Executive Summary

Environmental Impact Assessment & Risk Assessment Study for BS VI Auto Fuel Quality Compliance and Associated Projects Facilities at MRPL, Mangalore

Sponsor:

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1. Introduction:

The Ministry of Road Transport and Highway issued a notification of Bharat Stage (BS) VI emission standards, similar to Euro VI standards. The standards, as proposed, will take effect throughout the country for all light-duty and heavy-duty vehicles as well as two and three wheelers manufactured on or after 1st Apr 2020. The BS VI standard specifies 10 ppm sulfur content, in gasoline (Petrol / MS) and diesel fuels. The Ministry of Petroleum and Natural Gas (MoPNG) announced nation-wide supply of BS VI fuel in conjunction with the proposed BS VI emission standard implementation date of 1st April 2020. In view of the nation switching over to BS VI fuel specifications in April 2020, Mangalore Refinery & Petrochemicals (MRPL) proposes up-gradation / augmentation of its existing facilities to produce products that comply with BS VI specifications.

MRPL commissioned, as a grass-root petroleum refinery, its Phase 1 Refinery Complex in March 1996 with an initial design capacity to process 3.69 million metric tons per annum (MMTPA) crude oil near Katipalla village in Mangalore taluka of Dakshina Kannada district, Karnataka state. The Phase-II expansion (6 MMTPA), which was commissioned in 1999, enhanced the total crude oil processing capacity to 9.69 MMTPA. The crude oil processing capacity of the refinery was further enhanced to 11.3 MMTPA in year 2005 by increasing the refinery operation days from 333 to 345 days per year & utilizing the available design margins to some extent. This refinery capacity was further enhanced to 12.5 MMTPA crude through-put in year 2006 by purely operational changes in existing primary distillation units (CDU/VDUs) of both the Phases and other secondary processing units & utilities as well as increased number of operating days in a year without compromising the efficacy of maintenance of the Refinery Complex by undertaking online / on stream service & maintenance of the Refinery complex, wherever possible. MRPL was conceived as a joint venture oil refinery promoted by M/s Hindustan Petroleum Corporation Limited (HPCL) and M/s IRIL & Associates (AV Birla Group) in 1988. MRPL became a Central Public Sector Unit (CPSU) subsequent to the acquisition of its majority shares by M/s Oil and Natural Gas Corporation Limited (ONGC), in year 2003. Subsequently, MRPL implemented the Diesel Quality Improvement Project along with enhancement of refinery capacity to 13.6 MMTPA crude oil processing to meet BS III & BS IV specification of auto-fuels (MS & HSD).

Further with a view to meet the growing demand of petroleum products in the state of Karnataka and also to enter into the strategic segment of petrochemicals a decision was taken to upgrade and enhance the processing capacity of the Refinery complex.

Accordingly the Phase 3 project was conceived and implemented enhancing the processing capability of heavier crude oil to some extent and bringing the total Refinery capacity of the complex to 15 MMTPA.

Now, in view of the above mentioned National Policy on "Clean Auto-fuels" to produce and supply BS VI grade MS & HSD from April 2020, MRPL proposes up-gradation/augmentation of its existing facilities to produce MS and HSD to comply BS VI specifications (sulfur content < 10 ppm) with the following objectives:

- Treatment facilities for MS and HSD to comply with BS VI specifications of fuel
- Revamp/augment units to debottleneck/ improve operational flexibility
- Additional storage tanks (9 Nos.): Initially, requirement of 8 new tanks was identified and the same was requested in the ToR. However, during the Engineering stage owing to operational flexibility and ergonomics, it has been suggested to split 1 Naphtha tank of higher capacity into 2 smaller tanks of 7500 m^3 each, wherein one tank will receive the untreated Naphtha coming from the PFCC unit and simultaneously the other tank will be feeding the FGT.

The estimated total capital investment for all proposed developments is about Rs.1810 Crore for upgradation of MS & HSD to BS VI grade fuels quality.

1.1 Location of Project:

The location of existing MRPL refinery is located in coastal belt of Arabian sea near Katipalla village in Mangalore taluka of Dakshina Kannada district, Karnataka state. The refinery complex occupies an area of 1592 Acre situated within the geographical locations 12°58' - 13°01'N latitude and 74°50' - 74°52'E longitude. The project site is about 10 km from New Mangalore Port Trust in North-East direction. The proposed developments / facilities are planned within the existing refinery premises; and about 20 Acre land available inside the refinery will be utilized. No additional land will be acquired for this project

1.2 Production Capacity:

M/s MRPL refinery has three primary distillation units (CDU I, II & III), and other various secondary processing facilities, treating units and utilities with an installed capacity to process 15.0 MMTPA crude oil. The products slate of the refinery corresponding to 15.25 MMTPA crude oil processing is given in **Table 1**.

Three primary resources required for MRPL refinery complex are crude oil, power and water as listed in **Table 2**.

Crude Oil:

Crude oil required for refinery complex is procured from both domestic and imported sources. The domestic crude is allocated by ministry of petroleum and natural gas (MoPNG) and

imported crude caters about 80% of the MRPL refinery requirement. It is under term contract with national oil companies across the world and about 10-20% is procured from spot purchase in the international market.

Power:

The existing refinery has captive cogeneration facilities to generate power ~235 MW (and associated process steam as required) from its three captive power plants.

Water:

The overall water requirement in the existing plant is 4386 m^3/h; which includes treated sewage, 908 m^3/h, the fresh water, 2658 m^3/h and recycled treated effluent 820 m^3/h. MRPL has consent for withdrawl of freshwater from Irrigation Department, Govt. of Karnataka. From Sarapady pumping station, which is about 45 km from MRPL refinery, on Netravati river the quantity of water 1242 m^3/h is drawn. Another source of fresh water is taken from MSEZL with the quantity 1416 m^3/h. MSEZL also provides treated sewage of 908 m^3/h for refinery.

1.3 Brief Description of Crude Oil Processing:

- Crude Distillation Unit (CDU) is the mother unit of crude oil refinery. In this unit, the crude oil is fractionated into various straight run products based on their boiling points. CDU overhead product liquefied Petroleum Gas (LPG) is routed to LPG MEROX unit to remove hydrogen sulfide and mercaptan.

