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Abstract :

Chennai Matropolitan Water Supply & Sewerage Board has planned to augment the water supply to Chennai city by setting up a 100 MLD Seawater Desalination Plant in Kattupalli village, near Minjur, north Chennai

This report presents the supplementary information on the environmental studies relating to the terrestrial aspects, viz., i) socio-economic aspects, ii) air environment, iii) water environment, iv) noise environment, v) flora & fauna, vi) risk analysis, and vii) environmental management plan.

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EXECUTIVE SUMMARY

Chennai Metropolitan Water Supply & Sewerage Board has planned to augment the water supply to Chennai city by setting up a 100 MLD Seawater Desalination Plant in Kattupalli village, near Minjur, north Chennai. The project has been awarded to Special Purpose Vehicle (SPV) named as Chennai Water Desalination Limited (CWDL) constituted of IVRCL Infrastructures & Projects Ltd., Chennai and BEFESA Construccion y Tecnologia Ambiental, S.A., Spain.

The project envisages ultimate delivery of 100 MLD (million litre per day) of water. The scheme comprises of: i) drawl of 237 MLD of sea water from the Bay of Bengal through intake pipeline, ii) pre treatment of intake water, iii) desalting seawater through Reverse Osmosis, and iv) discharge of 137 MLD of brine reject into the sea through submarine pipeline and outfall diffuser.

The present report involves supplementary information on the environmental studies relating to the terrestrial aspects, viz., i) socio-economic aspects, ii) air environment, iii) water environment, iv) noise environment, v) flora & fauna, vi) risk analysis, and vii) environmental management.

The socio economic study covers the project area the core zone (project area) and the buffer zone (5 km radius). Base line data and relevant information on socio- economic environment has been collected from 2001 census record and substantiated with field surveys.

Based on the 2001 census, the population and literacy levels are evaluated. The village wise population, literacy level and occupational structure are presented. Most of the villages depend on the ground water sources like open wells and bore wells. Educational facilities upto primary school levels are available in all the villages. Secondary schools with better educational facilities are available at nearby hamlet in Minjur. All the villages are electrified. The salt pans , fishing, collection of fire wood, collection of dead sea shells etc. provide employment for the local population.

The project will provide employment potential temporarily for about 125 persons. Besides, improvement of access roads with connected civil works, will give indirect benefit to many local people. Overall, the construction phase will bestow a positive impact on the area. During the operational phase, the project will provide permanent employment for about 30 people. Further it will provide direct and indirect employment for about 200 persons on account of contractual job as well as auxiliary services like maintenance of pipes, equipments etc. There will be no adverse impact on surrounding population on factors like culture, religion, etc.

The parameters on: Suspended Particulate Matter, Sulphur Dioxide, Oxides of Nitrogen, and Respirable Particulate Matter were analysed in the study area. The existing Ambient Air Quality for SO_2, NO_X, SPM & RPM are very low due to absence of any major polluting source in the region and within the prescribed CPCB limits. Air pollution monitoring schedule has been suggested to aim at regular and systematic study of ambient air quality.

Buckingham canal flowing west of the site is the nearest surface water body in the region. This is a drainage channel and water of Buckingham canal is not used for potable purpose. The general ground water quality in the project area at shallow depth of say 20 to 30 feet is comparatively good. However, the quality deteriorates and becomes saline at greater depth.

Water samplings were done at 2 locations viz., Open well at Kalanji village and W2 – Borewell inside the proposed plant premises. The ground water sample from the shallow well is found to be good when compared to IS10500 for ground water sources. The water sample from the bore well shows that the Total dissolved solids, total hardness, chlorides, sulphates, are generally higher than the limits.

Noise survey was carried out in and around the project site for assessing baseline status. It is seen that the ambient noise level in Kattupalli village varied from 36.40 to 53.40 dB(A) and in Kalanji village from 35 .90 to 50.10 dB(A) . The present noise levels in all the observed locations are within the limits prescribed. Suitable measures are suggested for minimizing the noise levels during the construction as well as operation stage.

The land use of the study area is presented. The Buckingham canal occupies major part of the area. Numerous salt pans are located in the Swampy area near Buckingham canal. The inlands in the buffer zone comprises of sparsely populated villages namely kattupally, kalanji, Uranamedu, Sanganimedu, sand hills, scattered trees. Casurina and cashew are predominantly seen at many places. Besides, Ain (Terminalia tomentosa , Bibla (Semicarpus anacardi), Karanji (Pongamia glabra) etc, are also seen. Grasses like Eragrostic sp. Dieanthium anulakum are commonly present. Agricultural activities are totally absent due to poor soil condition. There are no reserve forest or protected forests within the area.

In the study area, fauna common to rural India such as hare, jackals, monkeys, langoors, pigs, etc and several species of birds and reptiles are present. No rare or endemic species are generally observed. The green belt or plantation around the facility is proposed to mitigate fugitive emissions. It also helps to keep the area cool. By this way about 22.5 ha of the land can be covered under plantation.

Detailed risk analysis for the project has already been separately studied. The salient findings of the risk analysis indicate: a) The proposed plant consists of units mainly for treatment of sea water and uses the common chemicals being used in water treatment, b) No other chemical or hazardous reactions/processing is involved, ci) The main risk arising from the setting up the desalination plant is therefore only due to the accidental dispersion of residual chlorine (from hypochlorite tank), d) The consequence analysis have shown that all the hazards will be mainly confined on site and will have limited off-site bearings, e) The worst case scenario for on-site is the leak of continuous chlorine from the storage unit, e) The maximum distance, which needs to be delineated as a potential, danger zone is about 242m from the source of leak in the windward direction, f) However, it will not reach any population centers as the desalination plant is located in an uninhabited site surrounded by vacant barren lands. The nearest villages are on the upward(SW) directions at more than 1500m of the site. Hence in the event of chlorine release from the plant, the off – site impact will be very limited, g) It can be observed that the risk at the desalination plant is comparable to criteria as used in some developed countries. When compared to a risk to an average motorist, the risk at this unit would appear to be ten to hundred times lower.

In view of the aforesaid details, like incorporation of latest technological inputs with sophisticated equipments and control systems into the process design, pre project environmental status, predicted impacts due to the project operations and timely implementation of various environmental control measures to reduce the adverse effects due to the project operations, it will be seen that the advent of the project will give a big boost to this economically and socially backward region by way of creation of better employment potential, better educational and medical facilities, better aesthetical outlook of the area due to elaborate green belt development and better communicational facilities.

