Environmental Status Report of Navi Mumbai Municipal Corporation 2014-15

Foreword

Given the dependency on the environmental resources for our daily routine it is highly imperative to maintain them in their natural state for long term sustainability. Urbanization has already been attributed to exert pressure and exploit these resources. Realising this fact various initiatives have been taken worldwide to track and maintain the status of the environment, so that necessary action could be taken to appropriately mitigate the pressures.

As per the BPMC (Bombay Provincial Municipal Corporations Act) 1949, it is compulsory for the A class ULB's to document an annual ESR (Environmental Status Report) of the corporation. Towards this NMMC has been documenting the ESR for more than 14 years and this year it gives me immense pleasure to release the 15th edition of Navi Mumbai's Environmental Status Report for the year 2014-15.

Taking note of the areas which require improvement, during the last year, NMMC not only dedicatedly focused on the issues but also completed a few of the projects thus leading to overall improvement in Environment Quality Index and Urban Infrastructure Index of the city. The improvement in the above index has thus led to improvement in the Quality of Life Index for the citizens in Navi Mumbai.

Last year, under the Eco-City initiative NMMC launched the Eco-City cell, which has been developed to serve as a forum for the citizens to interact and learn about various environmental initiatives taken by NMMC and also for citizens to showcase the initiatives taken by them.

It is interesting to note that the air pollution levels have been contained and the NOx levels have been successfully reduced owing to completion of major road projects in Navi Mumbai. NMMC is dedicatedly working to reduce the PM pollution and is already in process to implement various new strategies to reduce the same. Reduction in PM levels would directly translate to reduction in air pollution as the pollutants like SOx, NOx, CO and Ozone are already under the standards as prescribed by CPCB. Water pollution levels in Navi Mumbai are already under control, owing to the initiative implemented under the Lake Vision project, erection of gabion walls, efficient sewage treatment facilities and so on.

NMMC already has a state of art process to scientifically dispose the Solid waste generated in the city, and the scientific closure of cell IV at the Turbhe land fill site is under process. Last year NMMC also increased the processing of plastic waste thus reducing the overall quantity of solid waste in the land fill. NMMC is also planning to soon install various waste to energy technologies for processing of segregated waste as well as a debris recycling plant.

The cumulative effect of the above initiatives taken by NMMC has enabled to improve the quality of life of the citizens of Navi Mumbai and the same has improved from 73.70% in the year 2011-12 to 75.52 in the year 2014-15. I am glad to present this report and I am sure this report would serve as a tool not only for NMMC but also for the citizens of Navi Mumbai.

Dinesh T Waghmare I.A.S

Municipal Commissioner, NMMC

Contents

Abbreviations

APMC	Agricultural Produce Market Complex
AQI	Air Quality Index
BEST	Brihanmumbai Electricity Supply and Transport
BOD	Biochemical Oxygen Demand
BPO	Business Process Outsourcing
CAAQMS	Continuous Ambient Air Quality Monitoring System
CAGR	Compound Annual Growth Rate
CBD	Central Business District
CIDCO	City and Industrial Development Corporation
CNG	Compressed Natural Gas
COD	Chemical Oxygen Demand
CPCB	Central Pollution Control Board
CSIR	Council of Scientific & Industrial Research
DO	Dissolved Oxygen
EPI	Environmental Performance Index
ESR	Environmental Status Report
FAO	Food and Agriculture Organization of the United Nations
FO	Furnace Oil
GTIPL	Gateway Terminal India Private Ltd
HSD	High Speed Diesel
IOCL	Indian Oil Corporation Limited
IT	Information Technology
JNPCT	Jawaharlal Nehru Port Container Terminal
LDO	Light Diesel Oil
LPCD	Liters per Capita per Day
LPG	Liquefied Petroleum Gas
LULC	Land Use and Land Cover
MCZMA	Maharashtra Coastal Zone Management Authority
MIDC	Maharashtra Industrial Development Corporation
MLD	Million Liters Per Day

