Table-4.11**

TABLE-4.11 SUMMARY OF IMPACT ASSESSMENT: WATER RESOURCES

Impact Area	Nature of Impact ¹	Targets/Interests affected ²	Magnitude and extent ³	Overall significance
Surface Water				
Physical Impact	Long term modification to the distribution of rain water catchment, if located near it	Local inhabitants depending on the water harvesting for water	Local, could be mitigated by avoiding water harvesting areas	Minor
	Short term due to increase in siltation load of the water bodies in rainy season	Localized impact to surrounding Rivers and adjoining the water bodies in monsoon	Regional, and for short term	Moderate
Chemical Impact	Short term contamination of surface water flows due to untreated effluent, run-off, seepage from water holding tanks etc.,	Localised impact to surrounding nallahs and the river bodies in monsoon	Local, small scale mitigated by well site design and operations	Minor
	Long term contamination in the region due to surface runoffs from well sites during flash floods	Could also result in sub surface contamination around the region	Regional, dependent on occurrence of flood. Good engineering practices will reduce risk of flooding and overflow	Moderate
Ground Water				

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Groundwater quantity	Long & medium term, reduction due to percolation of subsurface contamination	Shallow aquifers surrounding the well sites	Local/Regional possibility remote with mitigation measures	Minor
Resource Management				
Resource Management	Long term, medium reduction	Judicious abstraction of water for usage	Regional, Can be mitigated by sourcing water from water surplus catchment areas. Drill site borewell can be used by locals after drilling, if water quality is acceptable	Minor

1 Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc 2 Targets and interests potentially affected. 3 Adverse or beneficial; small, large, etc; much localised (sites only), local, regional national. 4 Overall significance against criteria (minor; moderate, major)

4.2.4 Topography and Climate


4.2.4.1 Impact on Topography

The envisaged topographical changes would be due to the manmade structures like drilling rig and other associated structures. As mentioned previously drilling exploratory well is a short duration activity at each drilling location, typically encompassing a period of 6-7 months from land acquisition to site abandonment. The impact would therefore be localised, temporary and minimal.

4.2.4.2 Impact on Climate

Impact on the climatic conditions from the drilling will not be significant. The maximum temperatures of the exit gas from the DG stack and flare stack will be around 300°C and 400°C respectively. In terms of total emission of greenhouse gases and consequent impact on global warming or on potential for local increase of ambient temperature, considering the quantum of exit gas and the total duration of flow, the impact on the local or global climate will be insignificant.

4.2.5 Land Environment

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Impact on land use and aesthetics is expected to be from vegetation clearance, excavation, levelling and grading of the site. Thus there might be need for clearing crops and trees. As the land requirement for each drill site is quite small (1.5-2.0 ha) compared to the large stretches of agricultural land there would be insignificant change to land use. Movement of heavy vehicles, earth moving equipment, piling of removed soil at the site periphery during construction would have aesthetic impacts.

4.2.5.1 Land Required for Drilling Activity

Though Exploratory drilling is a temporary activity yet the period for which the land is required would depend on discovery of hydrocarbons. Approximately, 15,600 m² of land for drilling rig facilities would be impacted for each drill site. The actual drilling platform area would be approximately 5200 m². The parcel of land would be temporarily acquired as per the applicable laws and in consultation with the land owners. Adequate compensation for loss of income from that piece of land, including crop loss, tree loss and any other direct or indirect loss as determined by the local revenue officials would be paid to the landowner. Drilling rig activities will result in disturbance and compaction of soils within a 1.0 ha zone around the drilling rig due to equipment, vehicles. Access roads to the drilling sites will also impact top soils. The total loss of soils as a result of exploration drilling with probably be in the order of 3-5 ha per well, depending on the length of access road required to access each site.

4.2.5.2 Impact on Soil Quality

During construction the major impacts on soil would occur due to excavation, compaction due to movement of heavy equipment and levelling. Site preparation will entail stripping and removal of the topsoil which contains most of the nutrients and organisms that give soil a living character and productivity. This will in turn result in minor changes in soil hydrology and small changes in the topsoil structure. However, as the project design takes into account the preservation of the top soil and its subsequently use for topping up of the rehabilitated land. The impact on soil quality will be insignificant considering the mitigation measures implemented.

4.2.5.3 Soil Contamination



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The chances of soil contamination are from the storage and handling practices of chemicals and fuels, surface runoff carrying contaminated substances. The drilling mud and the cuttings could also add to the sub surface contamination if not handled appropriately.

4.2.5.4 Localized Alteration of Subsoil and Overland Drainage Patterns

The exploratory drilling activity is not likely to cause any noticeable impact in the drainage pattern of the area, since it is a temporary activity and confined to a small plot of land.

4.2.5.5 Alteration of Soil Quality by Loss of Topsoil

Loss of topsoil in these areas, either by mechanical removal or by erosion would alter the soil structure with resultant implications for re-vegetation. Measures inherent in the design of the project to minimize loss of topsoil and overburden are as follows:

- Topsoil suitable for supporting agriculture, removed during site clearance will be retained, stored as a berm on the edge of the well site, protected from erosion by plastic sheeting;
- Native vegetation, wherever appropriate will be kept at the edge of the well site as a seed bank, or replanted at an alternate location or will be used to protect/stabilize soil surfaces on slopes;
- On demobilization, adequate measures would be provided to facilitate re-growth and hence retention of top soils; and
- Planned and systematic tree replanting program will be put in place.

On consideration of the poor vegetation cover, the physical features of the proposed exploration block, the impact of drilling operations on soil quality will be insignificant. It is, however, important that mitigation measures are monitored to ensure that they are effective. Summary of impacts on soil and land use are given in **Table-4.12**

The mitigation measures inherent in the design of the well site, together with rigorous implementation of the waste management plan will ensure that significant impacts in relation to soil quality are not anticipated at the well site.



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Table 4.12 Summary of Impact Assessment: Soil and Land Use

Impact Area	Nature of Impact ¹	Targets/Interests ²	Magnitude and extent ³	Overall Magnitude ⁴
Land Use	Change in original land use, land degradation,	Original land use	Well sites and access roads only, small scale; beneficial effect for afforestation and all weather access roads.	Minor
Derogation of Soil Quality	Cumulative contamination with dust, surface run-off; reversible	Soil quality, flora and fauna, including grazing livestock	Localised near sources; small contribution to existing background levels	Minor
	Physical effects on soils due to topsoil removal, nutrient loss; reversible	Soil quality, flora	Around the well location small scale degradation of soil quality	Minor
Soil Contamination	Subsurface contamination due to spillage and handling of the chemicals and other waste materials, reversible(partial)	Soil quality, groundwater flora and fauna and the grazing livestock	Localised near the source of operation and could be nullified with proper house-keeping & waste management	Minor

1 Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc 2 Targets and interests potentially affected. 3 Adverse or beneficial; small, large, etc; very localised (sites only), local, regional national. 4 Overall significance against criteria (minor; moderate, major)

4.2.6 Biological Environment

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Impact on the ecology of the study area will vary with the proximity of the habitats from the drilling locations. However, the impacts are of temporary nature, which will last only for few months at each drill location during the exploratory drilling activities and will thus allow subsequent recovery after the activities stops. Considering the above aspects the chance of irreversible ecological impact at the exploration stage is minor.

4.2.6.1 Impact on Terrestrial Environment


Prediction of Impacts on Biological Environment due to any exploratory activity is practically difficult because:

- Living subjects has a natural variation in numbers, changes in numbers cannot always be directly attributed to changes in the environment
- Most of the impacts on the living system or ecosystem takes long time period to become fully visible externally
- As such, the forests are getting vanished and the growing industrialization will affect the plant life due to industrial pollution load and influx of population.
- Therefore, to minimize the adverse effect of drilling activity, it is proposed to take adequate management measures as prescribed in the EMP.
- The nearby natural vegetation will be disturbed for short duration till the drilling activity continues due to increase in pollution load. However, it will improve due to follow up of Environmental Management Plan (EMP).
- Mangrove vegetation does not exist in the area hence no changes are anticipated.

There are no rare and endangered plant and animal species in the study area and hence no changes are anticipated. As regards soil microbiology, no oil bearing waste will be discharged to the ground and adequate emergency control measures in place to take care of any accidental spills.

4.2.6.2 Impact on Aquatic Environment

Waste mud and effluents from drilling activity will be contained in HDPE lined waste pit within the drill site premises and there will be no discharge to any aquatic environment. No disturbance or damage will be expected to the aquatic environment.


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The primary form of impact could be in form of habitat disturbances, which would normalize after completion of the drilling activity. During the site preparation activities vegetation clearance would be nominal or minor. The impact due to air pollution on flora & fauna can be expected to be negligible, as the impact predictions based on the dispersion modelling do not indicate any significant release of the pollutants and ground level concentrations. Implementation of erosion and sediment controls to direct construction runoff through silt fences, sediment traps, and vegetative berms to decrease sedimentation in streams.

The flora and faunal habitats in the study area may be affected by erosion, siltation and water stagnation arising from run-on and runoff at the well site, if suitable mitigative measures are not implemented. The mitigative measures pertain to surface run-off from well site, wastewater discharges, solid waste disposal, erosion abatement measures, etc; As long as strict environmental management measures are put in place, including adequate measures for supervision of contractors and staff, negative effects on fauna will be minimized. There are however, likely to be some residual, unavoidable, impacts, linked to the requirement of optimal clearing the vegetation to facilitate drilling activities. Based on air dispersion modelling studies the resultant concentrations of ambient air pollutants were found to be well within the prescribed standards. Hence the impact on the ecology will be negligible. The summary of impact assessment on flora and fauna are given in **Table-4.13**.

TABLE-4.13 Summary of Impact Assessment Flora and Fauna

Aspect	Nature ¹	Targets/Interests ²	Magnitude ³ and extent	Overall Significance ⁴
Loss of habitat	Loss of vegetation land	Flora and fauna, flora typically type vegetation, faunal comprise grazing animals and dependent mammals and reptiles.	Small & localised. . Beneficial, Medium,	Minor
Disturbance	Light, noise Surface run-off. Project duration only	Local community, Breeding birds, and flora and other fauna.	Small, localized. Mitigative measures in-built in equipment /well site design to meet ambient limits.	Moderate
Invading species	Colonisation by species associated	Avifauna and fauna and Weeds species	Small, Localised. No migration route / paths reported in the block.	Minor

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	with human activity			
Waste disposal / run-off	Contaminated water/rain water,	Fauna, especially birds and reptiles	Small, Localised. No off-site disposal is likely to occur from the exploratory drilling operation. Area fenced and maintained even after drilling operation completed	Minor

1 Description; short or long term; reversible or permanent; associated with construction, operation, decommissioning; cumulative, accidental, etc 2 Targets and interests potentially affected. 3 Adverse or beneficial; small, large, etc; much localised (sites only), local, regional national. 4 Overall significance against criteria (minor; moderate, major)

4.2.7 Socio-Economic Environment


Although the well site would be selected to avoid any major social impacts, there will, nevertheless, be some issues that need to be addressed in the region. The drilling programme would involve setting up the actual drilling rig, construction of campsite for accommodation and operational crew. An approach road from the road head to the drilling rig will also be developed and also to facilitate regular transport from campsite.

It is anticipated that the drilling activity would involve direct and indirect impacts on socio-economic environment. These impacts are short term in nature.

ONGC proposes to avoid any settlements, there is expected to be no displacement of people for the proposed drilling campaign. The well sites are expected to be in non-residential lands/ human settlement zones. The types of impacts due to drilling activities have been summarized below:

- Land required for drilling activity
- Partial loss of productivity of land due to the project
- Temporary losses during the drilling activity
- Common Property Resources

4.2.7.1 Impact on Civic Amenities

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The area has limited network of roads and communication in the village areas. Many villages have been electrified during the last decade. There are few business centres and industrialized zones in the project block area. Although, the level of existing communications and support services in the area are considered adequate based on the population density, establishment of the proposed project would be a distinct beneficial impact. The overall impact is considered to be positive.

4.2.7.2 Impact on Health

Impact on health due to emissions and noise from drilling activity has been assessed to be minimal. In addition employees working at the drill site would be provided protective devices like ear plugs/ear muffs for ensuring minimum impact on human health.

4.2.7.3 Impact on social well being

At the camp sites, while communication between locals and outside workers may sometimes be good (exchange of information about places and lifestyle) there is a risk that an influx of migrant population from outside areas could well lead to social tensions. As a general rules, base campsites would be located away from centres of population in order to minimize these risks.


Exploration drilling programme is expected to generate local employment in the order of 50 to 80 unskilled and semi- skilled people, for a period of approximately 4-5 months at each drilling site location. While this benefit is small by most standards, it is a significant employment opportunity in the block.

4.2.7.4 Impact due to Vehicular Movement

The anticipated traffic volume during the construction phase of about 30 days, would approximately be 30 truckloads per day of material movement. The installation of the drill site equipment / facilities involves about 80 trailer loads spread over 10 days and during regular drilling operations on an average 5 truck movements per day with 10 small vehicles for the visitors and the drilling team would take place.

Considering the sparse vehicular movement in the block as a whole, the above anticipated traffic volume and the resulting emissions will be well within the stipulated ambient air quality norms.

4.2.7.5 Other Impacts on Resources and Infrastructure

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As highlighted earlier, infrastructure is very scarce in the study area, especially in the vicinity of the proposed well sites. Preparation and drilling operations could conceivably affect the following infrastructure.

Critically analysing the existing status of socio-economic profile vis-à-vis its scenario with proposed project, the impacts of the project would be of varying nature. The predicted impacts are as follows:

- The proposed activities would generate indirect employment in the region; labour force will be required in site preparation and drilling activities, supply of raw material, auxiliary and ancillary works which will improve the economic status of the local unemployed persons.
- The commissioning of project would lead to improvement in transport facilities as loose or soft surface rural roads and trails will be upgraded to facilitate movement of the drilling rig and supply vehicles
- In the event of commercial quantities of hydrocarbons are discovered, more long term employment opportunities would be created and enhance the availability of fuel to various industries in this region.

Exploratory drilling is a temporary activity which lasts for about 4-5 months at each location. Thus, the environmental impacts are transient in nature and there will not be any residual impact on the environment.

Table 4.14 Summary of Identified Impacts and Proposed Mitigation Measures

S.No	Impacts	Mitigation Measures
1.	Air Emissions <ul style="list-style-type: none"> • Emissions from DG sets • Emissions from vehicular movement; 	In accordance with the ONGC Mines Regulations Rules 1984, a flare stack of 9 m height shall be provided at existing EPS at a distance of 30 m from well. <ul style="list-style-type: none"> • Fugitive emissions may result from handling and storage of hydrocarbons (crude & diesels) which are very minor. • At the time of transportation dust will be generated.

		<ul style="list-style-type: none"> Water spraying to be done on the access roads to control re-entrained dust during dry season(if required); The engines and exhaust systems of all vehicles and equipment used will be maintained as such, that exhaust emissions are low and do not breach statutory limits set for the concerned vehicle/equipment type; D.G set shall be properly maintained; Ensuring the availability of valid Pollution Under Control Certificates (PUCC) for all vehicles
2.	<p>Noise Generation</p> <ul style="list-style-type: none"> Noise from Production Operation Noise from vehicular Traffic / movement Noise from DG set / fire engine 	<p>Sufficient engineering control during installation of equipment's and machineries (like mufflers in DG sets) is to be ensured to reduce noise levels at source;</p> <ul style="list-style-type: none"> Proper and timely maintenance of vehicles is to be adopted to reduce noise levels; All noise generating operations, (except anything directly related to Production operations) to be restricted to daytime only to the extent possible; Personal Protective Equipment's (PPE) like ear plugs/muffs is to be provided to all the workers at site and it shall be ensured that the same are worn by everyone during their shift.
3.	<p>Wastewater Generation</p>	<ul style="list-style-type: none"> Domestic and produced waste water generated will be sent to ONGC. Waste water generation will be from domestic usage and produced water from the wells. Associated water from produced water will be collected, separated and sent to ONGC for treatment. The treated produced water complying with SPCB Waste water discharge standards will be re-injected into the reservoir through injection wells complying with SPCB Norms All chemical and fuel storage areas shall have proper bunds so that contaminated run-off cannot meet the storm-water drainage system; Re-injection/disposal system will be created and then treated water will be either used for green belt development of if salinity is high, it will be injected through injection wells in the field. (Depth below of 1000 m from ground level) Company shall strive continually on Reduce, Recycle, and Fuel and Crude oil shall be stored in Reuse principle.

		<ul style="list-style-type: none"> Chemical shall be stored in proper packing under shed, Spill control mechanism
4.	Land	<ul style="list-style-type: none"> On completion of works (installation of additional Tanks, Separators etc) at EPS site, surplus materials and wastes will be completely removed; Optimization of land requirement through proper site lay out design
5.	Soil	<ul style="list-style-type: none"> Management of spillage of contaminants such as oil from equipment's, etc. on the Soil; Chemicals / HSD to be stored at concrete paved designated area, with roofs Proper arrangement of soak pits to be provided at the production site for disposal of domestic waste water; Hazardous waste generated at site shall be segregated at source based on the categories and stored on concrete paved designated area with roofs.
6.	Solid and Hazardous Waste Management	<ul style="list-style-type: none"> Hazardous waste generation shall be restricted to EPS site only. Generation of Waste oil/ Used oil in very negligible quantity and shall be used for internal purpose for Oil / greasing whereas Oily cotton waste will be sent to approved TSDF site. Oil sludge generated will be sent to authorize recyclers. Hazardous Waste storage shall be properly designated and concreted. Domestic Solid waste generated at site will be segregated at source (Organic / inorganic) & disposed accordingly. General wastes, scrap metal and wood will be segregated and will be disposed of appropriately to authorized recyclers. All plastic/paper waste will be collected and will be disposed of to scrap dealers. Waste lubricants and hydraulic oil generated from the equipment will be disposed of the authorized waste recyclers. Containers of oil and other materials will be sold to SPCB/CPCB authorized recyclers. Oily cotton waste shall be segregated at source and shall be sent to authorize incinerator for disposal.


		<ul style="list-style-type: none"> • Proper provision of storage area and disposal method for solid and hazardous waste • Provision of concrete pit for storage of waste (produced) water
7.	Socio Economic	<ul style="list-style-type: none"> • Generation of indirect employment in the region due to the requirement of workers, supply of raw material, auxiliary and ancillary works, which would marginally improve the economic status of the people. • Result in an increase in local skill levels through exposure to activities. • As the existing loose / soft surface roads, shall be upgraded to facilitate the movement of the heavy equipment required, the project in turn would lead to improvement in transport facilities. • CSR activities shall be carried out by ONGC, under the directive of State Government which shall help in improvement of facilities in the area.
8.	<p>Flora and Fauna Impact on terrestrial fauna due to noise</p> <ul style="list-style-type: none"> • Project infrastructure and well development will disturb agriculture land of site • Spillage, leakage and well treatment may produce chemical spillage which will disrupt agriculture of nearby farm • Production activity (tanker movement) may increase deposition of dust and dust settling on the vegetation which may alter or limit plants' abilities to photosynthesize and/or reproduce 	<ul style="list-style-type: none"> • Acoustic enclosure shall be provided to D.G. set to reduce the noise intensity • Development of plantation of native species to substitute the access cutting, site preparation, which shall provide habitat, food and breeding areas to birds, small animals and insects • Use existing facilities (e.g. Access Roads) to the extent possible to minimize the amount of new disturbance • Avoid use of unnecessary lighting at night to avoid attracting avifauna
9.	<p>Occupational Health and risk to surrounding community</p> <ul style="list-style-type: none"> • Noise generated during operational activity may affect the workers and staff members. 	<ul style="list-style-type: none"> • Providing PPE to site workers and staff member or ensuring it through contractors. • Acoustic enclosures will be provided to DG sets and other noise generating equipment.




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	<ul style="list-style-type: none"> • Handling of chemicals, fuel, may cause health hazard if not handled properly. • Uncontrolled flow of hydrocarbon or other fluids during blow out may cause serious health • Injuries including fatality of workers as well as damage to surrounding communities. 	<ul style="list-style-type: none"> • ONGC will develop and implement a spill management plan to prevent risk of spill which may cause health problem. • All operational activities shall be carried out in confirmation with applicable OISD and OMR standards/regulations/guidelines. • Regular internal / external HSE inspection shall be carried out. • Community awareness with regards to Operation activities and Risk and Hazards associated with the same shall be carried out.
10.	Chemical, Fuel & Crude Storage	<p>Fuel and Crude oil will be stored in tanks which has provision of bund,</p> <ul style="list-style-type: none"> • Chemical will be stored in proper packing under shed • Spill control mechanism

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CHAPTER-5

Analysis of

Alternatives

(Technology & Site)

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5. ANALYSIS OF ALTERNATIVES

5.1 Alternate Site for the Proposed Project

No alternative site is applicable for this project, the PML blocks were awarded to ONGC by Govt. of India for Exploration of Oil & Gas. However, all safe distances from habitation and other information (like environmental settings) was considered for selection of well location.


5.2 Alternative for Technology

No alternative technology is applicable for this project, as the project would involve Conventional Rotary Drilling technology which is being used world-wide in Oil & Gas industry.

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CHAPTER-6

Environmental Monitoring Program

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6.0 ENVIRONMENTAL MONITORING PROGRAMME

6.1 Introduction

Regular monitoring of environmental parameters is of immense importance to assess the status of environment during project operation. With the knowledge of baseline conditions, the monitoring programme will serve as an indicator for any deterioration in environmental conditions due to operation of the project, to enable taking up suitable mitigatory steps in time to safeguard the environment. Monitoring is as important as that of control of pollution since the efficiency of control measures can only be determined by monitoring. Usually, as in the case of the study, an Impact Assessment study is carried over short period of time and the data cannot bring out all variations induced by the natural or human activities. Therefore, regular monitoring programme of the environmental parameters is essential to take into account the changes in the environmental quality.

6.2 Environmental Monitoring and Reporting Procedure

Development of the programmes during the planning process shall be conducted or supported by environmental specialists. However, the implementation responsibility rests with line managers, who should, therefore, ensure they fully understand and subscribe to the commitments being made. These commitments will include the legal and statutory controls imposed on the operation as well as other corporate commitment to responsible environment management. Monitoring shall confirm that commitments are being met. This may take the form of direct measurement and recording of quantitative information, such as amounts and concentrations of discharges, emissions and wastes, for measurement against corporate or statutory standards, consent limits or targets. It may also require measurement of ambient environmental quality in the vicinity of a site using ecological/biological, physical and chemical indicators. Monitoring may include socio-economic interaction, through local liaison activities or even assessment of complaints. The preventative approach to management may also require monitoring of process inputs, for example, type and stocks of chemical use, resource consumption, equipment and plant performance etc. The key aims of monitoring are: first to ensure that results/conditions are as forecast during the planning stage, and where they are not, to pinpoint the cause and implement action to remedy the situation. A second objective is to verify the evaluations made during the planning process, in particular in risk and impact assessments and standard and target setting and to measure operational and process efficiency. Monitoring will also be required to meet compliance with statutory and corporate

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requirements. Finally, monitoring results provide the basis for auditing. A more detailed approach to monitoring and performance measurement is provided in various publications.

6.2.1 Objectives of Monitoring

The objectives of monitoring are to:

- Verify effectiveness of planning decisions;
- Measure effectiveness of operational procedures;
- Confirm statutory and corporate compliance; and
- Identify unexpected changes.


6.2.2 Monitoring Schedule

Periodic environmental monitoring schedules are prepared covering various phases of project advancement. This comprises the duration of proposed exploratory drilling as well as post-project phase, when the hydrocarbon is established in the wells and production program is undertaken as well as the Decommissioning/Closure Phase for minimum 10 years. In order to assess the extent and nature of impacts on environment due to drilling operations, the monitoring on various attributes of environment will be carried out during various phases of drilling as under:

Pre-Drilling Phase: Prior to the start of drilling activities, the environmental status around the proposed drilling locations shall be monitored. These results will represent the baseline environment status, against which the monitoring results from the other phases are compared.

Drilling Phase: Monitoring during drilling phase serves as a measure of the impact on the environment due to drilling operations. Besides, the analysis of drill cuttings and drilling mud at various depths shall be carried out as per MoEF&CC guidelines on disposal of drilling wastes.


Testing Phase: Well testing is a short term activity spread over a period of 2 to 3 days. Testing operations are carried out to determine the presence of hydrocarbons and to understand the reservoir characteristics. Monitoring during this phase will serve as a measure of the impact on the environment due to testing operations.

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Post-Drilling Phase: Monitoring shall be carried out after completion of drilling and testing operations to determine if there has been any residual impact on the environment due to drilling and testing operations. The detailed monitoring program covering drilling phase is given in **Table-6.1**.