- CDU middle cut product naphtha contain hydrocarbon with boiling point ranging from ambient temperature to 150°C. Naphtha is split into light naphtha and heavy naphtha in Naphtha Splitter Unit (NSU). Heavy Naphtha octane number is increased from 68 to 101 in Continuous Catalytic Reforming (CCR) unit using platinum catalysts. Naphtha with High Research Octane Number (RON) is split into light reformate and heavy reformate in Reformate Splitter Unit (RSU). Mixed xylene product is extracted from heavy reformate using Mixed Xylene (MX) unit. Light reformate is processed in isomerization (ISOM) unit to generate high RON and low benzene isomerate which can be blended with other naphtha stream to produce MS.

- CDU Light naphtha with RON of 72 is blended with a proportion of CCR outlet to produce MS with RON 91/95.

- Mercaptan in CDU middle cut Kerosene removed and dehydrated to produce Aviation Turbine fuel in Kero Merox unit.

- CDU middle cut gas oil is processed in GOHDS, DHDT unit to produce low sulfur HSD and high Cetane number HSD respectively.

- Vacuum Distillation Unit (VDU) middle cut is Vacuum Gas Oil (VGO) has hydrocarbon with boiling range 360°C to 550°C. VGO is hydro-desulfurized and hydrocracked in Hydrocracker unit (HCU) at high temperature and pressure in fixed bed catalyst to produce ultra-low sulfur Kerosene and High Speed Diesel (HSD).

- HCU can be operated in once through mode to desulfurize VGO. Desulfurized VGO is fed to PFCC unit to produce Propylene, LPG, MS and HSD. Also, low sulphur VGO can be routed to PFCC unit depending upon the sulphur contents.

- Vacuum Distillation Unit (VDU) bottom product – Short residue contain heavier hydrocarbon with boiling point above 550°C. Short residue can be used to produce Fuel oil, Bitumen, Petcoke in Visbreaking Unit (VBU), Bitumen Blowing unit and Delayed Coker Unit (DCU) respectively. Gasoil generated in DCU is hydrotreated in CHT unit to produce low sulfur PFCC Feed stock.

2 Baseline Environmental Quality:

The baseline environmental quality has been carried out during Summer Season (March – May, 2016) and post-monsoon (September-October 2016) in the study area of project site for various environment components namely air, water, land, soil, ecology and socio-economic aspects.

2.1 Ambient Air Quality:

- The minimum and maximum concentration of 24 h average PM_{10} ranges between 33-58 µg/m³ and 57-83 µg/m³, respectively. The minimum concentration was observed at Haleangadi and Niddodi; and MRPL Substation 45 sampling station reported maximum; such variation would be due to wind-blown dust and unpaved roads. The concentration of $PM_{2.5}$ varies between 16-27 µg/m^3 and 23-37 µg/m^3 for minimum and maximum values. The concentration of particulate matter both PM_{10} and $PM_{2.5}$ are well within the stipulated standards set by CPCB.

- The minimum and maximum and average concentrations of SO_2 were observed in the range of 4-10 µg/m^3 and 7-13 µg/m^3 respectively. Similarly, for NO_x varied in the range of 7-10 and 10-15 µg/m^3 respectively. The concentrations of SO_2 and NO_x were observed below the stipulated standards of NAAQ, 2009; i.e., 80 µg/m³.

- The total VOCs also measured with the VOCs analyzer as spot concentration at selected locations. The values ranged between 0.39-1.37 ppm at selected locations within the study area. As seen the observed Benzene concentration were 0.13-0.41 µg/m^3 and is below the NAAQS of 5 µg/m^3.

- On-site hydrocarbon analyzer was used to record concentration of methane (MHC) and non-methane hydrocarbons (NMHC) in the study area. The concentration of MHC and NMHC concentrations ranged between 1.02-1.84 ppm and 0.11-0.19 ppm, respectively.

- In addition to above air pollutants, other parameters are also determined and given in the EIA report.

2.2 Noise:

- The noise levels in residential area were found to be ranging from 55 to 63 dB(A) during the day and 43 to 58 dB(A) during night. In commercial zone, noise levels varied between 52 and 68 dB(A) during day, and 44 and 55 dB(A) during night.

- In silence zones noise levels recorded were between 49 and 61 dB(A) during day and 46 and 49 dB(A) during night.

- Within industrial area the noise levels recorded were 41-72 dB(A) during day and 45-73 dB(A) during night.

- Noise levels in commercial zone, silence zone and Industrial zone were within the CPCB standards for respective areas.

2.3 Water Quality:

Ten surface water samples were collected, which included two samples from Gurupura river, one sample from raw water sump (source being Netravati river), one sample from Nandini river and other surface water bodies (nallahs) within study area having importance with respect to the present study. Sampling, preservation and transport of water samples from the field was done as per of guidance manual ISO (ISO 5667-1; 1980 water quality sampling part I: ISO 5667-11: 1993 part II) for surface and groundwater sources. Samples were analyzed for physico-chemical characteristics including physical, inorganic, organic, nutrient and heavy metals and also for bacteriological characteristics for total and faecal coliforms as per Standards IS 3025/Standard Methods for Examination of Water & Wastewater (APHA). The important findings are listed below:

- Surface water samples collected from Gurupura river (two samples), Netravati river (one raw water sample collected within MRPL premises) and Nandini river (one sample). Gurupura river samples collected falls under estuarine zone of the river; but because of the rainfall during monsoon season and various nallahs and drains joining the river, the estuarine water was highly diluted; which is also evident from the low TDS, EC and chlorides concentrations in these samples. Gurupura river falls under Class-C (drinking water source with conventional treatment followed by

disinfection); and the quality of this river water was tested for all relevant parameters as per IS: 2296-1982 Standards and compared the water quality for tolerance limits of inland surface waters.