MMR	Mumbai Metropolitan Region
MPCB	Maharashtra Pollution Control Board
MRSAC	Maharashtra Remote Sensing Application Centre
NAAQMS	National Ambient Air Quality
NAAQS	National Ambient Air Quality Standard
NAMP	National Air Monitoring Program
NEERI	National Environmental Engineering Research Institute
NMMC	Navi Mumbai Municipal Corporation
NMMT	Navi Mumbai Municipal Transport
NO_2	Nitrogen Dioxide
NO_x	Oxides of Nitrogen
NSICT	Nhava Sheva International Container Terminal
PDS	Public Distribution System
PM_{10}	Particulate Matter below 10 micrometers diameter
$PM_{2.5}$	Particulate Matter below 2.5 micrometers diameter
PNG	Piped Natural Gas
PUC	Pollution Under Control
PVC	Polyvinyl chloride
RSPM	Respirable Suspended Particulate Matter
RTO	Regional Transport Office
SO_2	Sulphur Dioxide
SO_x	Oxides of Sulphur
STP	Sludge Treatment Pool
tCO_2e	Tons of Carbon Dioxide Equivalent
TERI	The Energy and Resources Institute
TEU's	Twenty foot Equivalent Units
TTC	Trans-Thane Creek
ULB	Urban Local Body
US-EPA	United States Environmental Protection Agency
WHO	World Health Organization

List of Figures

List of Maps

List of Tables

List of Pictures

List of Awards Received by NMMC

- Award for Solid Waste Management 2014 by EPC World Media Group.
- National Urban Water Award 2011 for contracting O &M services.
- First prize award for Family Welfare Programme, TB prevention & Control program and Second award for Mother Child Health Care Programme in Maharashtra state.
- Best Urban ICT award for E-Governance project of NMMC by Government of Maharashtra.
- Best practices award for NMMC centre of Education and Training for Handicap by Social Justice & Special aid department of Government of Maharashtra.
- EPC World Award for Outstanding Contribution in Urban Civic Amenities (STP Project).
- Sant Gadge Baba Nagri Swachata Abhiyan special Award - 2008-09 from Government of Maharashtra for best Sanitation practices in city.
- Indian Municipal Vision-2020 Award for "WISITEX Green Urban Development Award of the Decade".
- Government of India National Urban Water Awards (NUWA) 2010 for "Sanitary Improvements and Safe Disposal Practices, Integrated Storm Water Disposal System".
- Government of India National Urban Water Awards (NUWA) 2010 for "Improved Customer Satisfaction, Governance, Public Disclosure and Transparency".
- Best City Award for Improvement in Waste Water and Sanitation Services under JNNURM (2009).
- Vasundhara Award – 2009 by Hon. Chief Minister of GOM for excellence in city environment.
- National Urban Water Award-2009, by Hon. President of India for “Services to Urban Poor.”
- Ranked 1st in the state for the year 2007-2008 & 2008-2009 in implementing the SARVA SHIKSHA ABHIYAAN campaign of the Government of India. (Education for All).
- National Water Award-2008 constituted by Urban Development Dept (Government of India), Administrative Staff College of India, Hyderabad and FCCI for successful implementation of 24x7 water supply in Navi Mumbai.
- 1st prize under the Sant Gadgebaba urban cleanliness campaign twice (2002-2003 & 2005-2006) with cash reward of Rs 50,00,000/-

Executive Summary

Navi Mumbai has been developed as a twin city to the Megacity of Mumbai. In the course of development a lot of emphasis has been given to sustainably manage and monitor the resources in the city. The NMMC (Navi Mumbai Municipal Corporation) is well equipped with state of art technologies specifically pertaining to water supply, sewage treatment, solid waste management, storm water management, public transport, health facilities and so on to cater to the needs of urban infrastructure.

However, the city is rapidly developing and as per Census 2011, in the last decade, it has recorded a growth by more than 51%[1]. This increase in population coupled with growth in industrial, educational hub, economic activities and infrastructure are the major driving forces for the growth of a city which exert pressure on the resources of the city like water, air and land. This pressure alters the normal state of the resources either in terms of resource availability (land and water supply) or pollution loads (water and air pollution). Taking this into consideration this report which documents the status of the environment has been presented as per the DPSIR (Drivers, Pressure, Status, Impact and Response) framework proposed by MPCB (Maharashtra Pollution Control Board) guidelines 2009.