Table 6.1 Schedule of Environmental Monitoring

Sr.No.	Aspect	Parameter	Frequency	No. of Locations
I. Pre-drilling Phase				
	Ambient air quality	PM10, PM2.5, SO2, NOx, CO and Hydrocarbons as CH4	Two Days in Week	4 locations
	Noise monitoring	Leq(n), Leq(d), Leq(dn)	Once	4 locations
	Water quality	As per IS: 10500 including heavy metals	Once	Min 5 Locations
	Soil quality	Texture, conductivity, organic carbon, P2O5, K2O, pH, Cl, Heavy metals viz. Cr, Ni, Cu, Zn, Cd, Hg and Pb	Once	8 locations
II. Drilling Phase				
1.	Ambient Air Quality	PM10, PM2.5, SO2, NOx, CO and Hydrocarbons as CH4	Two days in week for two weeks	4 locations
2.	Noise Monitoring	Leq(n), Leq(d), Leq(dn)	Once	4 locations
3.	Source emissions monitoring	Flue gas temp., velocity, flow, dust conc. SO2, NOx	Once	4 Samples
4.	Water Quality	pH, TDS, Alkalinity, F, Sulphates, Cl, Cr, Ni, Cu, Zn, Cd, Pb	Once	Min. 5 locations
III. Testing Phase				
1.	Ambient Air Quality	PM10, PM2.5, SO2, NOx, CO and Hydrocarbons as CH4	Two days in week for two weeks	4 locations
2.	Noise Monitoring	Leq(n), Leq(d), Leq(dn)	Once	4 locations
IV. Post Drilling Phase				
1.	Ambient Air Quality	PM10, PM2.5, SO2, NOx, CO and Hydrocarbons as CH4	Two days in week for two weeks	4 locations
2.	Water Quality	As per IS: 10500 including heavy metals	Once	Min. 5 locations

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3.	Soil quality	Texture, conductivity, organic carbon, P2O5, K2O, pH, Cl, Heavy metals viz. Cr, Ni, Cu, Zn, Cd, Hg and Pb	Once	8 Locations
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6.3 Reporting Schedules of the Monitoring Data

It is proposed that voluntary reporting of environmental performance with reference to the EMP should be undertaken. The environmental monitoring cell shall co-ordinate all monitoring programmes at site and data thus generated shall be regularly furnished to the State regulatory agencies. The compliance reporting shall be on six monthly basis to the local State PCB officials and to Regional Office of MoEFCC. The Environmental Audit reports shall be prepared for the entire year of operations and shall be regularly submitted to regulatory authorities.

6.4 Infrastructure for Monitoring of Environmental Protection Measures

A well-equipped laboratory with consumable items shall be provided for monitoring of environmental parameters in the site. Alternatively, monitoring can be outsourced to a recognized reputed laboratory.


The following equipment and consumable items shall be made available in the site for environmental monitoring.

Air Quality and Meteorology

High volume samplers, Stack monitoring kit, Personal Dust sampler, Central Weather Monitoring Station, Spectrophotometer (visible range), Single pan balance, Flame photometer, Relevant Chemicals as per IS:5182.

Water and Wastewater Quality

The sampling shall be done as per the standard procedures laid down by IS: 2488. The equipments and consumables required are: BOD incubator, COD reflex set-up, Refrigerator, Oven, Stop watch,

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Thermometer, pH meter, Distilled water plant, Pipette box, Titration set, Dissolved oxygen analyser, Relevant chemicals.

Noise Levels

Noise monitoring shall be done utilising an integrating sound level meter to record noise levels in different scales like A-weighting with slow and fast response options.

6.5 Environmental Costs


All costs involved in environmental mitigating measures and management are included in the project cost.

6.6 Audit and Review

Review and audit is essentially a management tool. However, its application is crucial at the operational level for verification and feedback on the effectiveness of organization system and environmental performance. Basically, Auditing involves in the following items:

- Line management system;
- Awareness and training;
- Procedures, standards, targets;
- Plans: waste, contingency, pollution control compliance;
- Monitoring programmes;
- Verify Environmental Impact Assessment;
- Verify mitigation;
- Reporting and communication;
- Documentation; and
- Feedback.

Audit serves to substantiate and verify monitoring programmes and compliance, and to ensure that site environmental plans, procedures and standards are both effective and fit for purpose. Other benefits of auditing include increased internal and external awareness, communication and credibility of company environmental activities by demonstrating commitment to and achievement of responsible environmental management.

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In addition to management and compliance audits, a number of technical or process audits, sometimes termed assessments or valuations, may be conducted. Thus, waste and emissions audits, energy audits, site (contamination) audits, emergency counter measure audits, worker health and safety audits, may be instigated independently or as part of a broader management audit. Reports on environmental performance shall be made available for a wide public readership including shareholders and financing bodies. An important audience is also the company employees, who benefit from having the company's environmental position and activities described in a way that allows him or her to be an ambassador in a general sense for the company. Reporting is becoming increasingly sophisticated, and more closely linked with the total environmental programme of companies. The contents of these reports still vary greatly, with a gradual but noticeable tendency to quantify environmental performance, and include mention of a range of environmental and sustainability indicators such as pollution and safety incidents, greenhouse gas emissions, and even non-compliance statistics.

6.6.1 Internal Audit

A system of HSE auditing should be undertaken at each project operation and includes the use of trained internal and external auditors. In addition, auditing should be undertaken to ensure compliance with all the applicable legislations.


6.6.2 Audit Type Frequency

- Internal – from other site in-charge Every month
- External - independent expert Every 3 months

ONGC shall depute internal/external auditors who are trained and certified as competent EMS auditors by an independent and external standards organisation. The results of monitoring and auditing shall be regularly reported through the senior management team to ensure that action items are addressed.

6.6.3 Non-Conformity, Corrective Action and Preventative Action

As per the Environmental Policy of the Company, non-conformities, corrective actions and preventative actions shall be managed in accordance with Non-Conformance, Preventative and Corrective Action Procedure. This procedure, which relates to all projects of the company, should detail the processes to be utilised with respect to the identification of non-conformances, the application of appropriate corrective

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actions(s) to address non-conformances and the establishment of preventative actions to avoid non-conformances.

The key elements of the process include:

- i. Identification of Non-Conformance and/or Non-Compliances;
- ii. Recording of Non-Conformance and/or Non-Compliance
- iii. Evaluation of the Non-Conformance and/or Non-Compliance to determine specific corrective and preventative actions;
- iv. Corrective and preventative to be assigned to responsible person and
- v. Management Review of corrective actions to ensure the status and effectiveness of the actions.

6.6.4 Management Review

A comprehensive review of the objectives and targets associated with the individual Project of the company shall be undertaken. These reviews, which include involvement from the senior site management and other key site personnel, assess the performance of the plant over the previous year and develop goals and targets for the following period.

6.7 Maintenance of Records:

Environmental monitoring program will be carried out by approved agency. The monitoring reports for every season will be regularly submitted to Regional Office of MoEF&CC. Also, one copy of the monitoring report will be kept in site office. The health records of the workers will be kept in site office as well as with the Doctor appointed for the purpose. All the records will be properly kept and maintained by the management.




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Chapter-7

Additional Studies

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7.0 Additional Studies

This chapter describes the public consultation for the proposed project, Risk Assessment and Disaster Management Plan, occupational health and safety issues.

7.1 Public Consultation

Public Consultation refers to the process by which the concerns of local affected persons and others who have plausible stake in the environmental impacts of the project or activity design as appropriate.

All category A and B projects or activities under Schedule II of the EIA notification, dated 14th September 2006 shall undertake public consultation

The proposed category falls under category A which requires EIA studies as well as public consultation.


The public consultation shall ordinarily have two components comprising of public hearing at the site or in its close proximity- district wise, to be carried out in the prescribed manner and obtaining responses in writing from other concerned persons having a plausible stake in the environmental aspects of the project or activity.

This report is being submitted to Pollution Control Board for conducting public hearing/consultations. After completion of the public consultation, ONGC shall address all the material environmental concerns expressed during this process, and make appropriate changes in the draft EIA and EMP. The final EIA report, so prepared, shall be submitted by ONGC to MOEFCC to the complete EC process.

7.2 Risk Assessment

Environmental Risk Assessment is a scientific analysis for identification of credible risk and thereafter estimating the safe distances from any hazardous installations/processes in the eventuality of an accident. Estimation of near-accurate safe distances is absolutely necessary to protect the public, property and environment. Risk Assessment' also known as 'Hazard Analysis' and 'Vulnerability Assessment' is a procedure for identifying hazards and determining their possible effects on a community and environment. Risk or hazard by itself is not an event - it is the potential for an event.

7.2.1 Approach to the Study

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Risk involves the occurrence or potential occurrence of various type accidents consisting of an event or sequence of events. The main objectives of the risk assessment of the proposed project are illustrated schematically in **Figure-7.1**.

Standard industry practices of risk assessment are considered in the project. Maximum Credible Accident analysis is carried out to arrive at the hazard distance for the worst case scenario.

7.2.2 Maximum Credible Accident Analysis (MCAA)

Maximum Credible Accident (MCA) is a probable accident with maximum damage distance. In practice, the selection of accident scenarios for MCAA is carried out on the basis of engineering judgement and past accident analysis. MCAA does not include quantification of the probability of occurrence of an accident.

Risk involves the potential occurrence of some accident consisting of an event or sequence of events. Accidental release of oil and gas to the atmosphere from well or processing equipment is studied by visualising scenarios on the basis of their properties and the impacts are computed in terms of damage distances. A disastrous situation is the outcome of fire or explosion of the released gas in addition to other natural causes, which eventually leads to loss of life, damage to property and/or ecological imbalance.


Depending on the effective hazardous attributes and their impacts, the maximum effect to the surroundings could be assessed.

The steps of MCA analysis along with data requirement are shown in **Figure-7.2**

- *Past Accident Data Analysis*

The data required for MCA analysis has either to be generated by monitoring and/or collected from the records of the past occurrences. This data, when analysed, helps in formulation of the steps towards mitigation of hazards faced commonly. Trends in safety of various activities can be evaluated and actions can be planned accordingly, to improve the safety.

Data analysis helps in correlating the causal factors and the corrective steps to be taken for controlling the accidents. It is, therefore, of vital importance to collect the data methodically, based on potential

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incidents, sections involved, causes of failure and the preventive measures taken. This helps to face future eventualities with more preparedness.

- *Hazard Identification*

A major hazard is defined as an event, which may have the potential to cause one or more fatalities and also the potential to affect the integrity of the facility as a whole. The aim of this step is to create a complete tabulation of identified hazards.

Hazards are identified in terms of safety and/or environmental impact. The hazard in terms of blowout has been identified from well pad in the present proposed project. It is noted that some hazards are incorporated within other hazards.

Identification of hazards in the proposed project campaign is of primary significance in the analysis, quantification and cost effective control of accidents involving chemicals and process. Hence, all the components of a system/process need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident.

Typical schemes of predictive hazard evaluation and quantitative risk analysis suggest that hazard identification step plays a key role. The hazard in terms of blowout has been identified from well pad in the present proposed project.

Major accident hazards considered are:

- Hydrocarbon escapes due to high geological pressures lead to possibility of fire, explosion, gas ingress to sensitive areas, contamination or toxic hazards arising from wells, test equipment fuel supply systems, storage, pipe work systems, etc.;
- Structural or foundation failure, including effects of corrosion, fatigue, extreme weather, overloading, seismic effects, abuse or accidental loading;
- Possibility of H₂S release while drilling; and
- Fire, including fires in accommodation, electrical fires, hot work, oxygen enrichment



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The complete list of hazards and Occupational Hazards applicable to onshore drilling are presented in **Table-7.1** and **Table-7.2**.

TABLE-7.1 : List Of Major Hazards


Sr. No.	Hazard Source/Reason	Description	Impacts
1	Fire and explosion	Occurrence of blow out	Topsides blow out
		Non hydrocarbon fires	Electrical fire in control room Fire in accommodation
2	Impacts and collisions	Objects dropped from a crane/ derrick	Fatal accidents Loss of materials and equipment
3	Loss of station/ stability	Loss of stability	Structural failure Tug failure (during towing)
4	Extreme weather conditions	Extreme winds	Loss of lives and material
			Temporary withdrawal of well operations
5	Earthquakes	Sudden ground movement	Strong vibrations, failure
6	War, crisis	Crisis situation	-

TABLE-7.2: Occupational Hazards

Sr. No.	Hazard	Description	Specific Hazard
1	Working at heights	Fall	Fall
			Man overboard
2	Disease/ Illness	Illness	Medical evacuation
3	Storage of chemicals	Release of chemicals	Exposure to chemicals, inhalation, ingestion, body contact etc

- *Consequence Analysis*

Quantification of the damage can be done by means of various models, which can then be translated in terms of injuries and damage to the exposed population and buildings. Oil and gas may be released and

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result into jet fire & less likely unconfined vapour cloud explosion causing possible damage to the surrounding areas. Extent of the damage depends upon the nature of release. The release of flammable material and subsequent ignition results in heat radiation, pressure wave or vapour cloud depending upon the flammability and its physical state.

An insight into physical effects resulting from the release of hazardous substances can be had by means of various models. The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs and also to get information as how to deal with the possible catastrophic events.

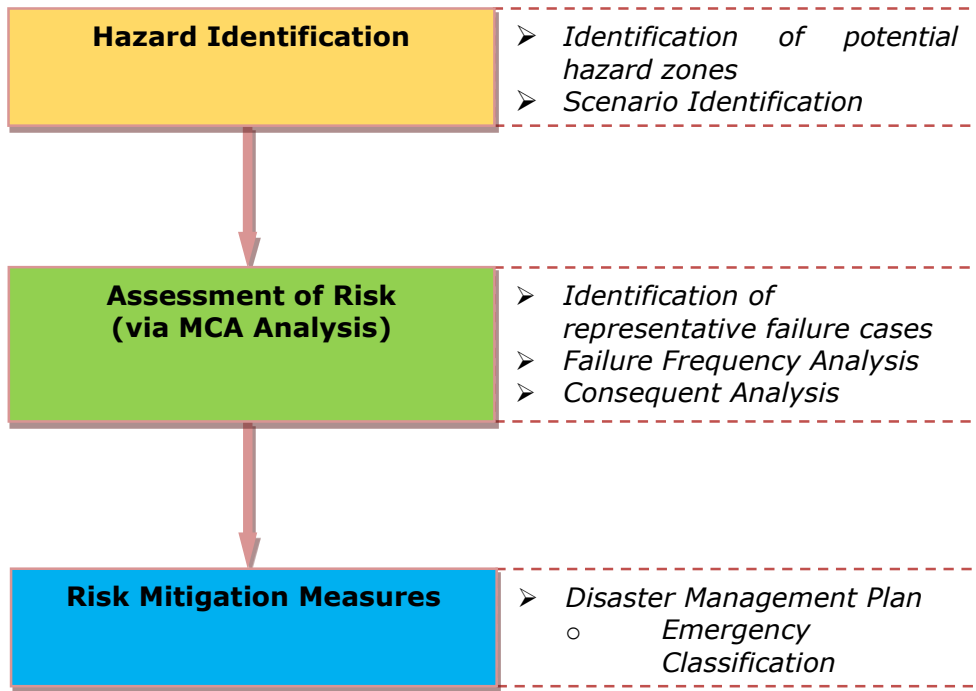


FIGURE-7.1: Objectives of Risk Assessment

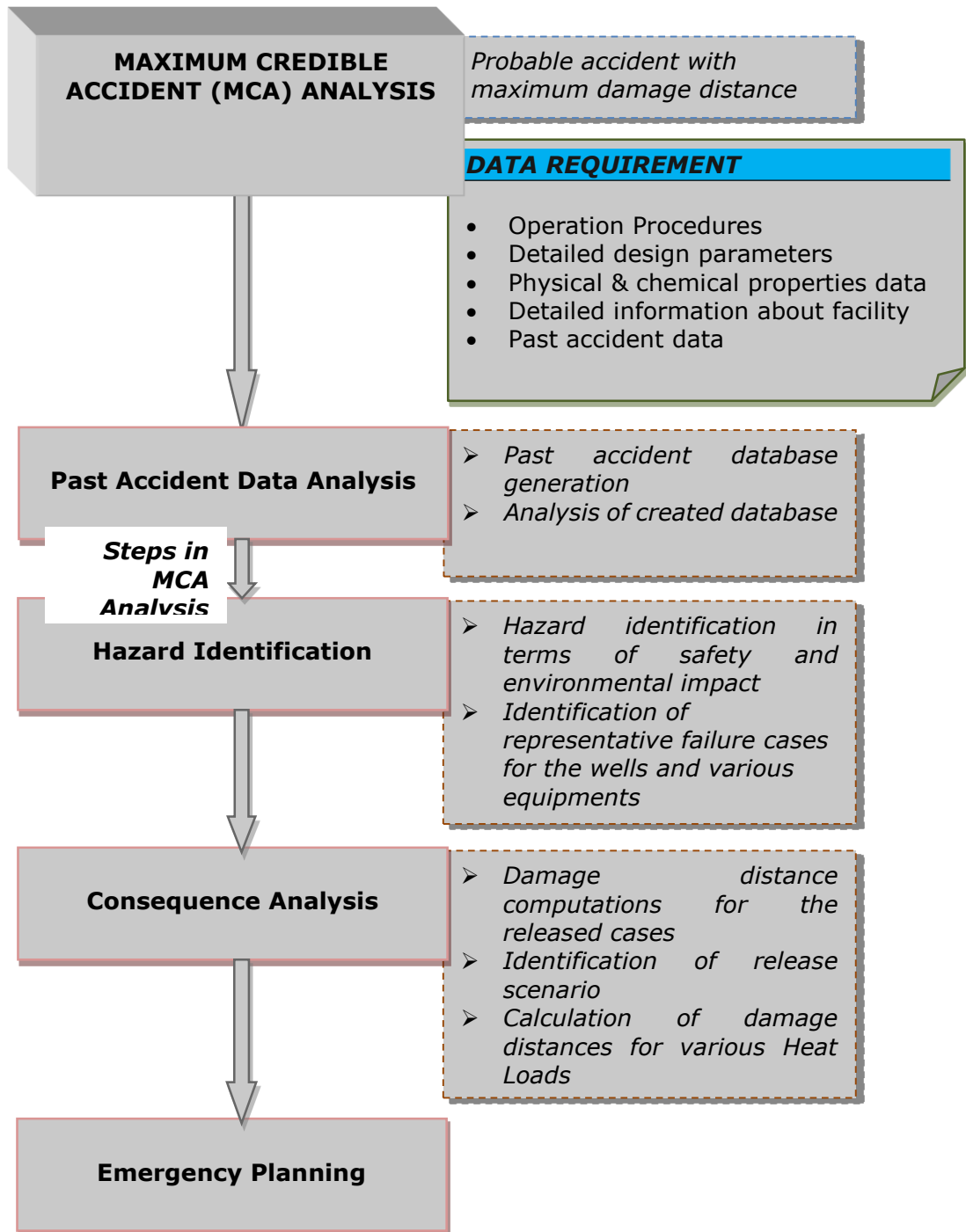


FIGURE-7.2: Methodology of MCA Analysis



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7.2.3 Damage Effects of Various Heat Loads

Damage effects of various peak over pressures and incident radiation intensities are detailed in **Table-7.3** and **Table-7.4** respectively.

TABLE-7.3: Damage due to peak over pressure


Human Injury		Structural Damage	
Peak Over Pressure - bar	Type of Damage	Peak Over Pressure - bar	Type of Damage
5 - 8	100% lethality	0.3	Heavy (90% damage)
3.5 - 5	50% lethality	0.1	Repairable (10% damage)
2 - 3	Threshold lethality	0.03	Damage of Glass
1.33 - 2	Severe lung damage	0.01	Crack of Windows
1 - 11/3	50% Eardrum rupture	-	-

Source: Marshall, V.C. (1977) 'How lethal are explosives and toxic escapes'

TABLE-7.4: Damage due to Incident Radiation Intensities

Sr. No.	Incident Radiation (kW/m ²)	Type of Damage Intensity	
		Damage to Equipment	Damage to People
1	37.5	Damage to process equipment	100% lethality in 1 min. 1% lethality in 10 sec.
2	25.0	Minimum energy required to ignite wood at indefinitely long exposure without a flame	50% Lethality in 1 min. Significant injury in 10 sec.
3	19.0	Maximum thermal radiation intensity allowed on thermally unprotected adjoining equipment	--
4	12.5	Minimum energy to ignite with a flame; melts plastic tubing	1% lethality in 1 min.
5	4.5	--	Causes pain if duration is longer than 20 sec, however blistering is unlikely (First degree burns)
6	1.6	--	Causes no discomfort on long exposures

Source: Techniques for Assessing Industrial Hazards by World Bank

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7.2.4 Scenario Identification

Emergency scenario is identified based on past experiences and historical evidences. A flowchart that can be followed to evaluate the consequences of the release of a flammable or toxic chemical is given in **Figure-7.3**


Historical evidence demonstrates that although unlikely, the most significant hazard arises from the thermal radiation produced by an ignited liquid or gas release. Releases from the wells could arise in the form of blowouts. This may lead to release of gas into the atmosphere. An availability of ignition source can lead to jet fire.

- *Model for the Calculation of Heat Loads and Shock Waves*

If a flammable gas or liquid is released, damage resulting from heat radiation or explosion may occur on ignition. Humidity of the air (water vapour) has a relatively high heat-absorbing capacity. The orientation (horizontal / vertical) of the object irradiated with respect to the fire is an important factor to be considered. If a jetted release of the oil & gas mixture is ignited, a stable diffusion torch or jet fire may be produced. For the flammable gas, in this model, an ellipse is assumed for the shape of a torch. The volume of the (torch) flare in this model is related to the outflow. In order to calculate the thermal load, the centre of the flare is regarded as a point source. This centre is taken as being half a flare-length from the point of outflow.

A flash fire is the non-explosive combustion of vapour cloud resulting from release of a flammable material in the atmosphere, which after mixing with air, ignites. A flash fire results from the ignition of a released flammable cloud, in which there is essentially no increase in combustion rate. The ignition source could be electric spark, a hot surface, and friction between moving parts of a machine or an open fire.

Part of the reason for flash fire is that flammable fuels have a vapour temperature less than ambient temperature. Hence as a result of spill, they are dispersed initially by the negative buoyancy of the cold vapours and subsequently by atmospheric turbulence. After the release and dispersion of a flammable fuel, the resulting vapour cloud is ignited and when the fuel vapour is not mixed with sufficient air prior to ignition, it results in the diffusion fire burning. Therefore, the rate at which the fuel vapour and air are mixed together during combustion determines the rate of burning in the flash fire.

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The main dangers of flash fires are radiation and direct flame contact. The size of the flammable cloud determines the area of possible direct flame contact effects. Radiation effects on a target depend on several factors including its distance from the flames, flame height, flame emissive power, local atmospheric transitivity and cloud size. Most of the time, flash combustion of a flash lasts for no more than a few seconds.

7.2.5 Input Data for Consequence Analysis

The data used for the consequence analysis is depicted in **Table-7.5**.

TABLE-7.5: Input Data for Consequence Analysis

Parameter	Case
Ambient Temperature	350C
Atmospheric stability	A & D
Relative humidity	70%
Wind speed	2 m/s for stability class A 5 m/s for stability class D

7.2.6 Results and Discussions

Jet Fire from Well (Oil) Blowout is visualised for carrying out the consequence analysis. A well blow out can lead to uncontrolled release of oil into the atmosphere. A subsequent jet fire could result on availability of an immediate ignition source. Heat load generated by the flame depends upon the mass flow rate of the released material. Damage distances are computed for the operating pressure of 290 psi and temperature of 70°C. Weather conditions 2A and 5D are considered while computing the damage distances. The damage distance of 95.7m is obtained for the heat load of 4 kW/m² in case of well blow out for 5D conditions. Results are shown in **Table-7.6**.