- Seven surface water samples collected from nallahs, streams and marshy land within study area have been analyzed for phyisico-chemical characteristics and these water bodies fall under Class-E (water use for irrigation, industrial cooling or controlled waste disposal) of IS: 2296-1982 Standards for tolerance limits for inland surface waters. Stream/nallah water sample near Nitrogen plant had low pH (6.2) and it subsequently flows towards Attarkodi and Kuthethoor villages, which had pH of 6.7 and 6.9 respectively. The oil and grease content in these water samples was in the range 1.0-2.8 mg/l; while the aromatic compounds such as benzene and BAP concentrations in trace concentrations (0.01 µg/l). Nallah water samples near HPCL which subsequently enter into the marshy land, the water was visibly clear, which also correlates with the TSS and turbidity results of these samples

- Groundwater samples were collected from six dug wells of different villages within study area and one hand pump and one bore well sample were collected and analysed for physical and chemical parameters. Results obtained were compared with the Drinking Water Standard IS 10500:2012. One of the peculiarities of the groundwater quality of the region was low pH (pH: 4.8-6.4), and low TDS in the dug well samples in most of the villages; which was also confirmed by MRPL's earlier reports Most of these villages have very old dug wells (60-70 years old). It is also evident with the physico-chemical characteristics data obtained for the collected groundwater samples and villagers are consuming the dug well water for drinking and domestic purposes from so many years. Hand pump and bore well water samples near Nitrogen plant shows high turbidity (>60 NTU); which may be due to the presence of colour causing pollutants such as iron associated organic and inorganic complexes.

- The bacteriological characteristic of four surface water samples collected from river Gurupura, river Netravati and River Nandini with reference to total coliform count was found in the range of 162-334 CFU/100 ml; whereas faecal coliform was 15-45 CFU/100 ml. This indicates that surface water bodies are contaminated and would require disinfection before consumption. The ground water samples showed total coliform from 16-256 CFU/100 ml; whereas faecal coliform was observed as 4-29 CFU/100 ml, implying that chlorination or disinfection is necessary before water is used for human consumption.

2.4 Marine Quality:

- Air temperature ranged from 30.5to 31.5°C and 31.25to 31.75°C in Chitrapur and Mukka regions, respectively, while seawater temperature varied from 30-31 ^{O}C and 31.5-33^{O}C. Variation in the recorded average surface and bottom water temperature is insignificant, suggesting vertical mixing seawater due to high tidal amplitude of the coast.

- pH of seawater ranged from 8.0-8.2 both in Chitrapur and Mukka coasts. In general, the surface pH was slightly higher than bottom pH in Chitrapur, however, reverse trend was observed in Mukka coast. Many sampling stations showed nearly similar pH values at surface and bottom levels. Overall, the pH in the study region is slightly higher as compared to previous data collected by NIO.

- TSS values in Chitrapur region ranged from 68 to 119 mg/L and 58 to 100 mg/L in Mukka region. Higher values of TSS were observed in Chitrapur region. In general, TSS values continuously increased form surface to bottom waters at studied stations. The average values of TSS in the study area showed significant variations at all the locations.

- Salinity of seawater off Chitrapur varied between 34.3‰ and 36.8‰; the maximum salinity 36.8‰ was observed in the offshore. The average salinity off Mukka coast varied from 35.8 to 37‰. In general, the surface salinity was slightly higher than near bottom salinity in both Chitrapur and Mukka regions.

- DO levels in the ranged from 3.9 to 4.5 mg/L and 3.7 to 4.1 mg/L in Chitrapur and Mukka regions, respectively. Comparatively higher DO values were observed in Chitrapur region. In general, all DO values are within acceptable limits. Previous studies conducted by NIO indicated that DO varied from 2.5 to 5.4 mg/L, also support this observation.

- BOD values both Chitrapur and Mukka regions are <3 mg/L.

- Oil & Grease levels ranged between 0.48 and 1.47 mg/L for Chitrapur region while Mukka region showed the oil & grease levels ranged from 0.42 to 8.4 mg/L.

- Total phosphorus (TP) and total nitrogen (TN) are also included because of their importance in relation to marine ecosystem. The nitrite varied from 0.08 µmol/Lin surface water during low tide to 8.88 µmol/L in surface water at during high tide in Chitrapur region while it ranged from 0.20 µmol/L in bottom water to 4.33 µmol/L in surface water during low tide in Mukka region. In general, nitrite shows increasing trend of variation from surface to bottom at many stations in both

regions. The average nitrite value in the study region is 1.26 µmol/L. All these nitrite values considered to be within the acceptable level for coastal water.

- Metals like, barium, cadmium, cobalt, chromium, copper, manganese, nickel, iron, lead, zinc, manganese and metalloid, arsenic were determined in seawaters of all studied stations. Barium, cadmium and lead were found below detectable limits at many stations and their highest concentrations were 4.2, 0.2 and 1.1 µg/L, respectively, in both Chitrapur and Surathkal regions. Highest Concentrations of copper, chromium and nickel in marine water are 22, 90.5 and 24 µg/L, respectively; whereas cobalt, iron, manganese and zinc highest concentrations are 1.9, 391, 24 and 40µg/L, respectively in both Chitrapur and Surathkal regions. In the present study, all heavy metals and As concentrations were much below the standards prescribed by any agency.

- Chlorophyll a ranged from below detectable level at many stations to 0.44 mg/m^3 and below detectable level at many stations to 0.014 mg/m^3 in Chitrapur and Mukka regions, respectively, while phaeophytin was below detectable level at all stations.

- Phytoplanktons species composition with respect to Shannon Weiner Diversity Index (SWDI) was studied to assess the biotic and abiotic relationships of these organisms with its Impact to the water quality. A total of 13 species from 4 families were recorded during the entire study period. The Shannon Weiner Diversity Index (SWDI) value less than 1 indicates organic pollution while SWDI 2 and above represents no pollution. The site MSW 1/HT reported SWDI value of 0.97 and the sites MSW 6/LT and MSW 8/HT reported SWDI values more than 2.

- Zooplanktons the samples were taken from the offshore in high tide and low tide periods at 11 sites. Total 10 species of zooplankton belonging to three different groups Rotifera (4 species), Cladosera (3 species), Copepoda (2 species) and Protozoa (1 Species) were recorded. As the Rotifera group was dominant in all the sites they were found in the range of 25-75% and Copepoda was in the range of 12-83%. Protozoa and Cladocera were less dominant groups and found in the range of 16-33% and 18-47%, respectively.

- Sediments of study region in both Chitrapur and Mukka were low in TOC content as compared to previous data. Comparatively, TOC content was high in Chitrapur region.

- In the present study, all the metals were detected except as which was below detectable range in the study area. The concentrations of all the metals in the present survey are less than or comparable to previous study in 2008 by NIO. Hence, the present data did not reveal any accumulation of the metals in the study region.