Environmental Indices for Navi Mumbai

To have a comprehensive overview of the environmental performance and the state of resources NMMC has been annually calculating indices such as, EQI (Environmental Quality Index); UII (Urban Infrastructure Index); and QOLI (Quality of Life Index), since the past 15 years. For the year 2014-15 the EQI (71.38%), UII (79.65%) and QOLI (75.52%) have improved as compared to the previous year. Overall improvement of EQI is attributed to completion of concretization of roads and major junctions leading to the reduction in RSPM values, higher share in recycling of plastic from municipal solid waste, continuous monitoring and disinfection by chlorination and so on. While the increase in value of UII is attributed to development of roads, increase in the development of sanitation facilities by increasing the number of toilets in slum area, transportation of solid waste through use of compactors, improvement in footpaths for physically challenged people and improvement in gardens and road side greenery.

NMMC has recorded an improvement in the EQI, UII and EPI, owing to various pro-environment initiatives like increased sanitation facilities in slums, recycling of plastic waste and strong policy for responsible disposal of debris taken by NMMC.

This year NMMC has calculated the EPI (Environment Performance Index), endorsed by MPCB. The calculator takes into consideration 65 data variables which are compared against the state level and national level benchmarks or averages as may be applicable. The EPI score for NMMC area was determined to be 663.30 out of 944 and registered an improvement of 6.8 owing to three major initiatives undertaken for increasing awareness related to environmental issues, responsibly addressing the management of construction and demolition waste and increasing sanitation and sewerage facilities in slums.

[1] Census of India, 2011

Eco City Program

Under the Eco-City program, launched in the year 2012, TERI and NMMC organized a one day workshop on 'Design and Policy Dialogue on Green Buildings', on 24th of February 2015 at NMMC Headquarters. The main objective of this workshop was to strike a dialogue amongst the key policy/decision makers upon the various design and the policy/legislative, pertaining to buildings, options available in India. The event also deliberated deeper insights on GRIHA (Green Rating for Integrated Habitat Assessment) and its national relevance. Various aspects like the existing building codes in India, role of green buildings, existing and possible incentives available in India and so on were also discussed at the forum.

The occasion also marked the launch of an Eco-city cell at the hands of Shri Sagar Naik, *Honorable Ex-Mayor, Navi Mumbai* in presence of Shri. Dinesh T Waghmare, *Honorable Municipal Commissioner*, *NMMC* as well as the HODs (Head of Departments) of NMMC. The cell has been launched with an intention to create an interphase between the NMMC and the citizens of Navi Mumbai and disseminate information about the pro-environment and sustainable initiatives undertaken by NMMC. The cell shall soon start organizing programs to interact with the citizens.

Air Quality

To monitor and record the concentrations of various air pollutants like SO_2 (Sulphur dioxide), NO_X (Oxides of Nitrogen), PM (Particulate Matter), Ozone, CO (Carbon Monoxide), Methane and so on, NMMC has installed four CAAQMS (Continuous Ambient Air Quality Monitoring Stations) at Airoli (fire station), Vashi (fire station), Turbhe (near landfill site) and Koparkhairne (near Teen Taki). In the year 2014-15 the Vashi CAAQMS was non-operational due to renewal of contract of the agency and maintenance of the machine.

The trend of air quality in NMMC area has shown improvement in recent years for the NOx and $PM_{2.5}$ concentrations as compared to the last five years. The NOx levels reduced by almost 1/3rd as compared to the previous year while the $PM_{2.5}$ concentrations improved by 10% lower than the 2012-13 levels. The reduction in levels could be attributed to the successful completion of concretization of 19 junctions within the city as well as the work of Sion- Panvel highway which has restricted a large amount of traffic from entering the city ensuring seamless commute at that highway. Also NMMC regularly undertakes sweeping of roads using vacuum suction sweeping machines as well as NMMC has planted trees along the roadsides and on the dividers has also contributed in reduction in dust pollution.