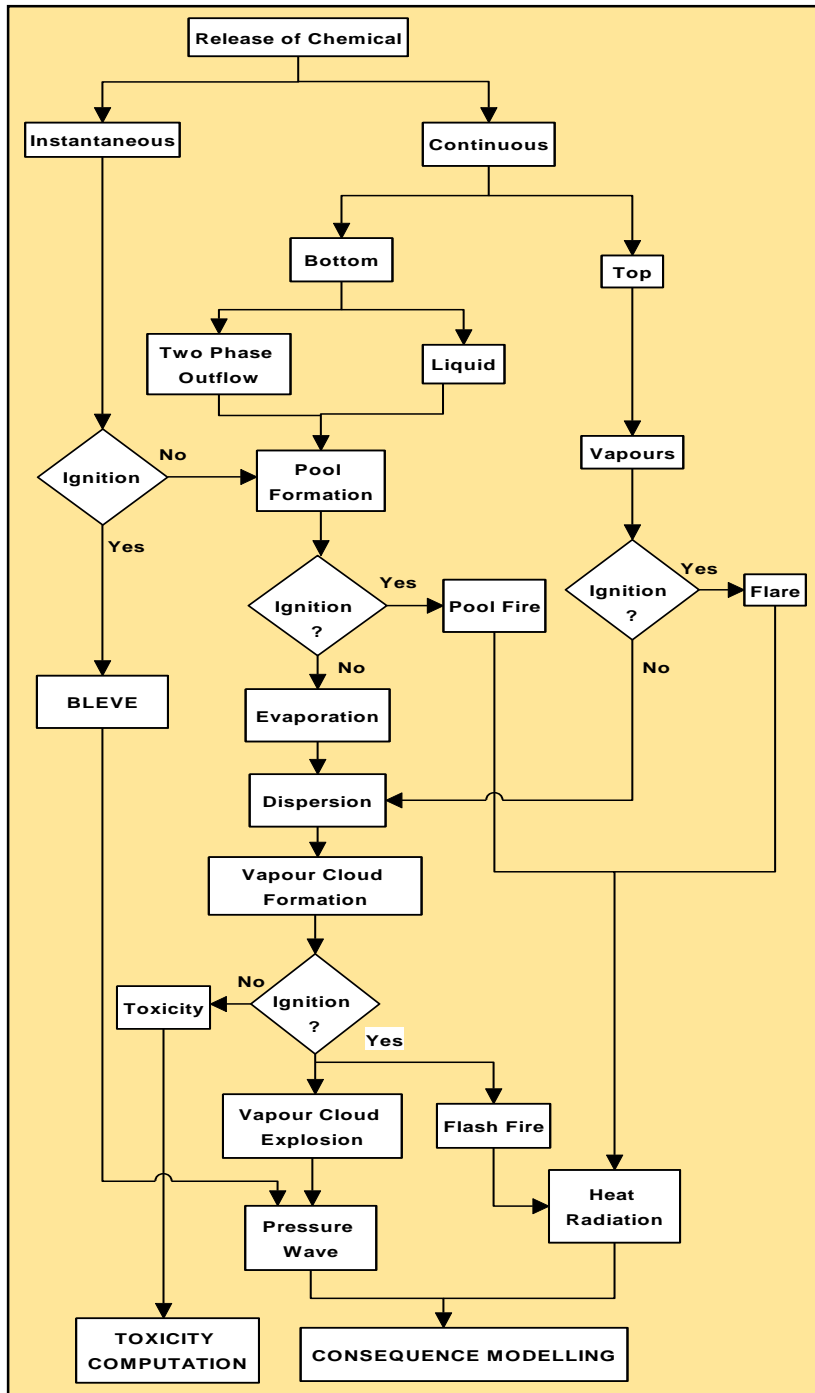


FIGURE-7.3: FlowChart for Evaluation of Consequences during the release of Flammable or Toxic Chemical


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TABLE-7.6 Summary of Consequence Analysis for Jet Fire Scenario at Well

Pressure (psi) / Temp (°C)	Scenario	Mass Flow Rate (kg/s)	Weather	Damage Distance (m) for various Heat loads		
				4.0 kW/m ²	12.5 kW/m ²	37.5 kW/m ²
290 / 70	Blow out	16	2A	82.5	-	-
			5D	95.7	-	-

7.2.7 Failure Frequency Analysis

A blowout is defined as an uncontrolled release of fluid, viz., hydrocarbon (oil and/or gas), but drilling mud, completion fluid or water from a well. It is most hazardous when the fluid is hydrocarbon. Blowouts are important because they have the potential to release large amounts of hydrocarbons and are very difficult to control.

A well control incident is one in which a high potential release which may result in blowouts either does not occur or is quickly stopped. They typically involve formation fluid accidentally entering the wellbore, but controlled by the available barriers such as the blowout preventer (BOP). These incidents usually have relatively minor consequences, and are not well reported.

For some events, it is unclear whether they should be counted as a full blowout or as a well control incident. Different databases categorise events in different ways, and some analyses use the term "blowout" to refer to all well control incidents.

7.2.8 Historical Data Sources

The main compilations of secondary data on blowouts are:

- **SINTEF blowout database** - An internal SINTEF compilation sponsored by 6 operators and 2 consultants (Holand 1995), including 319 blowouts for the period 1970-94, of which 128 occurred in the US GoM OCS or North Sea during 1980-94. It is an update of the Marintek blowout database, for which the full list (SINTEF 1983) and an analysis (NSFI 1985) were published. Detailed analyses have been published for the period 1980-93 (Holand 1996, 1997). Scandpower (1995) analysed the data for the period 1980-92, and included a full list of the events.



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- **E&P Forum database** - Frequencies from BLOWOUT for the period 1970-85 were published by OCB / Technica (1988) and E&P Forum (1992).

7.2.9 Probability of Immediate Ignition and Individual Risk Assessment Criteria

The information available on probability of ignition is mostly in the form of expert estimates. The details of immediate ignition probabilities used in this analysis are given in **Table-7.7**. This data has been obtained from E&P Forum. Similarly, the ADNOC individual risk assessment criteria are given in **Table-7.8**

TABLE-7.7: Probability of Ignition for leaks of flammable fluids

Leak Rate	Probability of Ignition	
	Gas	Liquid
Minor (< 1kg/s)	0.01	0.01
Major (1 to 50 kg/s)	0.07	0.03
Massive (>50 kg/s)	0.30	0.08

Source: E&P Forum

TABLE-7.8 The ADNOC Individual Risk Assessment Criteria


ADNOC Acceptability Criteria	Maximum Individual Risk Criteria for Workers		Maximum Individual Risk Criteria for Public
	Existing Installation	New Installation	
Benchmark	IR < 2 x 10 ⁻⁴	IR < 2 x 10 ⁻⁵	IR < 1 x 10 ⁻⁵
Unacceptable	IR > 1 x 10 ⁻³	IR > 1 x 10 ⁻³	IR > 1 x 10 ⁻⁴
Acceptable	IR < 1 x 10 ⁻⁵	IR < 1 x 10 ⁻⁵	IR < 1 x 10 ⁻⁶

Source: E&P Forum

7.2.10 Individual Risk Assessment

The Individual risk due to well blowout is calculated with the help of SAFETI Software. 20 persons were considered as a population present within the well pad in a shift and frequency of well blowout. The individual risk due to well blowout varies from 1E⁻⁰⁶ to 1E⁻⁰⁹ and it is concluded that the risk due to well blowout is acceptable for workers as well as for the public as per Table-7.8.

7.2.11 Geo-hazards

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Geo-hazards include landslides, flooding, land subsidence and earth quakes. The major geo-hazard associated with oil production is land subsidence. Land subsidence is termed as the sudden sinking or gradual downward settling of land with little or no horizontal motion, caused by a loss of subsurface support which may result from a number of natural and human caused occurrences including subsurface mining or the pumping of oil or ground water. Land subsidence events, depending on where they occur, can pose significant risks to health and safety or interruption to transportation and other services. Land subsidence is effected by characteristic of the reservoir rocks, pressure of overburden, relationship between compaction and pressure gradient in the reservoir, pressure decline dynamic and its influence on the compaction rate and the surface subsidence.

Drilling activities do not involve any extraction of hydrocarbon and thus in this case, any possibility of subsidence is ruled out. In the event of a successful discovery leading to production activities, geo-technical investigations, geological impacts assessment will be carried out and appropriate measures will be undertaken.

7.3 Recommendations to Mitigate Risk/Hazards

The recommendations to mitigate risk at the well site during the drilling operation are given in **Table-7.9**

TABLE-7.9: Recommendations to mitigate blow out Risk/Hazards

Sr. No.	Mitigative Measures	Remarks
1	Maintenance of mud weight	Drilling Mud Engineer should check the ingoing & out coming mud weight at the drilling well, at regular intervals; If mud weight is found to be less, barytes should be added to the circulating mud, to raise it to the desired level; Failure to detect this decrease in level may lead to well kick & furthermore, a well blow out.
2	Monitoring of active mud tank level	Increase in active tank level indicates partial or total loss of fluid to the well bore, which can lead to well kick; If any increase or decrease in tank level is detected, shift personnel should immediately inform the Shift Drilling Engineer & take necessary actions as directed by him.
3	Monitoring of Hole Fill-up / return mud volume during tripping	During swabbing or pulling out of string from the well bore, the hole is filled with mud for metallic displacement which returns back to the pit when the string runs back;



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Sr. No.	Mitigative Measures	Remarks
		Both the hole fill up & return mud volumes should be monitored, as they indicate any mud loss or inflow from well bore, which may lead to well kick.
4	Monitoring of inflow	The flow nipple during tripping or connection time should be monitored for any inflow from the well bore
5	Monitoring of Background / trip gas	Increase in background gas or trip gas indicates insufficient mud weight against drilled formation. Such indications should be immediately brought to the notice of the Shift Drilling Engineer.
6	Team Coordination	Each team member must religiously follow the safety aspects pertaining to respective operational area. Drilling operation is a team effort and success of such an operation depends upon the sincerity, efficiency & motivation of all team members. Safety in such operations is not the duty of a single person, but it is everyone's job. The use of protective fireproof clothing and escape respirators will reduce the risk of being seriously burnt. Adequate firefighting facilities and first aid facilities should be provided, in case of any emergency. Risk reducing measures include kick simulation training for personnel, presence of well-trained drillers and mud engineers, and strict adherence to safety management procedures and good well control procedures.

7.4 Disaster Management Plan

In view of the hazardous nature of products / process handled by the ONGC, a Disaster Management Plan (DMP) has been prepared. This plan is based on various probable scenarios like well blow out, fire, explosion, natural calamities etc. The consequence arising out of such incidents are accurately predicted with the help of latest technique available by various risk analysis studies. To minimize the extent of damage consequent to any disaster and restoration of normalcy is the main purpose of DMP.

7.4.1 Objectives of Disaster Management Plan

The purpose of DMP is to give an approach to detail organizational responsibilities, actions, reporting requirements and support resources available to ensure effective and timely management of

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emergencies associated to production and operations in the site. The DMP process flow diagram is shown in **Figure-7.4**

The overall objectives of DMP are to:

- Ensure safety of people, protect the environment and safeguard commercial considerations
- Immediate response to emergency scene with effective communication network and organized procedures
- Obtain early warning of emergency conditions so as to prevent impact on personnel, assets and environment
- Safeguard personnel to prevent injuries or loss of life by protecting personnel from the hazard and evacuating personnel from an installation when necessary
- Minimize the impact of the event on the installation and the environment, by:
 - Minimizing the hazard as far as possible
 - Minimizing the potential for escalation
 - Containing any release
- To provide guidance to help stack holders take appropriate action to prevent accidents involving hazardous substances and to mitigate adverse effects of accidents that do nevertheless occur.

7.4.2 Different Phases of Disaster

7.4.2.1 *Warning Phase*

Many disasters are preceded by some sort of warning. For example, with the aid of satellites and network of weather stations, many meteorological disasters like cyclones and hurricanes can be predicted and actions can be taken to eliminate/reduce their effect to counteract them.

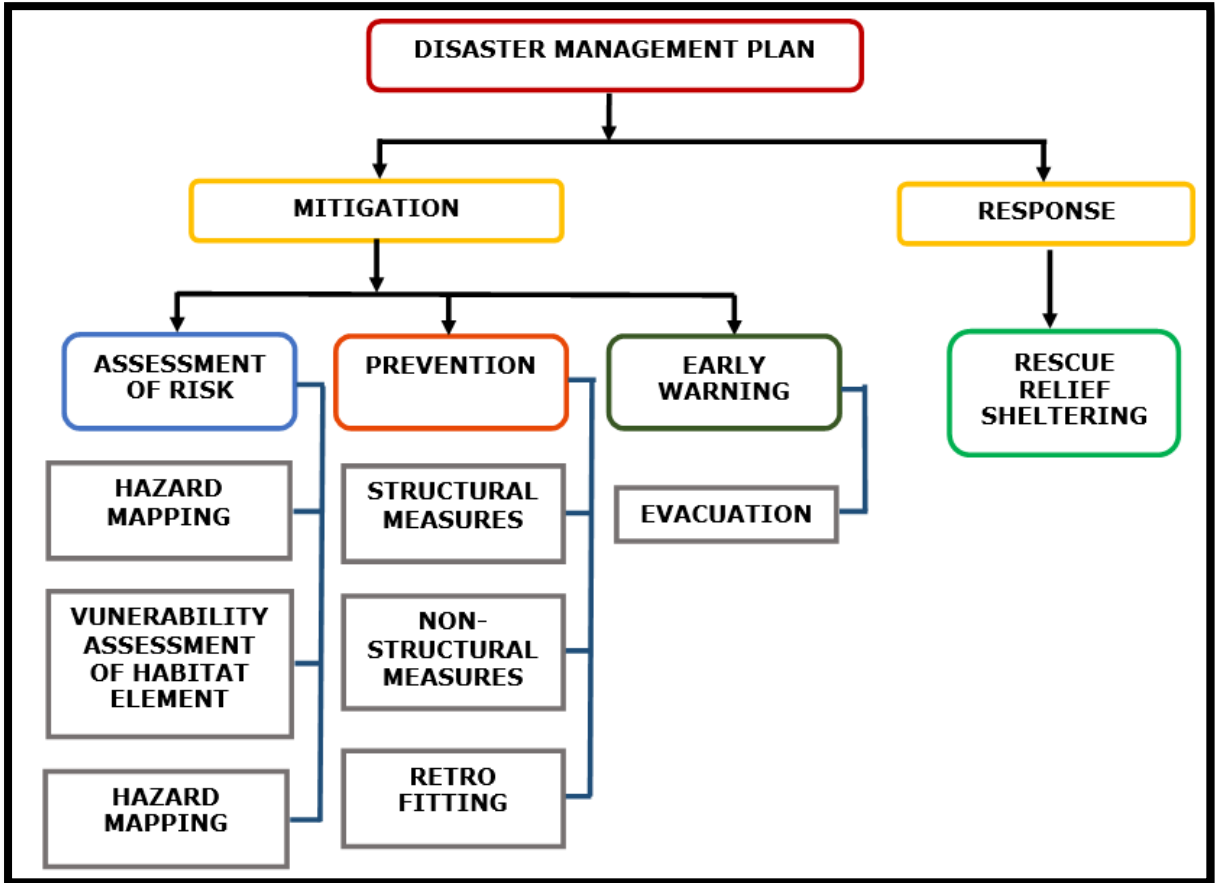



FIGURE-7.4: DMP Process Flow Diagram

7.4.2.2 Period of Impact Phase

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This is the period when the disaster actually strikes and very little can be done to lessen the effects of disaster. The period of impact may last for a few seconds (like fire, explosion, and gas leak) or may prolong for days (fire, gas leak, etc.). This is the time to bring the action plan in force.

The coordinators in organization structure will perform the responsibilities assigned to them. Needless to emphasize that prompt and well organized rescue operations can save valuable lives.

7.4.2.3 Rescue Phase

The rescue phase starts immediately after the impact and continues until necessary measures are taken to rush help and combat with the situation.

7.4.2.4 Relief Phase

In this phase, apart from organization and relief measures internally, depending on severity of the disaster, external help should also be summoned to provide relief measures (like evacuations to a safe place and providing medical help, food clothing etc.). This phase will continue till normalcy is restored.

7.4.2.5 Rehabilitation Phase


This is the final and longest phase. It includes rebuilding damaged property, estimating the damages, payment of compensation, etc. Help from revenue/insurance authorities need to be obtained to assess the damage, quantum of compensation to be paid etc.

7.4.3 Key Elements of DMP

Following are the key elements of Disaster Management Plan:

- Basis of the plan
- Accident/emergency Management Plan
- On-site Disaster Management Plan
- Off-site Disaster Management Plan

7.4.3.1 Basis of the Plan

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Identification and assessment of hazards is crucial for onsite emergency planning and it is therefore necessary to identify what emergencies could arise in production of various products and their storage.

Hazard analysis or consequence analysis gives the following results:

- Hazards from spread of fire or release of flammable and toxic chemicals from storage and production units; and
- Hazards due to formation of pressure waves due to vapor cloud explosion of flammable gases and oil spill hazards.


7.4.3.2 On-site Disaster Management Plan Purpose

The on-site DMP that deal with handling of the emergency within boundary of the proposed project well site mainly with the help of industry's own resources. The organizational setup for the on-site DMP is shown in **Figure-7.5**.

- To protect persons and property of processing equipments in case of all kinds of accidents, emergencies and disasters.
- To inform people and surroundings about emergency if it is likely to adversely affect them.
- To inform authorities including helping agencies (doctors, hospitals, fire, police transport etc.) in advance, and also at the time of actual happening.
- To identify, assess, foresee and work out various kinds of possible hazards, their places, potential and damaging capacity and area in case of above happenings. Review, revise, redesign, replace or reconstruct the process, plant, vessels and control measures if so assessed.

7.4.3.3 Off-site Disaster Management Plan Purpose

Emergency is a sudden unexpected event, which can cause serious damage to personnel life, property and environment as a whole, which necessitate to evolve Off-site Emergency Plan to combat any such eventuality. In Offsite disaster management plan, many agencies like government, revenue, public health, fire services, police, civil defence, home guards, medical services and other voluntary organization are involved. Thus, handling of such emergencies requires an organized multidisciplinary approach.

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Evacuation of people, if required, can be done in orderly way. The different agencies involved in evacuation of people are civil administration (both state and central), non Govt. organizations, factory Inspectorate and Police authorities. The organizational setup for the off-site DMP is shown in **Figure-7.6**.

The District administration of Silchar has identified 16 expected task forces for key response operation functions that are described below. Additional taskforces can be added under the operations section as needed by the circumstances of a disaster. Each Taskforce is led by one organization and supporter by other organizations. Emergency operation taskforce functions is given in **Table-7.10**.

TABLE-7.10: Emergency Operation Task Force Functions

Sr. No.	Emergency Operation Taskforce	Functions
1	Coordination and Planning	Coordinate early warning, Response & Recovery Operations
2	Administration and Protocol	Support Disaster Operations by efficiently completing the paper work and other Administrative tasks needed to ensure effective and timely relief assistance
3	Warning	Collection and dissemination of warnings of potential disasters
4	Law and Order	Assure the execution of all laws and maintenance of order in the area affected by the incident
5	Search and Rescue (including Evacuation)	Provide human and material resources needed to support local evacuation, search and rescue efforts
6	Public Works	Provide the personnel and resources needed to support local efforts to reestablish normally operating infrastructure
7	Water	Assure the provision of sufficient potable water for human and animal consumption (priority), and water for industrial and agricultural uses as appropriate
8	Food and Relief Supplies	Assure the provision of basic food and other relief needs in the affected communities
9	Power	Provide the resources to reestablish normal power supplies and systems in affected communities
10	Public Health and sanitation (including First aid and all medical care)	Provide personnel and resources to address pressing public health problems and re-establish normal health care systems
11	Animal Health and Welfare	Provision of health and other care to animals affected by a disaster.
12	Shelter	Provide materials and supplies to ensure temporary shelter for disaster-affected populations
13	Logistics	Provide Air, water and Land transport for evacuation and for the storage and delivery of relief supplies in coordination with other task forces and competent authorities



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Sr. No.	Emergency Operation Taskforce	Functions
14	Survey (Damage Assessment)	Collect and analysis data on the impact of disaster, develop estimates of resource needs and relief plans, and compile reports on the disaster as required for District and State authorities and other parties as appropriate
15	Telecommunications	Coordinate and assure operation of all communication systems (e.g; Radio, TV, Telephones, Wireless) required to support early warning or post disaster operations
16	Media (Public Information)	Provide liaison with and assistance to print and electronic media on early warning and post-disaster reporting concerning the disaster

7.4.4 Levels of Emergencies

A generally accepted definition endorsed by ONGC is a critical condition that may endanger life, the environment, or company assets. This Emergency Management Plan (DMP) addresses two levels of Emergencies:

- Minor (Tier I); and
- Major (Tier II & III).

7.4.4.1 *Minor Emergency*

An Emergency requiring local support that can be handled by members of Incident Response Team (IRT) such as:

- Light bodily injury requiring the assistance of the doctor or a local nurse; and
- Minor environmental or property damage

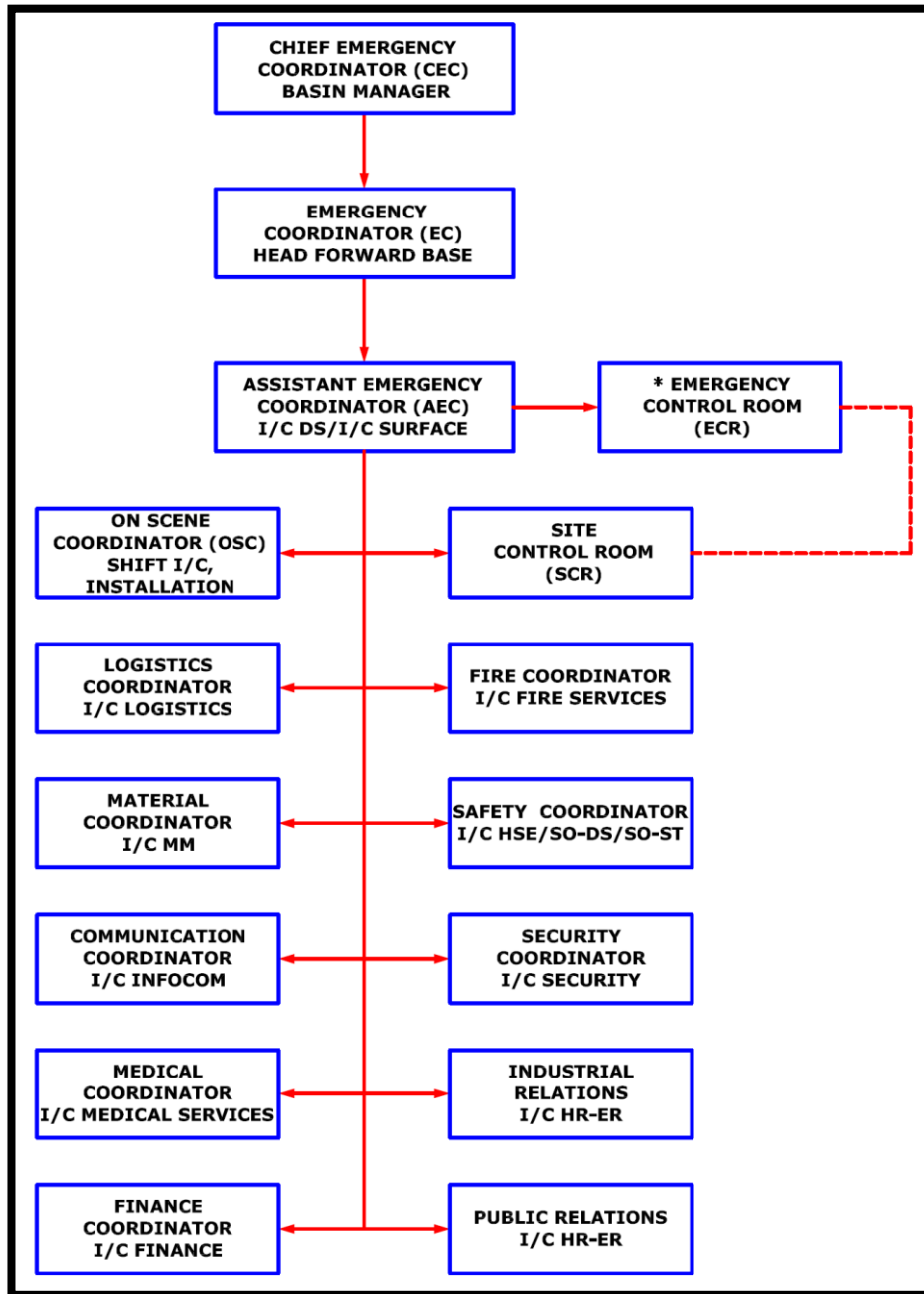


FIGURE-7.5 Organizational Setup for the Onsite DMP

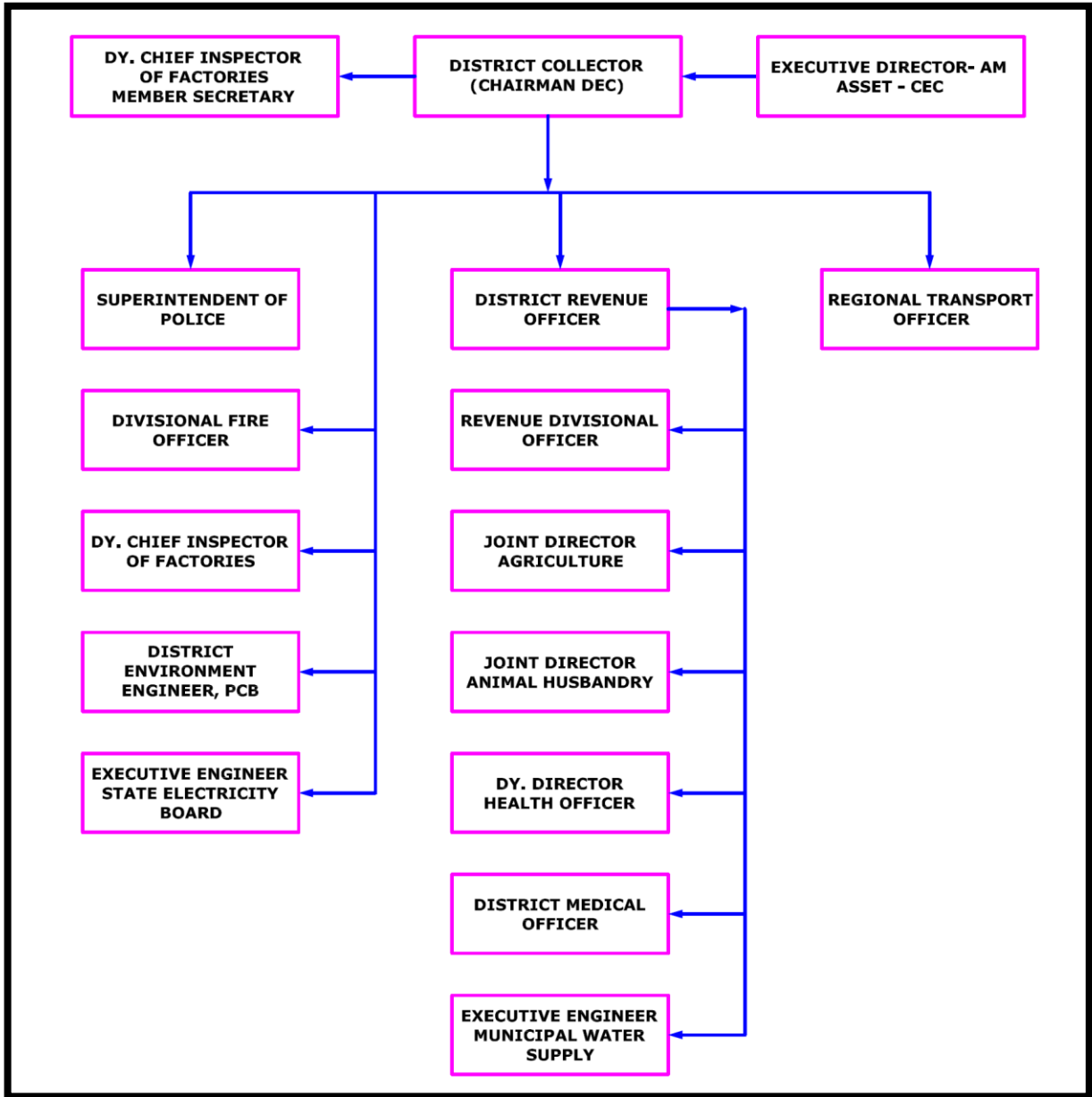



FIGURE-7.6: Organizational Setup for the Offsite DMP

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7.4.4.2 Major Emergency

An Emergency that may require the assistance and support of the Emergency Response Group (ERG) at Regional Office in case of Tire-II emergencies and Crises Response Team (CRT) at Head Office for the Tire-III emergencies and external agencies. e.g.:


- Serious incidents of spills, blow outs, release of hazardous / toxic substances, structural failure / collapse;
- Medical evacuation in the event of life threatening bodily injury or severe electric shock, life threatening illness;
- Major environmental or property damage;
- Man lost situation;
- Major fire, explosion, radiation; and
- Unplanned evacuations such as natural calamity, war crisis, security breach.