1. INTRODUCTION

1.1. GENERAL

The rapid growth of Chennai city with increasing trend in industrialization and economic development, demands the immediate augmentation of drinking water source for the long depleted water supply. Chennai Metropolitan Water Supply & Sewerage Board (CMWSSB) has planned to augment the water supply to Chennai city by setting up a 100 MLD Seawater Desalination Plant in Kattupalli village, near Minjur, north Chennai. The scheme has been proposed on Design, Build, Own, Operate and Transfer (DBOOT) basis under twenty five years license. The project location identified for development is shown in Fig. 1. The satellite imagery depicting the project region is shown in Fig. 2. The project has been awarded to Special Purpose Vehicle (SPV) named as Chennai Water Desalination Limited (CWDL) constituted of IVRCL Infrastructures & Projects Ltd., Chennai and BEFESA Construccion y Tecnologia Ambiental, S.A., Spain.

The project envisages ultimate delivery of 100 MLD (million litre per day) of water with a TDS not exceeding 500 ppm. The scheme comprises of: i) drawl of 237 MLD of sea water from the Bay of Bengal through intake pipeline, ii) pre treatment of intake water, iii) desalting seawater through Reverse Osmosis, and iv) discharge of 137 MLD of brine reject into the sea through submarine pipeline and outfall diffuser.

As the project is directly related to marine environment, a detailed Marine Environmental Impact Assessment report comprising of various proposed activities in the marine environment, base line environmental condition, impacts due to development, mitigation measures and Marine Environmental Management Plan has been prepared separately and submitted.

The present report involves additional information on the environmental studies relating to the terrestrial aspects, viz., i*) socio-economic aspects, ii) air environment, iii) water environment, iv) noise environment, v) flora & fauna, vi) risk analysis, and vii) environmental management.*

The objective are aimed: i) evaluate the existing environmental status of various environmental parameters, ii) identify the possible impacts due to the proposed desalination **plant, iii) suggest** proper mitigation measures to minimize the impact, and iv) devise a suitable environmental monitoring scheme and identify an Environmental Management Plan.

For the purpose of this study, the area has been divided into two zones, namely, the *core zone* and the *buffer zone*. Core zone represents the entire project area of about 60 acres, while the buffer zone encompasses the surrounding area lying in 5 km radius from the center of the project area.

The Ministry of Environment and Forests (MoEF), Government of India, has classified the coastal zone into four categories, namely, Coastal Regulation Zone (CRZ) I, II, III and IV. In strict consonance with above stipulation, all construction activities in the desalination plant are planned beyond 200 m from the HTL.

1.2. GEOGRAPHICAL LOCATION

The desalination plant is proposed to be located near Kattupalli village at Ponneri Taluk, Thiruvallur district, Tamil Nadu. The site falls part of the Survey of India Toposheet No 66 C/7, ant it is located approximately at Latitude $13^{0}19'06''$ N and Longitude $80^{0}20'17''$ E. It lies 4 km north of Ennore Port and 22 km north of Chennai. Athipattu is the nearest rail head and tThe area is approachable from the North Chennai Thermal Power Station (NCTPS) – Ennore Port road, through Chennai – Manali – Minjur road. The location plan is given in Fig 3.

1.3. TOPOGRAPHY & DRAINAGE

The project area is spread over 60 acres and it forms as coastal plain with sandy soil and sparse vegetation. The general slope of the area is from northwest to southeast. The area is bounded by Bay of Bengal on the east. Buckingham canal is flowing on the west.

1.4. CLIMATE

Climate of the region is subtropical without any extreme variation in temperature. The average annual rainfall is 1330 mm, out of which the maximum precipitation (70%) occurs during the northeast monsoon period (October to December). The intensity of rainfall is maximum November and minimum in March. The air temperature remains high (35^{o}C to 37^{o}C) in summer from May to July and occasionally it rise more than 40^{o}C. The air temperature remains relatively low (22^{o}C to 30^{o}C) in winter from December and January. However the minimum temperature does not drop below 15^{o}C.

During April, May, June and December, the monthly mean wind speed prevails around 10 -11 knots and during the remaining months between 7 and 9 knots. During April to September, the morning wind mostly prevailed from SW and W, and during November to February, it mostly prevailed from NW. The wind patterns during morning hours and evening hours show the influence of land-sea breeze system in this region. During the days of depressions and cyclones, the wind speed commonly exceeds 50 kmph.

2. PROCESS DESCRIPTION

The proposed desalination plant envisages a product water of 100 MLD and the scheme comprises of: i) drawl of 237 MLD of sea water from the Bay of Bengal through intake pipeline, ii) pre treatment of intake water, iii) desalting seawater through Reverse Osmosis, and iv) discharge of 137 MLD of brine reject into the sea through submarine pipeline and outfall diffuser. The plant layout is shown in Fig. 4. The process flow sheet indicating the salient details and the plant layout is shown in Fig. 5.

2.1. INTAKE

The intake is designed to draw seawater having the ambient salinity of around 35 PSU (**P**ractical **S**alinity **U**nit *equivalent to* ppt - **p**arts **p**er **t**housand), at the rate of 237MLD through an intake system. The water will be drawn from the Bay Bengal to the Plant through a gravity flow. The intake head will be located at 9 m water depth at a distance of 589 m from the shore. The intake and outfall layout is shown in Fig. 6.

2.2. PRE TREATMENT

Physical treatment

Disinfection

The untreated water will be chlorinated by applying a dose of sodium hypochlorite in the underwater intake channel and in the pump aspiration chamber. After the dose of chlorine has been applied, an ORPT gauge equipped with alarms will indicate the oxidation level obtained following chlorine injection.

Coagulation & Flocculation

In order to eliminate suspended matter and colloids present in the sea water, a dose of ferric chloride (coagulant) will be applied, enabling the formation of flakes. Flocculation will take place

immediately in three chambers (428 m^3 each unit), with the addition of polyelectrolyte. Suspended solids will be eliminated in three gravity settlers (1450 m^3 each unit).

Filtration

The seawater is filtered in two stages in order to eliminate remaining suspended solids and organic matter: the first stage consists of filtration through the sand filters; and the second stage consists of filtration through the anthracite filters at a faster speed. The sand filters will be single-bed filters, with two layers of silica sand, one with a sand height measuring 300 mm and an effective dimension of 2 mm; and another with a sand height measuring 1000 mm and an effective dimension of 0.9 mm. A static mixer will be installed before the sand filters in order to facilitate and complete the mixing of previously-metered chemical products. The horizontal cylindrical filters will be assembled in parallel formation, so that the discharge is distributed between all of them, in the normal operation process.

The nozzles of the sand filters are examined in order to prevent sand from escaping and ensuring that load loss is reduced to a minimum. A total of 50 nozzles per square metre of filtering surface will be installed. The nozzles are made from plastic material that is resistant to sea water and cannot be degraded by it. In the second filtration stage, similar filters will be used.