In 2014-15 it was observed that the SO_2 concentrations for all the 3 CAAQMS were well below the annual standards of 50µg/m³. As for the NO_X concentrations, the Airoli as well as Turbhe sites were recorded clean but the Koparkhairne site recorded a border line category for NOx concentration at 42µg/m³ just exceeding the standards of 40µg/m³. The AAQMS at Airoli which violated the NO_X standards for the past five years, has recorded annual NOx concentration of 27.25µg/m³ which is well below the annual permissible limit. Even though the readings are well below standards for Turbhe, an increasing trend can be observed in the past 3 readings which indicates

The decreasing trend in NOx and $PM_{2.5}$ levels in NMMC could be attributed to the successful completion of concretization of 19 junctions within the city as well as the work of Sion- Panvel highway, regular cleaning by vacuum suction machines and plantations along the road side.

that the station may record violation in concentration of NOx. This is because of ongoing work related to concretization of the road near the land fill site and movement and idling of the vehicles transporting MSW at the site.

All the CAAQMS have recorded violation for PM_{10} for the past 5 years which indicates that Navi Mumbai has PM_{10} pollution. Even though the annual PM_{10} concentrations were within limits for the year 2013-14 at Airoli, the concentration exceeded for the year 2014- 15 (139.67µg/m^3). Since the last five years the $PM_{2.5}$ and PM_{10} levels in Navi Mumbai have been higher than the standards at all sites. NMMC is already noted this issue and is already developing and implementing plan to reduce the PM pollution levels.

The CO and Ozone concentrations in Navi Mumbai were recorded under the standards indicating that the pollution levels of CO and ozone are well within the control.

Water Resource

The NMMC area has abundant water resources in terms of surface as well as ground water. The surface water resources includes 24 lakes and ponds, 11 holding ponds and creek front of about 22km, NMMC area merits various vital environmental and physical services provided by these entities in terms of controlling the floods, water logging, surface runoffs, regulating the urban heat island effect and so on. As for the water supply NMMC relies on the water from Morbe dam, self-owned dam of NMMC and from Barvi dam for water supply to industrial areas. In terms of ground water resources water resource include 132 wells. NMMC regularly monitors the water quality for all the water bodies in NMMC area.

The water quality of water in lakes and ponds in NMMC was under the permissible limits for the parameters of pH, suspended solids, dissolved oxygen, TDS, BOD and COD. This could be attributed to construction of Gabion walls for restricting idol immersion areas and separate cloth washing area distinct drainage

Owing to the initiatives implemented under the Lake vision project, the water bodies and lakes in the NMMC area have been maintained in good condition as per the quality analysis reports maintained by Environmental Laboratory of NMMC. All the water bodies (lakes and ponds) were in healthy state in the year 2014-15. The only cause of concern is the water quality of creek in NMMC area. They were detected to be polluted with high levels of Chlorides, COD (Chemical Oxygen Demand) and suspended solids. This could be attributed to the release of untreated effluents from industrial area and cities along the thane creek.

NMMC supplies water 24X7 to nearly 75% of the area of the city while the remaining area is catered to water supply for about 4-8 hours per day. Around 421 MLD (Million Litres per Day) water is supplied from Morbe dam to the treatment plant at Bhokarpada. In the year 2014-15, on an average, NMMC billed about 325 MLD (19% losses) of water supply, translating to per capita supply of about 240 LPCD (Litres Per Capita Per Day), almost 1.8 times the service level benchmark of 150 LPCD recommended by Ministry of Urban Development, Government of India.

NMMC area has 7 active STP's (Sewage Treatment Plants). Six STP's have secondary treatment facilities with an aggregate capacity of about 424 MLD, while there is one aerated lagoon of 17 MLD capacity at Nerul. The processing at lagoon shall be soon terminated and

connected to a nearby STP. It estimated that around 180[2] MLD of sewage is generated in the NMMC area. However the present operational load on these STP's is about 180 MLD, indicating that almost 100% of water is treated before releasing in the creek. NMMC regularly monitors the inlet and outlet water samples for bacteriological and chemical parameters. In the year 2014-15, the efficiency of the STP's were almost 100% in terms of regulating the BOD (Biochemical Oxygen Demand), COD levels, Suspended solids, pH, oil and grease, nitrate, nitrite and dissolved oxygen levels and the average effluent water quality released from the STP's was well within the standards for all the parameters.