7.4.5 Overall Philosophy of Emergency Response

Initial response to any incident will be managed at the incident location; in this case, it would be the site of infill well drilling. The overall level of response will depend on the nature and scale of the emergency.

The overall philosophy of emergency response is to:

- Ensure safety of people, protect the environment and safeguard commercial considerations;
- Immediate response to emergency scene with effective communication network and organized procedures;
- Obtain early warning of emergency conditions so as to prevent impact on personnel, assets and environment;

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- Safeguard personnel to prevent injuries or loss of life by protecting personnel from the hazard; and
- Evacuating personnel from an installation when necessary and minimize the impact of the event on the installation and the environment by:
 - Minimizing the hazard as far as possible;
 - Minimizing the potential for escalation; and
 - Containing any release.

7.4.6 Auditing

Audits should be carried out on a regular basis to verify and update the Emergency Response Plan and the corresponding procedures. The audit will review:


- The roles and responsibilities of the ERG and support organization;
- The requirements of legislation and regulatory bodies; and
- Resource requirements and availability.

7.4.7 Emergency Priorities

In the event of an Emergency occurring, the ONGC Policy lists, in order, the following priorities:

- Safeguard Life;
- Protect the Environment;
- Protect the Company / Third Party assets;
- Maintain the Company image and reputation; and
- Resume normal operations as soon as possible.

7.4.8 Emergency Response Management Group Interfaces

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The relationship between the Remote Location “Incident Response Team” (IRT), “Emergency Response Group” (ERG), “Crisis Response Team” (CRT) and classification of emergencies is illustrated in the **Figure-7.8**

7.4.9 Emergency Response Procedure

7.4.9.1 *Minor Emergency*

To enable the appropriate level of response to be implemented, emergency incidents are to be categorized according to three levels as follows:

Tier-1 (Minor Emergency) – an event with no escalation potential, which can be controlled and contained by the action of personnel of Incident Response Team (IRT) at the incident site. In such cases of local alert, the ‘ERG leader’ will be notified but the ERG is not called out.

Some typical incidents are:

- Minor accident;
- Equipment damage;
- Medical evacuation (not very serious cases); and
- Minor fires.

7.4.9.2 *Major Emergency*

Tier-II Emergency

Events with escalation potential, depending on the effectiveness of the local response. These incidents may impact the entire site. For such type of incidents the installation manager assumes the charge of Incident Response Controller (IRC) and activates ERG who aide/guide the IRC in controlling the emergency situation. The country manager is notified on the same.

Some typical incidents are:



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- Substantial security incident;
- Multiple casualties;
- Cyclone flooding;
- Serious damage to man/machinery;
- Substantial fire;
- Cultural conflict, and
- Serious incident.

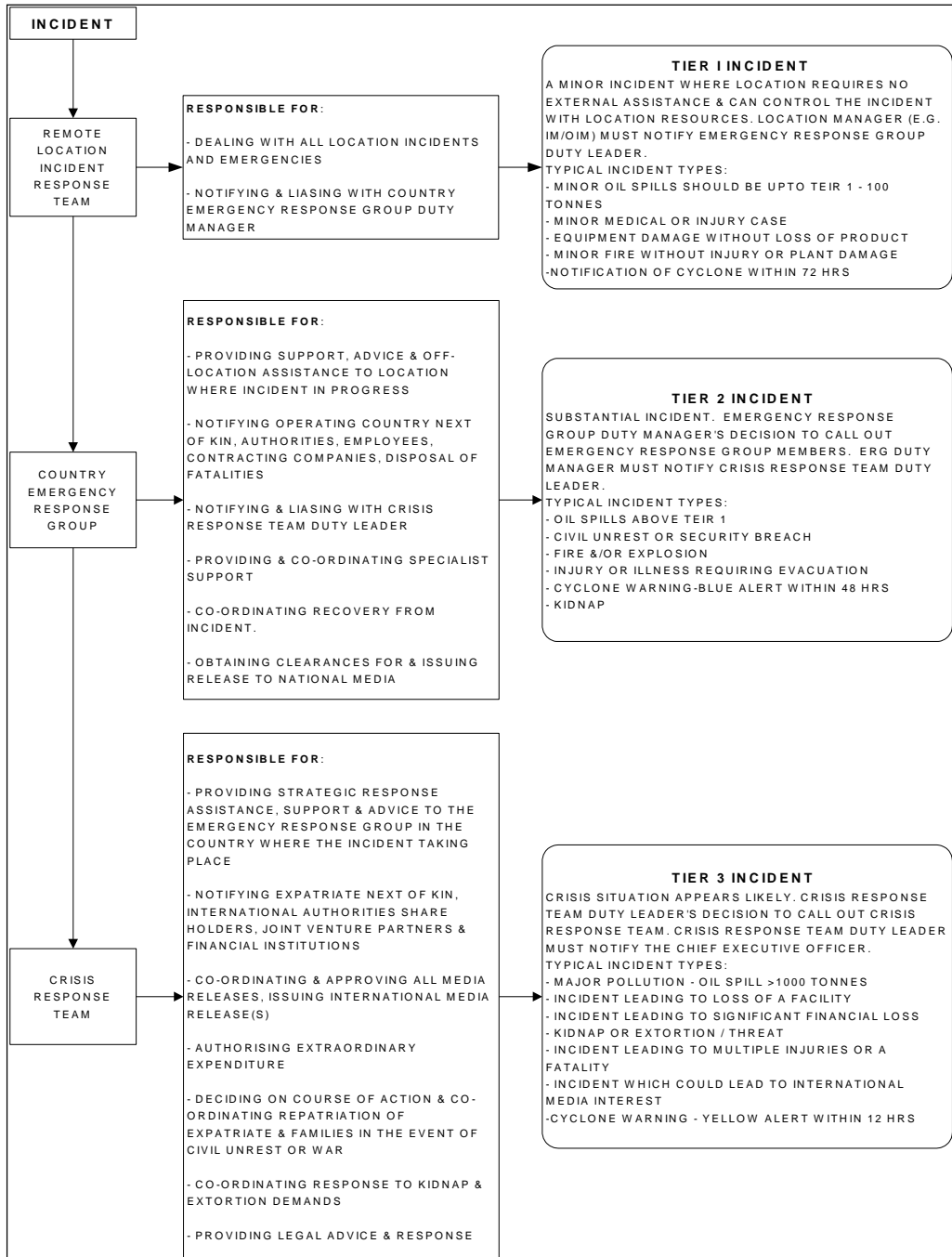



Figure 7.8: Emergency Classification

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Tier- III Emergency

A crisis that requires assistance from external resources in order to save lives, minimize damage and to bring the abnormal situation back under control. These incidents have the potential to impact beyond ONGC site limit. In such cases, IRC activates the ERG who notify the country manager and Crises Response Team (CRT) in Head Office will be activated. The CRT would guide / aide the ERG in controlling the emergency situation.

Some typical Tier-3 incidents are:


- Major fire/explosion;
- Evacuation of the rig/platform;
- Loss of the rig/platform;
- Fatality; and
- Terrorist attacks.

For a major emergency, the ERG team will use the Emergency Control Centers (ECCs) to enable constant guidance / aide during emergency situation between the incident site, ERG and CRT.

7.4.9.3 Emergency Response Strategies

Whenever there is an emergency, the response team is required to swing into action without losing time. Time is the essence of the immediate relief and rescue operations to save human life, to mitigate the impact on the environment and to safeguard commercial consideration. This DMP has been prepared keeping in mind the above fact and it is conceptually based on the *Trigger Mechanism*.

The Trigger Mechanism envisages that on receiving signals of a disaster happening or likely to happen, all activities required for the mitigation process are energized and activated simultaneously without loss of any time. The primary objective of this mechanism is to undertake immediate rescue and relief operations and stabilize the mitigation process as quickly as possible.

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The main parameters of such a response plan include:

- Signal / Warning Mechanism;
- Activities and their Levels;
- Sub-activities;
- Command and Control Structure;
- Individual Roles and Responsibilities of each specified authority to achieve the activation as per response time;
- Response teams for each specified authority;
- Emergency Procedures; and
- Alternate Plans & Contingency measures.


7.4.10 Alert Phase

It will be the duty of all site personnel at the site to remain alert at all times for hazardous situations that have the potential to escalate into an emergency incident. The ERG members would be activated as required.

Emergencies on site can be initiated in a number of ways depending upon the severity of the incident i.e., by the site fire alarm siren, which any personnel on the incident site can activate. The site siren will sound in an intermittent mode. Also, the individual fire alarms will sound in the area of the incident.

This procedure initiates the site fire and Rescue Department and Site Security into their standard procedures to attend the incident. This has the advantage of permitting the earliest possible action to be taken to control the immediate situation, which may avoid the development of a major emergency.

The 'Incident Controller' will attend the scene of the incident and the 'ERG Leader' will be notified. Depending upon the severity of the emergency (Tier-2) the ERG Leader will activate the ERG and notify

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the 'Country Manager' as appropriate. The incident controller will assess the situation from the edge of the incident scene to reduce the probability of personal injury. The ERG members will be on standby to go to the Emergency Control Centre (ECC).

Evacuation of employees to the nearest assembly point or refuge may be required, if not hindered by fire or toxic cloud (all personnel present on the incident site would make it a point to always move upwind in case of fire).

7.4.11 Preparedness for Emergencies

- *Command by Competent Persons*

Effective command and control starts with a clear definition of the overall command and control structure and description of the duties of key personnel with specific responsibilities for emergency response.

- *Number of Persons for Emergency Duties*

The command/control of emergencies must identify the minimum number of persons required to provide an adequate response to emergencies. This includes having staff trained and competent to fulfil the roles of other members of staff if they are not available.


- *List of Persons for Emergency Duties*

A list of those staff that has emergency duties is displayed in the Control room. It is the responsibility of the *ONGC Radio Officer* would ensure that these lists are kept up to date.

7.4.12 Control of Emergencies

The major systems for controlling emergencies and preventing escalation are detailed in subsequent sections of the DMP, which gives the emergency procedures to be followed in case of an impending/occurring disaster.

It is absolutely necessary for the ERG leader to review the incident response and provide his inputs for improvements / modifications to the DMP and update accordingly. ERG leader would debrief all personnel involved in the emergency response action. It will be the responsibility of the ERG leader to develop a Post Emergency Action Plan with the assistance of Incident Controller.

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It will be the responsibility of the designated HSE personnel to prepare a complete incident report collating incident reports/ logs from the respondents and forward the same to higher authorities as appropriate.

7.5 Emergency Response Action

Incident Control Centers (ICC)

The Incident Controller will be responsible for co-ordinating the site response to any emergency and direct emergency response personnel as appropriate to the emergency. The installation manager's office shall be the designed ICC:


At the drilling rig, it is suggested that the best location for control center will be main control room and alternately it may be shifted to Temporary Refuge (TR) in case of major emergency. There will be radio, telephone or messenger contact with the ICC.

The incident area will be tapped off and warning notices posted. The in-house Fire Team cordon off the incident area (Inner Cordon). Route markings from ICC to the incident to aid the emergency services will be arranged;

Various personnel will wear fluorescent jackets with a description of their role. This will include the Incident Controller and medics.

Emergency Control Centers (ECC)

The Emergency Control Centre is to be set up by a person designated by the ERG office. The ONGC's Guesthouse (if available) could be the alternate ECC. It is place from where the operations to handle the emergencies are directed and coordinated. The center is equipped to receive and transmit information and direction from and to the Incident Controller as well as from outside. ECC shall contain equipment for logging the development of the incident to assist the controllers determine any necessary action:

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The ICC and ECC should contain:

An adequate number of external telephones. At least one will be ex-directory or capable of use for outgoing calls only. This will avoid the telephone switchboard being overloaded with calls from anxious relatives, the press etc;

An adequate number of internal telephones; and

Radio equipment;

A plan or plans of the works to show;

- Areas where there are large inventories of materials, including oil storage, drilling materials;
- Sources of safety equipment;
- The fire water system and additional sources of water;
- Stocks of other fire extinguishing materials;
- Assembly points, casualty treatment centers;
- Location of the works in relation to the surrounding community; and
- Lorry/truck parks.


Additional plans which may be marked up during the emergency to show

- I. Areas affected or endangered;
- II. Deployment of emergency vehicles and personnel
- III. Areas where particular problems arise;
- IV. Area evacuated; and
- V. Other relevant information

- HAZCHEM sheets for the various hazardous materials used on-site;
- Note pads, pens, pencils to record all messages received and sent by whatever means;
- Nominal roll of employees or access to this information;
- List of key personnel, addresses and telephone numbers.

Emergency Control Centre is located, designed and equipped to remain operational in an emergency.

7.6 Emergency Response Procedures

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7.6.1 Blowout

During a blowout, the Rig (specific) emergency Response Plan would be referred. The contingency plan for onshore blowout (drilling rig) is given in **Figure-7.9** Common steps required during blowout are discussed as below:

Driller/person on the spot

In case, the kick is timely detected

In case of string at the bottom of hole


1. Lift and clear tool joint out of rotary and stop pumps;
2. Close BOP and choke;
3. Record Shut In Drill Pipe pressure (SIDP) and Shut In Casing Pressure (SICP); and
4. Prepare kill sheet and make calculations for standard well killing procedures;

In case of while making trip:

1. Stop tripping operations;
2. Position tool joint at rotary table and set slips;
3. Install safety valve and close safety valve;
4. Open choke line;
5. Close BOP and choke;
6. Make up Kelly;
7. Record shut in SIDP and SICP; and
8. Prepare the kill sheet and make calculations for standard well killing procedure.

In case of string out of the well:

1. If well condition permits attempt run in hole and whenever situation is critical shut the well by following steps as mentioned in case of while making trip; and

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2. If the trip in is not possible then use volumetric method off well control.

In case of sudden kick:

1. Close the BOP;
2. Record SIDC & SICP; and
3. Prepare kill sheet and make calculations for standard well killing procedure.

On detection of a kick the Senior Tool pusher/Drilling supervisor is to be informed immediately; and
 Person discovering the blowout should notify radio room of the incident.

Radio Room

Alert to the fire team;

Notify Incident Controller of the incident to clear non-essential traffic; and Send radio and other
 communications on instructions from Incident Controller

Drilling Supervisor/PIC


Minimize ignition sources;

Assess the situation along with Senior Tool pusher and declare the incident to be:

- Minor event, which can be brought under control using in situ equipment
- Serious event, which may not be brought under control; and
- Major event, in which the well is unlikely to be brought under control
- Incident controller to be informed immediately if the event is classified as serious or major event; and
- Instruct control room to suspend drilling operations

Incident Controller

- Inform to the ERG Leader, provide full details and likely requirements and maintain contact;
- Activate site response personnel as appropriate, provide full incident briefing and likely requirements and maintain liaison;
- Ensure that Fire team is on standby;

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- Instruct to all non-essential personnel to prepare for evacuation. In a major emergency, an order for total evacuation must be given;
- After situation has returned to normal, inspect incident site to determine whether further corrective action is required to make situation safe.

ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;
- Active ERG appropriate contact Directory;
- Notify EMT Leader and provide full incident briefing and likely requirements;
- Co-ordinate support activities as required; and
- Determine need for external assistance for safety of personnel, well control and pollution prevention;

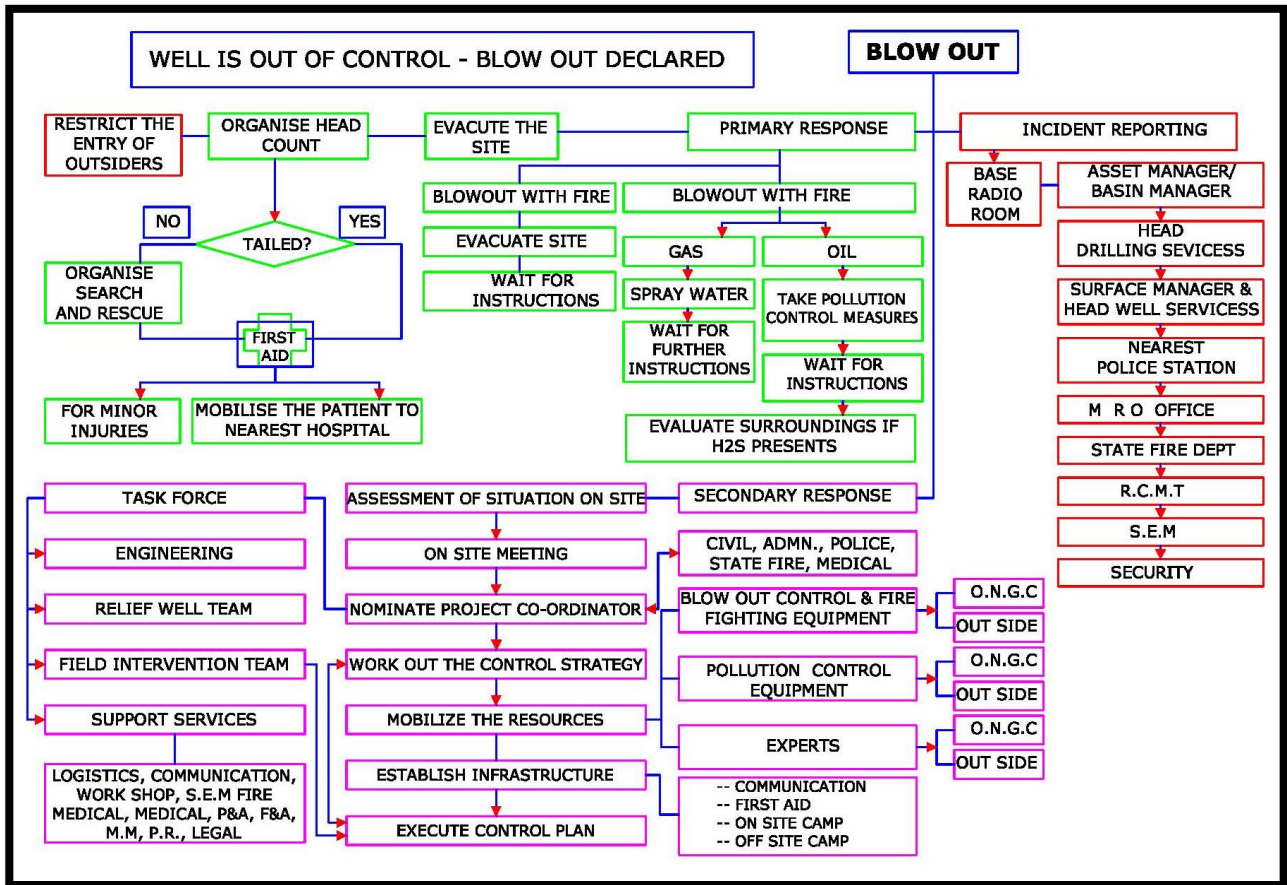



FIGURE-7.9 Contingency Plan for Onshore Blowout (Drilling Rig)

7.6.2 Well Control

The following preventers are stacked in a sequence and this assembly of preventers is termed as “BOP Stack” as shown in the Figure–7.10

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Blowout Preventers: Blow out Preventer consists of Annular Preventer, which can generally close on any size or shape of tubular in the well bore which closes the annular space between drill string and casing.

Ram Preventer: Ram preventers are of two types i.e. Pipe Rams and Shear Rams. Pipe rams also close the annulus between drill string and casing, but they have a fixed size. As such a specific pipe rams can be closed on a specific size of pipe. Shear rams are generally the last choice of preventer to be operated as they shear drill string and shut off the well bore.

Blowout prevention equipment shall be installed, tested and operated according to the Well Control Manual for Drilling Operations. Certain key personnel on the drilling unit shall hold a valid certificate of examination from a recognized pressure control course.

The BOP stack in use shall be pressure tested initially before drilling out of the casing shoe and thereafter weekly. A sequence of successful tests indicate that greater confidence could be placed in the stack and control equipment, then the testing interval can be extended up to a maximum of two weeks.

All pipe fittings, valves and unions placed on or connected to blow-out prevention equipment, well casings, casing head housing, drill pipe or tubing shall have a working pressure rating at least equivalent to that of the component to which it is fitted.

Drilling operations shall not proceed until blowout prevention equipment is found to be serviceable by visual inspection and appropriate pressure testing.

BOP control systems are installed, tested and operated according to the Well Control Manual for Drilling Operations. In addition to the instrumentation to indicate the availability of air pressure and fluid pressure, the following safety features will be considered for the control systems:

A relief valve installed; accumulator low-pressure alarm; air-driven hydraulic fluid charge pumps; electric-driven hydraulic pump to be connected to the emergency generator; fail safe regulators; manifold pressure is consistent with ram closing force requirements at anticipated maximum surface pressure (high pressure wells); accumulator capacity at elevated manifold pressures still meets requirements; fire resistant hydraulic control hoses and control fluid; appropriate location of remote operating panels; redundant functions plugged off; hydraulic control hose are tested to the rated pressure of the unit.

7.6.3 Hydrogen Sulphide (H₂S)



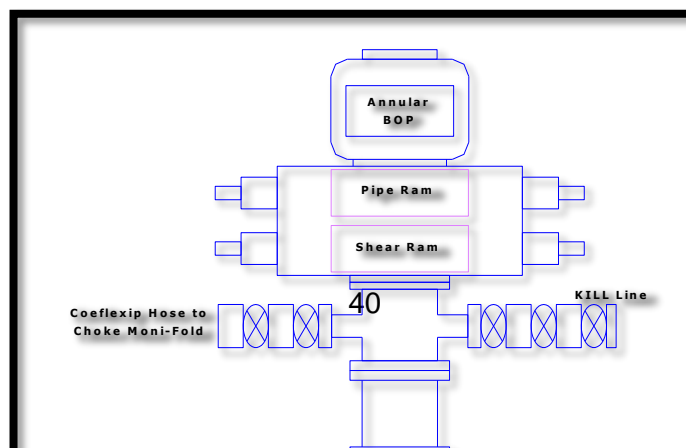
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Natural gas leaks are expected regardless of the location. Natural gas is an extraneous material. As such all natural gas leak carry the risk of fire and explosion until the leak is contained. Hydrogen sulfide is a toxic chemical gas frequently found in natural gas deposits.

During drilling operations, the consequences of leaks or kicks with sour gas or crude can be very serious. Personnel can be incapacitated by relatively low concentrations of H₂S in a very short time and equipment can suffer catastrophic failure due to H₂S embrittlement.

A contingency plan will be drawn up when H₂S may be expected during well operations. A study will be made of the geological and geographical features of the area, in order to predict the expected areas where H₂S may be encountered or may accumulate. Information about the area and known field conditions, including temperatures, pressures, proposed well depth and H₂S concentrations will be obtained and taken into consideration. The drilling program will highlight this hazard and give details of controls and recovery measures in place.

