Chapter 11

Summary and Conclusion

11.1 About the Proposed Project

The massive exploration programmes undertaken by Cairn Energy India Ltd. (CEIL) have resulted in a number of oil and gas field discoveries in RJ-ON-90/1 Block in Rajasthan. In order to facilitate the early production from these discovered fields, CEIL in partnership with Oil Natural and Gas Corporation (ONGC) propose to lay an onshore oil evacuation pipeline of approximately 600 km length with associated facilities from Mangala terminal, Barmer district, Rajasthan to Salaya terminal in Jamnagar district via Viramgam terminal in Ahmedabad district.

Out of the total 600 km pipeline proposed, the pipeline will traverse about 150 km in Rajasthan and 450 km in Gujarat state. Storage, handling and pumping facilities will be established at Viramgam and Salaya terminals in Gujarat state. The pipeline will traverse two districts in Rajasthan and six districts in Gujarat States given as under:

Sr. No.	Route	Approx. Length	Districts Covered
1	Mangala Terminal to Raageshwari gas terminal	80 km	Barmer, Rajasthan
2	Raageshwari gas terminal to Sanchor	70 km	Barmer and Jalore, Rajasthan
3	Sanchor to near IOC terminal, Viramgam	190 km	Sanchor in Rajasthan and Banaskantha and Ahmedabad in Gujarat
4	Viramgam to Salaya Terminal	260 km	Ahmedabad, Patan, Rajkot, Surendranagar, Jamnagar,

The pipeline route has been finalized based on the least disturbance to the environment and would not pass through any environmentally sensitive area, human habitations, coastal and estuarine areas, archeological monuments nor reserved forests. The major land use along the proposed pipeline is agricultural / barren land. There are no established breeding grounds and migratory routes along the pipeline route and in the proposed storage terminals. The pipeline will buried at a minimum depth of 1.0 m below the ground level.

11.2 Technical details of Project

The overall pipeline project envisages setting up of the following facilities:

- Laying of approximately 600 km buried oil evacuation pipeline 24" Insulated oil pipeline and 8" gas pipeline) from Mangala Terminal to Salaya Terminal in Gujarat via Viramgam
- Establishment of associated facilities such as heating stations (32 Nos.) and pigging stations along the pipeline route
- Establishment of storage, handling and pumping stations, diluent's mixing facilities at Viramgam terminal of 10,000 m^3 crude oil capacity and at Salaya terminal of 300,000 m^3 crude oil capacity in Gujarat state
- Establishment of captive power generating facilities at all heating stations (32 Nos. of 1 MW each) and Viramgam terminal (8 MW) and Salaya terminal (10 MW). The total power requirement for the entire pipeline project is estimated to 50 MW

As the crude oil is waxy by nature, heating of the crude along the pipeline is essential for the continuous flow of liquids. This will achieved through Skin Effect Heat Tracing (SEHT) System and / or contingency gas fired indirect heating system and blending of diluents. The crude oil pipeline will insulated with 90 mm Poly Urethane Foam (PUF) and 8 mm HDPE jacket to arrest the heat loss from pipeline to the surrounding environment.

Power requirement will met by dual fired generator based on gas and / or diesel oil. Gas preferably will be used for power generation and diesel is an alternative option. A parallel gas pipeline of 8" diameter from Raageshwari gas terminal will be laid along the main crude oil pipeline corridor for supply of natural gas. Suitable systems shall be provided for emergency power, DC power systems and uninterrupted power supply.

Gate valves/shutdown valves and Motor operated valves with controls shall be provided on the pipeline to regulate the flow as well as for isolation purpose and shall be capable of both remote and local operation.

The entire length of pipeline shall be monitored at Viramgam and Salaya terminals for various parameters like temperature, pressure, and other pipeline condition monitoring parameters. Voltage, current and other important parameters associated with the SEHT will also be monitored.

Operating Parameters of Pipeline

Sr. No	Parameters	Crude Oil Pipeline	Gas Pipeline
1.	Line pressure	Design Pressure 93 bar Operating pressure 90 bar	Design Pressure 49 bar Operating pressure 41 bar
2.	Temperature	65℃	60℃
3.	Flow rate	Max. 1,50,000 BOPD Min. 30,000 BOPD	6.63 MMSCFD

Viramgam Terminal

Viramgam terminal will primarily consist of storage, handling and pumping stations. The terminal will have 10,000 m³ storage capacity of crude oil. The terminal will have two crude oil receipt tanks of 5,000 m^3 capacity each along with intermediate pumping stations. Adequate storage facilities with fire fighting and waste disposal facilities along with dyke and bunds for crude oil, fuel oil, chemicals and water will be planned as per the OISD guidelines. The land area required at this terminal is 25 ha. Viramgam terminal requires 8 MW power for heating and pumping the crude oil. Power requirement will be met by establishing captive power generating facility based on gas and / or oil. This terminal will be having electrical sub-stations, metering facilities, telecom system and control room. Fuel gas and sewage treatment package units will be installed at this terminal.