2.5 Soil Quality:

- The particle size distribution in terms of percentage of sand, silt and clay showed dominance of sandy loam, loamy sand and sandy Clay Loam in nature
- The bulk density was observed to be varying from 0.9–1.3 g/cm^3 which is considered to be moderate to high.
- The porosity and water holding capacity of soils are in the range of 51.1-64.8 % and 39.8–67.4 % respectively.
- The pH of soil was observed to be in the range of 4.9-6.6 indicates strongly acidic to slightly acidic in nature.
- Electrical conductivity is in the range from 0.03-0.15 dS/m.
- The most important cations present in soluble state in the soil is calcium and magnesium. It was observed that calcium and magnesium are in the range of 0.4-1.8 meq/l and 0.2-0.8 meq/l respectively. The sodium and potassium are in the range of 0.1-2.3 meq/l and 0.01-0.06 meq/l respectively.
- In general, the soil in the region has high to very high adsorption capacity as evident from the cations exchange capacity to be in the range of 21.9-43.4 cmol (p+) kg^{-1}. Amongst the exchangeable cations, Ca^{+2} and Mg^{+2} were observed in the range of 0.5-3.3 and 0.1-0.9 cmol (p+) kg^{-1} whereas sodium and potassium are in the range of 0.8-2.0 and 0.5-3.1 cmol (p+) kg^{-1}respectively.
- Exchangeable sodium percentage ranged from 1-2% indicating that the soil in study area is non-sodic in nature.
- The classification of soil and their relationship between productivity and absorptivity based on cations exchange capacity which indicate moderate productivity and high to very high adsorptivity in the study area
- Organic carbon, available nitrogen, available phosphorus and available potassium are found to be in the range of 0.4-1.5 %, 131.7-288 kg/ha, 33.5-55.6 kg/ha and 19.8-79.6 kg/ha respectively which shows that the soils are poor to fertile in organic carbon content.
- Azotobactor are non-symbiotic nitrogen fixing microorganisms and improve soil fertility by fixing nitrogen in the soil.

- Fungi also constitute an important part of the micro-flora of normal soil. They are active in initial stages of decomposition of plant residues and actively participate in the process of soil aggregation.

- Total viable microbial population per gram of soil varied from 3-89 x 10^6 CFU. Different microflora observed per gram of soil samples were fungi (ND-4 x 10^4 CFU), Actinomycetes (ND-35 x 10^4 CFU), Rhizobium (ND-37 x 10^4) and Azotobacter (ND-9 x 10^4 CFU).

2.6 Ecology:

- The forests of the division exhibit rich diversity. Because of their distribution in widely varying conditions of locality and a number of external factors of the ecosystem to which they are subjected, the forest types of the division are diverse and complex. Variations in climatic, edaphic, topographic and biotic factors have led to variations in the nature and growth of the vegetation. Entire Mangalore range does not have any Reserve Forest. Mangalore is a versatile division. Favorable climatic and edaphic factor have favored in experimenting with different type of Plantations of Rubber, Cashew, *Cocoa, Casuarina, Ailanthus, Hopea, Acacia auriculiformis, Vateria indica* Nutmeg, Clove, Oil palm, Teak, Bamboo Cane, Areca nut, Mangrove species, etc. have been raised successfully.

- There are no distinct zones and in the transition from one type to another is very frequent (Evergreen forest consists 0.5%, Semi evergreen forest consists 54%, Moist deciduous forest consists 42%, other forest 3.5%).

- Natural vegetation prominently consists of Hopea parviflora, Hopea wightiana, Vateria indica, Diospyros microphylla, Eugenia gardneri, Aporasa lindleyana, Olea dioica, Syzygium species, Terminalia paniculata, Lagerstroemia lanceolata, Lophopetalum wightianum, Machilus macarantha, Cinnamomum spp, Mangifera indica, Artocarpus hirsuta, Holigarna arnotiana. Elaeocarpus serratus, Mallotus philippensis, Ixora and Calycopteris floribunda bushes.

- The coastal vegetation observed in Jokkate and Gurupur river had coconut (*Cocos nucifera),* Tari palm (*Borassus flabellife*r) as dominant floral elements. *Cyperus rotundus* and other Cyperaceae members were seen at the banks of water streams where mud was present. The ponds in the project region were observed to have plants, which comes under the category of aquatic weed like *Ipomoea cornea* and *Chara* sp. Other than this, *Ammania* sp. and *Hydrilla* sp., occupied some of the areas of water submergence.

- There were certain species of plants like *Caryota urens*, *Syzgium cumini* (Jamun) and *Tectona grandis* whose IVI value was found to be 8.26, 5.68 and 6.18

respectively, that signifies the species are medium dominant and very frequently observed in the study area.

- The bird population of study area is also rich and diverse. The birds observed during primary data collection survey were *Milvus migrans* (Black Kite), *Vanellus indicus* (Red-wattled lapwings), *Euploea core* (Common Crow), *Phalacrocor axauritus* (Cormorant) etc.

- Mangrove species observed in the study area was *Kandelia candel* as a dominant mangrove species.*Avicinnea marina, A. alba, Rhizophora mucronata, A. officinalis* and *Kandelia candel* were dominant species. However, no notified areas are there with mangroves in Mangalore division.

- Social plantations in industrial areas road sides and townships include various ornamental plants like Nerium indicum, Polyalthia longifolia, and Bougainvillea glabra and trees like Acacia nilotica, Azadirachta indica, Saraca indica and Leucena lucocephala was observed. In village gardens plantation of Vateria indica, Delonix regia and Zizypus jujuba. In the southwest sector from Suratkal to Pavanje and Delanthbetu, platation of Hopea, Hebalasu, Peltoforum, Pterocarpum and Mayflower.

- During the study period water samples from ten sites of surface water were taken in order to check the Planktons composition and diversity. A total of 11 phytoplankton species from 4 families were found during the entire study period. The overall communities of the Phytoplanktons were represented mainly by four families i.e. Chlorophyceae, Bacillariophyceae, Myxophyceae and Euglenophyceae.