Once the cellar has been excavated, the drill pad constructed and equipment set in place, drilling can commence. Typically, at the time of site construction, a false conductor of large diameter will be grouted up to 3.5 m from surface. Initially, the drilling fluid used is quite often water alone. Drilling will then continue for several hundreds of meters. At this depth smaller diameter casing is usually cemented into the hole. This intermediate casing protects the well by sealing potentially weak zones. At this stage low density drilling muds will be used and although it is unlikely that gases or fluids under pressure might be encountered, a blowout preventer is typically installed to prevent fluid from the formation gushing to the surface. Drilling continues using progressively smaller bits and incrementally decreasing casing diameters. Changes in mud composition, and drill bit, are likely to occur according to the different strata encountered.





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Figure7.10: Typical Schematic of BOP Stack

7.6.4 Abandonment of Rig/Well

In case of major incident, which necessitates the abandonment of the rig/well, the following actions will be taken;

Emergency Siren Modes		
Fire	High/Low tone	Proceed to muster point(s)
Evacuation	On/off monotone	Evacuate as directed
All clear	Continuous monotone	Emergency ended

Control room will activate Emergency Siren upon fire Call Point or ESD being activated.
Personnel can also alert Control Room by radio or phone

Rig/well PIC

- Notify Radio Room of intention to abandon the rig
- Ensure that rig facilities are cleared for evacuation (e.g. clear equipment from heli-deck etc);



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- Determine appropriate safe method of abandonment and notify all personnel to assemble at appropriate Muster Point;
- Contact Incident Controller to provide full incident briefing and likely requirements and maintain liaison; and
- Instruct all personnel to evacuate the rig.

All Other Personnel of Rig

- On hearing alarm, put on life jacket and proceed to Muster Point nominated by Rig–PIC, remain calm and await instructions; and
- If evacuating by jumping into “buddy up” and tie off if possible any try to stay together with as many people as possible.

Radio Room

- On receiving emergency call, nominate a dedicated frequency for the emergency calls;
- Notify Incident Controller and advise of emergency frequency and update frequently;
- Inform all ONGC radio stations of incident and ask to clear non-essential traffic; and
- Send radio and other communications on instructions of Incident Controller.

HSE Support

- Conduct headcount of personnel assembled at Muster Point;
- Notify Incident Controller of headcount/token results and emphasize on any discrepancy;



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- Ensure that headcount is updated if people are allocated tasks that remove them from Muster Point (e.g. fire team etc); and
- For any discrepancy in headcount, reconcile daily record of persons on site with lists of persons assembled at Muster Points and notify Incident Controller of identify of missing person(s).

Incident Controller


- Obtain full incident briefing and likely requirements from RIG PIC and maintain liaison;
- Ensure that all production is shut in and that all machinery is rendered safe;
- Ensure that all personnel are accounted for via headcount as SAR is conduct for any missing persons;
- Obtain a personnel list on the affected rig; and
- Notify ERG Leader of rig evacuation and any likely requirements

ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller an maintain liaison;
- Activate ERG with appropriate Contact Directory
- Notify EMT Leader and provide full incident briefing and likely requirements; and
- Co-ordinate support activities as required.

7.6.5 Structural Damage/Failure of the Rig

The actions to be taken during a structural damage/failure of the rig/well are as follows:

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Drilling Supervisor/PIC


- Notify Radio Room of incident;
- Instruct Site Control Room to shut the drilling operation if required;
- Inspect any damage/failure sustained by rig, if safe to do so, assess actions required to make rig safe;
- Ensure that all personnel are accounted for and consider need for evacuation; and
- Contact Incident Controller to provide full incident briefing and likely requirements and maintain liaison.

Radio Room

- Call support vessel to affected rig if required;
- Notify Incident Controller of incident and update as further communications received;
- Inform all ONGC radio stations of incident and ask to clear non-essential traffic; and
- Send radio and other communications on instructions from Incident Controller.

Incident Controller

- Obtain full incident briefing, and likely requirements from Drilling Supervisor/PIC and maintain liaison;
- Ensure that all personnel have been accounted for;
- Ensure that drilling activity has been stopped if appropriate;

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- Notify ERG Leader, provide full incident briefing and likely requirements;
- Proceed to affected part of the rig for damage assessment and depending on severity of damage, suspend drilling operations, make all equipment secure and restrict access until repairs can be undertaken;
- To assess and declare the incident to be a minor, serious or major event; and
- To consider evacuation of non-essential personnel and depending on the severity of the incident, the evacuation of all personnel.

ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;
- Activate ERG with appropriate Contact Directory;
- Notify EMT Leader and provide full incident briefing and likely requirements; and
- Activate technical support as appropriate for evaluation and control of situation.
- All response Members Maintain log of events for collection at end of incident

7.6.6 Well Control Emergencies

Person first on scene

- Notify radio Room of incident;
- Follow appropriate well control procedure;
- Instruct all non-essential personnel if any to proceed to Muster Point(s); conduct headcount(s) as required;



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- Ensure that all possible ignition sources on affected platform are turned off;
- Determine source of the problem and safest & most effective way to prevent incident from escalating;
- Ensure that wire line crew are advised/aware of any incident and likely requirements;
- Contract Incident Controller to provide full incident briefing and likely requirements, Maintain liaison.

Radio Room

- Notify Incident Controller, Production Supervisor and Petroleum engineer of incident; update as further communications received;
- Inform all ONGC radio stations of incident and ask to clear non-essential traffic;
- Send radio and other communications on instructions from Incident Controller.

Incident Controller

- Obtain full incident briefing and likely requirements from Wire line and/or site Supervisor, Maintain liaison;
- For wire line incident, ensure that drilling supervisor and petroleum engineer is notified;
- Consider need to evacuate platform, if any, request results of any headcount and ensure that all personnel are accounted for conduct SAR for any missing personnel; and

ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller. Maintain liaison
- Activate ERG with Contact Directory as required;
- Notify wire line contactor management and maintain liaison;
- Determine need for external assistance for safety of personnel, well control and pollution prevention;



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- Activate pollution control procedures as required;
- Liaise with support coordinator to activate well control specialties and equipment to incident site as required;
- Consult with Incident Controller and Wire line Supervisor regarding safest, most effective way to resolve incident.

All Response Member

- As time permits, maintain log of events for collection at end of incident

7.6.7 Fire On Rig

Person first on scene

- Shut down production by activating ESD;
- Close down any manual feed valve that may be feeding the fire, if safe to do so,
- Notify Radio Room on incident;
- Attempt to extinguish the fire with portable equipment, if safe to do so; and
- Contact Incident Controller to provide incident briefing and any likely requirements.

Radio Room

- Alert Fire Team of incident,
- Notify Incident Controller of incident and update as further communications received;
- Inform all radio stations of incident and ask to clear non-essential traffic; and
- Send radio and other communications on instructions from Incident Controller.

Rig PIC (if any maintenance/survey team is on the platform)

- Instruct Control room to shutdown activities from affected rig;



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- Instruct all non-essential personnel, if any to proceed to Muster Point and conduct headcount as required; and
- If fire cannot be extinguished safely, consider need for evacuation (if any) of rig.

Incident Controller

- Activate site response personnel as appropriate and provide full incident briefing and likely requirements. Maintain liaison;
- If fire extinguished, ensure that there is no gas leak. If gas leak detected, and if safe to do so, shut off all ignition sources, close all relevant shut-off valves and evacuate rig;
- Notify ERG Leader, provide full incident briefing and likely requirements;
- After situation has returned to normal, inspect incident site to determine whether further corrective action is required to make situation safe.

ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller. Maintain liaison;
- Activate ERG with appropriate Contact Directory;
- Notify EMT Leader and provide full incident briefing and likely requirements; and
- Co-ordinate support activities as required.


All Response Members

- As time permits, maintain log of events for collection at end of incident.

7.6.8 Rig Evacuation

Person on Rig

- Notify Radio Room of intention to abandon the rig
- Ensure that platform/rig facilities are cleared for evacuation;

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- Determine appropriate safe method of abandonment and notify all personnel to assemble at appropriate Muster Point'
- Contact Incident Controller to provide full incident briefing and likely requirements. Maintain liaison;
- Instruct all personnel to evacuate the platform / rig;
- Put on a lifejacket and proceed to Muster Point nominated by rig PIC. Remain calm and await instructions; and
- If evacuating by jumping into the water, "buddy up" and tie off, if possible, try to stay together with as many people as possible.


Radio Room

- On receiving emergency call, nominate a dedicated frequency for the emergency calls;
- Notify Incident Controller and advise of emergency frequency and update frequently;
- Inform all radio stations of incident and ask to clear non-essential traffic; and
- Send radio and other communications on instructions from Incident Controller.

Incident Controller

- Obtain full incident briefing and likely requirements from rig PIC and maintain liaison;
- Ensure that all activity is shut in and that all machinery is rendered safe;
- Ensure that all personnel are accounted for via headcount and SAR is conducted for any missing persons;
- Obtain a personnel list for the affected rig; and
- Notify ERG Leader of platform evacuation and any likely requirements.

ERG Leader

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- Obtain full incident briefing and likely requirements from ERG Leader and maintain liaison;
- Activate ERG with appropriate contact directory;
- Notify EMT Leader and provide full incident briefing and likely requirements; and
- Co-ordinate support activities as required;

All Response Members

- As time permits, maintain log off events for collection at end of incident

7.6.9 Gas Release on Rig

Person Discovering Release


- Avoid creating any source of ignition;
- Shutdown platform/rig by activating ESD;
- If the location of the leak is known, and if safe to do so, shut any relevant manual valves;
- Notify Radio Room of incident; and
- Inform radio room of incident

Rig PIC

- Stop all hot work and shutdown all other sources of ignition;
- If safe to do so, attempt to locate and shut off the source of the leak; and
- Contact Radio Room/Incident Controller to provide full incident briefing and likely requirements. Maintain liaison.

Radio Room

- Notify Incident Controller of incident and update as further communications received;

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- Notify Drilling Supervisor, if appropriate;
- Inform all radio stations of incident and ask to clear non-essential traffic; and
- Send radio and other communications on instructions from Incident Controller;

Incident Controller

- Obtain full incident briefing and likely requirements from radio room and maintain liaison;
- Instruct Site Control Room to shut in production, if required;
- Ensure that all personnel are accounted for and consider need to evacuate that all personnel are accounted for and consider need to evacuate non-essential personnel (in case team is present on the platform). Evacuate all personnel if gas concentration reaches danger level;
- Notify ERG Leader and provide full incident briefing and likely requirements.


ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;
- Activate ERG with appropriate Contact Directory;
- Notify EMT Leader and provide full incident briefing and likely requirements; and
- Co-ordinate support activities as required.

All Response Members

- As time permits, maintain log of events for collection at end of incident

7.6.10 Structural Damage

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Rig PIC


- In case of any maintenance/survey team is present on the rig.
- Notify Site Radio Room of Incident;
- Instruct site controller room to shut in production if required;
- Inspect any damage sustained by rig, if safe to do so and assess actions required to make rig/platform safe;
- Ensure that all personnel are accounted for and consider need for evacuation, if any, and
- Contact Incident Controller to provide full incident briefing and likely requirements, Maintain liaison.

Site Radio Room

- Notify Incident Controller of incident and update as further communications received;
- Inform all radio stations of incident and ask to clear non-essential traffic; and
- Send radio and other communications on instructions from Incident Controller.

Incident Controller

- Obtain full incident briefing including status of any instrument, which may have collided with the rig/platform, and likely requirements from site radio room. Maintain liaison;
- Ensure that support vessel proceeds to affected platform if required;
- Ensure that production on the affected rig/platform has been shut in;
- Notify ERG Leader and provide full incident briefing and likely requirements; and
- Proceed to affected platform for damage assessment and depending on severity of damage, keep production shut in, make all equipment secure and restrict access until repairs can be undertaken.

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ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;
- Activate ERG with appropriate Contact directory.
- Notify EMT Leader and provide full incident briefing and likely requirements; and
- Activate technical support as appropriate for evaluation and control of situation;

All response Members

- As time permits, maintain log of events for collection at end of incident

7.6.11 Ground Movement

Any Person


- Establish the severity of the movement;
- Drilling/production Supervisor/PIC is to be alerted as the movement is detected; and
- Contact Site Radio Room and notify the incident

Site Radio Room

- Inform the Incident Controller
- Inform all radio stations of incident to clear non-essential traffic; and
- Send radio and other communications on instructions from Incident Controller;

Drilling/Production

- Assess the situation;
- Drilling/production to be suspended; and
- Inform the Incident Controller and to be informed immediately if the event is classified as serious or major.

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Incident Controller

- Obtain full status briefing from the Drilling/production supervisor/PIC and maintain continuous contact;
- Ensure that support are proceeded to the rig/platform if required;
- Ensure the safety of all personnel;
- Consider evacuation if it is required depending upon the severity of the situation;
- Contact ERG leader and provide details of the situation; and
- Proceed to carry out damage (if any) assessment and take control measures as required;

ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;
- Activate ERG with appropriate Contact directory;
- Notify EMT Leader if required and provide full incident briefing and likely requirements


All Response Members

- Maintain log of events for collection at end of incident

7.6.12 Un-ignited Gas Release

Person discovering Fire

- Avoid creating any source of ignition;
- Shutdown drilling by activating ESD;
- If location of the leak is known, and if safe to do so, shut any relevant manual valves;
- Notify Site Radio Room of incident; and

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- Contact Incident Controller to provide incident briefing and any likely requirements.

Site Radio Room


- Alert Fire Team of incident;
- Notify Incident Controller of incident and update as further communications received;
- Inform all radio stations of incident and ask to clear non-essential traffic;
- Send radio and other communications on instruction from Incident Controller.

Incident Controller

- Stop all hot work and shutdown all other sources of ignition;
- Instruct Site Control Room to shut in production, if appropriate;
- Evacuate all non-essential personnel and ensure that alternate Muster Point advice is given if a gas release threatens Primary Muster Point;
- Evacuate all personnel, if gas concentration reaches danger level;
- If safe to do so, organize for location and shut off of leak source;
- Ensure that system is depressurized to flare/atmosphere as appropriate;
- Notify ERG Leader, provide full incident briefing and likely requirements and maintain liaison;
- Ensure that all personnel have been accounted for and ensure that non-essential personnel stay clear of incident site and initiate SAR for any missing persons;
- Notify ERT Leader provide full incident briefing and likely requirements

ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison
- Activate part or all of ERG as appropriate;

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- Notify EMT Leader and provide full incident briefing and likely requirements; and
- Co-ordinate support activities as required;

All Response Member

- As time permits, maintain log of events for collection at end of incident

7.6.13 Hydrocarbon Spill

Equipment and Training

- Assure emergency dispersant and spray equipment for dealing with spills is readily available; and
- Assure personnel are trained in use of emergency dispersant and spray equipment, and with the provision of this procedure.

Oil Spill Detection

- Be alert during operations such as fuel oil transfer and critical drilling operations that could result in oil spills;
- Keep watch on the transfer pump, manifolds, transfer hoses, and all other connections;
- During critical drilling operations, keep watch on the drilling equipment instrumentation and stop drilling when unsafe conditions arise; and

Shut Down the Source

- Review site for safety hazards;
- Stop the spill at the source as quickly as possible;
- Assure that transfer pumps are immediately stopped if spill occurs during fuel oil transfer;



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and

- If the spill occurs from any equipment on either vessel, shut down the operating equipment and close any valves between the leak source and the equipment.

Oil Spill Reporting

Spills should be reported using the Pollution Report Form.

Oil Spill Contingency Plan

Detailed oil spill response actions are included in Oil Spill Contingency Plan (OSCP).

7.6.14 Medical Evacuation


- The incidents that may require medical evacuation are mainly severe casualties. The actions to be taken during medical evacuation are as following:

Incident Controller

- Determine need for Medevac and type and special conditions of transport required. Consult with Site doctor regarding appropriate action and maintain liaison;
- Consult with Site doctor on appropriate destination for serious Medevac;
- If patient is a contractor, contact contractor manager and provide full Medevac details; and
- Notify ERG Leader and provide full incident briefing and likely requirements.
- Name of ill/injured person(s) to be communicated secure communications.

ERG Leader

- Obtain full incident briefing and likely requirement from Incident Controller and maintain liaison;
- Activate ERG as appropriate;

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- Liaise with aircraft operator and airport authorities to facilitate medevac and ensure that site representative is at airport to accompany patient to hospital;
- If required, obtain permission for hospital ambulance to access airport security zone. If access denied, ensure that airport ambulance should be available for transfer to hospital ambulance;
- Notify next of kin;
- If patient is a contractor, ensure that contractor manager is informed with full Medevac details; and
- Maintain liaison with patient and patient's family until discharged and consider arranging for relatives of injured person to be brought to hospital.

All Response Members

- Maintain log of events for collection at end of incident

7.6.15 Criminal Acts

Incident Controller

- Take actions to detain offender(s) if, appropriate;
- Notify ERG Leader and provide full incident briefing for the following:
 - Nature of crime;
 - Identify of person(s) involved;
 - Extent of any injury to personnel and if Medevac required
 - Any assistance required; and
 - Action taken to date



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- If person(s) have been taken into custody, determine with ERG Leader the need to involve Police and contact Police as appropriate:
- Secure evidence, close off incident site, prepare sketches and photographs, identify witnesses and take statements;
- Consider need for suspension of any impending crew change;
- Consider restriction of information to “need-to-know” basis; and
- Assist Police with their inquiries.

ERG Leader

- Obtain full incident briefing and likely requirements from Incident Controller and maintain liaison;
- Activate ERG as appropriate;
- Notify EMT Leader and provide full incident briefing and likely requirements; and
- Submit reports to relevant authorities

All Response Members

- Maintain log of events for collection at end of incident.

7.6.16 Bomb Threat/Extortion

- If there is a contingency like bomb threat/extortion attempt then the following procedures would be followed:

Person Receiving Threat

- For written threat, keep all paper, envelopes etc. to preserve as evidence;
- For verbal threat, use bomb threat checklist while talking to the person making threat and write details notes checklist not available;




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- Do not use radio to raise alarm—radio signals may trigger an explosive device
- For verbal contact, be calm and respectful and DON'T PANIC;
- Take threat seriously;
- Signal for assistance if in a position to do so;
- Pay attention to what is being said and to any background noise;
- Accurately write all that is being demanded and ask calmly for confirmation if unclear;
- Do not agree or concede to any demands without prior approval;
- Try to keep caller talking as long as possible and DON'T HANG UP;
- If caller “hangs up, do not hang up your phone (it may be possible to trace call); and
- At the conclusion of the call, check all notes taken to ensure accuracy.

Incident Controller

- Immediately shut in all drilling/production activities if appropriate;
- Notify ERG Leader and provide full incident briefing and likely requirements;
- Evacuate all non-essential personnel to a safe area and consider total evacuation as required;
- Ensure that all relevant authorities (e.g. Police etc) are notified immediately;
- Ensure that bomb threat checklist is completed by person receiving a verbal threat;
- Make every effort to calm all involved and don't aggravate situation by personal attempts to resolve situation hastily;

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- Ensure that someone is continually standing by a phone to receive next communication from extortionist or ensure that alternative number is provided to caller; and
- Await assistance from appropriate authorities.

ERG Leader

- Obtain full incident briefing and likely requirement from Incident Controller and maintain liaison;
- Activate ERG as appropriate;
- Ensure that all relevant authorities (e.g. Police etc.) are notified immediately;
- Liaise with relevant Government agencies to obtain assistance (e.g. Indian Armed forces etc) as required; and
- Notify EMT Leader and provide full incident briefing and likely requirement.

All Response Members

- Maintain log of events for collection at end of incident

7.7 End of Emergency

- Prior to termination of an emergency, the following issues would be considered and necessary action taken:
 - Confirm that the emergency is concluded;
 - List of resources that are required for ongoing incident control (if appropriate);
 - Final information release and/or notification to
 - Site incident response personnel, ERG, EMT and Chairman;
 - Consultants;



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- Contractors;
- Customers;
- Emergency services;
- Employees
- State Regulatory Authorities;
- National Regulatory Authorities
- Environmental Agencies
- Joint Ventures;
- Local Communities;
- Neighbour / third parties
- Pressure groups
- Suppliers
- Trade unions; and
- Media
- De-briefing of all personnel (including people currently relieved or stood down);
- Close down additional security arrangements;
- Finalize additional catering and other services;
- Continuing counselling for those involved in the incident;
- Compile and file all documents relating to the response;
- Arrange for full incident investigation and analysis;



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- Carry out follow up review to ascertain effectiveness of
- Callout;
- Site incident Response, ERG and EMT Functions;
- Operational emergency response;
- Approve / comment on incident debriefing reports and recommended actions; and
- Recommended revision of Emergency Plans as required


7.8 Communications

All nominated and dedicated emergency response stall will carry VHF radios programmed with the relevant Watch Keeping / Emergency Frequency.

7.8.1 Communication Network

- It is essential that all emergency communications will be relayed to the Incident Controller (or Alternate) and/or the ERG leader (or alternate as soon as possible in case of an emergency situation. As far as possible all Emergency Calls from site, helicopter and base station would be passed on through the site Radio Room. The Radio Operator will allocate a dedicated emergency frequency and will advise the Incident Controller of the emergency situation and frequency.
- Upon the commencement of an emergency, the Radio Operator will inform radio stations that there is an emergency and ask to clear all non-essential radio traffic on the designated emergency radio channel/frequency for communications.
- If an incident occurs after normal business hours, the Site Radio Room will make contact with all Radio rooms, which will in turn activate the ERG Leader and other personnel as advised.


7.9 Occupational Health & Safety Management Plan

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The Occupation Health & Safety Management Plan (OHSMP) is applicable for all project operations which have the potential to adversely affect the health and safety of contractors' workers and onsite ONGC personnel. The Occupation Health & Safety Management Plan (OHSMP) has been formulated to address the occupational health and safety related impacts that may arise from proposed project activities viz. testing operation of construction machinery/equipment's, storage and handling of fuel and chemicals, operation of drilling rig and associated equipment, during drilling and decommissioning/site closure.

Mitigation Measures:


- Contractor workers involved in the handling of construction materials viz. borrow material, cement etc. will be provided with proper PPEs viz. safety boots, nose masks etc.
- No employee will be exposed to a noise level greater than 85 dB(A) for a duration of more than 8 hours per day. Provision of ear plugs, ear muffs etc. and rotation of workers operating near high noise generating areas.
- Hazardous and risky areas, installations, materials, safety measures, emergency exits, etc. shall be appropriately marked.
- All chemicals and hazardous materials storage container will be properly labeled and marked according to national and internationally recognized requirements and standards. Materials Safety Data Sheets (MSDS) or equivalent data/information in an easily understood language must be readily available to exposed workers and first –aid personnel.
- The workplace must be equipped with fire detectors, alarm systems and fire-fighting equipment. Equipment's shall be periodically inspected and maintained to keep good working condition.
- The sewage system for the camp must be properly designed, built and operated so that no health hazard occurs.
- Adequate sanitation facilities will be provided onsite for the operational workforce both during construction and operational phase of the project.

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- Garbage bins will be provided in the camp and regularly emptied and the garbage disposed off in a hygienic manner.
- Training programs will be organized for the operational workforce regarding proper usage of PPEs, handling and storage of fuels and chemicals etc.


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CHAPTER-8

PROJECT BENEFITS

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8.0 Project Benefits

The project benefits are summarized below based on the demand and growth of the country.

8.1 Benefits for the Country

The oil and gas sector is among the six core industries in India and plays a major role in influencing decision making for all the other important sections of the economy. In 1997–98, the New Exploration Licensing Policy (NELP) was envisaged to fill the ever-increasing gap between India’s gas demand and supply. India’s economic growth is closely related to energy demand; therefore the need for oil and gas is projected to grow more, thereby making the sector quite conducive for investment.


India is expected to be one of the largest contributors to non-OECD petroleum consumption growth globally. Oil imports rose sharply year-on-year by 27.89 per cent to US\$ 9.29 billion in October 2017. India’s oil consumption grew 8.3 per cent year-on-year to 212.7 million tonnes in 2016, as against the global growth of 1.5 per cent, thereby making it the third-largest oil consuming nation in the world.

State-owned Oil and Natural Gas Corporation (ONGC) has come up with the new blueprint to increase the crude oil production by 4 million tonnes and to double its natural gas production by 2020 to curb the country’s import dependency by 10 percent. The company will raise its crude oil production from 22.6 million tonnes in 2017-2018 to 26.42 million tonnes in 2021- 2022.

8.2 Improvements in the Physical Infrastructure

The beneficial impact of hydrocarbon development on the civic amenities will be substantial after the commencement of project activities. The basic requirement of the community needs will be strengthened by extending health care, educational facilities to the community, building/strengthening of existing roads in the area.

ONGC will initiate the above amenities either by providing or by improving the facilities in the area, which will help in uplifting the living standards of local communities.

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The construction of new roads in the project area will enhance the transportation facilities. With improved transportation facilities there is always a scope for development.