Salaya Terminal

Salaya terminal is located near Jamnagar in Gujarat state having 300,000 m^3 storage capacities of crude oil and diluents. The capacity will be spread into six storage tanks of 50,000 m^3 each. The facilities at Salaya terminal will primarily consist of storage tanks, blending facilities, crude oil pumps to consumers, utilities, power generators, control systems and terminal buildings. OISD guidelines will be followed for establishment of storage facilities. The land area required at this terminal

is 100 ha. Salaya terminal requires 10 MW power for heating, diluents mixing and pumping the crude oil.

Skin Effect Heat Tracing System

As the crude is highly waxy and viscous, to assure continuous flow in the buried pipeline, Skin Effect Heat Tracing (SEHT) system will be installed. Heat tube duct of 1'', which may be one or more in numbers, will run along the entire length on the 24'' pipeline for running the cables of Skin Effect Heat Tracing System and for monitoring important parameters for the pipeline healthiness. To arrest the heat loss from pipeline to the surrounding environment the insulated crude oil pipeline with 90 mm Poly Urethane Foam (PUF) and 8 mm HDPE jacket will be buried 1 m below the ground level.

Heating and Pigging Stations

Heating and pigging stations will be installed along the pipeline route. Captive power generating facilities will be established at all heating stations and Viramgam and Salaya terminals. Gas and / or diesel based Generators of 1 MW rating will be established at every 18 km interval along the pipeline route to supply power for these heating and pumping stations.

The total estimated cost for the development of pipeline project including associated facilities is estimated about Rs. 3500 Crores.

11.3 Pipeline Construction Methodology

The pipeline is designed to transfer crude oil at a maximum flow rate of 1,50,000 BOPD and minimum 30,000 BOPD. The evacuation pipeline facilities will be designed and constructed to meet the National and Environmental Standards and complies with HSE and legislation requirements. The integrity and safety of the pipeline will be monitored through computerized supervisory control and Data Acquisition (SCADA) and leak detection systems.

The pipeline construction is proposed to be carried out through deployment of 4 to 5 spreads. During construction phase, it will be ensured that:

i) Minimum number of trees are cut

ii) Maintain safe distance from settlements, public utilities

iii) Inconvenience is minimized to the public

iv) Irrigation channels, roads and rail crossings, fencings etc., affected during construction, is restored back ensuring that no damage to the respective owners

v) All wastes including hydrostatic test water will be properly treated and disposed

vi) Trenches shall be backfilled and restored to original condition after the pipeline construction is over.

The following activities will be carried out during construction:

a) Clearing and Grading: A 30 m wide Right of Use (RoU) area will be cleared off vegetation and other obstacles such as boulders. RoU boundaries will be clearly delineated and the site inspector will ensure that no clearing or encroachment occurs beyond these boundaries.

b) Stringing: Pipes transported to the site on trucks will be offloaded using side booms and strung adjacent to the trench. Trailers and cranes will be used for the manoeuvring of pipes. The pipes shall be strung in such a way that normal use of the surrounding area is disturbed as little as possible.

c) Trenching: Trenchers and backhoe type excavators will be used to dig the trench for laying the pipeline.

d) Bending: The pipe will be bent using a bending machine to the appropriate angle to match the vertical and horizontal alignment of the trench.

e) Welding: Once the pipe is strung a line-up crew will position the pipe using side booms in preparation for welding. Following the completion of each working day or pipeline section, open pipe ends shall be effectively closed and shall not be opened until work restarts.

f) Non-Destructive Inspection (NDT): Mechanized Ultrasonic Testing (MUT) is the specified method to be applied for the execution of NDT. Each field weld will be 100% radiographed to test for soundness of the weld in compliance with specifications (API standard 1104).

g) Coating: After welding at each weld joint, coating of field joints of bare pipes and the repair of FBE coating shall be done by High built liquid epoxy coating. A holiday test shall be carried out using an adjustable high voltage holiday tester having an audible and visual alarm to test the soundness of coating.

h) Backfilling and Restoration: Soil generated during trenching will be backfilled into the pits. Top soil will be separately stored and restored in original position upon completion of pipeline construction. Restoration of the ROU will be conducted progressively following the completion of construction work. The construction crew shall remove wastes, wrappers, packages daily. The terrain will be returned to its original condition by spreading the topsoil over the ROU and agriculture activities will be restored to original.

k) Pipeline Warning Markers: As the construction proceeds, good warning marker posts will be erected indicating the location of the pipeline and the crossing of other pipelines, cables and features

L) Pipeline traverse at crossings: The proposed pipeline crosses network of National Highways, State Highways, Village Roads, Canals, Railway Lines and Rivers. The rivers that encountered along the pipeline route are Luni, Sukri and Banas, Mahanadi, Brahmani. All these rivers are seasonal and water flow can be found only during rainy season. The major irrigation canals include Narmada Canal and Sujlam Suphlam.

Auger boring method will be used to cross National highway and State Highways and major irrigation canals. Rivers crossings will be crossed using 'Open Cut' procedure where feasible to a depth 1.5 m pipeline cover below the estimated scour of river bed. Buried pipeline will be concrete coated for anti-buoyancy. Lined canals will be crossed using Auger boring below the canal concrete lining to a minimum of 1.5 m clearance. Un-lined canals will be crossed with the buried pipeline using Auger boring / open cut method as per statutory approval. Railways will be crossed using cased pipe and auger-bored methodology. Permissions will be obtained from respective statutory authorities (railways, irrigation, highways, etc) prior to the commencement of work.