Biodiversity and Gardens

Navi Mumbai is bestowed with high biodiversity due to presence of several habitats ranging from low hills with tropical semi-evergreen to mangroves forests. Navi Mumbai is currently home to more than 168 species of birds, 80 species of reptiles and amphibians, 140 species of butterflies, 125 species of marine fish and 800 species of flora. Various migratory birds such as the Flamingos are observed to visit mangrove and mudflats of the city for breeding and feeding purposes increasing the bio wealth of the city.

There are about 199 gardens in NMMC area which further add to the aesthetic beauty of the city and also provide habitat for various flora and fauna. NMMC has also developed green cover patches along the major roads and junctions in Navi Mumbai (Picture No. 1).

Picture No. 1: Plantations and green cover along Thane Belapur road

[2] Source: ACE, NMMC

Land use and Land Cover

As per MRSAC (Maharashtra Remote Sensing Application Centre), the total area under NMMC's jurisdiction was estimated to be approximately 108.63 sq. km. The land use pattern of the city consists of Built Up area (56%), Forests (24%), Wetlands (12%) and the remaining area is broadly classified under water bodies or agriculture.

Navi Mumbai's coastline has rich mangrove coverage, spread over approx. 49.78 sq. km. Mangroves play a valuable role as natural barrier against possible natural calamities like cyclones, floods and tsunamis. They also play a vital role by reducing carbon footprint owing to its carbon sequestration potential. The mangrove coverage in NMMC area is estimated to sequester about 7280 Metric Tons of CO_2 emissions annually[3]. However, owing to urbanization the land resource in NMMC area is exposed to various pressures arising from anthropogenic activities and demands. Mining, dumping of debris, destruction of mangroves and so on are the pressures on land resource. In the year 2014-15 about 2685 tons of illegal debris dumping was caught by the flying squad team appointed by NMMC. Mining and quarrying activities induce pressure on the land resource as well as significantly increase the PM levels in the air.

NMMC has designed & proposed several measures such as green building, vigilance against dumping, restoration of quarry sites, raising awareness about biodiversity and so on in order to reduce the current pressures, and conserve land resources.

NMMC has designed & proposed several measures such as green building, vigilance against dumping, restoration of quarry sites, raising awareness about biodiversity and so on in order to reduce the current pressures, and conserve land resources.

Solid Waste Management

NMMC has designed a specific solid waste management strategy for effective disposal of municipal waste thereby reducing the adverse impacts caused by its accumulation and in appropriate disposal. In the year 2014-15, the daily average MSW increased by about 25 tons from the last year and accounted to about 675 MT waste (470gms per capita). The waste generated from the residential, commercial and industrial areas is comprised mainly of biodegradable waste. Waste from the roads is collected through sweeping while household waste is collected by door to door collection. NMMC has been implementing sweeping of roads using mechanical sweepers for effective cleaning of roads. Biomedical waste is collected from various hospitals and dispensaries by private contractors and disposed of at the hazardous waste disposal facility at Taloja. In 2014-15 more than 12000 kg of biomedical waste was generated in NMMC. Domestic solid waste (wet & dry) from NMMC area is transported to the sanitary landfill at Turbhe on daily basis. The leachate from the waste is also regularly treated & disposed of scientifically. NMMC has also taken several initiatives such as scientific closure of dumping ground at Koparkhairane and has also proposed an e-waste recycling plant, and various waste to energy technologies for further treatment and disposal of municipal solid waste.

[3] Singh et al (2012). Carbon Sequestration In Mangroves Ecosystems, Journal of Environmental Research And Development, Vol. 7 No. 1A.