8.3 Improvement in the Social Infrastructure


- Generation of employment: The project will create opportunities for direct and indirect employment;
- Increase in purchasing power and improved standard of living of the area;
- Establishment of small and medium scale industries may be developed as consequence;
- Increased revenue to the state by way of royalty, taxes and duties;
- Regular Fund flow to local market;
- Overall Growth of the neighbouring Area viz.
- Agriculture and Animal husbandry;
- Health and family welfare;
- Watershed development;
- Sustainable livelihood and strengthening of village Self Help Groups; and
- Infrastructure development.

In addition to above, due to increase in purchasing power of local habitants:

- There shall be significant change in the socio-economic scenario of the area;
- The proposed project shall enhance the prospects of employment;
- Recruitment for the unskilled and semiskilled workers for the proposed project will be from the nearby villages;
- The basic amenities viz., roads, transportation, electricity, proper sanitation, educational institutions, medical facilities, entertainment, etc. will be developed as far as possible; and
- Overall the proposed project will change living standards of the people and improve the socio-economic conditions of the area.

8.4 Employment Potential

The impact of the project on the economic aspects can be clearly observed. The proposed project activities will provide employment to persons of different skills and trades. The local population will be

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given preference to employment. The employment potential will ameliorate economic conditions of these families directly and provide employment to many other families indirectly who are involved in business and service oriented activities.


- The employment of local people in primary and secondary sectors of project shall upgrade the prosperity of the region. This in-turn will improve the socio-economic conditions of the area.
- During construction phase of the project, this project will provide temporary employment to many unskilled and semi-skilled labourers in nearby villages;
- This project will also help in generation of indirect employment to those people who render their services for the personnel directly working in the project; and
- In case the hydrocarbon is established in the block, considerable number of people will be benefited by provision of services to the residents in for of employment opportunities. Thus, the direct and indirect employment generation by this project.

The present trend of out migration for employment is likely to reduce due to better economic opportunities available in the area.

8.5 Other Tangible Benefits

India is not among the major producers of crude oil, as it doesn't have much oil reserves. Therefore, India generally depends on imports of crude oil from other countries. There is a heavy imbalance between oil production and consumption in India. The Indian government is encouraging exploration and production of oil and gas to a great extent. This would primarily allow India to tap its own resources there by reducing its import bill. Discovery of viable hydrocarbon reserves in the state can boost the state's economic development to a great extent. The proposed exploration project is thus of immense significance for the state as well as nation's energy security for the sustainable and economic growth.

Energy Security has become one of the top three goals of the Indian Government. The Indian Government is encouraging exploration and production of oil and gas to a great extent. This would primarily allow India to tap its own resources there by reducing its import bill.

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Discovery of viable hydrocarbon reserves in the state can boost the state's economic development to a great extent. It would also catalyse influx of industries in the state. The proposed exploration project is thus of immense significance for the country.

Discovery of hydrocarbons in this block will substantially improve the socio-economic conditions of the region. The proposed exploration will also help to discover the geological past to create the economic future for the region as well as to the country.




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Chapter 9

Environmental Cost Benefit Analysis

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9.0 Environmental Cost Benefit Analysis

Thus, it is proposed to prepare EIA report as per the request from ONGC based on environmental quality data with the following scope and detailed work plan. The scope of work presented here is subjected to revision based on scrutiny and review of the Expert Appraisal Committee (EAC) members of Ministry of Environment, Forest and Climate Change (MoEF&CC) and to decide upon the comprehensive terms of reference (TOR) for the preparation of EIA report in respect of the proposed activity.


Besides the tangible benefits, the project has got number of intangible benefits like controlled emissions, minimum adverse impact on environment, socio-economic benefits to the local people through employment and the region and enhancement of the fuel / energy / products and infrastructural facilities for the region and particularly the country. The PCPIR when in operation will provide significant supply of petroleum products to the consumers.

The cost of the project and expenditure on the implementation of Environmental Management Plan (EMP) is very essential for the benefit of the project. The order of costs is presented in **Table 9.1**.

9.1 Project Cost

S.No.	Funds allocated for the activity	Rupees
1.	Total Cost of the Project at current price level	120 crores
2.	Funds Allocated for Environment Management (Capital)	52,86,000 lakhs
3.	Funds Allocated Towards ESC (Entrepreneur Social Responsibility)	1.8 crores
4.	Funds Allocated for Environment Management Plan (EMP) (Recurring per Annum)	84,93,000 lakhs


9.2 CAPITAL AND RECURRING COST FOR POLLUTION CONTROL MEASURES

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The capital and recurring cost towards pollution control measures for proposed project is more of related to monitoring and maintenance of machineries/ equipments. The Capital and recurring cost for each drilling location is given in table 9.2.

Table: Capital and Recurring Cost for Pollution Control Measures


S.No.	Pollution Control Measures	Total cost	Capital	Recurring Cost
1.	Wastewater Effluent Management			
	Septic Tank	37,000		15,000
	Water Quality Monitoring			40,000
2.	Fuel, lubricant and Chemical Management	15,00,000		65,000
3.	Noise and Vibration Mitigation			
	Acoustic Enclosure and Personal Protective equipment	1,75,000		-
	Noise Monitoring	-		35,000
	Maintenance Cost of equipment	-		58,000
4.	Solid Waste Management	50,000		
5.	Air Emission Mitigation			
	Maintenance of D.G. sets	-		21,50,000
	Air Monitoring	-		1,25,000

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6.	Soil Quality	-	
7.	Training to Staff	-	1,25,000
8.	General Awareness in Local Public	-	1,75,000
	Total	17,62,000	28,31,000


The Costs are calculated based on the current charges of an accredited laboratory/consultant/ contractor to perform the above said work.

The updated capital cost and recurring cost (per annum) for the environmental facilities for the proposed project works(for each drilling location) to be **Rs. (17,62,000) lakhs** Rupees only) and **Rs. (28,31,000 lakhs / yr** respectively given in the Table 9.2.

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CHAPTER: 10

ENVIRONMENT MANAGEMENT PLAN

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10.0 ENVIRONMENT MANAGEMENT PLAN

10.1 Introduction

This chapter provides a description of the administrative aspects of ensuring that mitigative measures are implemented and their effectiveness monitored, after approval of the EIA.

Based on the evaluation of impacts and baseline conditions, an Environmental Management Plan (EMP) has been delineated to mitigate the adverse impacts. The EMP includes formulation, implementation and monitoring of environmental protection measures. The EMP features guidelines and methodologies to be adopted at different stages of the proposed project for mitigating the impacts of various activities.


The EMP is herein outlined after taking into account the various Acts, Rules and Regulations/Standards concerned with the environmental management.

10.2 EMP during Various Project Phases

Environmental Management Plan (EMP) is the key to ensure a safe and clean environment. The desired results from the environmental mitigation measures proposed in the project may not be obtained without a management plan to assure its proper implementation and function. The EMP envisages the plans for the proper implementation of mitigation measures to reduce the adverse impacts arising out of the project activities. EMP has been prepared addressing the issues like:

- Pollution control/mitigation measures for abatement of the undesirable impacts caused during the construction and operation phase of the project.
- Details of management plans (air pollution control devices/measures, utilization of treated effluents, solid waste management plan etc.).
- Institutional set up identified/recommended for implementation of the EMP.
- Post project environmental monitoring programme to be undertaken
- Expenditures for environmental protection measures and budget for EMP.

The environmental management plan has to be implemented to minimize the adverse impact on environment such as reduction in atmospheric emissions, liquid effluents, solid wastes and noise generation.

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10.3 Environmental Policy of the Company

ONGC has a well laid Environment Management Systems (EMS) and contingency plans and processes that help them in preventing, mitigating and controlling environmental damages and disasters, which may be caused due to their operations or that of a member of its value chain.

10.4 Organisation Structure - HSE

A dedicated team at site will be responsible to ensure project operations with due reference to environment management and the Safety of the workers.

10.5 EMP plan for the Proposed Project


The EIA for the exploratory drilling programme has identified a number of impacts that are likely to arise during site preparation, drilling, well testing and demobilization. The EIA has examined biophysical and socio-economic effects of the proposed exploratory drilling programme, from site clearance and preparation of the drilling sites, drilling and testing through to abandonment, demobilization and restoration.

Where adverse impacts have been identified, the EIA has examined the extent to which these impacts would be mitigated through the adoption of industry standard practice and guidelines and following local legislative requirements. The Environmental Management Plan (EMP) describes both generic good practice measures and site specific measures, the implementation of which is aimed at mitigating potential impacts associated with the exploratory drilling programme.

The EMP provides a delivery mechanism to address potential adverse impacts, to instruct contractors and to introduce standards of good practice to be adopted for all project works. The EMP can be developed into a standalone document covering each stage of the exploratory drilling programme.

For each stage of the programme, the EMP lists all the requirements to ensure effective mitigation of every potential biophysical and socio-economic impact identified in the EIA. For each impact, or operation which could otherwise give rise to impact, the following information is presented:

- a comprehensive listing of the mitigation measures
- the parameters that will be monitored to ensure effective implementation of the action

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- the timing for implementation of the action to ensure that the objectives of mitigation are fully met

ONGC is committed to the adoption of these measures and will carry out ongoing inspection to ensure their implementation and effectiveness by its contractors.

The EMP comprises a series of components covering direct mitigation and environmental monitoring, an outline waste management plan and a drilling site restoration plan.


However the baseline monitoring data shows that the baseline concentrations of various pollutants in air, noise, water and soil are well within the permissible limits. The exploratory drilling programme has been designed to avoid or minimize impacts to the environment and local communities wherever practicable. Where residual impacts remain, which may have moderate or significant impacts on the environment, mitigation measures have been prescribed in this EIA which will either reduce the impact to an acceptable level or adequately offset it.

Environmental Management Plan of the project provide the details of environmental quality control measures which will be taken up and which are proposed by complying with the stipulated standard limits specified by CPCB and State Pollution Control Board. Environmental Management Plan which will be implemented is detailed under the following heads.

- Air Pollution Control
- Noise Mitigation
- Biological Environment
- Soil environment
- Socio Economic Environment
- Wastewater Management
- Solid Waste Management

10.6 Environment Protection and Reclamation Plan

- Construction activities will be coordinated in consultation with landowners to reduce interference with agricultural activities


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- Topsoil will be stripped to color change or to plough depth and will be stored on the site. The depth of stripping will be on the basis of site specific soil survey
- If required for rig stabilization the well site will be temporarily padded with granular fill
- The drill site would be provided with sufficient sanitary facilities
- Combustible wastes generated would be disposed of in an approved TSDF site
- Hazardous materials such as petroleum, spirit, diesel lubrication oil and paint materials required at the site during construction activities would be stored as per safety norms
- To ensure that the local inhabitants are not exposed to the hazards of construction the site would be secured with manned entry posts
- It would be ensured that both gasoline and diesel powered construction vehicles are properly maintained. The vehicle maintenance area would be so located that the contamination of surface/soil/water by accidental spillage of oil/diesel will not take place and dumping of waste oil will be strictly prohibited
- All irrigation canals and ditches encountered by the proposed well site access and well site will be maintained in a fully functional state
- No Construction material debris will be left on site

10.7 Environment Management Plan

10.7.1 Air Environment

- It is recommended that all equipment are operated within specified design parameters during construction, drilling and operational phases.
- Any dry, dusty materials (chemicals), muds etc. shall be stored in sealed containers.
- Water spraying will be done on the access roads to control re-entrained dust during dry season (if required);
- Well testing (flaring) should be done for a minimum duration to minimise impacts of emissions. This can be achieved by minimising the duration of testing, installation of elevated flare system

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as per OMR and through careful planning. The flaring system will be installed as per OMR guidelines and will be properly managed at all times;


- The engines and exhaust systems of all vehicles and equipment used will be maintained as such, that exhaust emissions are low and do not breach statutory limits set for the concerned vehicle/equipment type;
- Availability of valid Pollution under Control Certificates (PUCC) shall be ensured for all vehicles used on site.

10.7.2 Noise Environment

- It is recommended that while procuring major noise generating equipment such as diesel generators etc. it should be checked that all mufflers are in good working order and that the manufacturers have taken the normal measures for minimizing the noise levels.
- Noise barriers/shields in the form of well berm or sheeting should be provided around the units wherever possible. Use of ear muffs/plugs and other protective devices should be provided to the workforce in noise prone areas. Enclosures around noise sources may be provided depending on the size of the unit.
- Wherever generator noise occurs in proximity to human settlements, acoustic enclosures shall be provided.
- Preventive and predictive maintenance of machines and vehicles is to be carried out to reduce the noise levels;
- All noise generating operations, except drilling is to be restricted to daytime only to the extent possible;
- Personnel Protective Equipments (PPE) like ear plugs/muffs is to be given to all the workers at site and it will be ensured that the same are wore by everybody during their shift;

10.7.3 Water Environment

Waste water generated during drilling operations would be around 4 m³/d during drilling operation. Drilling is a temporary activity lasting for 60-90 days. Wastewater characteristics would be of varied nature and

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likely to contain soil particulate matter along with organics. The following mitigation measures are suggested.


- Efforts will be made to reduce the water requirement;
- All chemical and fuel storage areas will have proper bunds so that contaminated run-off should not meet the storm-water drainage system;
- Strict supervision and spill control measures will be implemented at site;
- Proper care will be taken so that the ground water aquifers does not get contaminated due to leak in the HDPE lined pit;
- Best engineering technique will be adopted during drilling operation jobs like cementation job and installation of casing etc. so that drilling fluid does not contaminate the ground water.

10.7.4 Biological Environment

- Only elevated flare shall be installed temporarily during testing phase as per OMR standard to minimize effect on nocturnal avifauna.
- Acoustic enclosure shall be provided to D.G. set to reduce the noise intensity during their operation
- Development of plantation of native species(given in Figure: 10.1) to substitute the access cutting, site preparation will provide habitat, food and breeding areas to birds, small animals and insects
- Use existing facilities (e.g. Access Roads) to the extent possible to minimize the amount of new disturbance
- Minimum use of necessary lighting at night to avoid attraction of avifauna.

10.7.5 Land Environment

- Necessary efforts will be made during selection of drill site to minimize disruption to existing land use pattern to the extent possible;
- Necessary restoration efforts will be made during decommissioning and site closure to restore the site back to its original condition to the extent possible;
- Proper restoration of site will be carried out to bring the physical terrain, soils and vegetation, as closely possible, to their original condition;

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- On completion of works (in phases), all temporary structures, surplus materials and wastes will be completely removed till 1m below the surface;
- Temporary new approach roads can be constructed and existing roads can be improved, if required, for smooth and hassle free movement of personnel as well as materials and machineries;
- Optimization of land requirement through proper site lay out design will be a basic criteria at the design phase;
- The drill cuttings (approx. 200 - 250 m³) are mostly inorganic in nature and may be used either for land filling or road making.
- Drill cuttings could be collected in HDPE lined pit at site and after solar dry shall be covered with top layer of soil which was stacked at site during site preparation as per MOEF notification dated 30th August 2005, Sr. No. C Point No. 1.

10.7.6 Soil Environment

- Store, preserve and protect topsoil separately for its use during restoration period;
- Carry out adequate restoration of soil at the drilling site, to the extent possible using the soil stored from piling and excavation activities;
- Dispose drilling mud and drill cutting temporarily in an impervious HDPE lined pit for evaporation and solar drying carefully so that there is no spillage.
- Management of spilling of contaminants such as chemicals, lub oil from equipment, cement, drilling mud etc. on the soil;

10.7.7 Storage and Handling of Materials and Spoils

ONGC will ensure that the Contractors employed for site preparation carry out proper storage and handling of spoil, sub-soils, top-soils and also solid powdery raw materials to minimize the risk of windblown material and dust. If possible all loose heaps of materials will be covered by polythene sheets. In addition, procedures and work instruction for all activities that may generate fugitive dust emissions will be created. All loading and unloading activities shall be carried out as close as possible to the storage facilities. Dry cement handling should be enclosed to the extent possible. It will be ensured that lids of all containers containing volatile substances/chemicals are properly fitted. All chemical and fuel storage areas, will have proper bunds so that contaminated run-off cannot escape as runoff into the storm-water

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drainage system Personal protective equipment shall be provided to all workers involving in handling of hazardous materials

10.7.8 Social Management Plan


Programs for environmental education and public participation would be developed with the help of audio visual aids to create awareness about the activities. Camps to provide people with information on geology, energy and drilling technology in addition to the likely environmental hazards due to existing and proposed facilities could be organized. Certain welfare measures be implemented for the benefit of local population. Employment opportunities would be considered for local population during the exploratory drilling phase.

In order to mitigate the adverse impacts likely to arise out of construction activities, it is required that some of the key issues which are identified through evaluation of the baseline status are addressed carefully before commencing project work. Keeping this in view the following measures are suggested to avoid undesirable impacts in the future.

Suggestions are given below:

- Protection of persons against dust emissions during construction and transportation activities
- During construction/drilling activity, local people should be given preference regarding jobs in skilled and semi-skilled categories on temporary basis
- People losing their land are against cash compensation at government rate, therefore, compensation should be agreed with land losers before arriving at amount to be disbursed
- Communication with the local community, land losers should be implemented to get local people into confidence
- For social welfare activities to be undertaken by the project authorities, collaboration should be sought with the local administration, gram panchayat etc. for better co-ordination.

During the public consultation it is found that the local communities of the surrounding villages are in favor of the ONGC proposed project subject to providing the new job opportunities for the youth. The

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project proponent should also assist in bringing out the permanent solution for the supply of drinking water, electricity and improvement in the education of their children.


To improve the socio-economic conditions of the surrounding areas the project proponent will carry out different social activities under CSR scheme in the fields of health, education, infrastructure, skill development program in the full block. According to “The Companies Act 2013” the project proponent will invest at least 2% of their net profit for the cause of social development of the area. The undermentioned activities will be conducted at regular interval by the project proponent as a mitigation measure for the adverse impact.

- The project proponent will initiate to improve the sanitation, education and health quality of people under company’s CSR Scheme, if hydrocarbon reserves are discovered.
- To minimize the strain on the existing infrastructure, adequate provisions related basic amenities like village road, transport, health etc. will be considered for the migratory and the work force in the surrounding areas.
- Awareness programs to the local people will be given at different interval regarding potential risks and hazards arising out of project activities.
- Job oriented skill development courses will be organized through ITIs/ Vocational Training Institute like electrician, motor winding, automobiles repair, driving, tailoring, welding and fabrication related other jobs.

10.7.9 Environmental measures during well construction

i. As a preventive measure to avoid impacts the well site will be located based on the following consideration:


- Located at least 300 - 500 m away from the nearest village habitat / sensitive receptors;
- Located at least the height of the well must away from public road;
- Located at least 300 - 500 m away from existing water bodies;
- Ensure natural drainage channels are avoided or drainage channels rerouted to ensure unhindered flow of rain / flood water. Where necessary adequate erosion control measures will be provided;

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- Located in a manner to avoid plantations of timber yielding trees
- ii. Construction activities will be coordinated in consultation with landowners and local authorities to reduce interference with agricultural activities
- iii. In dry weather conditions, water sprinkling during excavation, levelling and transportation will be implemented.
- iv. Topsoil will be stripped below plough depth from the well site and stored on the site. The depth of stripping will be on the basis of site specific soil survey. Topsoil will also be stripped from and stored adjacent to the site.
- v. The well site ground level will be raised and hard standing provided. Drainage channels around the site area will be constructed to ensure no obstruction to flow pattern.
- vi. The approach roads will be routed in a manner so that disturbance to existing activity and to the local community is minimized. Routing through village habitat areas will be avoided, as far as practical. The road surface will be maintained to minimize generation of vehicular movement dust in the local area.
- vii. The drill site would be provided with sufficient and suitable sanitary facilities and these will be connected to well designed and maintained septic tanks.
- viii. The chemical and diesel storage area will be paved and provided with spill containment walls. Pits for storage of water, drilling mud and drill cuttings will be provided with impervious liner. Sufficient free-board will be provided to prevent overflow.
- ix. It would be ensured that diesel powered construction vehicles are properly maintained. Vehicle maintenance would be carried out authorised service centres. Service centres will be so selected to ensure that these conform to statutory regulations.

- **Removal of Equipment and Materials**

In the event that economic quantities of hydrocarbons are found, the well will be suspended with a wellhead in place, but all other equipment and materials will be removed from the site. All empty drums, wastes, used and unused drilling fluids, fuel and lubricants will be removed from the drilling site. Water

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supply and effluent discharge hoses and associated equipment will be removed. The access road(s) would be reinstated.


10.7.10 Management of Drilling Wastes

The major waste product of a drilling operation is the generation of rock cuttings with residual mud adhering to the drill cuttings and spent drilling fluid. About 500 m³ drill cuttings per well and 40 m³/day spent drilling fluid would need to be disposed of. Following measures to be adopted for disposal of drill cutting and residual drilling fluids:

- Drill cuttings separated from WBM should be properly washed and unusable / residual drilling fluids WBM should be disposed of in a well-designed pit lined with impervious liner located offsite or on sit.
- The chemical additives used for preparation of DF should have low toxicity i.e 96 hr LC50 > 30,000 mg/l as per mysid toxicity or toxicity test conducted on locally available sensitive species. The chemicals used (mainly organic constituents) should be biodegradable.
- The waste pit after it is filled up shall be covered with impervious liner, over which, a thick layer of native soil with proper top slope is provided.
- Drilling wastewater including DC wash water should be collected in the disposal pit evaporated or treated and should comply with the State Pollution Control Board discharge standards.
- Total material acquired for preparation of drill site must be restored after completion of drilling operation leaving no waste material at site. ASPCB should be informed about the restoration work.

The proposed control measures include:

- Use of water based drilling mud; only in case of problem due to geological formation Synthetic Based Mud would be used. Proper washing and disposal as per MOEF guidelines vide GSR 546 (E) would be adhered to in case of use of SBM.
- Mud recovery from cutting during drilling and recycling of drilling fluid;
- Management of drill fluid losses as part of the standard operational procedures of the drilling rig;
- Impervious layer lined storage pond for the storage and recycling of drilling mud;
- Drill cuttings to be stored in impervious lined drill cutting pits; and

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- Drill cutting and spent drilling fluid to be treated with flocculants and liquid fraction solar evaporated. The solids to be solar dried and covered with an impervious lining and buried in a lined secure pit and the disposal pit covered with soil and closed. The disposal pit location to be fenced to prevent any stray animal / unauthorized man entry.

Most of the hired drill rigs are provided with facility for maximum recycle of drilling fluids. The site during construction phase is provided with waste pit to hold treated/settled liquid wastes. The cuttings are segregated and stored in confined area and used later on being inorganic in nature for reclaiming the site or for preparation of approach road. Waste pits are provided with adequate holding capacity to store the wastewater generated during entire drilling phase of the rig. The waste pits are lined with impervious material to prevent leachate and percolation into groundwater.

10.7.11 Management of Solid Wastes

Small amounts of solid wastes will be generated during normal operation at the drilling rig. Measures for effective waste management include:

- Solid wastes generated on the Drilling Rig will be properly segregated;
- The wastes will be disposed on compliance with local and national legislations;
- Spent waste oil to be stored in a secure paved area and disposed to MoEF&CC/ SPCB approved waste oil recyclers;
- Ensure that a waste management programme is implemented to minimize the amounts generated. ONGC has a well-established waste management plan which is strictly implemented at all well sites;
- Ensure all waste packaging material are suitably stored and kept to prevent unintended use;
- Drill cuttings and sludge from drilling mud to be buried within the impervious lined pit and covered with soil as part of the site abandonment plan;
- Biodegradable waste arising from kitchen and canteen activities to be scientifically composted and the bio-manure so generated to be used for green belt development. Alternatively, the food wastes to be disposed as domesticated animal feed;
- Proper training and information on regulatory requirements shall be provided to the staff responsible for waste disposal to ensure proper disposal of the waste; and

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- Inventory of solid waste generation and type shall be prepared and disposal facilities should be audited for suitability prior to the commissioning of drilling programme.

The drill cuttings are washed on the screen and separated. Quantity of cutting vary from well to well depending on well drill programme, casing policy and depth of well. About 500 m³/well of drill cuttings - are envisaged per well. These cuttings are inorganic in nature and stored at the corner of a drill site and later removed from the site when site is reclaimed.

10.7.12 Management of Discharge of Aqueous Effluents

Wastewater generated from drilling rig wash down possibly contains mud, lubricants and residual chemicals in traces resulting from small leaks or spills. Though, these are all relatively low volume discharges containing small residual quantities, measures shall be taken to ensure no waste is discharged directly onto the land or in a manner to impact any water body. Potential control measures include:

- The drilling rig should be equipped with suitable containment and treatment systems as part of the contract specifications;
- ONGC shall also ensure that good housekeeping standards are maintained to prevent hydrocarbons and other containments entering the storm water drainage systems;
- Careful consideration should be given and necessary controls exercised to minimize the amount of waste generated;
- The spent drilling fluid to be stored in impervious lined pit with sufficient free board to prevent any overflows. On completion of the drilling operation the waste drilling fluid to be solar evaporated; and
- The sanitary effluents should be treated in a septic tank system designed for the anticipated person equivalent loading and the treated sewage to be let out into soak away pits.
- At the conclusion of well testing at each drilling site, the lined pits of drilling wastes will be covered with soil and left onsite. All these sites will be fenced as per the HSE Management. With appropriate lining of the pit in place, it therefore does not pose any environmental hazard.