Chemical treatment

Sulphuric acid Dosing

Sulphuric acid dosing equipment is designed to reduce the pH of sea water and prevent precipitation of carbonates and bicarbonates, as well as to generate sufficient CO_2 for post-treatment with dolomite. The installations consist of storage tanks, transfer pump and one metering pump per line, plus one reserve pump. The reduction of pH makes the bactericide action of the chlorine more effective. The injection points of these products may be located at the outlet of the sea water pumps.

Sodium bisulfite dosing

Sodium bisulfite product is added in order to eliminate residual chlorine from the dose of sodium hypochlorite. The equipment consists of two preparation tanks and one metering pump per line, plus one reserve pump. The product is added on line in order to provide the longest contact time possible.

Antiscalant dosing

Since sea water is concentrated in the membranes, and in order to prevent the precipitation of ferric hydroxide, calcium fluoride, calcium sulphate and strontium sulphate salts, an antiscalant will be metered to prevent the formation of crystalline networks, by maintaining the dispersed ions and enabling the limit of the solubility product of these salts to be exceeded. The product is added on line and before the RO system.

Ultrafiltration

Due to the characteristics of raw water, and in order to prevent fouling in the reverse osmosis membrane, an ultra filtration unit will be installed. It consists of 26 modules containing 88 modules each. The working pressure is established at maximum 2 bar. Auxiliary equipment for backwash and chemical cleaning is also provided.

2.3. REVERSE OSMOSIS

High-pressure pumping

As mentioned previously, the pumping and energy recovery equipment consists of high-pressure pumps, a unit for recovering energy from the brine with hyperbaric or compression chambers, and recirculation or booster pumps to increase the pressure of the rest of the water transferred in the direction of the membranes. The aim of the pressure groups is to provide the necessary pressure to overcome the osmotic pressure of the raw water and system pressure drops.

The water discharged from the reverse osmosis modules is used to feed the hyperbaric/compression chambers, thus achieving maximum energy economy. The high-pressure pumping equipment consists of the same number of motor-pump groups as lines, each group provides the total discharge that must be treated by each line. One complete non-installed group will also be kept in reserve. This reserve group will be available to replace any of the other groups. This reserve group is connected to the collector which feeds the chassis of the R.O. modules, so that any one of the motor pump groups can be replaced in normal operating conditions.

Reverse Osmosis Train

Spiral wound membranes will be used. Seven (7) membranes of each type are placed in the pressure vessel. The proposed design consists of one pass and one stage. System recovery is established at 45%. Number of trains is established at 5 units for 100 MLD output. A differential pressure gauge is placed between the feed water and the brine, with a high-pressure alarm and on-screen recording unit. The differential pressure indicates when and to which extent the membranes have been fouled. Each general produce water collection pipe will be connected to the product tank. A three-way valve will be installed at the product outlet of each pressure vessel for sampling purposes. A panel for each train will also be provided.

Booster Pumps

The hyperbaric/compression chambers supply part of the feed water to the membranes until a slightly lower pressure results to that achieved by the brine. These recirculation pumps are used to increase this pressure to the membrane feed.

Energy recovery system

As mentioned previously, brine energy is recovered at the outlet of the membranes by means of hyperbaric/compression chambers. This system is used instead of Pelton-type turbines because of its greater energy performance. These chambers comprise cylinders with internal pistons that enable brine to be separated from the sea water, whenever you want to increase pressure. Sea water enters on one side and when the cylinder is full, the brine enters from the other side and, due to its high pressure, exerts pressure on the sea water and displaces it; when the sea water is to be displaced, a valve opens on the brine side to be discharged, sea water enters on the other side, thus repeating the cycle. Since a piston separates the brine from the sea water, the mixing of the two is minimal, less than 1.5 %. The performance rate of the chambers is 95.4%.The cylinders will be made of stainless steel and wet surfaces will be covered with HDPE (High Density Polyethylene). The rest of the pipes and sets of valves will be made of AISI 904 L-class stainless steel. Due to the large number of chambers installed in parallel formation, there are no flow or pressure fluctuations.

2.4. POST TREATMENT

Treated water tank

The produced water will be stored in a 20,000 m^3 tank .The dolomite saturation towers will be installed on the tank. Since the water is treated before entering the tank of the unit, an auxiliary 200 m^3 tank will be available for internal usage.

Disinfection of produced water

Before the produced water is transferred to the network, it will be treated with dolomite in order to increase its pH level to a value between 6.5 and 8.5 and to maintain the LSI (Langelier Saturation Index) between 0 and 0.4. Sodium hypochlorite will also be used in order to achieve residual chlorine around 0.5 ppm.

Adjustment of the pH of produced water

The pH levels will be adjusted to between 6.5 and 8.5, as established in the Specifications, by means of treatment with dolomite. Dolomite reacts with the CO_2 produced during treatment of make-up water with sulphuric acid, thus increasing water alkalinity and hardness. Two towers will be built for treating produced water with dolomite; like counter-flow filters, these towers will be placed on the produced water tank.

Auxiliary services

Besides various auxiliary services like membrane cleaning equipment, neutralisation and emptying system, flushing system, filter cleaning equipment, service water network, instrumentation, service air supply, fire prevention system, communication systems, laboratory services, workshops, control system, etc will also be provided in the plant.

2.5. CIVIL ENGINEERING

All necessary buildings will be constructed to house decanter and sea water cabins, process requirements, control room, laboratory, electrical services , work shop and store, offices and staff area, etc. State of art latest technological systems and equipments will be deployed in the project to achieve desired objectives.

2.6. BRINE DISCHARGE PIPE

The brine rejects of the order of 137 MLD with a salinity of 70 PSU are released into the sea, using HDPE submarine pipelines of 1 x 1400mm dia and diffuser ports outfall system, which has been designed to have maximum mixing in order to attain ambient salinity within a short distance. The typical outfall diffuser is shown in Fig. 7. A detailed mathematical model study has been done and a separate report has been submitted on the design of diffuser and ports, initial dilution, and a secondary diffusion. As the latest technological inputs and state–of-art instrument and equipments are inbuilt into the process system, there will be practically no negative impacts on the environment due to the project.

3. SOCIO-ECONOMIC ENVIRONMENT

3.1. EXISTING SOCIO-ECONOMIC ENVIRONMENT

The proposed desalination plant and the related project activities would entice more positive impact as well as marginal adverse impacts on the socio economic front. Keeping this in view, the existing socio-economic setup of the area has been studied in order to predict the likely impacts and to suggest a mitigation measures for minimizing adverse impact, if any. The socio economic study covers the project area the core zone (project area) and the buffer zone (5 km radius). Base line data and relevant information on socio- economic environment has been collected from 2001 census record and substantiated with field surveys.