NMMC Head Office - A Green Building

Picture No. 2: IGBC's LEED Gold certificate awarded to NMMC's HO - A green building

This year NMMC received the Indian Green Building Council's (IGBC) LEED India NC Gold 2015 award for the NMMC headquarters which is a green building and it houses the following features:

- Rainwater harvesting system consisting of 13 pits with a capacity to store up to 80,000 liters of water.
- Reflective tiles fitted on the terrace to reduce the load on electric consumption by air-conditioners.
- STP of 0.15 MLD capacity to treat sewage generated in the building.
- Recycled water is used for toilet flushing & gardening purpose.
- Biomethanation Plant for scientific disposal of canteen waste.
- Grass pavers are fitted on the ground to allow percolation of water.
- Use of Double Glazed Unit glass to reduce heat transfer & increase energy efficiency
- Pneumatic plumbing system to reduce load on water flow.
- Recycled wood has been used for furniture in the building

Environmental Indices for Navi Mumbai

The information on environmental parameters is often complex and technical for common man. The problem further complicates as environment covers broad spectrum of areas. The goal of assessing status of environment is planning for sustainable development while maintaining quality of environment.

Many indices have been developed globally to determine an environmental index (absolute value) using various parameters. These indices can be used to determine a baseline value and then a trend could be developed for the following years to track the development and address the gaps specifically. Three indices have been calculated annually for the past 15 years by NMMC, viz EQI (Environmental Quality Index); UII (Urban Infrastructure Index); and QOLI (Quality of Life Index). This year NMMC has also calculated the EPI (Environmental Performance Index), endorsed by MPCB (Maharashtra Pollution Control Board).

The computation of these indices has been presented in Annex-I. Overall improvement of EQI is attributed to the completion of concretization of roads and major junctions, higher share in recycling of plastic from MSW (Municipal Solid Waste), continuous monitoring of water quality and disinfection by chlorination and so on. While the increase in value of UII is attributed to increase in the development of sanitation facilities by increasing the number of toilets in slum area, transportation of solid waste through use of compactors, improvement in footpaths for physically challenged people and improvement in gardens and road side greenery. The improvement of EQI and UII has thus improved the QOLI for citizen of NMMC. The trend of the EQI, UII and QOLI for the past four years is presented in Figure No. 1 and Table No. 1.

Table No. 1: Environmental Indices of Navi Mumbai

Sr. No	Index	2011-12	2012-13	2013-14	2014-15
1	Environmental Quality Index (EQI)	69.05%	70.02%	70.69%	71.38%
2	Urban Infrastructure Index (UII)	78.35%	78.94%	79.06%	79.65%
3	Quality of Life Index (QOLI)	73.70%	74.48%	74.88%	75.52%