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10.7.13 Management of waste disposal sites within Drill site

ONGC will dispose the drill cuttings, drill mud and waste water generated during the drilling operations into the lined pits of various sizes and undertaking plantation within the drill site particularly on the reclaimed pits.

10.7.14 Occupational Health Surveillance Program:

All the employees working will undergo PME (Periodical Medical Examination) by approved medical doctor / Hospital at fixed interval as per the company policy:

Up to 45 years - Once in a 5 Years

45 to 55 years - 3 years &

> 55 years - 2 years

As per plan 10 % employees are being medically examined every year and records are being kept in track for future reference. There are ONGC Panel hospitals / Laboratories /Doctors with necessary medical facilities for PME like X-Rays, ECG, Sonography, PFT, Audiometry, Eye / ENT Surgeon / Blood / urine test etc.

ONGC has its own dispensaries and empanelled hospitals for employees and their family members for day to day medical problems. Ambulance is available 24 hrs. All the work centres have First Aid Box, Stretcher and 24 Hrs. emergency vehicles. Free medical camps (medical check-up / eye check-up) are also organized by ONGC in villages around the operational area, and accordingly patients are treated and free medicines are given. If required free operations are also done by ONGC under CSR. Summary of the Environment Management Plan is given in the **Table 10.1**



Acacia farnesiana (Mexican plant)



Callestemon (Bottlebrush)



Pinus roxburghii (Pine)



Eucalyptus sp. (Nilgiri)



Vetiver species



Ocimum sanctum (Tulsi)

Figure 10.1: Plants which Counteract Air Pollution (Odour of Sulphur)



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TABLE-10.1
SUMMARY OF ENVIRONMENTAL MANAGEMENT ACTIONS

Potential Impact	Action	Responsibility	Parameters for Monitoring	Timing
1. Land take	1.1 Ensure that all necessary protocols are followed and legal requirements implemented: a) Ensure that appropriate legal requirements have been met with regard to land occupancy, land ownership or usage rights, notice and compensation etc; b) Establish and clearly document land take agreements with owners, users and state authorities.	ONGC, Land Acquisition coordinators Land Acquisition coordinators	Check list of action items	Pre-deployment of topographic survey team or site clearance crew.
	1.2 Mark out site boundaries. Ensure that land take during drilling site construction is restricted to pre-agreed area	ONGC/Contractors	Site boundaries marked	After selection of precise site location and orientation. Prior to onset of site clearance.
2. Soil Erosion	2.1 Minimize area extent of site clearance, by staying within defined boundaries.	Contractor Supervisor	Site boundaries marked	Prior to onset of site clearance.
	2.2 Stockpile of topsoil wherever possible and applicable at the edge of site.	Contractor supervisor	Topsoil stockpile in place on site edge.	Site Construction. Duration of program up until demobilization.
	2.3 Install and maintain effective run-off controls, including siltation ponds,	Drilling Site manager	Condition of siltation ponds. Rill or gully development in immediate off-site surroundings.	Site construction. Duration of program and beyond.



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Potential Impact	Action	Responsibility	Parameters for Monitoring	Timing
	traps and diffusion methods so as to minimize erosion.			
	2.4 Avoid uprooting trees or removing undergrowth where possible, so as to retain land stability.	Contractor supervisor	Trees to be preserved identified	Site clearance.
3. Habitat disturbance	3.1 Mark out site boundaries	Drilling Site manager	Clear boundary markers in place.	Prior to commencement of site clearance.
	3.2 Avoid uprooting trees and other plants where possible so as to facilitate subsequent re-growth.	Contractor Supervisor	Trees to be preserved identified	Entire drilling campaign

3.3 Avoid uprooting trees and other plants where possible so as to facilitate subsequent re-growth.	Contractor Supervisor	Trees to be preserved identified	Entire drilling campaign
3.4 For cleared areas, retain top soil in stockpile where possible on perimeter of site for subsequent re-spreading onsite during restoration	Contractor Supervisor	Topsoil stockpile in place on site edge.	Duration of programme until Demobilization or prior opportunity for revegetation of verges.
3.5 All bulldozer operators involved in site preparation shall be trained to observe the defined site boundaries.	Contractor Supervisor	Maintenance of integrity of boundary markers.	Duration of site preparation.
3.6 Hunting, fishing and wildlife trapping is forbidden. Removal or disturbance to nesting or breeding birds and animals, their eggs or young is strictly prohibited.	Contractor Supervisor	Awareness training	Entire drilling campaign
4.1 Maintain strict inventory of all fuel, lubricants and chemicals brought to the drilling site.	Drilling Site manager	Up-to-date inventory in place.	-do-



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4.2 All fuels, lubricants and chemicals placed in controlled storage.	Contractor Supervisor	Periodic checking of Integrity of storage area, impervious liner; All drums and containers located within footprint of storage area.	-do-
4.3 All used and unused lubricants and chemicals no longer required, to be stored in a secure paved area and disposed to authorized recyclers	Drilling Site Manager	Validity of authorization of the approved recyclers; Manifest and records to be maintained;	-do-
4.4 Refueling operations to be undertaken over area with impervious flooring and surface drainage with oil traps.	Drilling Site Manager.	Paved facilities to be installed and training to concerned to be provided.	-do-
4.5 Delivery of fuel to drilling site to be supervised.	Drilling Site Manager.	Detailed procedure in place and training to concerned provided.	-do-
4.7 Adequate oil spill containment and clean-up equipment and materials on-hand and available to contain foreseeable oil spill.	Construction Supervisor/ Drilling Site manager	Facilities and inventories readily available and in good working order.	Entire drilling campaign
5.1 Implement Drilling Waste Management Plan	Drilling site Manager.	Comprehensive Waste Management Plan in place and available at site.	Prior to site clearance.
6.1 Impervious liners in place for a. Fuel, lubricants and chemicals storage area. b) cuttings pit; \$ stream side pump set station.	Contractor Supervisor	Evidence of protective measures in place. No visual sign of oil spills.	Daily throughout duration of programme.
6.2 Effective bunds capable of containing 110% of the volume of the largest container within and enclosing all potentially contaminating	Contractor Supervisor	Evidence of protective measures in place. Absence of visual evidence of contamination.	Daily throughout duration of programme.



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materials. To be used for fuel lubricants and chemicals storage area.			
6.3 Non - contaminated and potentially contaminated run-off will be kept separate. Non-contaminated run-off will be routed to off-site areas via silt traps. Potentially contaminated surface run-off will be routed through oil traps	Drilling Site manager	Evidence of separate routes and effectively working silt traps. Oily water separation in good working order.	Duration of entire drill programme.
6.4 Oil drip pans shall be used wherever there is significant potential for leakage including, but not limited to; <ul style="list-style-type: none"> • Drill rig engine; • Electric generator engine; • Compressors, pumps or other motors; • Maintenance areas; • Fuel transfer areas. 	Contractor Supervisor	Drip pans in place. Absence of visible signs of soil contamination.	Duration of entire drill programme.
6.4 All spills/leaks contained, reported and cleaned up immediately: <ul style="list-style-type: none"> • Oil absorbent /spill containment material deployed to contain large spills; • Contaminated soil dug up, placed in drums and subsequently removed from site. 	Contractor Supervisor	Written spill procedure in place Oil spills containment materials on-site (and always ready for deployment). Spill reporting procedure in place	Duration of entire drill programme.
7.1 No untreated discharge to be made to watercourses.	Drilling Site manager	Ensure no untreated effluent discharged on land or watercourse from the drilling site / campsite.	Duration of programme with particular emphasis during site layout design and site construction.



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7.2 Minimize suspended solids loads to watercourses by installing appropriate surface run-off drainage systems (eg. silt traps)	Contractor Supervisor	Surface drainage systems in good working order. Absence of visible erosion and gullies. Absence of visible suspended solids loads in streams. Results from water monitoring programme.	Duration of programme.
8.1 List of all potential noise / vibration generating machinery on-site identifying age of plant.	Drilling Site manager	Ensure that the drilling rig DG sets have acoustic hoods and noise dampers in place; Mapping of noise generating equipments noise levels before commencement of drilling and once during the drilling operation; Check the anti-vibration pads / other measures in place to attenuate transmission of machinery vibration	Prior to commencement of work by contractors at each drilling site. During drilling operation
8.2 Equipment maintained in good working order. Workers near noise source provided with noise protection equipment (ear muffs)	Contractor Supervisor	Written record of maintenance for all equipment. Monitor effective use of personnel protective equipments	Prior to commencement of work by contractors at each drilling site.
8.3 Implement good working practices to minimize noise.	Contractor Supervisor	No machinery running when not required.	Duration of entire drill programme.
8.4 Acoustic mufflers in large engines (where practicable)	Contractor Supervisor	Mufflers in place.	Duration of entire drill programme.
9.1 All equipment operated within specified design parameters (site preparation and drilling phases)	Drilling Site manager	N/A	Duration of entire drill programme.



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9.2 Any dry, dusty materials (chemicals, mud etc) shall be stored in original packings and loose storage avoided (wherever possible).	Contractor Supervisor	Absence of stockpiles or open containers of dusty material.	Duration of entire drill programme.
9.3 Well testing (flaring) to be undertaken so as to minimize impacts of emissions: <ul style="list-style-type: none"> • Duration of testing minimized by careful planning; • High combustion efficiency, smokeless flare/burner to be used. 	Drilling site Manager / Contractors supervisor	Check flare controls before flaring; Physical Inspection during flaring; Maintenance checklist of flaring equipment; Check firewall in place, where required and flare direction	Well testing.
10.1 Well site to be developed to avoid any habitat and cultural / archaeological centers 10.2 Adequate dialogue with the local population and the authority while designing compensation packages, close monitoring on the type of land loss: <ul style="list-style-type: none"> • Permanent • Temporary 	ONGC Land Acquisition Supervisor	Checklist of action items. Continued dialogue with the local villagers and other stake holders	At the initial stage of well site planning
Protection of traditional water structures provision of health and education services. Loss of land and crop loss to be compensated. Provide temporary employment generation opportunities, where feasible	ONGC Land acquisition supervisor	Project management plan should incorporate these aspects at the initial planning stage	All through drilling and post drilling operation During site acquisition phase During the site preparatory works

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ANNEXURE-1 Corporate Environment Policy

शशि शंकर
Shashi Shanker

अध्यक्ष एवं प्रबन्ध निदेशक
Chairman & Managing Director

ऑयल एण्ड नेचुरल गैस कॉरपोरेशन लि.
Oil and Natural Gas Corporation Ltd.



Corporate Environment Policy

Oil and Natural Gas Corporation Limited (ONGC) is committed to:

1. Achieve Environmental Leadership in all its Business Activities.
2. Abide by all applicable Legislative & other requirements associated with Environment Protection and Ecological Preservation.
3. Strive for Environment Protection and maintain Ecological Balance in and around its Operational areas for Sustainable Development.
4. Ensure Conservation of Natural Resources.
5. Enhance Community Awareness towards the Environmental Risks associated with Exploration & Production activities, mitigation measures undertaken and preparedness to tackle emergencies; to minimize its impact on Environment.
6. Minimize Waste Generation through Reduction at Source, Recycling & Reuse.
7. Maximize Recovery of Oil from Oily Waste and to exercise options for Utilizing Oily Waste for Energy purposes, wherever possible.
8. Prevent, Respond, Contain & Combat Oil Spill at Offshore & Onshore areas and ensure maximum reclamation of Oil.
9. Develop and Implement action plan on Social Needs around its Operational areas to meet obligations of Enterprise Social Responsibility.
10. Reduce Emissions at Source by adopting Clean and Green Technologies and phase out usage of Hazardous Substances in its Operations.
11. Meet provisions of Climate Change Treaty in line with Intended Nationally Determined Contribution targets of the Government of India including other applicable International Treaties.
12. Achieve Excellence in Knowledge Management and Skill Development for Environment Protection.


(Shashi Shanker)

Dated: 28th May, 2018





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ANNEXURE-II TERMS OF REFERENCE

F. No. J-11011/172/2016-IA-II(I)

Government of India

Ministry of Environment, Forest and Climate Change
(IA Division)

Indira Paryavaran Bhawan,
Jor Bagh Road, New Delhi - 3

Dated: 25th November, 2016

To

The Deputy General Manager (Chemistry),
M/s Oil and Natural Gas Corporation,
Corporate HSE, 8th Floor, Core IV, Scope Minar
Delhi - 110092

Sub: Exploratory drilling of three wells in Districts Badarpur and Cachar in Assam by M/s Oil and Natural Gas Corporation – Terms of Reference - reg.

Sir,

This has reference to your Proposal No. IA/AS/IND2/56473/2016 dated 3rd August, 2016, submitting to this Ministry for seeking Terms of Reference (ToR) in terms of the provisions of the Environment Impact Assessment (EIA) Notification, 2006 under the Environment (Protection) Act, 1986.

2. The proposal was considered by the Expert Appraisal Committee (EAC) in the Ministry for (Industry-2), in its 13th meeting held on 26th – 27th September, 2016. The details of the project, as per the documents submitted by the project proponent, and also as informed during the above said EAC meeting, are reported to be as under:-

- (i) The project involves exploratory drilling of three wells in Districts Badarpur and Cachar in Assam promoted by M/s Oil and Natural Gas Corporation. Following are the locations of three wells:-

S.No.	Proposed location	Co-ordinates	
		Latitude	Longitude
1	BPAA	24° 52'25.00"	92° 35'45.94"
2	BPAB	24° 51'11.22"	92° 35'16.06"
3	WHRAA	24° 56'28.48"	92° 33'47.97"

- (ii) The area required for drilling location would be 1.8 Ha.
(iii) HSD will be used @ of about 06 m³ /day.
(iv) The daily fresh water consumption will be 25 m³ /d, of which 15m³ /d will be used for mud preparation and 10 m³ /d will be used for domestic purposes. Water based mud will be used for drilling.
(v) **Power requirement:** The power requirement will be met from 6 DG sets. DG sets will be attached with adequate stack height.
(vi) 3 Nos. waste pits will be made of 15000 m³ capacity.
(vii) Drill cuttings of underground rocks and solids in water based mud used for drilling will be stored in impervious pits within the drilling site.
(viii) It is proposed that waste oil/sent oil will be recycled through approved recyclers.



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- (ix) **Wildlife issues:** It is reported that no national parks, Reserve/ protected forest and Wildlife Sanctuaries lies within 10 km distance.
- (x) **Water bodies:** Barak River is flowing at distance from the wells location namely BPAA, BPAB and WHRAA are 300 m, 2.5 Km and 5 km respectively.
- (xi) **Investment/cost:** Total project cost is ₹120 crore.

4. The EAC recommended the project for grant of ToR. As per the recommendation of the EAC, the Ministry of Environment, Forest and Climate Change hereby accords following specific and additional ToR in addition to generic ToR provided at Annexure - I (refers to Ministry's website) to the **'Exploratory drilling of three wells in Districts Badarpur and Cachar in Assam by M/s Oil and Natural Gas Corporation** for preparation of the Environment Impact Assessment (EIA) Report and Environment Management Plan (EMP):-

- (i) Executive summary of the project.
- (ii) No. of exploratory wells for which environmental clearance is accorded and No. of new wells proposed during expansion. Status and No. of the wells which are completed and closed.
- (iii) Project description and project benefits;
- (iv) Cost of project and period of completion.
- (v) Employment to be generated.
- (vi) Distance from coast line.
- (vii) Details of sensitive areas such as coral reef, marine water park, sanctuary and any other eco-sensitive area.
- (viii) Recommendation of SCZMA/CRZ clearance as per CRZ Notification dated 6th January, 2011 (if applicable).
- (ix) Details on support infrastructure and vessel in the study area.
- (x) Climatology and meteorology including wind speed, wave and currents, rainfall etc.
- (xi) Details on establishment of baseline on the air quality of the areas immediately affected by the exploratory drilling and also particularly with reference to hydrogen sulphide, sulphur dioxide, NOx and background levels of hydrocarbons and VOCs.
- (xii) Details on estimation and computation of air emissions (such as nitrogen oxides*, sulphur oxides*, carbon monoxide*, hydrocarbons*, VOCs*, etc.) resulting from flaring, DG sets, combustion, etc. during all project phases
- (xiii) Base line data collection for surface water for one season leaving the monsoon season within 1 km for each exploratory wells, particularly in respect of oil content in the water sample and sediments sample.
- (xiv) Fisheries study w.r.t. benthos and marine organic material and coastal fisheries.
- (xv) Source of fresh water. Detailed water balance, waste water generation and discharge.
- (xvi) Noise abatement measures and measures to minimize disturbance due to light and visual intrusions in case of project site closed to the coast.
- (xvii) Procedure for handling oily water discharges from deck washing, drainage systems, bilges etc.
- (xviii) Procedure for preventing spills and spill contingency plans.
- (xix) Procedure for treatment and disposal of produced water.
- (xx) Procedure for sewage treatment and disposal and also for kitchen waste disposal.



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- (xxi) Details on solid waste management for drill cuttings, drilling mud and oil sludge, produced sand, radioactive materials, other hazardous materials, etc. including its handling and disposal options during all project phases.
- (xxii) Storage of chemicals on site.
- (xxiii) Commitment for the use of water based mud (WBM) and synthetic oil based mud in special case.
- (xxiv) Details of blowout preventer Installation.
- (xxv) Risk assessment and mitigation measures including whether any independent reviews of well design, construction and proper cementing and casing practices will be followed.
- (xxvi) Handling of spent oils and oil from well test operations.
- (xxvii) H2S emissions control plans, if required.
- (xxviii) Details of all environment and safety related documentation within the company in the form of guidelines, manuals, monitoring programmes including Occupational Health Surveillance Programme etc.
- (xxix) Restoration plans and measures to be taken for decommissioning of the rig and restoration of on-shore support facilities on land.
- (xxx) Documentary proof for membership of common disposal facilities, if required.
- (xxxi) Any litigation pending against the project or any directions/order passed by any Court of Law against the project. If so, details thereof.
- (xxxii) Total capital and recurring cost for environmental pollution control measures.
5. A detailed draft EIA/EMP report shall be prepared in terms of the above additional ToRs and shall be submitted to the concerned State Pollution Control Board for conduct of Public Hearing. Public Hearing to be conducted for the project in accordance with the provisions of Environmental Impact Assessment Notification, 2006 and the issues/commitments raised by the public, shall be addressed in the EIA/EMP in the form of tabular chart with financial budget for complying with the commitments made. The Public Hearing should be conducted based on the ToR letter issued by the Ministry and not on the basis of Minutes of the Meeting available on the web-site.
6. You are requested to kindly submit the detailed final EIA/EMP prepared as per ToRs including issues raised during Public Hearing to the Ministry for considering the proposal for environmental clearance within 3 years as per the MoEF&CC O.M. No.J-11013/41/2006-IA-II(I) (P) dated 8th October, 2014.
7. The consultants involved in preparation of EIA/EMP report after accreditation with Quality Council of India/National Accreditation Board of Education and Training (QCI/NABET) would need to include a certificate in this regard in the EIA/EMP reports prepared by them and data provided by other Organization(s)/Laboratories including their status of approvals etc. vide notification of the MoEF dated 19th July, 2013.


(Yogendra Pal Singh)
Scientist D

Copy to:
The Member Secretary, Assam Pollution Control Board, Guwahati (Assam).



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ANNEXURE-II **TERMS OF REFERENCE**

STANDARD TOR FOR ONSHORE OIL AND GAS EXPLORATION, DEVELOPMENT & PRODUCTION

1. Executive summary of a project.
2. Project description, project objectives and project benefits.
3. Cost of project and period of completion.
4. Site details within 1 km of the each proposed well, any habitation, any other installation/activity, flora and fauna, approachability to site, other activities including agriculture/land, satellite imagery for 10 km area. All the geological details shall be mentioned in the Topo sheet of 1:40000 scale, superimposing the well locations and other structures of the projects. Topography of the project site
5. Details of sensitive areas such as National Park, Wildlife sanctuary and any other eco-sensitive area alongwith map indicating distance.
6. Approval for the forest land from the State/Central Govt. under Forest (Conservation) Act, 1980, if applicable.
7. Recommendation of SCZMA/CRZ clearance as per CRZ Notification dated 6th January, 2011 (if applicable).
8. Distance from nearby critically/severely polluted area as per Notification, if applicable. Status of moratorium imposed on the area.
9. Does proposal involve rehabilitation and resettlement? If yes, details thereof.
10. Environmental considerations in the selection of the drilling locations for which environmental clearance is being sought. Present any analysis suggested for minimizing the foot print giving details of drilling and development options considered.
11. Baseline data collection for air, water and soil for one season leaving the monsoon season in an area of 10 km radius with centre of Oil Field as its centre covering the area of all proposed drilling wells.
12. Climatology and Meteorology including wind speed, wind direction, temperature rainfall relative humidity etc.
13. Details of Ambient Air Quality monitoring at 8 locations for PM2.5, PM10, SO2, NOx, CO, VOCs, Methane and non-methane HC.
14. Soil sample analysis (physical and chemical properties) at the areas located at 5 locations.
15. Ground and surface water quality in the vicinity of the proposed wells site.



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16. Measurement of Noise levels within 1 km radius of the proposed wells.
17. Vegetation and land use; flora/fauna in the block area with details of endangered species, if any.
18. Incremental GLC as a result of DG set operation, flaring etc.
19. Potential environmental impact envisaged during various stages of project activities such as site activation, development, operation/ maintenance and decommissioning.
20. Actual source of water and 'Permission' for the drawl of water from the Competent Authority. Detailed water balance, wastewater generation and discharge.
21. Noise abatement measures and measures to minimize disturbance due to light and visual intrusions.
22. Details on wastewater generation, treatment and utilization /discharge for produced water/ formation water, cooling waters, other wastewaters, etc. during all project phases.
23. Details on solid waste management for drill cuttings, drilling mud and oil sludge, produced sand, radio active materials, other hazardous materials, etc. including its disposal options during all project phases.
24. Disposal of spent oil and lube
25. Storage of chemicals and diesel at site. Hazardous material usage, storage and accounting.
26. Commitment for the use of water based mud (WBM) only
27. Oil spill emergency plans for recovery/ reclamation.
28. H2S emissions control.
29. Produced oil/gas handling, processing and storage/transportation.
30. Details of control of air, water and noise pollution during production phase.
31. Measures to protect ground water and shallow aquifers from contamination.
32. Whether any burn pits being utilised for well test operations.
33. Risk assessment and disaster management plan for independent reviews of well designed construction etc. for prevention of blow out. Blowout preventer installation.
34. Environmental management plan.
35. Total capital and recurring cost for environmental control measures.



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36. Emergency preparedness plan.
37. Decommissioning and restoration plans.
38. Documentary proof of membership of common disposal facilities, if any.
39. Details of environmental and safety related documentation within the company including documentation and proposed occupational health and safety Surveillance Safety Programme for all personnel at site. This shall also include monitoring programme for the environmental.
40. A copy of Corporate Environment Policy of the company as per the Ministry's O.M. No. J-11013/41/2006-IA.II(I) dated 26th April, 2011 available on the Ministry's website.
41. Any litigation pending against the project and or any direction/order passed by any court of law against the project. If so details thereof.