Core zone

The total project area of the desalination plant comprises of 60 acres. It is a barren land and it belongs to TIDCO, Government of Tamilnadu. The land has been leased for construction by TIDCO. There are no habitations in this designated area and no rehabilitation is involved.

Buffer zone

The buffer zone of the proposed project, encompassing 5 km radius from the center of the core zone, consists of 6 rural villages namely Kattur, Karugali, Kalanji, Kattupalli, Voyalur and Puzhidivakkam of Ponneri Taluk from Tiruvallur district. The details of villages falling in the study area are given in the Index plan in Fig. 8.

Based on the 2001 census, the following details are gathered.

- There are 2660 households in the buffer zone.
- The Total population works out to 10979 of which 5464 (49.77%) are male & 5515 (50.23%) are female.

- There are 3998(36.42%) people belonging to Schedule caste, of which 1986(18.09%) are male & 4175(18.33%) are female. The total schedule tribe's population works out to 135 (1.23%) and in this 69 (0.63%) are male & 66 (0.60%) are female.

- Of the total population, there are 6046 (55.07%) literates of which 3495 (31.83%) are male and 2551 (23.24%) are female.

- About 29.77% of the total population are Main workers , 11.40% are Marginal workers and the remaining 58.83 % are non-workers.

- Cultivators and the agricultural laborers contribute about 62.18% of the total Main workers.

The demographic structure within the buffer zone is represented diagrammatically in Figs. 9 to 11. The village wise population, literacy level and occupational structure details are given in Tables 1 and 2.

Basic amenities

The project area, upto Ennore port is connected by good metal road and there after for a reach of 4 km till the site is connected by Kutcha road. Surrounding villages are well connected by metal road.

- Most of the villages depend on the ground water sources like open wells and bore wells.
- Educational facilities upto primary school levels are available in all the villages. Secondary schools with better educational facilities are available at nearby hamlet in Minjur.
- All the villages are electrified. Electricity is used for domestic purpose.
- Due to saline nature of the soil, agriculture is not conducive in this region.
- The salt pans , fishing, collection of fire wood, collection of dead sea shells etc. provide employment for the local population.

3.2. IMPACT ON SOCIO-ECONOMICS

The socio-economic impact due to the project during construction and operational phases are enlisted below.

Construction stage

During the peak construction phase, about 100 unskilled and 20 skilled workers are expected to be employed. Since it is expected that the project developer will employ local people during construction, the people from nearby villages are expected to migrate close to project site for the job opportunity. But such migration will be purely temporary and will prevail only during construction phase. These temporary workers have to be provided with basic necessary facilities like temporary shelters, drinking water, fuel, sanitation and garbage disposal, food supply, fire fighting etc. Accordingly, the need for felling fire woods for cooking purpose will not arise. Hence, the hygienic status of the area will not be disturbed.

During the construction activities, preference will be given for the local population only. Hence, there will be less migration and there will not be any adverse impact on the host community.

As all the safety and health protection measures will be strictly followed during construction phase, no occupational health or safety problems are envisaged.

The existing Kutcha road will be laid as metal road and lighting facilities will be erected along the roadside during the construction stage itself. Hence, better access facilities to the area will be created for the surrounding population of the project site, particularly for the people at Kattupalli and Kalanji villages.

Looking to the above factors, the project will provide employment potential temporarily for 125 persons. Besides, improvement of access roads with connected civil works, will give indirect benefit to many local people. Overall, the construction phase will bestow a positive impact on the area.

Operational phase

During the operational phase, the project will provide permanent employment for about 30 people. Further it will provide direct and indirect employment for about 200 persons on account of contractual job as well as auxiliary services like maintenance of pipes, equipments etc.

Besides, the project will provide about 100 MLD of potable water to Chennai city, catering to the needs of nearly 2.5 million people.

The project operations are limited to production of clean water directly involving about 30 persons only. The staff will be housed mostly at developed locations like Chennai, Minjur etc. Looking to the sparse personnel absorption in the project, there will be no adverse impact on surrounding population on factors like culture, religion, etc.

3.3. IMPACT ON MARINE COASTAL COMMUNITY

Along the eastern side of the project area lies the sea and adjoining beaches, which are free from habitation and any dwellings. There are no boat beaching locations. No mechanized fishing boats are anchored in this region. The Kattupalli kuppam, which is the nearest small fisherman hamlet is situated more than one kilometer away from the project site and thus will not be affected by the project operations. The main occupation of the people in this hamlet is fishing in deep sea only.

As mentioned earlier, there will be sea water intake pipe lines for the drawl of sea water and an outfall pipeline for discharging the brine rejects into the sea. Installation of sub marine pipelines, intake head and outfall diffuser in the sea will not have any adverse impact on the marine organisms, fishing, boating operations due to inbuilt design factors as shown below:

a) The top of the intake and outfall heads will be kept well below the sea surface so as not to cause obstruction to the movement of boat and craft.

b) Marker buoys placed close to intake and outfall can help the boats to divert and avoid collision.

c) The pipeline will be buried or allowed for natural burial in sea floor so that it will not cause any hindrance to fishing and navigation.

d) The intake head is designed in cylindrical form to avoid interference with current. The intake head will be designed with small openings with velocity cap and trash bars to minimize the entry of small marine organisms, fishing larvae etc.

e) The outfall diffuser are designed with appropriate number of ports which can increase the mixing of brine discharge so that it attains the ambient salinity within a short distance and time.

In view of above well planned control measures to avoid any impact on the marine front, the overall effect due to project advent is bound to be positive.

On the otherhand, the local fishermen community and others are bound to get the following positive socio economic benefits:

a) Direct employment opportunities during construction stage, during laying of inlet and outfall pipelines, by the way of hiring of boats etc.

b) Direct and indirect employment opportunity during the operation stage of the plant.

c) Improvements of the local amenities like better approach roads, communication, electricity, water supply, educational & recreational facilities, hospitals/ dispensaries, etc. which will bring the basic comfort to the local society.

d) Improvement in the general living standards and knowledge sharing.

e) Improvement in child welfare and education.

f) Improvement in the wage level and the living standard of the local as a result of higher earnings, and

g) Improvement in the economic growth in the region.

Besides, the project implementation will augment the water supply capacity to Chennai City for about 2.5 million people on the basis of 40 litres per day. This is a great boon for the water starved city.

In view of the above facts, it can be concluded that the advent of this project will result in a net positive impact on the socio economic front of the local population due to improvement in the social status of the area and the economic benefits derived from this project.

4. AIR ENVIRONMENT

4.1. EXISTING AMBIENT AIR QUALITY

Air pollution is emanated basically due to the presence of foreign substances in air. The principal objective of the Ambient Air Quality Monitoring (AAQM) is to assess the existing levels of air pollution as well as the regional background concentration surrounding the site.