11.4 Baseline Environmental Status

The environmental monitoring was carried out on various attributes of environment during pre-monsoon season of year 2007 (March 15-June 15, 2007) to assess the baseline status. Primary environmental quality monitoring was carried out within 10 km radius around Viramgam and Salaya terminal and at few sensitive locations along the pipeline route. The secondary data available from various sources have also been collected for the entire stretch of 600 km pipeline.

11.4.1 Meteorology

Rajasthan: The climate of the Rajasthan in the study area is characterized by its dryness, extreme temperature and erratic rainfall. The annual average rainfall ranges is about 263 mm. Summer months experience frequent dust storms. The predominant winds are mostly from S-W sector during summer season followed by NW direction. The maximum and minimum temperatures recorded during summer season are 6.3℃ and 45.8℃ respectively. The relat ive humidity found varying from 27% to 74%.

Gujarat: In Gujarat, the pipeline route represents typical terrestrial and coastal environments. Ahmedabad and Rajkot districts on average receive good rainfall during July-September (874 mm) and number of rainy days ranges from 60-70 days in a year. Temperature ranges 7.4 ℃ to 44. 3 ℃. The annual average wind speed is 5-10 km/h. The costal area of Gujarat (Jamnagar district.) receives moderate rainfall of 450 mm. The maximum ambient temperature ranges from 46℃ during summer to minimum of 7℃ during winter. The maximum relative humidity was recorded 96% during July to September and minimum 27% during November to March. The average wind speed varies from 10 - 15 km/hr.

11.4.2 Ambient Air Quality

To establish the baseline status of the ambient air quality in the study area, the air quality was monitored at 55 locations during summer season of 2007. The Suspended Particulate Matter (SPM) observed to vary from 168 μg/m³ to 1145 μg/m³ in Rajasthan (Mangala / Jalore) and 107 μg/m³ - 436 μg/m³ in Gujarat (Viramgam/ Wankhaner / Salaya). High levels of SPM and RSPM at Mangala and Jalore areas in Rajasthan can be attributed to the heavy dust storms, which are common in Rajasthan region. The Sulphur dioxide (SO_2) and Oxides of nitrogen as well as CO and HC concentrations are observed well below the CPCB standards for rural and residential areas.

11.4.3 Ambient Noise Levels

The noise level monitoring has been conducted at 40 locations in the study area from Mangala to Salaya. During daytime and night time noise levels found varying from 40 dBA to 50 dBA and 34 dBA to 48 dBA respectively. Relatively higher noise levels are found along the highways, though the noise levels at other places are found within the acceptable standards.

11.4.4 Water Quality

Water Resources in Rajasthan

Surface water resources are limited within the study area of Rajasthan. Irrigation is limited by the scarcity of water and has traditionally been restricted to deep wells and groundwater harvesting systems. The river Luni is the major river which runs through the sandy area with its tributary Sagi and Sukri. The rivers are seasonal and flow only during rainy season. The Barmer region has Tankas or Kunds which are under ground storage system of rain water harvesting during the monsoon.

The depth of the ground water ranges between 20 m to 60 m in Barmer and Jalore districts and the yield of wells ranges between 30 m^3/day to 90m^3/day. The groundwater quality in north-western part of Barmer district is saline with limited suitability for drinking and agricultural use. However, in south-western region, dugs wells are used for irrigation.

Water Resources in Gujarat

The Gujarat region has several rivers in the area such as Banas, Machchu, Und rivers. The general watershed is towards the Gulf of Kutch and the Arabian Sea. Narmada canal water is used for drinking water supply to the near by towns and villages along the pipeline route. There are few surface water resources in the form of lake and pond in the area. The major source of water for villages along the pipeline route is groundwater. The groundwater quality is affected by coastal salinity in Jamnagar and Rajkot districts. The ground water level in the area varies from 6 m to 18 m depending upon the rainfall and its duration.

The baseline water quality status in the region is established by analyzing 25 groundwater and 8 surface water samples. The physico-chemical and biological analysis revealed that ground water in Rajasthan has high Total Dissolved Solids (1060 – 5090 mg/l), Chlorides (532 -2451 mg/l) and Fluoride exceeds the prescribed limits of IS: 10500-1993 at many of the locations. This may be attributed to local geological characteristics and over exploitation.

The concentrations of total dissolved solids, total hardness, chloride and sulphate in surface water in Gujarat range from 140 – 1040 mg/l, 77 – 371 mg/l, 8 - 72 mg/l and 10 – 315 mg/l respectively. The ground water in Gujarat is characterized by moderate hardness. Total dissolved solids varied from 1450 to 1830 mg/l, total hardness from108 to 200 mg/l, chloride from 374 to 420 mg/l and sulphate

from 33 to 52 mg/l. The water quality meets the Indian Standards / Specification for drinking water as stipulated in IS 10500-1991 for water source in absence of any alternate source.