- The Shannon wiener diversity index in the Gurupur River and Nandini river shows the range of 2.08 and 1.98 respectively indicating the oligotrophic quality of water. The family Euglenophyceae in the water samples of Nallah (near HPCL- joining of two drains passing through MRPL premises) and marshy lands indicates the enriched organic matter and the Shanon Weiner Diversity Index of 0.91. One species i.e. G*omphosphaeria* representing the family Myxophyceae was found in some of the samples and was the least abundant species

- Zooplankton studies in ten surface water samples in the study area depicts a total of 8 species belonging to four different groups i.e Rotifera (4 species), Protozoa (2 species), Cladocera (1 species) and Copepoda (1 species). Copepoda was found in water samples of Nallah near HPCL- joining of two drains passing through MRPL premises and Nallah near village Kuthethoor. It was observed that, Copepoda species was the least abundant as compared to Rotifer species.

2.7 Socio-economic Status:

- Population of the study area was 1,18,319, out of which male population was 58,462(49.41%) and female population was 59,857 (50.59%).
- Total number of household was 26,118 with average occupancy of 4.53 persons per household.
- Total geographical area of 29 villages was 126.1995 km^2 and total six towns geographical area of 48.54 km^2. Its population density was 540 and 902 person/km^2.
- Overall population density was 640 persons/ km^2.
- Total child (below 6 years of age) population was 11,080 (9.36%) out of which male population was 5,716 (51.59%) and female population was 5,364 (48.41%).
- Sex ratio (number of females per 1000 males) of total population was 1024. Among child population, sex ratio was 938
- According to census 2011, in the study area, overall literate population was 95,555 (80.76%) and illiterate population was 22.764 (19.24%).
- Out of total literates, male literates were 49,228 (51.52%) and female literates were 46,327 (48.48%).
- Out of total illiterates, male illiterates were 9,234 (40.56%) and female illiterates were 13,530 (59.44%)
- According to 2011 Census, total worker population in the study area was 55,807 (47.17%). Out of total workers, male workers were 35,352 (63.35%) and female workers were 20,455 (36.65%).
- Main workers were 50,218 (42.44%) and marginal workers were 5,589 (04.72%). Total non-working population was 62,512 (52.83%).
- The average QoL index values are estimated as:
- QoL (S) = 0.58
- QoL (O) = 0.67
- QoL (C) = 0.63

- The average QoL Index value for the study area is leaning towards neutral and satisfactory level due to good economic status like income, employment, educational facilities and also availability of basic needs, viz. food, clothing, and housing.

3 Anticipated Environmental Impacts and Mitigation:

The anticipated environmental impacts due to the proposed project and the suggested mitigation measures are given below:

3.1 Air Impacts:

- The total stipulated quantities of stack emissions prescribed by KSPCB at existing refinery are SO_2: 56.9 TPD and NO_x: 29.9 TPD. The ground level impacts due to these emissions are covered in (pre-project) air quality status monitored during study period for description of environment.

- The emission rates of SO_2 & NO_x from individual stacks are derived based on 1% S (max) for Phase I & II and 0.5% S (max) for Phase III in internal fuel oil and consumption rates corresponding to individual combustion units. There are 49 major flue gas stacks in the refinery and two stacks are proposed in the BS VI project i.e. FCC Gasoline and SRU incinerator stacks, cleaner (Ultra low sulphur) Refinery fuel gas will be combusted at these units. Accordingly, the SO_2 & NO_x emissions through the proposed stacks are estimated 22.0 g/s (1.9 TPD) and 9.5 g/s (0.8 TPD), respectively.

- The details of SO_2 and NO_x emissions of phase-wise in the existing refinery and the proposed new units are given below:

- SO_2 and NO_x Emission Rate:

Emissions	Actual Emission Rate Mar - Oct 16	Predicted Maximum Emission Rate from BS VI Project	Predicted total Emission Rate	Emission Rate as per the Consent
SO_2 (MTPD)	51.39	1.9	53.29	57
NOx (MTPD)	16.13	0.8	16.93	29.9

The 24-hourly maximum GLCs of SO_2 and NO_x for summer season are predicted to be 9 µg/m^3 and 3 µg/m^3 respectively, both occurring at a distance of about 0.7 km distance in NNE direction. After implementation of BS VI project, the overall air quality in terms of SO_2 and NO_x shall remain well within the prescribed National Ambient Air Quality Standards (NAAQS), 2009.

3.1.1 Mitigation Measures:

By adopting suitable measures and use of appropriate equipment, air quality impacts would be reduced. Some of the important mitigation measures currently practiced in the MRPL refinery are given below:

- Tall stacks (much higher than CPCB standards) are installed for various heaters/ processes for effective dilution and dispersion of air pollutants
- Provided maximum balanced draft heaters to reduce fuel consumption
- Low NOx burners are provided to various heaters to reduce NOx emissions
- Safety vents of all process equipment are routed to flare
- Installed advanced cyclone systems in PFCCU to meet stipulated standards of dust emissions
- Vapour adsorption system and secondary seals provided in hydrocarbon tanks to prevent/reduce fugitive emissions
- Sulphur Recovery Units 3 Nos. in Phase – I & II with 99% efficiency and 3 Nos. in Phase – III with 99.9% efficiency are provided to recover sulphur from various off gases to meet the Environmental Standards.
- Crude oil and most of the products storage tanks are designed with floating roof to minimize fugitive emissions
- Secondary seals are provided to the crude and product storage tanks for reducing the emissions of Volatile Organic Compounds (VOCs)
- Utilization of low sulphur (≤1% S in Phase I and II, ≤0.5 % S in Phase III) fuel oil in furnaces
- Maximum utilization of ultra-low sulphur Refinery fuel gas (<10 ppm S) in furnaces
- Off gases generated from the process units being utilized in process heaters to reduce fuel oil consumption
- Two Sulphur pelletization plants are installed to reduce dust emissions drastically from SRU.

- Online Analyzers for SO_2, NOx, CO and SPM are provided at various process stacks to monitor online emissions of these air pollutants

- Two Continuous Ambient Air quality monitoring systems have been installed in the Refinery for monitoring real-time concentrations of various ambient air quality parameters as per the KSPCB instructions

- Manual Stack Monitoring for emission parameters being carried out in regular intervals.

- VOC monitoring is being done as per MoEF stipulated frequency by approved external agency.

3.2 Noise Pollution:

The site, owing to presence of vegetation and uneven ground surface at sites of proposed FGT, SRU, and storage tanks (at Beta land), will require site clearing, and site preparation. This activity will be of very short duration and will not have any significant impact on the nearby villages.