The ambient air quality depends upon the emission scenario, meteorological conditions and the background concentration of specific contaminants. The study of the baseline ambient air quality data in the area is an essential. It is a primary requirement for assessing the impact on air quality due to the proposed activity and also to enumerate the potential environmental changes likely to occur when the project is commissioned.

The following parameters were analysed at the sampling locations established in the study area.

- Suspended Particulate Matter
- Sulphur Dioxide
- Oxides of Nitrogen
- Respirable Particulate Matter

Design criteria for ambient air quality monitoring study network

As previously described, the morphological formation of the site is a plain coastal area with sandy soil and sparse vegetation. Due to proximity of sea, the soil is saline and no agricultural activities are possible in the area. The Ennore port is about 4 km south of the site and the North Chennai Thermal Power plant is about 6.5 km south of the plant.

Two ambient air quality-monitoring stations were selected based on the proximity of the habituated villages to the plant, wind directions and other logistics of setting up the necessary monitoring instruments at the required locations. The relative directions and distances of these stations with respect to the project site and details of these stations are described below.

Location	Place	Distance from Core Zone (Km)	Direction
A_1	Kattupalli village	1.5	S
A_2	Kalanji village	2.0	N

Method of sampling

Standard Monitoring and Analysis procedures were adopted for determining the Air quality parameters. The methodology adopted is briefly described here under:

Suspended Particulate Matter / Respirable Particulate Matter	-	Gravimetric (RPM sampler)
Sulphur Dioxide	-	Calorimetric (Modified West & Gaeke Method)
Oxides of Nitrogen	-	Calorimetric (Modified Jacob & Hocheiser Method)

The SPM, RPM, SO_2 and NO_x are monitored on 24 hourly basis as per CPCB (Central Pollution Control Board) guidelines.

Data Analysis

The Ambient Air Quality data for SO_2, NO_x , SPM and RPM are presented in Fig. 12. It is seen that , the SO_2 levels in the studied locations ranged from 6.0 mcg/m^3 to 9.0 mcg/m^3. The NO_x concentrations varied from 8.0 mcg/m^3 to13.0 mcg/m^3. In case of SPM, the values varied from 58.0 mcg/m^3 to 76.0 mcg/m^3 , while the RPM values varied from 19.0 mcg/m^3 to 22.0 mcg/m^3.

The existing Ambient Air Quality for SO_2, NO_X, SPM & RPM are very low due to absence of any major polluting source in the region and within the prescribed CPCB limits.

NATIONAL AMBIENT AIR QUALITY STANDARDS FOR RESIDENTIAL AND RURAL AREA – MCG / M^3 (refer Appendix 1)	SO_2	NO_X	SPM	RPM
	80	80	200	100

4.2. IMPACT ON AIR QUALITY:

The study shows that the existing ambient air quality parameters are within the prescribed limits. The potential impact on the air quality due to the proposed desalination plant both during construction phase and operation phase are enumerated below.

Construction stage

There will be minor variation in air quality parameters, during construction of plant, due to transport of vehicles, storage and handling of construction materials, other construction activities, etc. due to generation of fugitive dust emission and vehicular emissions. However, this minor impact on the air environment expected during construction, will be practically minimized with the environmental management plan.

Operation stage

This is a fully water related desalination plant, devoid of any chemical process, vehicular emissions, burning of fuels or any other process proceeds related to affecting air quality. All the motors and pumps will be electrically driven. Hence there will not be any gaseous emission. Therefore impact on air quality is not envisaged during operation phase.

4.3. MANAGEMENT PLAN – AIR ENVIRONMENT

Construction stage

a) Only vehicles meeting vehicular pollution standards will be allowed for the construction activity and within the site.

b) All vehicles and construction equipment with internal combustion engines in use will be maintained for effective combustion to reduce gaseous emissions.

c) As far as possible unleaded petrol will be used for possible vehicle in use.

d) Water will be sprayed by high pressure water hoses during dust generating construction activities like excavation, material handling, etc to suppress dust.

4.4. MONITORING

The following monitoring schedule is suggested to aim at regular and systematic study of ambient air quality.

Parameter:

Sulphur di oxide (SO_2), Oxides of Nitrogen (No_x), Suspended Particulate Matter (SPM), Respirable Particulate (RPM).

Frequency of Monitoring: *2 days in a month / quarter on 24 hrly basis in each location.*

Location: *2 locations namely Kattupalli village, Kalanji village.*

The monitoring can be done by any reputed external agencies or departmentally. In case the project proponents proposes to carry out regular monitoring departmentally, the equipments needed may include the following:

a) High Volume Air sampler with RPM attachment, Photo colorimeter/ Spectro photometer, Electronic Weighing balance, Desiccators, Glass wares, etc.

b) Wind anemometer, Wind direction finder, Wet and dry bulb thermometer, Pressure gauge and Rainfall gauge for meteorological studies

5. WATER ENVIRONMENT

5.1. EXISTING WATER ENVIRONMENT

Buckingham canal flowing west of the site is the nearest surface water body in the region. This is a drainage channel and water of Buckingham canal is not used for potable purpose. The general ground water quality in the project area at shallow depth of say 20 to 30 feet is comparatively good. However, the quality deteriorates and becomes saline at greater depth.

Sampling locations

The following water sampling locations were selected for water analysis.

W1- Open well at Kalanji village
W2 – Borewell inside the proposed plant premises.

Five different samples were drawn from the bore well within the plant premises (W2) namely,

i) 40m depth sample collected at starting time.
ii) 40m depth sample collected after 1 hour
iii) 40m depth sample collected after 2 hours
iv) 15m depth sample collected at starting time, and
v) 15m depth sample collected after 11/2 hours.

Data Analysis & Interpretation

The water quality of the well at Kalanji village is as follows:

pH	7.2
TDS	566mg/l
TSS	2.5mg/l
Chlorides	77.8 mg/l
Total hardness	192mg/l
Total alkalinity	132 mg/l

The ground water sample W1 is found to be good when compared to IS10500 for ground water sources. This is mainly due to shallow nature of the well .

The water quality of 5 samples collected from location W2 is given in Table 3. From the Table , it is seen that the Total dissolved solids, total hardness, chlorides, sulphates, are generally higher than the limits. It is also observed that these values increase with the depth of water as pumping time increases.

5.2. IMPACT ON WATER ENVIRONMENT & MANAGEMENT PLAN

Construction stage

During the project construction stage, water will be required only for construction activities and for potable use of the manpower. This requirement will be met by procuring water from the outside source and as such there will not be any pumping of ground water from the area and hence there will not be any impact on the ground water regime in the area. There will not be any effluent generation due to construction activity. During construction, no waste will be dumped

on land in the site. With these measures and due to the short term nature of construction phase, there will be no impact on this parameter.