11.4.5 Soil Quality

The pipeline route endowed with a wide range of Physiographic landforms, geology and vegetation that have influence on the genesis of the soils. The proposed pipeline corridor in Barmer and Jalore districts is mostly covered with fine sand, ranging in thickness from a couple of meters to over 25 m. Surface soil is sand with gypsum deposit at shallow depth. The texture of the surface soil varies from fine sand to loamy sand. The land is barren land interspersed with dry cultivation fields. The major crops are pearl millet, mungben, moth, til and gaur. Agriculture is the main source of livelihood besides livestock. The common crops grown in the region includes wheat, bajra, Jowar, zeera, isabgol.

Agriculture is the predominant land use around the proposed pipeline route in Gujarat state and 60 % of the total land is under cultivation. The agriculture is done during Kharif and Rabi season. Cereals, wheat, bajara, jowar, oil seed, groundnut, sugarcane, mustard, sesame and caster; pulses-gram etc. and fibre crop cotton are grown in the area. Vegetables viz. brinjal, tomato, cabbage, cauliflower, chilly, garlic, etc. are grown around pipeline route in Gujarat state. The agriculture soil has loamy and clayey texture. The soil in non-agriculture areas is mostly sandy loam.

The soil samples were collected from 30 locations along the pipeline route and analyzed covering various land uses. pH in soil is found to be alkaline in nature (8.2 - 9.3) in Rajasthan due to gypsum deposit at shallow depth. The pH in soils ranges between 6.99 – 8.22, 7.74 – 8.31 and 7.32 – 8.3 at the sections of Banaskanatha / Patan / Ahmedabad, Suredranagar / Rajkot and Jamnagar sections respectively. Thus it indicate the pH of the soil in Gujarat region are neutral and conducive for the growth of plants. Organic content present in soil influences its physical and chemical properties. Organic carbon are found in the range of 0.02 cmol $(p+)kg^{-1}$ to 0.04 $(p+)kg^{-1}$ and 0..02$(p+)kg^{-1}$ to 0.81$(p+)kg^{-1}$ in the soils of Rajasthan and Gujarat respectively. Available phosphorus in soil is found in the range of 6.8 kg/ha to 9.8 kg/ha in Rajasthan and 6.8 kg/ha to 24.2 kg/ha in Gujarat. This shows that the soil in Rajasthan is non-fertile because of low in organic and nutrient content. The soils in Gujarat are fertile due to moderate organic and nutrient content.

Land Use Studies

The land use pattern along the pipeline alignment in 5 km radius has been studied by analyzing satellite imageries. Agriculture is the major activity with accounting about 40% and 60% land area under cultivation in Rajasthan and Gujarat region respectively. On an average cultivated waste covers about 22.3 % in Rajasthan and 12.5 % in Gujarat. Thick vegetation covers 0.52% in Rajasthan and 4.0% in Gujarat region.

11.4.6 Biological Environment

The area along the pipeline route and storage terminals does not have any natural forest and it is characterized by scanty vegetative cover of Xerophytic plants. The pipeline route avoids passage through any national parks or sanctuaries or any of the other notified biosphere nor reserved forest. There are no established breeding ground and migratory routes with in the pipeline route. The Wild Ass Sanctuary in the Little Rann of Kutch is located about 15 km from north of pipeline route. Nal Sarovar bird sanctuary and Rampura Vidi Wild Life Sanctuary are located over 30 km and 5 km away from the proposed pipeline and other facilities. Marine National Park is situated approximately 15 Km from the coast of Jamnagar and approximately 30 Km from the Salaya Terminal.

In Rajasthan, a total 29 plant species have been identified in the study area. Out of which, 11 tree species, 8 herbs species and 10 grass species were recorded in the study area of Rajasthan. In Gujarat, a total of about 176 plant species have been identified out of which 83 tree species, 31 shrub species, 23 herbs, 23 grass species and 16 climbers species have been recorded.

Mammals observed in the study area are Chinkara, Indian wild Ass, Squirrel, Common Mongoose and Indian Porcupine. 29 different species of birds and 3 species of reptiles have been observed in the study area.

11.4.7 Socio-economic Environment

The pipeline traverses through 28 villages in 3 talukas of Rajasthan and 180 villages in 18 talukas of Gujarat. The study area in Rajasthan is sparsely populated with isolated pockets of habitation. About 80 % – 90 % of total population lives in the rural area. The total population of the pipeline study area in Rajasthan and Gujarat are 31068 and 410230 respectively. The sex ratio ranges from 917 in Rajasthan to 921 in Gujarat. The literacy rate in Rajasthan and Gujarat study area

are 44.83% and 57.95% respectively. The study area in Rajasthan and Gujarat contains about 38.51% and 31.99% are Main workers, 15.87% and 5.88% Marginal workers and 45.62% and 62.13% Non workers respectively. Overall, the area has good network of communication facilities (telecommunication, access roads, post offices, banks etc.).

11.5 Anticipated Environmental Impact and Management Measures

The environmental impacts during construction, development and operation phases of the proposed pipeline project have been assessed and adequate management plan has been evolved to mitigate the impacts.

The construction activities will mainly involve:

- Land preparation activities along the pipeline ROW
- Civil construction and mechanical erection at heating and storage terminals
- Pipeline laying and strengthening and development of access roads

The environmental impacts during the construction stage will be short term, temporary in nature and will be confined very close to project sites. A total of about 1500 to 2000 construction persons on an average at various stretched will be employed for a period of one year during the construction phase. The manpower required for these activities should preferably be employed from nearby villages.