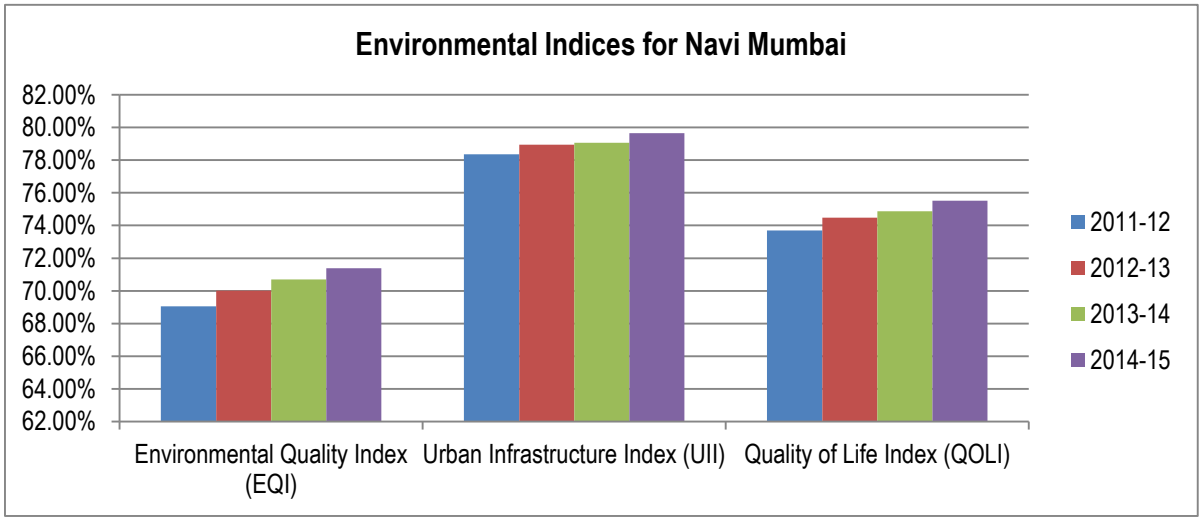


Figure No. 1: Environmental Indices of Navi Mumbai

Environmental Performance Index

The EPI (Environmental Performance Index) is a method of quantifying and numerically marking the environmental performance of a city. The MPCB guidelines provide 65 data variables, which are to be analysed as a preliminary step to calculate the EPI. The data output gets aggregated to give the score of four thematic indicators, which is further used to calculate the EPI. The four thematic indicators are (1) Growth of city (2) State of resources (3) Urban services and (4) Initiatives taken to improve the city environment.

A definite score has been allotted to the 65 data variables (Annex -II) depending upon the benchmarks set according to the national, state or the defined average as per international standards. For example, the population growth is one of the key indicators of the environment and if it exceeds the limits, it exerts pressure and adversely impacts the environment and, hence, the score given would be less in such a situation. Vice-a-versa, a pro-environment initiative is given better score. Hence, better the EPI score better is the state of environment of that city.

The EPI has been calculated based on the model developed by MPCB using MS™ Excel software. The EPI score for NMMC area was determined to be 663.30 out of 944 in the year 2014-15 and recorded an improvement of 6.8 as compared to last year 2013-14 which was 656.50. This improvement is attributed to the initiatives taken by NMMC for increasing awareness related to environmental issues, responsibly managing the issue of construction and demolition waste and increasing sanitation and sewerage facilities in slums.

Table 1: Environmental Performance Index

Gap Analysis		
Environmental Score	**Achievable Score**	**Achieved Score**
Thematic Indicators	**944**	**663.30**
Growth of cities	250	140.00
State of natural resources	300	225.60
Urban Services	250	198.50
Initiatives for improving city environment	144	99.20