Operation phase

The total water requirement for this plant is as follows:

a) About 237 MLD of sea water to produce 100 MLD potable water.
b) Water for cleaning of membranes which eliminates contamination and fouling of the membranes.
c) Sea water for cleaning of sand and anthracite filters

The water required for cleaning of membranes and the potable need will be met from service tank in the plant. The sea water required for sand and anthracite filters will be met from the sea water inlet source.

As such, there will be no requirement of any surface or ground water sources for meeting the water needs of the plant. The effluents generated from this unit are:

i) About 137 MLD of brine reject.
ii) The washing water from the filters and membranes as well as drainage water.
iii) Domestic effluent.

Since the salinity of the brine reject will be high around 70 PSU, the discharge of brine must be selected in a manner that it has a minimum impact on the marine environment. This is achieved by releasing the brine reject into the sea through diffuser ports outfall system which will be designed to have mixing in order to attain ambient salinity within a short distance. A mathematical model will determine the form, name, distribution and attack angle, as well as the expulsion speed of the brine in the diffusers at the end of the underwater discharge/outlet pipe in order not to harm marine life.

The washing waters from the filters and the membranes will be neutralised and will be emptied into the sea through an independent pipe, separate from the brine discharge pipe. The domestic effluent comprising mainly sewerage water will be collected in Septic tank of adequate size with soak pit arrangements.

From the above, it is seen that the plant process envisages zero discharge of water on the land and as such there will not be any adverse impact on the terrestrial water environment. By adopting mitigation measures as described earlier, the impact on the marine water environment will be negligible.

5.3. MONITORING

The following monitoring schedule is suggested for Water quality monitoring.

Parameters: PH, Total Dissolved Solids, Total Suspended Solids, Bio chemical Oxygen Demand, Chemical Oxygen Demand, Alkalinity, Dissolved oxygen, Oil & grease, residual chlorine etc.

Frequency: Once in a month/quarter in each location as will be necessary .

Location: Ground water source: 2 nos – Open well in Kalanji village, Bore well in Kattupalli village

Besides, monitoring of marine front as suggested in the Marine Environment report like brine dispersion study, sea floor changes and under water ecology, sea water quality study at different depths, study of phytoplankton, zooplankton population, benthic fauna, sea weeds, nature of fisheries in the area have to be carried out at periodic intervals.

A laboratory with separate air-conditioned dust proof room is required for installing analytical instruments. The following major instruments shall be kept in the laboratory.

Conductivity Meter, pH meter, Electronic Balance, Analyser, BOD incubator, UV/Visible Spectrophotometer, Hot Oven, Bacteriological Incubator, ION analyser for Sulphate, Nitrite and Chloride, Flame Photometer, etc.

6. NOISE ENVIRONMENT

6.1. EXISTING NOISE ENVIRONMENT:

Noise may be defined as unwanted sound, which interferes with the normal hearing of a human. Noise levels near the roads depend on the type of vehicles plying (light vehicles, heavy vehicles) etc., the intensity of traffic, maintenance of vehicles and also on the human / industrial activity in the vicinity. Noise is sound that is composed of many frequency components of different sounds distributed over the wide audible frequency range.

Exposure to noise levels beyond prescribed limits may lead to several effects such as:

a) Noise induced hearing loss
b) Physiological responses and
c) Sleeplessness and annoyance.

Noise survey was carried out in and around the project site for assessing baseline status.

Sampling Locations

The noise measurements were carried out at the following stations where the ambient air quality was measured :

N1 - Kattupalli Village
N2 – Kalanji Village

Methodology of Assessment

In order to assess the pattern and intensity of noise levels with reference to time, the following methodology was adopted.

i) Measurement of 'A-weighted' sound level continuously both during day & night levels using noise level meter at each site on hourly basis continuously for 24 hours.

ii) The noise levels were taken from 1 to 1.5 m height level at each site. The intensity of the sound energy in the environment is measured on a logarithmic scale and is expressed in decibel scale. Ordinary sound level meters measure the sound energy reaching the microphone of the sound level meter by converting it into electrical energy, and then measuring its magnitude in dB. Regarding the permissible noise levels, it is the sound level that is expressed in dB(A) scale, which is universally accepted by the international community.

The noise was measured in 'A-weighted' decibels [dB(A)]. The human ear can detect sound within a particular frequency range from approximately 20 to 20,000 Hertz. However, the ear is more sensitive to mid-frequencies between 1000 to 6000 Hz where most speech information is carried out, than low or high frequencies. This characteristic is taken into account in sound measurements by adjusting the spectrum of the measured sound pressure level for the sensitivity of human hearing. In the standardized sound measuring instruments, this is implemented with selectable 'A-B and C-weighted networks'. The term 'weighting' is used because some frequencies are given higher or lower importance or weightage than other frequencies. The weighting functions employed correspond approximately to the response of human ear to low, medium and high sound levels. By far, the most common rating scale is the 'A-weighted' sound level and is expressed in dB(A). This noise rating was developed by the Environmental Protection Agency (EPA) specifically for community noise from all sources in the day and night. It was in this manner, the Sound Pressure Level (SPL) was measured at the sites.

$$SPL = (20 \text{ Log}_{10} P)/Po$$

Where 'P' is the root-mean square sound pressure and 'Po' is the reference sound pressure (20 μ Pa)..

Data Processing

The data collected from the field on an hourly basis were analyzed to determine the following statistical evaluation.

The following statistical data for the noise levels measured were determined.

i) L_{10} or Ten percentile exceeding level is the level of sound which is exceeding 10% of the total time of measurement.
ii) L_{50} or Fifty percentile exceeding level is the level of sound which is exceeding 50% of the total time of measurement.
iii) L_{90} or Ninety percentile exceeding level is the level of sound, which is exceeding 90% of the total time of measurement.
iv) Leq. – Equivalent continuous sound level

The simplest and most popular method for rating intermittent or fluctuating noise intrusions is to rely upon some measure of the average sound magnitude over time. The common average is the equivalent sound level, Leq. It is the energy average of the level (usually A-weighted) of a varying sound over the measurement period. It can be considered as the continuous steady noise level which would have the same total A-weighted acoustic energy as the real fluctuating noise measured over the same period of time.

v) L_{day} - Day average sound level:

L_{day} is defined as the equivalent noise level measured over a period of time during day (6 am to 10 pm). The L_{eq} value measured for each individual hour and then averaged for 6.00 a.m. to 10 p.m. and is known as $L_{day.}$

vi) L_{night} - night average sound level :

L_{night} is defined as the equivalent noise level measured over a period of time during night (10 p.m to 6 a.m). The L_{eq} value measured for each individual hour and then average for 10.00 p.m. to 6.00 a.m. and is known as $L_{night.}$

vii) L_{max} - maximum noise level :

This is the maximum level recorded at a particular site during the monitoring period.

viii) L_{min} - minimum noise level :

This is the minimum level recorded at a particular site during the monitoring period.