11.5.1 Impacts due to Loss of Land, Structures, Assets, Standing Crops

The project area typically consists of arid climate in Rajasthan and semi-arid to costal environment in Gujarat. The area is covered with vast expanses of sandy soil with minimal vegetation. In absence of the reliable water source, subsidence cultivation and farming is done in the area, hence it is expected that there will be minimal impact due to the conversion of land for developmental facilities. Further, the construction of the project would not entail displacement of people. The impact due to land acquisition will be minimized by providing fair compensation and encouraging alternative means of livelihood either directly or indirectly through project related activities. Hence, the impact on livelihood of locals due to project

development is expected to be minimal and quite possibly a positive impact due to alternative economic activities.

11.5.2 Impacts on Public Infrastructure and Civic Amenities

The electricity requirement during construction and operational phase will be self-generated and the project proponents' will not source electricity from the State electricity grid supplies. On completion of construction works all temporary structures, surplus materials and wastes will be completely removed and standard construction procedures will be implemented to ensure that the impact on surface drainage pattern and soil erosion is kept minimal.

11.5.3 Impacts on Air environment

Air Pollution Management during Construction Phase

The construction activities during pipeline laying such as excavation, embankment formation, transport of construction materials, handling, laying and jointing of pipelines, etc. will be generate fugitive dust emissions. A marginal increase in the levels of oxides of nitrogen, carbon monoxide and hydrocarbons is envisaged due to the movement of vehicles for transportation of construction material and DG sets. DG sets of about 150 KVA Capacity will be established at temporary camps and ware houses will also contribute for continuous air emissions. The air quality modeling carried out for the construction equipment and DG set along the pipeline route for SO_2 and NOx indicates an incremental Ground Level Concentration (GLC) of 3.2 ug/m^3 and 29.7ug/m^3 respectively at distance of 176 m from the pipeline alignment. Thus these emissions are temporary and confined to localized effect during the construction period for a few days. The following measures will be taken:

- Particulate emissions should be controlled by water sprinkling on unpaved roads and right of way
- Trucks hauling dirt, rock or other granular or particulate material will be covered to prevent material from being spilled / scattered or wind blown over public streets
- No on-site burning of any waste arising from construction activities
- Adequate maintenance measures to meet the emission standards for all construction equipment and vehicles

Air Pollution Management during Operational Phase

There will be no impact on air quality due to this buried pipeline during operational phase. However, heating stations (1 MW) located at an interval of 18 km along the pipeline route and power generating units at storage terminals will contribute for atmospheric emissions of SO_2, NOx, CO, Particulates and Hydrocarbons. As natural gas and / or diesel is envisaged to used as fuel to run the engines, NOx and SO_2 will be the major air pollutant in terms of quantities.

The air quality modeling carried out with various source of emissions at Viramgam and Salaya terminals and Wankhaner and Sanchore heating stations representing the regional meteorological conditions has indicated that the highest incremental levels are generated during diesel based power generation.

The maximum GLC of NOx and SO_2 at heating stations due to diesel based power plant is predicted to be 4.1 µg/m^3 and 0.72 restively at distance of 1.41 km distance in SE direction. The maximum concentration of NO_x, predicted from the proposed diesel based power plant at Viramgam and Salaya terminals during summer season would be 10.1 µg/m^3 and 12.9 µg/m^3 at a distance of 1.0 km and 1.41 km in E and NE direction respectively. However, as natural gas available from Raageshwari filed is proposed to be preferably used, the impact on the air quality due to gas based power plants will be insignificant.

The fugitive emissions of VOC may result from the crude oil storage tanks. However, as the vent gases from the fixed roof tanks proposed to be collected and connected to the proposed natural gas pipeline, no VOC emissions are expected from the storage tanks.

Adequate stack heights as per the CPCB norms will be provided to ensure wider dispersion of pollutants. Low NOx burners will be installed to reduce the emissions. The premises of storage terminals and heating stations will be paved to suppress the dust emission. Power generating units will preferably use gas as fuel to the maximum extend possible. A thick greenbelt (about 25% of the total area) will be developed around the permanent facilities to control the fugitive emissions of hydrocarbons and noise levels. Regular inspection of tank roof seals and preventive maintenance of valves and other equipment will be undertaken.

11.5.4 Noise Environment during Construction Phase

Noise Management during Construction Phase

The equipment and diesel generator at construction site are sources of noise emissions. The noise levels at most of the places along the pipeline alignment are ranging from 40-45 dBA. The noise impact due to transportation will only occur during the construction phase when transporting construction material and machinery to the construction site. These activities are likely to increase the background noise levels by 1-2 dB(A) at a distance of 0.5 km. As the major human settlements are 1 km away from the site, no noise impact on the community is envisaged.

The traffic in the area represents the normal to low traffic volumes. It is expected that about 100 vehicles per day will be plying to construction sites. Though it may not be a continuous operation but it may last for few weeks at a particular site. The predicted noise levels with increase of traffic will range between 60-56 dBA at distance of 10 - 20 m from centre of the road and attains back ground levels at a distance of 100 m from the road edge.