3.2.1 Construction Phase:

Distances of nearby settlements (i.e., Jokatte, Kalavara, and CISF Colony) vary between 900 m to 1.8 km. Since, the noise levels decrease by 6dBA for every doubling of distance; it is anticipated that in the nearby villages, the noise levels will increase by 1-2 dBA.

During operation phase of the proposed project, SRU and FGT are the main noise sources of noise and their anticipated noise levels are 85 dBA (i.e., at standard distance of 1.5 m from source). Similar to that of construction phase, It would be expected that the noise levels in the in the vicinity of the facility (i.e., CISF colony, Kalavara, Jokatte) are expected to increase by 1-2dB, without taking into account the mitigation measures.

There will be an increase in noise levels in residential areas situated close to the road due to movement of trucks. However, the impact of truck movements on noise level in residential areas situated at 50 meter and beyond from the road will be insignificant considering the excess attenuation and will be below the stipulated standard of CPCB.

3.2.2 Mitigation Measures:

Some of the important mitigation measures are given below to control noise pollution:

- Proper maintenance of construction equipment/machinery for controlling excessive noise levels.

- Use of silencers/mufflers for high noise generating equipment

- All the workers engaged at and around high noise generating sources shall be provided with ear protection devices like ear muffs/plugs. Their place of attending the work will be changed regularly so as to reduce their exposure duration to high levels.

- Employees/workers will be regularly subjected to medical check-up for detecting any adverse impact on their TLV of hearing.

3.3 Water Requirement and Wastewater Generation:

The source of water to the refinery is Netravati river. The refinery has a consent for withdrawal of 29.55 MLD (6.5 MGD) water from the river for various purposes for Phase I and II, while MSEZ also has consent for drawl of water from this river and has agreement for supply of 29.55 MLD (6.5 MGD) to MRPL for Phase III together amounting to 59.1 MLD (13 MGD). The water is pumped from the pumping station at Sarapady, about 45 km from the refinery, and brought to the refinery through pipeline and through MSEZL. In addition to this, Mangalore City's treated sewage to the tune of 908 m^3/h is also received through MSEZL and forms a part of the water consumption by the refinery. The present raw water consumption is 2658 m^3/h, comprising 1242 m^3/h from Sarapady pumping station of MRPL and 1416 m^3/h from MSEZL of which about 50 m^3/h is supplied to neighbouring industries, viz. HPCL, BASF etc. The existing water consumption for Phases I & II and III is 1497 and 2889 m^3/h, respectively. This consumption is within the permissible limit of KSPCB consent of 4386 m^3/h comprising of 3566 m^3/h of water (fresh and MSEZ STP) and 820 m^3/h of recycled treated effluent. The additional water requirement for the proposed BS-VI project is anticipated to be 85 m^3/h to meet the industrial and cooling water requirements which will be met from the existing municipal treated sewage received from MSEZ and hence no additional freshwater drawl is envisaged.

The limit for quantity of effluent discharged is 400 m^3/1000 tonne of crude processed, while the refinery is discharging 329-367 m^3/1000 tonne of crude processed which is within the stipulated limit arrived at on the basis of flow rates measured during monitoring (crude processed on 30/9/2016 and 01/10/2016 being CDU - I - Shut Down, CDU - II - 25.552 thousand tonnes and CDU - III - 11.507 thousand tonnes and CDU - I - Shut Down, CDU - II - 25.482 thousand tonnes and CDU - III - 11.768 thousand tonnes, respectively).

As per KSPCB consent No. AW-301293 dated 28/10/2016, MRPL shall recycle the treated effluent at maximum extent from ETPs. However, as per the details provided by MRPL for the period October 2015-July 2016 , the average recycle rate was 37-77%. During the study period October 01-02, 2016, the treated effluent recycled was 368 m^3/h (58% recycling with respect to dry weather flow rate). Efforts are therefore warranted towards enhancing the effluent recycle rate thereby minimizing the waste load discharges into the sea.

With proposed BS-VI project the anticipated wastewater generation from process unit is about 7 m³/h. This effluent shall be routed through existing ETPs. Since the design capacity of primary treatment facility of ETPs is 880 m³/h and secondary treatment facilities is 1015 m³/h, and the average processing during 2015-16 was 611 m^3/h. The additional hydraulic load of 7 m³/h could be routed through the treatment facilities.

3.4 Land Use and Greenbelt:

- The proposed project will be implemented within the MRPL refinery premises. There is no additional land to be acquired for the proposed project. The BS-VI project will be established in 20 Acre land, which is identified as per appropriate location based on construction engineering and environmental requirement. In view of this, it is clear that the project site has been already designated for industrial use. The site will be prepared for construction of three newly proposed unit operations within the MRPL refinery

- MRPL refinery is committed to maintain the 33% of plant area for greenbelt. In view of the above, the construction phase impacts would be insignificant exclusively due to proposed project.

- The major sources of semi-solid and solid wastes are process reactors generating spent catalysts & base material; storage tanks (crude oil, intermediates and final products) generating tank bottom sludge; and wastewater treatment plant generating oily sludge and biological sludge apart from domestic wastes from canteen and office buildings. The process wastes generated at petroleum refinery fall in the hazardous waste category SI. Nos. 1, 4, 5, 33, 34 and 35 under Schedule-I (list of process generating hazardous wastes) and class B2 under Schedule-II (list of waste constitutes based on threshold limit concentration) as per Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016.

- During wastewater treatment about 2m^3/d oily sludge and 3m^3/d biological sludge generation is estimated from ETP operation including proposed project. The oily sludge will be stored in HDPE lined sludge pit, bio-remediated and upon complying the TCLP test results only the bio-remediated sludge will be used for land application along with biological sludge.

- Existing MRPL refinery has comprehensive sludge handling/ management facilities within the premises. The oily and biological sludges are thickened, centrifuged in respective systems and stored in impervious sludge pits. So far, about 2000 Ton oily sludge from existing pits has been bioremediated through TERI/IOCL technology within MRPL premises. Presently, the oily sludge is consumed in the Delayed Coker Unit (DCU) at MRPL. Further, possibility of co-processing the oily sludge in Cement industry is being explored.