Data Analysis & Interpretation

The results of the background noise level measured are given in Tables 4 & 5 . A comparative chart showing noise for both the locations is given in Fig 13. It is seen that the ambient noise level in Kattupalli village varied from 36.40 to 53.40 dB(A) & in Kalanji village from 35 .90 to 50.10 dB(A) . The present noise levels in all the observed locations are within the limits prescribed by Ministry Of Environment & Forests Notification given vide Appendix 2..

6.2. IMPACT ON NOISE ENVIRONMENT

Construction phase

Construction equipment like Shovels/loaders, mixer machines, vibrators etc and vehicular movement will cause minor rise in noise levels on site during construction. This will be limited and localised to the area of operation only. The study area is sparsely populated and as already motioned the nearest habituated village Kattupalli is situated about 1.5km away from the project site. As such the impact of noise on community is not significant. Also , appropriate mitigation measurers as given in para 6.3, will be taken to keep the noise level to the minimum.

Operation phase:

During the operation of the desalination plant, there may be noise level emanation from the following places:

a) In the reverse osmosis process unit, high pressure pumps as well as booster/recirculation pumps may produce some noise.

b) The blower provided in the filter cleaning unit for effective cleaning.

These blowers in the filter cleaning unit have been provided with its own noise silencers. Hence the noise generation from this unit will be negligible.

The expected noise level from the unit are:

S. No.	Source	Noise level at (dBA) 10 m from Source
1	High pressure pumps/booster	80 - 95
2	Blower	75 - 85

Prolonged exposure to a high noise level is harmful to the human auditory system and can create mental fatigue, rebellious attitude, annoyance and carelessness which may lead to neglect of work and also result in accidents.

The impact of noise level as per World Health Organisation's 1986 notification is given below:

Noise levels	Adverse effects
20-50 dB	Speech impairment and annoyance
50-90 dB	Hearing impairment for eight hour exposures
90-115 dB	Partial deafness and nervous irritability
> 115 dB	Permanent deafness
Impulsive noise (>90dB)	Frightens livestock grazing in the nearby areas

OSHA (Occupational Safety and Health Administration), USA and other similar organisations stipulate that noise level up to 90 dBA is acceptable for eight hours exposure Leq (Equivalent sound level) (8hrs) per day.

But for the active working area of high pressure pumps, blowers, the noise level in the other areas say at a distance of 20m or so will come down and will be within the tolerance limits. In the active working areas earplugs will be used for personal protection of the staff.

As already mentioned, the habituated villages are located far away from the unit and there will not be any impact of noise on the community due to this plant operation

6.3. MANAGEMENT PLAN – NOISE ENVIRONMENT

The following measures are suggested for minimizing the noise levels during the construction as well as operation stage:

Construction & Operation Stage

i) Choosing construction equipment generating minimum noise and vibration only.
ii) The operator's cabin of equipments like shovel / loader used during construction would be made sound proof.
iii) Allowing only vehicles and construction equipment with internal combustion engines with proper silencer to operate.
iv) Providing Ear plugs/ Muffs to the workers / staff working near the noise generating activities/machines/equipment.
v) Proper and regular maintenance of equipments may lead to less noise generation.
vi) Manufacturers of pumps / blowers will be advised to provide in-built mechanism for reducing sound emissions.
vii) Planting rows of native trees along roads, around the plant to act as acoustic barriers.
viii) Regular health check-up of workers will be undertaken.
ix) Displaying the noise level status of operational machinery / pumps on the machines to enable control measures to be taken in this respect. This will enable to know the extent of noise level and to control the time to which the worker is exposed to higher noise levels.

6.4. MONITORING

The following monitoring schedule is suggested for Noise level monitoring:

Parameters : Noise level In dB(A),

Frequency : Hourly interval for a day, once in a month in each location

Location:

Inside the plant : Inside the plant at various noise generating centers, Administrative building

Outside the plant : Kattupalli and Kalanji villages

The location and the frequency of monitoring shall be suitably modified as per the actual requirements and prevailing conditions of the plant and environmental factors, as dictated from time to time, depending on the prevailing pollution levels, if required. A good quality Sound Pressure Level Meter shall be deployed.

Audiometric tests shall be conducted to test the effectiveness of noise abatement programmes. The examination shall be performed under the supervision of health officials.

7. BIOLOGICAL ENVIRONMENT

7.1. EXISTING BIOLOGICAL ENVIRONMENT

Flora & Fauna

Flora

Core Zone

The total project area of 60 acres is a plain land devoid of any major vegetation. The soil in the project area is of coastal alluvium type with the pH in the range of 6.3 to 7.0. The soil has very low phosphorous and potash content but are fairly well supplied with nitrogen and organic matter.

Bufferzone

The 5km Buffer zone study area can be sub divided in to 3 micro eco regions namely

a) Area facing the open sea
b) Creeks and water bodies namely Buckingham canal
c) Inland areas

The land use of the study area is shown in Fig. 14.

The sea front area is typically of sandy type and from Puzhidivakkam in the south of the buffer zone up to the proposed desalination plant is developed for North Chennai TPS and Ennore Port.

The Buckingham canal occupies major part of the area. Numerous salt pans are located in the Swampy area near Buckingham canal.

The inlands in the buffer zone comprises of sparsely populated villages namely kattupally, kalanji, Uranamedu, Sanganimedu, sand hills, scattered trees. The area is sparsely vegetated

(Refer Photo). Casurina and cashew are predominantly seen at many places. Besides, Ain (Terminalia tomentosa) , Bibla (Semicarpus anacardi), Karanji (Pongamia glabra) etc, are also seen. Grasses like Eragrostic sp. Dieanthium anulakum are commonly present.

Agricultural activities are totally absent due to poor soil condition

There are no reserve forest or protected forests within the area.

Fauna

In the study area, fauna common to rural India such as hare, jackals, monkeys, langoors, pigs, etc and several species of birds and reptiles are present. No rare or endemic species are generally observed.

Pulicat Bird Sanctuary

This sanctuary is situated about 15kms north of the project area. Egrets, herons, kites, waterside birds, grey pelicans, ducks, etc are found visiting the lake. Species like crabs, clams, mussels, oysters, snails, sponges, prawn, etc are found in the lake.