The following control measures are given below:

- Provision of adequate mufflers on all motorized equipment
- Transport of construction material to the site only during daytime
- Earmuffs to operators of heavy construction equipment

Noise Management during Operational Phase

The operational phase of the pipeline will have no noise generation along the route except at storage terminals and heating locations. The cumulative noise levels due to the combined operation of booster pumps and power generating units at Salaya and Viramgam terminal are predicted to be 55 dBA - 47 dBA and 45 dBA - 39 dBA at distance of o.5 km and 1 km respectively from the centre of sources. The back ground noise levels are expected to be increased by 1-2 dB(A) at a distance of 500 m from the proposed terminals. As no major settlement is located within 1 km from the storage terminals, no noise impact on the community is envisaged. The DG sets will be provided with acoustic control enclosures and the exhausts are provided with silencers. The operators / personnel working near the noise sources will be provided with earmuffs and earplugs.

11.5.5 Water Environment

Water Management during Construction Phase

The water is required for civil works and drinking water at construction camps. Water requirement is estimated as 100 m^3/day and will be procured from local registered water suppliers. The sewage generated from construction camps will be treated in septic tanks followed by soak pits.

Water required for testing of pipeline will be obtained from local sources. The wastewater generation during hydrostatics testing of equipment and pipeline is a major source of discharge and same water will be reused for multiple tests in other sections. The residual hydro testing wastewater at the end of the testing will be collected in holding ponds and tested for its toxicity and biodegradability. Depending upon the quantity of wastewater generated, the wastewater treatments will be either solar evaporated or disposed off into a near by CETPs in Gujarat. As water requirement is one time during testing, the impact will be temporary.

Some impacts will be arised from sediments being washed into the water bodies while the pipeline is laid across them. However, as most of the water bodies' en-route are small and non-perennial, precautions will be taken to minimize sediment run-off during the rainy season.

Water Requirement and Wastewater Generation during Operational Phase

There is no requirement of water during pipeline operations. However, a marginal water will be required for domestic and washing purposes at the storage terminals during operational phase. The total water requirement during operational phase is estimated approx. 15 m^3/day i.e. 10 m3/day at Salaya terminal and 5 m^3/day at Viramgam terminal.

Since the pipeline will be buried and coated with Cathodic Protection layer, there is no possibility of water ingress to the environment. There is no continuous process wastewater generation at storage terminals of Viramgam and Salaya. The occasional liquid effluent generated by draining and washing at storage terminals will be of very small quantity. These oily waters will be collected in lined pits and treated to meet the standards laid down by State Pollution Control Board before it disposal. The domestic sewage at the Viramgam and Salaya storage terminals will be treated by using appropriate sewage treatment systems to comply with the GPCB on-land discharge standards and reused for greenbelt maintenance. The intermediate

heating and pumping stations will be automated and have very low operating staff, hence these installations will have a septic tank-soak away systems

11.5.6 Land Environment

Land Management during Construction Phase

The land required for the pipeline project will be obtained on Right of Use (RoU) basis. Physico-chemical changes in soil quality may occur during construction mainly due to clearing of vegetative cover along the pipeline route and storage terminals causing temporary soil erosion resulting in turbidity in surface run-off.

The pipeline route in Rajasthan falls within the Thar Desert region with vast expanses of sandy soils with minimal vegetation. The pipeline route in Gujarat would not pass through any environmental sensitive or reserved forest areas. As major land-use along the proposed pipeline is agriculture / barren land, there will be temporary disturbance during construction phase and land will be reinstated to its original position once pipeline laying is over. The pipeline will be buried minimum 1.0 m below the ground level all along its length hence impact on land-use pattern will be marginal and reversible. Once the construction activity is over and pipeline commissioned, normal surface activity can be resumed including crop plantation.

The pipeline construction work during rainy season will be avoided to prevent soil erosion. Excavated top soil should be preserved near the trench and back filled after laying the pipeline. Temporary drainage channels will be provided to minimize soil erosion. Centralized waste management facility will be provided to collect all wastes during construction phase. The stockpiles, construction camps etc. during construction period will be located to the extent possible on land, which is devoid of vegetation and barren. On completion of construction works all temporary structures, surplus materials and wastes will be completely removed to avoid future land use incompatibility. Dumping of construction waste on agricultural land will be prohibited and stockpiles will be provided with gentle slopes. The project site will be secured by fencing and controlled entry points.

Storage of Hazardous Materials

The hazardous materials such as lubricating oils, compressed gases, paints and varnishes etc. generated during construction phase will be handled and disposed as per the prescribed / accepted norms. The used and spent oils will be collected in metallic barrels and stocked in warehouse. Upon accumulation of

manageable quantity, the used and spent will be disposed to authorized agencies. Secondary containment measures will also be provided.

Solid wastes generated from the temporary campsites, canteen and other wastes like plastics, paper, cardboard, etc. will be properly collected, segregated and reused appropriately (recycle, reuse, and composting).