4. Risk Assessments:

Rapid Risk Assessment has been carried out for the proposed MRPL plant operations for BS VI Auto Fuel Quality Compliance under abnormal conditions. The objectives of the study are to identify the vulnerable zones in the different units of the refinery cum complex; estimation of hazard distances for the scenarios generated due to accidental release of hazardous chemicals through Maximum Credible Accident (MCA) analysis. MCA analysis has been worked out at various wind velocities and atmospheric stability classes to estimate the maximum effective distances in case of partial and Catastrophic rupture scenarios. The Fire & Explosion Indices were computed for the identification and screening of vulnerable sections & consequence analysis was carried out for the accidental release scenarios of hazardous chemicals. The hazards associated with the various units have been identified by the computation of Fire, Explosion and Toxicity Indices (FETI). The units have been categorized based on the FETI into Low, Medium, Heavy and Severe hazards categories.

The overall objective is to compute the extent of damage distance in the event of accidental releases of hazardous chemicals. Damage distances for the accidental release of hazardous materials have been computed at 2F, 3D and 5D weather conditions. In these conditions, 2, 3 and 5 are wind velocities in m/s and F and D are atmospheric stability classes. These weather conditions have been selected to accommodate worst case scenarios to get maximum effective distances. Depending on the physical properties of the material and the operating parameters, the combustion of material in a plant is considered to form scenarios like jet fire, flash fire, pool fire and vapour cloud explosion. DNV based **PHAST 6.51**, software has been used to carry out consequence analysis. The effective distances have been tabulated for heat radiation levels of 37.5, 12.5 and 4 KW/m2 for fire scenarios and overpressure levels of 0.03, 0.1 and 0.3 bar for explosion scenarios.

The effective distances for toxic release scenarios have been computed for Immediate Dangerous Life and Health (IDLH) concentration. Risk mitigation measures for process equipment and storage tanks have been recommended. Specific recommendations for pipelines, storages, Naphtha Splitter Unit (NSU), FCC Gasoline Treatment Unit, Sulfur Recovery Unit (SRU), CCR-NHT, Reformate Splitter Unit (RSU), Diesel-hydrotreater (DHDT), and HCU SWS - 1&2 have also been incorporated. Disaster Management Plan (DMP) have been purposed to give an approach to detail organizational responsibilities, actions, reporting requirements and support resources available to ensure effective and timely management of emergencies. Personal protective equipment according to types of hazards have been tabulated. Mitigative measures for natural disasters viz. earthquake, flood, cyclones and severe storms have been recommended.

5. Environmental Management Plan:

Environmental impacts during the construction phase can be attributed to the site preparation, civil construction, erection & mechanical fabrication, welding operations, waste disposal, non-destructive testing, etc. and provision of civic amenities to the construction

workforce. The potential for environmental impact during construction phase on most of the environmental components, except land use, is temporary, and the environment returns back to its previous status on completion of the construction. However, the land use change and any associated loss of flora, is permanent.

State of the art technology will be adopted for control of pollution during project execution phase, whenever and wherever applicable. Site preparation and construction for the plant shall be undertaken on vacant land of the MRPL complex.The environmental management plan for the construction phase is described below:

- During construction phase, It is suggested that the earthen stock piles may be stabilized depending on requirement to prevent washout during rainy season. During dry weather conditions, it is necessary to control the dust nuisance caused by earth work, levelling and transportation activities (vehicular movement) by water sprinkling (dust suppression).

- During construction if any equipment is found to make abnormal noise, same shall be reported to site engineer and necessary maintenance work shall be done

- Instructions/conditions related to compliance of all prescribed regulatory limits related to exhaust as well as noise generation for all construction machinery and vehicles used by contractors should be included in all bid documents

- Efforts should be made to prevent accidental spillage of any oil from construction equipment. Combustible waste, if any, should be burnt in a controlled manner. Other wastes should be disposed off by adopting environmentally compatible methodology.

- It shall be ensured that, workers working in noise prone area or operating noise producing equipment (e.g., jack hammer, drilling machines etc.) shall wear ear-muff/ ear plugs.

- The runoff water from the construction area shall be channelled through sedimentation tanks to remove suspended solids.

- Suitable water supply and sanitation facilities shall be provided to the labour colonies housing the construction work force. The sanitary waste from these areas shall be accorded suitable treatment measures such as septic tanks & soak pit.

- MRPL shall ensure provision of potable water supply and sanitary facilities etc. to construction workers

- MRPL shall also plan provision of storm water management and rooftop rainwater harvesting facility in the new building and associated facilities as detailed in the subsequent section

- Safety equipment such as earplugs and earmuffs, helmet, face shields, safety goggles etc. shall be provided to workers engaged in high risk areas.

- The medical facility shall be adequate to provide immediate medical aid to the workers and their family members. An ambulance provision to be made to transport injured workers to nearby hospitals and/or MRPL dispensary.

- Development and maintenance of adequate green belt and green cover shall be undertaken.

- Well maintained construction equipment shall be used to minimize the exhaust and subsequent atmospheric pollutants.

- Required fuels, acetylene cylinders, compressed gases, paint materials etc. shall be stored as per accepted safety standards.

- All construction equipment shall be properly maintained and greased to minimize noise generation and vibration.

- Strict instructions will be given to contractor/construction agency to maintain construction vehicles and other materials transport vehicles with minimal pollution with proper/ up to date PUC certification. Vehicles carrying solid raw materials / fuels should be covered to avoid fugitive dust.

- The construction area shall be secured by fencing.

5.1 Operational Phase:

Several control measures are already in place of the process technology to minimize the generation of wastes and subsequent environmental impacts during the operational phase of the existing facilities at MRPL refinery and the similar technologies will be followed by MRPL for the proposed BS-VI project. Strict adherence to these pollution prevention and control measures shall moderate the environmental impacts to the minimum possible level during operational phase. In general, the EMP during operational phase of the plant shall be directed to the following:

- The adequacy of all the pollution control / environment management systems for the proposed project should be ensured as part of main refinery equipment, before the commencement of operation of the project.

- Wherever possible, the control systems shall be interlinked with the operational units, so that failure of the control system shall shut down the respective operational unit.

- Regular performance evaluation of the control systems shall be undertaken to ensure their optimum performance.

- Preventive maintenance schedule of the control systems will be matching with that of the respective operational unit.

- Regular monitoring for various components of environment shall be undertaken to ensure effective functioning of pollution control measures as well as to safe guard against any unforeseen changes in environment.