7.2 IMPACT ON BIOLOGICAL ENVIRONMENT

As already mentioned in details in the earlier chapters, the project, because of its pollution free nature of operation on many parameters, the inbuilt design features do not create any adverse impact on the surrounding area. Pulicate lake being about 15kms away from the project site, will not be affected at all from the environmental angles, due to project operation both during construction and operational phases.

7.3 MANAGEMENT PLAN

Green belt development

The green belt or plantation around the facility is proposed to mitigate fugitive emissions. It also helps to keep the area cool. The objectives of green belt development are:

- Mitigation of fugitive gaseous emissions
- Noise abatement
- Reuse of Waste water to the extent possible
- Prevention of soil erosion
- Ecological restoration
- Aesthetic improvement, keeping in mind the existing soil conditions and the topography of the land.

The different areas where green belt can be developed are:

i) The seaward side 200m" no development zone"

ii) About 100m wide on the western side in between the approach road and the plant

iii) About 25 to 50m on the northern and southern side of the plant

By this way about 22.5 ha of the land can be covered under plantation. Thus the area covered under plantation works out to 37.5%, which is more than the norms prescribed by the pollution control boards.

The green belt development shall be carried out effectively by external agencies.

Considering the locality, soil conditions and objective of plantation, the following species are suggested.

Name of Plant Species

- Casurina
- Cashew
- Polyalthia longifolia
- Acacia leucophloea
- Acacia nilotica
- Zyziphus glabrata

8. RISK ANALYSIS AND DISASTER MANAGEMENT PLAN

Detailed risk analysis for the project has already been separately studied. The objective of risk analysis comprises of following aspects:

- Identifying the worst chemical and general plant hazards and the corresponding plant section and assessing their consequences in terms of asphyxiation, thermal radiation, explosion and toxicity effects.
- Assessing the overall damage potential of the identified hazardous events on the internal and external installation and on the population in the vicinity.
- Identification of accident sequences and consequences and
- Providing guidelines for the containment and mitigation of any incident and plan on-site or off-site emergencies based on the identified scenarios on the proposed plant.

The risk analysis study has been carried out in two phases, viz. Preliminary Hazard Analysis (PHA) followed by Consequence analysis. Finally the vulnerable zones are plotted from which risk reducing measures are deduced and recommended.

The salient findings of the risk analysis study are as follows:

- The proposed plant consists of units mainly for treatment of sea water and uses the common chemicals being used in water treatment.
- No other chemical or hazardous reactions/processing is involved
- The main risk arising from the setting up the desalination plant is therefore only due to the accidental dispersion of residual chlorine (from hypochlorite tank).
- The consequence analysis have shown that all the hazards will be mainly confined on site and will have limited off-site bearings.
- The worst case scenario for on-site is the leak of continuous chlorine from the storage unit.
- The maximum distance, which needs to be delineated as a potential, danger zone is about 242m from the source of leak in the windward direction.

- However, it will not reach any population centers as the desalination plant is located in an uninhabited site surrounded by vacant barren lands. The nearest villages are on the upward(SW) directions at more than 1500m of the site. Hence in the event of chlorine release from the plant, the off – site impact will be very limited.

- It can be observed that the risk at the desalination plant is comparable to criteria as used in some developed countries. When compared to a risk to an average motorist, the risk at this unit would appear to be ten to hundred times lower.

8.1. DISASTER MANAGEMENT PLAN

Based on the risk analysis carried out for the project, a broad Disaster Management Plan (DMP) has been prepared, to incorporate both "On-site" and "Off – site" emergency plans, taking into consideration all technical reviews and suggestions as per acceptable norms. An organization structure is also devised to combat the emergencies. Roles and responsibilities of the emergency team are also fixed and the details are given in the main report.

9. CONCLUSIONS

In view of aforesaid details, like incorporation of latest technological inputs with sophisticated equipments and control systems into the process design, pre project environmental status, predicted impacts due to the project operations and timely implementation of various environmental control measures to reduce the adverse effects due to the project operations, it will be seen that the advent of the project will give a big boost to this economically and socially backward region by way of creation of better employment potential, better educational and medical facilities, better aesthetical outlook of the area due to elaborate green belt development and better communicational facilities.

Besides, the project implementation well augment potable water supply to Chennai city by 100 MLD which can cater to the demand of about 2.5 million population. This achievement will far out way any possible minor impact if any due to the project operations in the area.

Table 1. POPULATION BREAKUP & LITERACY LEVEL WITHIN 5KM RADIUS AS PER 2001 CENSES

THIRUVALLUR DISTRICT
PONNERI TALUK PROJECT : DESALINATION PLANT NEAR MINJUR

NAME OF THE VILLAGE	HOUSE HOLDS	POPULATION			SCHEDULE CASTE			SCHUDULE TRIBE			LITERATES		
		MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL	MALE	FEMALE	TOTAL
1. Kattoor	804	1762	1732	3494	988	973	1961	54	54	108	1255	940	2195
2. Karungali	75	143	143	286	58	65	123	0	0	0	19	20	39
3. Kalanji	59	143	143	286	2	3	5	0	0	0	25	20	45
4. Kattupalli	230	430	475	905	330	355	685	11	10	21	157	111	268
5. Voyalur	1399	2779	2828	5607	587	595	1182	4	2	6	1903	1365	3268
6. Puzhuthivakk	93	207	194	401	21	21	42	0	0	0	136	95	231
TOTAL	**2660**	**5464**	**5515**	**10979**	**1986**	**2012**	**3998**	**69**	**66**	**135**	**3495**	**2551**	**6046**

Table 2. OCCUPATIONALE STRUCTURE WITHIN 5KM RADIUS AS PER 2001 CENSES

THIRUVALLUR DISTRICT
PONNERI TALUK **PROJECT : DESALINATION PLANT NEAR MINJUR**

NAME OF THE VILLAGE	MAINWORKERS		MAIN CULTIVATORS		MAIN AGRI LABOURS		MAIN HOUSE HOLDS		MAIN OTHERS		MAIN MARGINAL WORKERS		NON WORKERS	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
1. Kattoor	937	200	268	15	389	133	31	7	249	45	107	179	718	1353
2. Karungali	91	79	2	1	0	1	0	2	89	75	1	2	51	62
3. Kalanji	79	71	2	0	0	0	0	1	77	70	0	2	64	70
4. Kattupalli	223	26	42	3	170	22	2	0	9	1	34	195	173	254
5. Voyalur	1109	322	308	40	355	224	11	4	435	54	508	213	1162	2293
6. Puzhuthivakk	114	17	0	0	48	9	5	0	61	8	4	7	89	170
TOTAL	**2553**	**715**	**622**	**59**	**962**	**389**	**49**	**14**	**920**	**253**	**654**	**598**	**2257**	**4202**