Land Management during Operational Phase

The land on permanent basis is required at heating and storage terminals. The land requirement at each heating station is approximately 1ha. Thus, the total area requirement for 32 heating stations is 32 ha. However, the area is not contagious piece of land but spread over several land parcels along the pipeline route of 600 km length. The land requirement at proposed Viramgam and Salaya terminal is approximately 25 ha and 100 ha respectively. Thus, the total land required on permanent basis across several locations is 157 ha. which will be procured directly from the land owners. Upon construction of storage and heating / pigging facilities, the area will be notified as Industrial use.

No hazardous wastes are envisaged from pipeline construction activities. The oily wastes (waxy) generated during pigging operations will be re-melted and injected back to the line itself along with the flowing crude oil.

- To prevent corrosion / rusting of the underground steel pipe and contamination of the sub-soil, the entire pipeline will be coated with a 3-layer polyethylene coating and cathodic protection is provided. A state-of-the-art communication and SCADA network will be provided to check for leaks in the pipeline.
- Standard insulation material will be used for crude oil pipeline to prevent heat losses. The integrity of the crude oil pipeline including PUF insulation and HDPE jacket will be monitored. The soil temperature along the pipeline route at sensitive locations including heating stations shall be monitored
- The solid wastes such as paints, lubricants, oil diesel containers or any other non-biodegradable wastes that have leaching characteristics will be disposed in approved landfill sites

11.5.7 Biological Environment

The physiography of the region is arid to semi-arid land with scattered and scanty vegetation. Owing to the scanty vegetation, the loss of vegetation during clearing of right of way would be marginal and will be compensated by afforestation plan.

Though there are three endangered plants *(Barleria prionitis, Cenchrus prieurii and Tecomella undulata)* and two endangered birds (Whitebecked Vulture and Great Indian Bustard) are found in Barmer district in Rajasthan, there would not be any impact on the endangered species as adequate control measures are envisaged and as such these species are not coming in the pipeline corridor route.

As the pipeline route avoids passage through any national parks or sanctuaries or any of the other notified biosphere reserves, there would not be any danger to wild animals and forest. Temporary fencing arrangements should be made along the pipeline construction area to prevent the entry of wild life and animals.

The vegetation cut along the roadside plantation will be compensated with plants in the equivalent area as per the guidelines of Forest Department.

A thick greenbelt with a combination of trees and shrubs would be developed in the storage terminals and heating stations. List of native species which can survive in the area based on the field studies have been identified. The species suggested for greenbelt not only attenuate air and noise pollution but also add to the green cover in the region.

11.5.8 Socio-economic Environment

The impacts on socio-economic environment due to the proposed project are:

- Proposed project does not involve any displacement of villages / settlements
- Existing ancillary as well as auxiliary industries would be benefited by way of getting additional work
- The land shall be required to the extent of Right of Use (RoU) and there will be temporary disturbance to agriculture during construction phase. The land will be reinstated to its original position once pipeline

laying is over. Compensation will be paid in accordance with the regulations laid down by the land revenue departments

- Due to the project activities there is potential for employment both during construction stage (short term) and during the post construction / operation stage (long term)
- Residential / built-up land will not be acquired for the proposed pipeline, hence rehabilitation and resettlement (R & R) will not be associated with the project

11.6 Environmental Monitoring Programme

A detailed post project monitoring in respect of air, water, soil, landuse, occupational noise etc. to assess the changes has been evolved covering various phases of project advancement, such as constructional phase, and regular operation phase. A network of sampling locations around the operational facilities will be established. The monitoring shall include the compliances to legal and statutory controls imposed on the operation as well as other corporate commitment to responsible environment management. Systems for monitoring sources 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 program will be place during various phases of activities.

11.7 Additional Studies

11.7.1 Risk Assessment and Disaster Management Plan

Risk is quantified in terms of probability of occurrence of hazardous events such leak or rupture of storage tanks, pumps at the terminals, Storage, handling and pumping of hazardous materials and magnitude of its consequences. Scenarios like Jet fire, Pool fire and Flash fire are considered for consequence analysis.

Maximum damage distances computed by MCA analysis are 164.87 m for storage tank and 135.87 m for pumps for worst case scenarios of catastrophic rupture. Frequency analysis carried out to estimate the likelihood of hazards occurring indicates that probability of fire frequency for 2'' mm pipe leak is 0.235×10^{-5} / year for Mangala – Viramgam pipeline section and 0.177×10^{-5} / year for Viramgam – Salaya Pipeline section.

Heat transmission in case of pipeline failure and its impact on surrounding soil have been studied through heat modeling. It has been observed from heat loss computations that incremental change in ground surface temperature is about 2-3 ^{0}C for buried pipeline depth of 1 to 1.5 m. The variation of soil temperature from pipe surface to ground surface is in decreasing order and attains surface soil temperature. For a depth of 1 m or above, soil temperature does not show any significant change in its original value. As CEIL is taking all preventive measures to avoid heat loss from pipeline, even in case of worst case leak or failure of insulation system, the effect on the ground temperature will be insignificant.

Mitigation measures to control the above risks will be considered at design stage itself. Secondary spill / leak containment systems to limit the spread any losses of oil escaping from the pipeline and tanks will be provided. The oil storage facilities at Viramgam and Salaya will have adequate dyke walls and designed as per OISD rules.