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Air Monitoring Results



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TABLE-7.1: Ambient Air Quality Monitoring Results – AAQ 1 : Panchgram

Date of Sampling	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (mg/m ³)	H ₂ S (µg/m ³)	VOCs & BTX (µg/m ³)	Methane HC (µg/m ³)	NMHC (µg/m ³)
28.04.2018	68.3	33.4	6.8	14.6	0.23	< 5.0	< 1.0	< 0.1	< 0.1
29.04.2018	73.8	37.1	7.1	13.6	0.15	< 5.0	< 1.0	0.86	0.39
02.05.2018	61.6	39.0	6.6	13.9	0.16	< 5.0	< 1.0	0.30	< 0.1
03.05.2018	65.9	42.6	8.0	15.2	0.13	< 5.0	< 1.0	0.34	0.41
08.05.2018	70.7	40.2	7.8	11.8	0.25	< 5.0	< 1.0	0.69	0.47
09.05.2018	76.0	48.5	6.3	12.0	0.19	< 5.0	< 1.0	< 0.1	< 0.1
15.05.2018	63.4	36.9	8.6	14.0	0.23	< 5.0	< 1.0	0.75	0.47
16.05.2018	68.9	33.4	6.3	16.4	0.25	< 5.0	< 1.0	0.63	0.41
23.05.2018	65.2	31.4	6.2	17.0	0.28	< 5.0	< 1.0	< 0.1	< 0.1
24.05.2018	67.4	32.7	7.0	13.8	0.22	< 5.0	< 1.0	< 0.1	< 0.1
29.05.2018	61.7	35.7	7.4	20.4	0.19	< 5.0	< 1.0	0.68	0.41
30.05.2018	58.9	30.4	6.5	19.1	0.27	< 5.0	< 1.0	0.78	0.53
04.06.2018	62.6	33.1	5.6	13.6	0.14	< 5.0	< 1.0	0.88	0.56
05.06.2018	55.0	28.6	5.9	16.6	0.18	< 5.0	< 1.0	< 0.1	< 0.1
14.06.2018	54.1	29.2	6.2	15.8	0.11	< 5.0	< 1.0	0.41	< 0.1
15.06.2018	56.7	27.6	6.6	17.2	0.16	< 5.0	< 1.0	0.73	0.50
19.06.2018	65.9	36.0	6.7	19.5	0.18	< 5.0	< 1.0	< 0.1	< 0.1
20.06.2018	66.7	35.4	5.8	13.5	0.19	< 5.0	< 1.0	0.66	0.49
28.06.2018	59.1	27.6	6.1	16.5	0.14	< 5.0	< 1.0	< 0.1	< 0.1
29.06.2018	55.4	24.8	6.7	15.9	0.17	< 5.0	< 1.0	0.55	0.32
03.07.2018	58.9	25.8	6.4	12.9	0.23	< 5.0	< 1.0	< 0.1	< 0.1
04.07.2018	61.0	29.0	6.3	14.6	0.17	< 5.0	< 1.0	< 0.1	< 0.1
12.07.2018	62.1	26.8	6.6	12.3	0.21	< 5.0	< 1.0	0.59	0.43
13.07.2018	64.6	29.1	6.8	11.9	0.14	< 5.0	< 1.0	< 0.1	< 0.1
NAAQ Standards	100	60	80	80	2	--	--	--	--

Detection limit: H₂S-5 µg/m³; VOC and BTX-1µg/m³; Methane and Non methane HC-0.1µg/m³

Source: ABC Techno Labs India Private Limited



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TABLE-7.2: Ambient Air Quality Monitoring Results - AAQ 2 Badarpur Town

Date of Sampling	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (mg/m ³)	H ₂ S (µg/m ³)	VOCs & BTX (µg/m ³)	Methane HC (µg/m ³)	NMHC (µg/m ³)
27.04.2018	87.2	52.3	6.1	16.2	0.33	< 5.0	< 1.0	< 0.1	< 0.1
28.04.2018	80.8	41.4	6.8	15.8	0.28	< 5.0	< 1.0	< 0.1	< 0.1
02.05.2018	84.6	45.2	6.3	14.3	0.25	< 5.0	< 1.0	0.61	0.47
03.05.2018	91.7	47.9	8.1	17.8	0.12	< 5.0	< 1.0	0.64	0.42
07.05.2018	82.1	50.3	6.3	13.4	0.22	< 5.0	< 1.0	0.70	0.59
08.05.2018	79.0	39.8	8.8	18.6	0.31	< 5.0	< 1.0	0.73	0.67
14.05.2018	74.3	38.6	5.5	21.7	0.26	< 5.0	< 1.0	0.57	0.42
15.05.2018	75.7	39.4	6.2	20.8	0.22	< 5.0	< 1.0	< 0.1	< 0.1
21.05.2018	69.1	41.1	6.7	20.9	0.21	< 5.0	< 1.0	< 0.1	0.51
22.05.2018	70.9	40.8	6.9	21.4	0.26	< 5.0	< 1.0	0.64	0.43
28.05.2018	71.8	35.4	5.8	22.3	0.24	< 5.0	< 1.0	0.72	0.53
29.05.2018	72.4	37.3	5.9	20.4	0.22	< 5.0	< 1.0	0.69	0.51
04.06.2018	64.8	32.2	5.8	12.9	0.16	< 5.0	< 1.0	< 0.1	0.50
05.06.2018	59.7	35.7	5.9	17.7	0.18	< 5.0	< 1.0	0.89	<0.1
14.06.2018	67.3	29.5	5.7	15.6	0.12	< 5.0	< 1.0	< 0.1	< 0.1
15.06.2018	63.0	34.1	6.6	17.9	0.14	< 5.0	< 1.0	0.70	0.56
19.06.2018	70.1	34.9	6.7	13.3	0.19	< 5.0	< 1.0	0.69	0.43
20.06.2018	59.4	30.7	6.9	15.6	0.13	< 5.0	< 1.0	< 0.1	< 0.1
28.06.2018	63.2	32.3	5.5	17.7	0.20	< 5.0	< 1.0	0.64	0.41
29.06.2018	63.7	29.1	5.8	15.9	0.17	< 5.0	< 1.0	0.77	0.50
03.07.2018	66.8	31.5	7.1	18.3	0.19	< 5.0	< 1.0	0.56	0.29
04.07.2018	71.5	28.9	6.4	17.3	0.15	< 5.0	< 1.0	< 0.1	< 0.1
12.07.2018	68.2	36.5	5.9	20.6	0.19	< 5.0	< 1.0	0.61	0.35
13.07.2018	65.3	34.2	7.7	24.8	0.15	< 5.0	< 1.0	< 0.1	< 0.1
NAAQ Standards	100	60	80	80	2	--	--	--	--

Detection limit: H₂S-5 µg/m³; VOC and BTX-1µg/m³; Methane and Non methane HC-0.1µg/m³

Source: ABC Techno Labs India Private Limited



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TABLE-7.3: Ambient Air Quality Monitoring Results - AAQ 3: Bakori Hawar

Date of Sampling	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (mg/m ³)	H ₂ S (µg/m ³)	VOCs & BTX (µg/m ³)	Methane HC (µg/m ³)	NMHC (µg/m ³)
30.04.2018	52.8	24.2	5.4	10.8	0.14	< 5.0	< 1.0	0.65	0.53
01.05.2018	46.5	24.1	6.3	11.5	0.15	< 5.0	< 1.0	< 0.1	< 0.1
04.05.2018	50.4	26.9	5.2	13.3	0.11	< 5.0	< 1.0	< 0.1	< 0.1
05.05.2018	55.2	25.4	5.5	13.7	0.17	< 5.0	< 1.0	< 0.1	< 0.1
10.05.2018	57.6	28.6	5.6	12.5	0.20	< 5.0	< 1.0	0.59	0.41
11.05.2018	48.3	24.9	6.0	13.9	0.13	< 5.0	< 1.0	< 0.1	0.47
17.05.2018	50.4	24.3	5.6	19.2	0.25	< 5.0	< 1.0	0.59	0.41
18.05.2018	49.3	26.2	5.9	19.6	0.21	< 5.0	< 1.0	0.63	0.55
21.05.2018	58.7	24.8	6.4	19.7	0.19	< 5.0	< 1.0	0.56	0.44
22.05.2018	50.3	22.8	6.6	20.3	0.23	< 5.0	< 1.0	< 0.1	0.47
31.05.2018	48.7	28.7	6.5	20.1	0.22	< 5.0	< 1.0	0.62	0.44
01.06.2018	48.9	20.2	6.3	21.5	0.23	< 5.0	< 1.0	< 0.1	0.43
07.06.2018	49.2	26.6	5.9	14.5	0.17	< 5.0	< 1.0	< 0.1	< 0.1
08.06.2018	53.3	21.8	6.4	17.7	0.21	< 5.0	< 1.0	0.68	0.46
12.06.2018	44.9	23.9	6.7	13.1	0.14	< 5.0	< 1.0	0.76	0.54
13.06.2018	57.4	23.7	6.9	15.2	0.19	< 5.0	< 1.0	< 0.1	< 0.1
21.06.2018	54.6	27.1	5.5	16.8	0.12	< 5.0	< 1.0	< 0.1	< 0.1
22.06.2018	52.9	20.9	5.7	16.3	0.19	< 5.0	< 1.0	0.77	0.43
25.06.2018	49.4	23.3	6.2	18.8	0.15	< 5.0	< 1.0	< 0.1	< 0.1
26.06.2018	46.6	25.1	6.9	14.3	0.17	< 5.0	< 1.0	< 0.1	< 0.1
05.07.2018	50.2	24.6	5.6	17.8	0.16	< 5.0	< 1.0	0.66	0.53
06.07.2018	52.9	28.1	5.9	15.4	0.13	< 5.0	< 1.0	0.53	0.49
10.07.2018	49.1	26.4	5.4	19.6	0.21	< 5.0	< 1.0	< 0.1	< 0.1
11.07.2018	47.9	23.5	6.0	11.6	0.19	< 5.0	< 1.0	0.73	0.46
NAAQ Standards	100	60	80	80	2	--	--	--	--

Detection limit: H₂S-5 µg/m³; VOC and BTX-1µg/m³; Methane and Non methane HC-0.1µg/m³

Source: ABC Techno Labs India Private Limited



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TABLE-7.4: Ambient Air Quality Monitoring Results - AAQ 4: Katakhal Railway Station

Date of Sampling	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (mg/m ³)	H ₂ S (µg/m ³)	VOCs & BTX (µg/m ³)	Methane HC (µg/m ³)	NMHC (µg/m ³)
30.04.2018	49.8	24.9	6.1	10.9	0.15	< 5.0	< 1.0	0.77	0.54
01.05.2018	54.6	26.2	5.7	13.1	0.13	< 5.0	< 1.0	< 0.1	< 0.1
04.05.2018	55.8	29.4	6.3	13.8	0.13	< 5.0	< 1.0	< 0.1	< 0.1
05.05.2018	53.9	23.8	5.4	12.8	0.12	< 5.0	< 1.0	0.79	0.48
11.05.2018	47.2	26.0	6.8	12.1	0.14	< 5.0	< 1.0	< 0.1	< 0.1
12.05.2018	50.1	28.1	6.4	10.4	0.17	< 5.0	< 1.0	0.76	0.42
17.05.2018	57.3	24.6	6.8	13.8	0.18	< 5.0	< 1.0	0.72	0.47
18.05.2018	50.1	24.8	5.9	16.7	0.18	< 5.0	< 1.0	< 0.1	0.53
21.05.2018	52.5	24.6	7.4	19.3	0.19	< 5.0	< 1.0	0.76	0.58
22.05.2018	48.2	22.7	5.6	14.5	0.16	< 5.0	< 1.0	0.71	0.49
01.06.2018	50.2	27.3	5.9	18.4	0.14	< 5.0	< 1.0	< 0.1	< 0.1
02.06.2018	48.7	26.4	6.3	11.8	0.16	< 5.0	< 1.0	< 0.1	< 0.1
07.06.2018	51.8	25.6	5.7	12.6	0.17	< 5.0	< 1.0	0.86	0.73
08.06.2018	49.1	24.0	5.8	16.5	0.16	< 5.0	< 1.0	0.67	0.50
12.06.2018	50.6	27.2	5.8	15.2	0.21	< 5.0	< 1.0	< 0.1	< 0.1
13.06.2018	52.7	25.1	6.0	19.6	0.19	< 5.0	< 1.0	0.80	0.68
21.06.2018	49.6	21.2	6.6	17.3	0.11	< 5.0	< 1.0	< 0.1	0.40
22.06.2018	47.9	26.7	6.1	13.2	0.14	< 5.0	< 1.0	0.70	< 0.1
25.06.2018	50.1	22.9	5.5	15.8	0.18	< 5.0	< 1.0	0.78	0.65
26.06.2018	47.1	24.2	5.8	17.3	0.19	< 5.0	< 1.0	0.59	0.37
05.07.2018	50.2	28.5	5.7	11.3	0.15	< 5.0	< 1.0	0.64	0.51
06.07.2018	43.9	25.9	5.4	11.1	0.17	< 5.0	< 1.0	< 0.1	0.46
10.07.2018	45.6	28.4	5.1	10.5	0.19	< 5.0	< 1.0	0.62	0.41
11.07.2018	53.2	23.5	5.4	11.0	0.17	< 5.0	< 1.0	0.81	< 0.1
NAAQ Standards	100	60	80	80	2	--	--	--	--

Detection limit: H₂S-5 µg/m³; VOC and BTX-1µg/m³; Methane and Non methane HC-0.1µg/m³

Source: ABC Techno Labs India Private Limited



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TABLE-7.5: Ambient Air Quality Monitoring Results - AAQ 5: Katigara

Date of Sampling	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (mg/m ³)	H ₂ S (µg/m ³)	VOCs & BTX (µg/m ³)	Methane HC (µg/m ³)	NMHC (µg/m ³)
27.04.2018	47.1	29.0	6.7	13.8	0.20	< 5.0	< 1.0	0.45	0.36
28.04.2018	51.5	32.9	5.9	12.8	0.14	< 5.0	< 1.0	0.48	0.39
02.05.2018	44.4	28.2	6.3	12.1	0.17	< 5.0	< 1.0	< 0.1	< 0.1
03.05.2018	54.6	32.6	6.5	10.4	0.18	< 5.0	< 1.0	0.51	0.43
08.05.2018	51.9	27.7	5.4	10.9	0.13	< 5.0	< 1.0	< 0.1	< 0.1
09.05.2018	58.7	30.4	5.4	13.1	0.15	< 5.0	< 1.0	0.48	0.39
14.05.2018	50.6	27.1	5.7	10.6	0.22	< 5.0	< 1.0	0.41	0.31
15.05.2018	57.2	25.2	5.8	15.7	0.18	< 5.0	< 1.0	0.44	0.36
25.05.2018	45.2	20.8	6.1	13.8	0.19	< 5.0	< 1.0	0.48	0.32
26.05.2018	48.6	24.3	5.5	20.9	0.21	< 5.0	< 1.0	< 0.1	< 0.1
29.05.2018	50.1	19.2	5.9	16.8	0.22	< 5.0	< 1.0	0.43	0.31
30.05.2018	49.3	24.8	6.7	16.9	0.21	< 5.0	< 1.0	0.44	0.37
04.06.2018	48.4	25.1	6.3	14.4	0.17	< 5.0	< 1.0	0.65	0.45
05.06.2018	46.8	20.0	6.6	16.9	0.2	< 5.0	< 1.0	< 0.1	< 0.1
14.06.2018	43.6	22.7	5.5	15.2	0.13	< 5.0	< 1.0	0.55	0.34
15.06.2018	44.9	21.0	6.8	18.3	0.16	< 5.0	< 1.0	0.77	0.5
19.06.2018	50.4	24.1	6.7	18.6	0.12	< 5.0	< 1.0	0.67	< 0.1
20.06.2018	47.4	20.8	6.5	16.5	0.15	< 5.0	< 1.0	0.69	0.47
28.06.2018	53.1	23.1	5.6	14.8	0.17	< 5.0	< 1.0	0.8	0.64
29.06.2018	50.9	21.4	6.0	16.3	0.20	< 5.0	< 1.0	< 0.1	< 0.1
03.07.2018	49.1	24.9	5.8	10.8	0.18	< 5.0	< 1.0	0.62	0.43
04.07.2018	44.1	25.4	5.6	12.1	0.19	< 5.0	< 1.0	0.76	0.58
12.07.2018	52.4	26.4	5.8	10.4	0.16	< 5.0	< 1.0	< 0.1	< 0.1
13.07.2018	53.9	22.4	5.7	11.6	0.18	< 5.0	< 1.0	0.47	0.35
NAAQ Standards	100	60	80	80	2	--	--	--	--

Detection limit: H₂S-5 µg/m³; VOC and BTX-1µg/m³; Methane and Non methane HC-0.1µg/m³

Source: ABC Techno Labs India Private Limited



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TABLE-7.6: Ambient Air Quality Monitoring Results - AAQ 6: Hilara Railway Station

Date of Sampling	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (mg/m ³)	H ₂ S (µg/m ³)	VOCs & BTX (µg/m ³)	Methane HC (µg/m ³)	NMHC (µg/m ³)
30.04.2018	51.5	28.1	5.3	13.8	0.13	< 5.0	< 1.0	< 0.1	< 0.1
01.05.2018	52.1	27.6	5.6	12.8	0.12	< 5.0	< 1.0	< 0.1	< 0.1
04.05.2018	48.0	25.4	5.3	12.1	0.15	< 5.0	< 1.0	0.79	0.54
05.05.2018	51.2	30.1	5.7	10.4	0.14	< 5.0	< 1.0	0.71	0.53
10.05.2018	44.2	26.3	5.2	10.9	0.17	< 5.0	< 1.0	0.77	0.56
11.05.2018	56.3	28.0	5.6	13.1	0.14	< 5.0	< 1.0	0.78	0.54
16.05.2018	59.7	30.1	6.0	11.4	0.24	< 5.0	< 1.0	0.61	< 0.1
17.05.2018	59.9	27.1	5.8	12.6	0.21	< 5.0	< 1.0	< 0.1	< 0.1
22.05.2018	72.1	22.8	5.7	18.6	0.17	< 5.0	< 1.0	0.76	0.49
23.05.2018	58.4	31.7	5.5	13.4	0.19	< 5.0	< 1.0	0.71	0.55
31.05.2018	58.2	24.3	5.8	16.8	0.19	< 5.0	< 1.0	0.75	0.54
01.06.2018	56.3	23.6	6.7	16.9	0.15	< 5.0	< 1.0	0.63	0.4
07.06.2018	47.4	24.8	5.7	17.5	0.14	< 5.0	< 1.0	0.7	0.56
08.06.2018	53.1	23.1	6.9	13.7	0.17	< 5.0	< 1.0	< 0.1	< 0.1
12.06.2018	50.9	27.4	6.1	14.5	0.19	< 5.0	< 1.0	< 0.1	< 0.1
13.06.2018	54.8	28.9	6.6	16.7	0.12	< 5.0	< 1.0	< 0.1	< 0.1
21.06.2018	50.5	25.7	5.7	14.7	0.16	< 5.0	< 1.0	0.65	0.5
22.06.2018	49.2	23.3	5.5	12.6	0.11	< 5.0	< 1.0	< 0.1	< 0.1
25.06.2018	51.8	25.6	6.0	16.6	0.20	< 5.0	< 1.0	0.76	0.50
26.06.2018	49.1	24.0	5.7	16.3	0.17	< 5.0	< 1.0	0.48	0.31
05.07.2018	55.1	23.6	5.7	12.3	0.17	< 5.0	< 1.0	0.59	0.58
06.07.2018	58.6	23.4	5.8	11.7	0.16	< 5.0	< 1.0	< 0.1	0.3
10.07.2018	60.4	24.5	6.1	12.8	0.15	< 5.0	< 1.0	< 0.1	< 0.1
11.07.2018	59.6	23.8	6.2	12.4	0.14	< 5.0	< 1.0	0.35	0.35
NAAQ Standards	100	60	80	80	2	--	--	--	--

Detection limit: H₂S-5 µg/m³; VOC and BTX-1µg/m³; Methane and Non methane HC-0.1µg/m³

Source: ABC Techno Labs India Private Limited



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TABLE-7.7: Ambient Air Quality Monitoring Results – AAQ 7: Lakhipur

Date of Sampling	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (mg/m ³)	H ₂ S (µg/m ³)	VOCs & BTX (µg/m ³)	Methane HC (µg/m ³)	NMHC (µg/m ³)
28.04.2018	50.7	29.5	6.3	10.8	0.14	< 5.0	< 1.0	0.43	0.34
29.04.2018	55.1	29.2	5.5	10.9	0.17	< 5.0	< 1.0	< 0.1	< 0.1
02.05.2018	53.2	30.1	6.1	9.9	0.14	< 5.0	< 1.0	0.59	0.48
03.05.2018	58.7	38.3	5.7	10.8	0.13	< 5.0	< 1.0	< 0.1	0.53
08.05.2018	60.2	35.5	6.6	10.4	0.17	< 5.0	< 1.0	< 0.1	BDL
09.05.2018	53.6	34.9	5.9	11.7	0.15	< 5.0	< 1.0	< 0.1	0.36
15.05.2018	54.6	26.5	5.7	17.3	0.22	< 5.0	< 1.0	0.4	0.35
16.05.2018	56.4	28.3	6.1	17.8	0.21	< 5.0	< 1.0	< 0.1	< 0.1
25.05.2018	60.1	27.4	6.6	17.9	0.22	< 5.0	< 1.0	0.55	0.37
26.05.2018	56.2	28.2	5.7	16.4	0.14	< 5.0	< 1.0	< 0.1	< 0.1
29.05.2018	52.8	26.7	6.2	16.2	0.23	< 5.0	< 1.0	0.42	0.31
30.05.2018	59.4	25.2	6.6	16.3	0.17	< 5.0	< 1.0	0.45	0.37
04.06.2018	48.2	24.8	6.3	16.6	0.17	< 5.0	< 1.0	< 0.1	< 0.1
05.06.2018	54.9	23.0	5.7	13.8	0.25	< 5.0	< 1.0	0.79	0.62
14.06.2018	63.2	21.9	5.5	13.9	0.12	< 5.0	< 1.0	< 0.1	< 0.1
15.06.2018	53.7	27.2	5.7	17.3	0.15	< 5.0	< 1.0	0.7	0.56
19.06.2018	56.8	25.5	6.7	12.6	0.18	< 5.0	< 1.0	< 0.1	< 0.1
20.06.2018	57.9	25.8	6.6	18.8	0.12	< 5.0	< 1.0	< 0.1	< 0.1
28.06.2018	45.8	27.0	6.2	16.4	0.16	< 5.0	< 1.0	0.8	< 0.1
29.06.2018	50.3	29.5	5.6	17.1	0.19	< 5.0	< 1.0	0.48	< 0.1
03.07.2018	49.5	20.7	5.9	15.1	0.15	< 5.0	< 1.0	0.42	0.61
04.07.2018	52.4	34.6	5.6	17.7	0.19	< 5.0	< 1.0	0.51	0.58
12.07.2018	55.6	30.4	6.3	19.8	0.17	< 5.0	< 1.0	< 0.1	< 0.1
13.07.2018	59.1	25.6	5.4	15.6	0.14	< 5.0	< 1.0	0.52	0.25
NAAQ Standards	100	60	80	80	2	--	--	--	--

Detection limit: H₂S-5 µg/m³; VOC and BTX-1µg/m³; Methane and Non methane HC-0.1µg/m³

Source: ABC Techno Labs India Private Limited



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TABLE-7.8: Ambient Air Quality Monitoring Results - AAQ 8: Chandpur Pt III

Date of Sampling	PM ₁₀ (µg/m ³)	PM _{2.5} (µg/m ³)	SO ₂ (µg/m ³)	NO _x (µg/m ³)	CO (mg/m ³)	H ₂ S (µg/m ³)	VOCs & BTX (µg/m ³)	Methane HC (µg/m ³)	NMHC (µg/m ³)
30.04.2018	62.6	32.8	6.1	11.7	0.15	< 5.0	< 1.0	0.69	0.56
01.05.2018	57.8	30.2	6.8	12.6	0.16	< 5.0	< 1.0	< 0.1	0.54
04.05.2018	53.5	29.3	6.6	10.8	0.13	< 5.0	< 1.0	0.76	0.52
05.05.2018	58.6	34.7	5.9	11.5	0.14	< 5.0	< 1.0	< 0.1	< 0.1
10.05.2018	49.0	28.2	6.6	13.3	0.11	< 5.0	< 1.0	0.63	0.41
11.05.2018	60.2	26.7	6.0	13.7	0.10	< 5.0	< 1.0	0.78	0.41
17.05.2018	57.2	28.3	6.3	18.3	0.22	< 5.0	< 1.0	0.65	0.49
18.05.2018	59.1	27.5	6.8	20.6	0.23	< 5.0	< 1.0	< 0.1	< 0.1
23.05.2018	64.3	29.1	6.7	19.4	0.21	< 5.0	< 1.0	0.64	0.54
24.05.2018	59.1	30.9	5.9	23.4	0.26	< 5.0	< 1.0	0.62	0.41
31.05.2018	58.6	32.4	6.5	23.5	0.27	< 5.0	< 1.0	< 0.1	< 0.1
01.06.2018	58.9	31.4	6.8	18.9	0.21	< 5.0	< 1.0	0.68	0.51
07.06.2018	58.4	30.4	5.6	17.4	0.19	< 5.0	< 1.0	0.79	0.68
08.06.2018	64.8	32.2	5.7	12.8	0.12	< 5.0	< 1.0	< 0.1	< 0.1
12.06.2018	59.7	25.7	5.5	15.6	0.18	< 5.0	< 1.0	< 0.1	0.52
13.06.2018	57.3	29.5	6.8	16.3	0.15	< 5.0	< 1.0	0.8	0.65
21.06.2018	63.0	34.1	6.9	13.4	0.13	< 5.0	< 1.0	< 0.1	< 0.1
22.06.2018	70.1	27.9	6.6	16.6	0.14	< 5.0	< 1.0	< 0.1	< 0.1
25.06.2018	59.4	26.7	5.7	18.7	0.21	< 5.0	< 1.0	< 0.1	< 0.1
26.06.2018	63.2	29.3	5.9	19.3	0.16	< 5.0	< 1.0	< 0.1	< 0.1
05.07.2018	62.5	25.8	5.6	15.4	0.18	< 5.0	< 1.0	0.53	0.46
06.07.2018	69.4	29.5	5.9	16.7	0.14	< 5.0	< 1.0	< 0.1	< 0.1
10.07.2018	64.8	34.7	6.4	16.8	0.19	< 5.0	< 1.0	< 0.1	< 0.1
11.07.2018	65.4	30.8	6.1	14.5	0.25	< 5.0	< 1.0	0.49	0.29
NAAQ Standards	100	60	80	80	2	--	--	--	--

Detection limit: H₂S-5 µg/m³; VOC and BTX-1µg/m³; Methane and Non methane HC-0.1µg/m³

Source: ABC Techno Labs India Private Limited