- Transport vehicles and construction machinery should be checked and properly maintained so as to control air emissions and noise generation and comply the statutory limits (set by CPCB for that vehicle/equipment type and mode of operation)

- Truck parking area and the approach roads should be paved to reduce fugitive/entrainment dust emissions.

- Personnel Protective Equipment (PPE) like dust filters gasmasks, earplugs/earmuffs etc. should be provided to construction workers with strict instructions to use the same when they are on duty.

- The solid waste generated should be collected and disposed in an appropriate manner at identified landfill site or composted.

- The hazardous materials such as lubricating oils, compressed gases, paints and varnishes, radioactive materials etc. as required shall be stored at existing construction warehouses as per the prescribed safety standards.

- The health checkups (diagnostic) for all employees at the refinery complex shall be undertaken at regular scheduled intervals along with maintenance of the respective health records. Work force deployment on rotation basis may be implemented, if necessary, at any particular unit.

6. Post-Project Monitoring:

The environmental quality-monitoring program will be carried out in the impact zone with suitable sampling stations and frequency for environmental parameters with respect to different environmental components. Conventional parameters will be monitored by MRPL and analyzed at MRPL's NABL approved laboratory and also other laboratories approved by MoEF/NABL will be consulted for third party study. For conventional pollutants, the standard methods prescribed in "Standard Methods for Water and Wastewater Analysis" published by APHA (American Public Health Association), AWWA (American Water Works Association) & WPCF (Water Pollution Control Federation) will be adhered with and will be followed procedures prescribed by KSPCB/CPCB. The schedule, duration and parameters will be monitored as per KSPCB/MoEF directives and the table .e showing environmental parameters proposed to monitor are given in **Table 3**.

- Environment Management Cell of MRPL will be also be responsible for all environment management activities including environmental monitoring, greenbelt development, ensuring good housekeeping, ensuring statutory compliance as well as creating environmentally aware work forces for proposed project. The cell will form short term & long term plans for environmental issues, which require monitoring and effective implementation.

- Compliance to statutory provisions, norms of State Pollution Control Board, Ministry of Environment and Forests and the conditions of the environmental clearance as well as the consents to establish and consents to operate will be ensured.

7. Project Benefits:

- This project aims to improve the quality of MS and HSD to meet the BS VI quality requirement with reference to sulfur content, which is limited to a maximum of 10 ppm as per the policy of Government of India for producing BS VI auto fuels. The use of such low sulfur fuels will reduce the environmental and health impacts and overall improve the ambient air quality of our nation.

- The proposed project has a potential for employment of skilled, semi-skilled and unskilled employees during construction phase. The proposed project would generate indirect employment opportunities as daily wage labours during construction, transportation activities, supply of raw materials, auxiliary and ancillary works. It is assessed that the entire construction phase may see upto 5000 people of various skill categories at different stages, concurrently or sequentially

- The project will contribute additional revenue to the State and Central exchequer in the form of royalty, cess and other taxes etc.

- The CSR activities will strengthen the bond between the project authorities and the local population in the vicinity. MRPL will follow the planned activities related to community welfare such as Education, Health, Community Welfare, Ecology and Environment under CSR.

8. Conclusions:

The proposed project aims to improve the quality of MS and HSD to meet the BS VI quality requirement with reference to sulfur content, which is limited to a maximum of 10 ppm as per the policy of Government of India for producing BS VI auto fuels. The use of such low sulfur fuels will reduce the environmental and health impacts and overall improve the ambient air quality of our nation. To meet the low sulfur fuels production (meeting BS VI fuel specifications for MS and HSD), an advanced sulfur recovery unit and desulfurization unit (along with associated systems) will be used. The supply of BS VI quality MS and HSD will greatly help to reduce sulfur emissions by vehicular traffic which otherwise have a significant human health impacts. This is the primary benefit of the proposed project. The state of the art technology will be adopted for the proposed new facilities and the existing facilities will be continued to be operated at optimal level of efficiencies, to maintain the present status of the environment quality, and appropriate control/mitigation measures in practice will be followed for environmental management during construction and operation phases. It is concluded that the project will not have significant negative impact on environment. All emissions, discharges and disposals will be in conformity with the statutory norms. Further, in view of creation of direct as well as indirect additional employment opportunities during construction and operation phase, the project would have positive impact on the economy of the area, the state, the nation and the company.

Table 1: Product Slate of MRPL

Material	Considering processing of 15.25 MMTPA* Crude Oil
LPG	0.90
Naphtha	1.83
Motor Spirit	1.05
Kerosene	0.24
ATF	1.10
Diesel	6.83
Fuel Oil	0.42
Bitumen	0.30
Sulphur	0.23
Mixed Xylene +A7 + A9 streams	0.37
Pet Coke	0.89
Polypropylene	0.44
Fuel & Loss	2.00

* Product yield are based on the gross crude rate of 15.25 MMTPA

The net crude is 16.6 MMTPA which includes gross crude of 15.25 MMTPA+ LSHS import as fuel of 0.41 MMTPA+LNG as fuel of 0.34 MMTPA+ 0.6 MMTPA of Naphtha as feed to the new Naphtha splitter unit.

Product yields are estimated based on typical crude mix, the actual product yield may vary as per the crude assay.

Table 2: Resources Utilized during 2015-16 in the MRPL Refinery

Sr. No.	Resource	Quantity
1	Power Generation at MRPL	11,17,712 MWH
2	Purchased power from Power Grid	13103 MWH
3	Power required for ton of crude	0.0728 MWH
4	Water required per ton of crude processing	0.901 GPD
5	Crude oil processed	15.53 MMTPA

Table 3 :Environmental Monitoring

Sr. No.	Environmental Component	Parameters to be Analyzed
1.	Meteorology	Wind Speed, Wind direction, Temperature, Relative Humidity, Rainfall
2.	Ambient Air Quality	Parameters as per MoEF Notification 2009
3.	Stack Emission	SO_2, NO_X, NH_3, CO
4.	Water quality of surface and ground water	Physical and chemical parameters as per KSPCB norms
5.	Liquid effluents	Parameters as per KSPCB consent
6.	Noise	Sound Pressure Levels (Leq) as per the CPCB guidelines.
7.	Coastal/Marine Monitoring	Sediment, water, flora, fauna etc. as per directives of KSPCB