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.

11.7.2 Public Consultation

As per the MoEF approved TOR, for the proposed oil evacuation pipeline project public hearing was to be carried out for the two terminals that is Viramgam and Salaya. The public hearing for Slaya terminal was scheduled for 20th November from 10.30 AM at Rajput Samajni Wadi, Nana Lakhiya, District Jamnagar. Advertisements were published in local as well as national dailies inviting public and stakeholders to raise concerns and seek clarifications in writing as well verbal during public hearing. Notice for public hearing for Salaya was published in 'Times of India' in English and 'Gujarat Samachar' in Gujarati on 18th October 2007. The public hearing for Viramgam terminal was scheduled for 24th November from 11.00 AM at Lohana Mahajan Samaj Wadi, Station Road, Viramgam, District Ahmedabad. These were conducted by respective GPCB Regional Officers and Additional District Magistrates. CEIL made

presentation on the project, anticipated impacts and management plan. Issues and concerns raised were addressed by CEIL, the details of which have been provided in Chapter 7.

11.8 Project Benefits

It is estimated that the Rajasthan block to produce of about 150,000 BOPD of crude oil, which is about 20% of the total country's production. The major benefits of the proposed pipeline and storage terminals for transportation of crude from Rajasthan to Gujarat will reduce the oil import bill of nation as well as helps in reducing imbalances in oil consumption in the region. The project will also add revenue to state and central governments in the form of royalty, cess, taxes etc.

CEIL will initiate many amenities either by providing or by improving the facilities in the area, which will help in uplifting the living standards of local communities.

11.9 Administrative Aspects of Implementation of EMP

The basis of the operational philosophy is that the activities proposed in crude oil transport from Mangala terminal to Salaya terminals shall be operated in complete compliance with all applicable laws, regulations, standards and permits, CEIL corporate policies, procedures, specifications rules, standards and guidelines. In order to achieve this, the crude oil terminals and pipeline route will be operated and maintained by technically qualified and experienced staff. Detailed procedures and plans will be developed for each activity prior to operation start up.

CEIL has well defined organization for Environmental Management System. Both its operating assets in India are Certified with ISO 14001. The Director (operations) of the project oversees the total environmental activities on a day-to-day basis. All individual departments take prompt action in dealing with environmental issues. The HSE department is the nodal agency to coordinate and provide necessary services on environmental issues during construction and operational phase.

11.10 Decommissioning

The pipeline and associated facilities (storage terminals, heating stations) needs to be decommissioned at the end of their commercial life, or due to the changes in management strategy or operational requirements. There is a growing

realization that decommissioning is not just a technical or environmental issue, but there is also safety, economic and social implications to be considered while designing the decommissioning and site rehabilitation plan. The decommissioning process for these units can take up two to three years time. The decommission plan shall be formulated on specific case-by-case basis in consultation with the interested stakeholders (operator, authorities, local community, etc).

The decommissioning process shall be planned in advance to select best decommissioning option depending upon the prevalent condition during the period. CEIL will strictly adhere to all protocols of the National and regional Conventions / Regulations (MoEF E&P forum etc.). The various options that have been practiced worldwide for dealing with decommissioned installations such as dismantle and re-install elsewhere and dispose in units / packages will be explored.

Assessment of Seismic and Geo-hazard

The pipeline project traverses through various geological and terrain structures in Rajasthan and Gujarat. Earth quakes are common in western part of Gujarat and sand dune migrations are common in Thar Desert of Rajasthan. The majority of the proposed pipeline route (450 Km length from Barmer to Wankaner in Rajkot district) passes through IS 1893 Seismic Hazard Zone III and approximately 150 km passing through Zone IV from Wankaner to Salaya terminal in Jamnagar District. Based on severity of the earth quake ground motion and potential consequence of the various hazards (the 475 year return period peak ground acceleration) the pipeline route has been assessed as moderately seismic, with acceleration levels of 0.16 g (Zone III) to 0.24 g (Zone IV).

In order to understand the potential of seismic and geo-hazards along the pipeline and to ensure minimization of environmental impacts and life safety risks to acceptable levels, CEIL has conducted a study and mapped the seismic zones, sand liquefaction areas due to earth quake shaking and dune migration. The relevant tectonic, geological, geo-technical seismic data will be analyzed and earthquake and geological loading factors will be incorporated during the pipeline design and construction phase.

The research studies conducted by Physical Research laboratory, Ahmedabad and CAZRI, Jodhpur indicate that Thar dunes are likely to be very ancient (pre-Holocene, 10,000 years old) and their mobility along the pipeline route during the design life of the project is unlikely and stable.

Seismic Risk mitigation Measures

The pipeline route will be designed in accordance with the Indian seismic design code IS 1893 (Indian Standard criteria for Earth quake resistant design of structures) which was updated after the Bhuj earthquake in the year 2002. In addition, consideration will be taken to the requirements of draft Indian design code "guidelines for seismic design of buried pipelines, accepted international codes and standards for pipelines. Selection of ground amplification factors depending upon soil classification along different sections of the route, provision of automatic shutdown valves across fault zones, use of ductile coatings at joints are some of the measures envisaged to mitigate the seismic and geo-hazard risks.