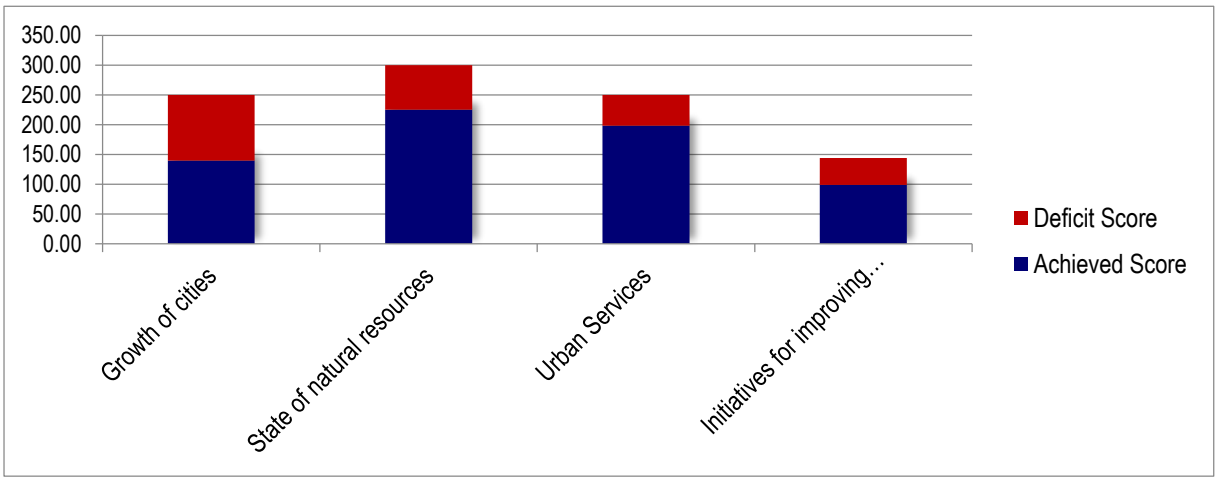


Figure No. 2: Environmental Performance Index

Eco City Program

As a response to the environmental indicators and to minimize the local and global impacts from NMMC area, the corporation has undertaken the 'Eco-City program in collaboration with The Energy and Resources Institute (TERI). The program aspires to develop Navi Mumbai as India's first 'Eco City' on the principles of sustainable development. The major objective of the project is to appropriately utilize and conserve the natural resources within the municipal limits and promote sustainable development in the city. In the first phase (

Figure No. 3) TERI developed the carbon inventory to estimate the carbon footprint of the city and subsequently developed a comprehensive action plan.

This year under the Eco-City program, TERI in collaboration with the Navi Mumbai Municipal Corporation (NMMC) had organized a one day workshop on 'Design and Policy Dialogue on Green Buildings', on 24th of February 2015 at NMMC Headquarters. The main objective of this workshop was to strike a dialogue amongst the key policy/decision makers upon the various design and the policy/legislative, pertaining to buildings, options available in India. The workshop was graced by Shri Sagar Naik, Honorable Ex-Mayor, Navi Mumbai as the Chief Guest, Shri Rajan Kop, Joint Secretary, Urban Development Department, GoM, Shri Dinesh T Waghmare, Honorable Municipal Commissioner NMMC. Shri Mohan Dagaonkar, City Engineer, NMMC and Mr G S Gill, Senior Advisor TERI and Ex Managing Director CIDCO.

Figure No. 3: Timeline depicting progress and accomplishments under Eco-city program

In the technical sessions, Dr. Anjali Parasnis, Associate Director TERI WRC presented the highlights of the Eco city' project whereas Ms. Mili Majumdar, Director, Sustainable Habitat, TERI gave deeper insights on GRIHA (Green Rating for Integrated Habitat Assessment) and its national relevance. Various aspects like the existing building codes in India, role of green buildings, existing and possible incentives available in India and so on were also discussed at the forum.

The occasion also marked the launch of an Eco-city cell at the hands of Shri Sagar Naik, Honourable Ex-Mayor, Navi Mumbai in presence of the esteemed guests listed above. The cell has been launched with an intention to create an interphase between the NMMC and the citizens of Navi Mumbai and disseminate information about the pro-environment and sustainable initiatives undertaken by NMMC. The cell shall soon start organizing programs to interact with the citizens.

Picture No. 3: Inauguration of Eco city cell

Navi Mumbai – City Profile

Navi Mumbai is one of the largest planned cities of India conceived in the year 1972 and was designed to decongest Mumbai. In 1970 CIDCO (City & Industrial Development Corporation) was incorporated with purpose to plan, develop and maintain the city of Navi Mumbai under 'Companies Act' of 1956'. CIDCO has planned to develop 14 nodes in Navi Mumbai out of which 8 nodes were handed over to NMMC (Navi Mumbai Municipal Corporation) in 1991 for its maintenance. The development of industrial belt in Navi Mumbai attracted a large population as it gave rise to employment opportunities. Further given the ease of connectivity to Mumbai, the city witnessed quick progress in term of urbanisation.

Navi Mumbai is a part of Konkan coast line and is located in centre of MMR (Mumbai Metropolitan Region) with Thane creek on west side while the Parsik hill ranges surrounded on right side, whereas Thane and Panvel region covers the North and South zone. NMMC jurisdiction is divided in eight zones starting with Digha in north and Belapur in south (Map No. 1). Out of the total area of 343.70 sq km for Navi Mumbai, 108.63 Sq. km area is under NMMC[4]. As per Urban Health Post (UHP) estimate for the year 2014-15 the population residing within NMMC, area is more than 14 lakhs (14,37,379) with an average population density of about 13,231 persons per sq km. The geographic and demographic profile of Navi Mumbai is represented in Table No. 2.

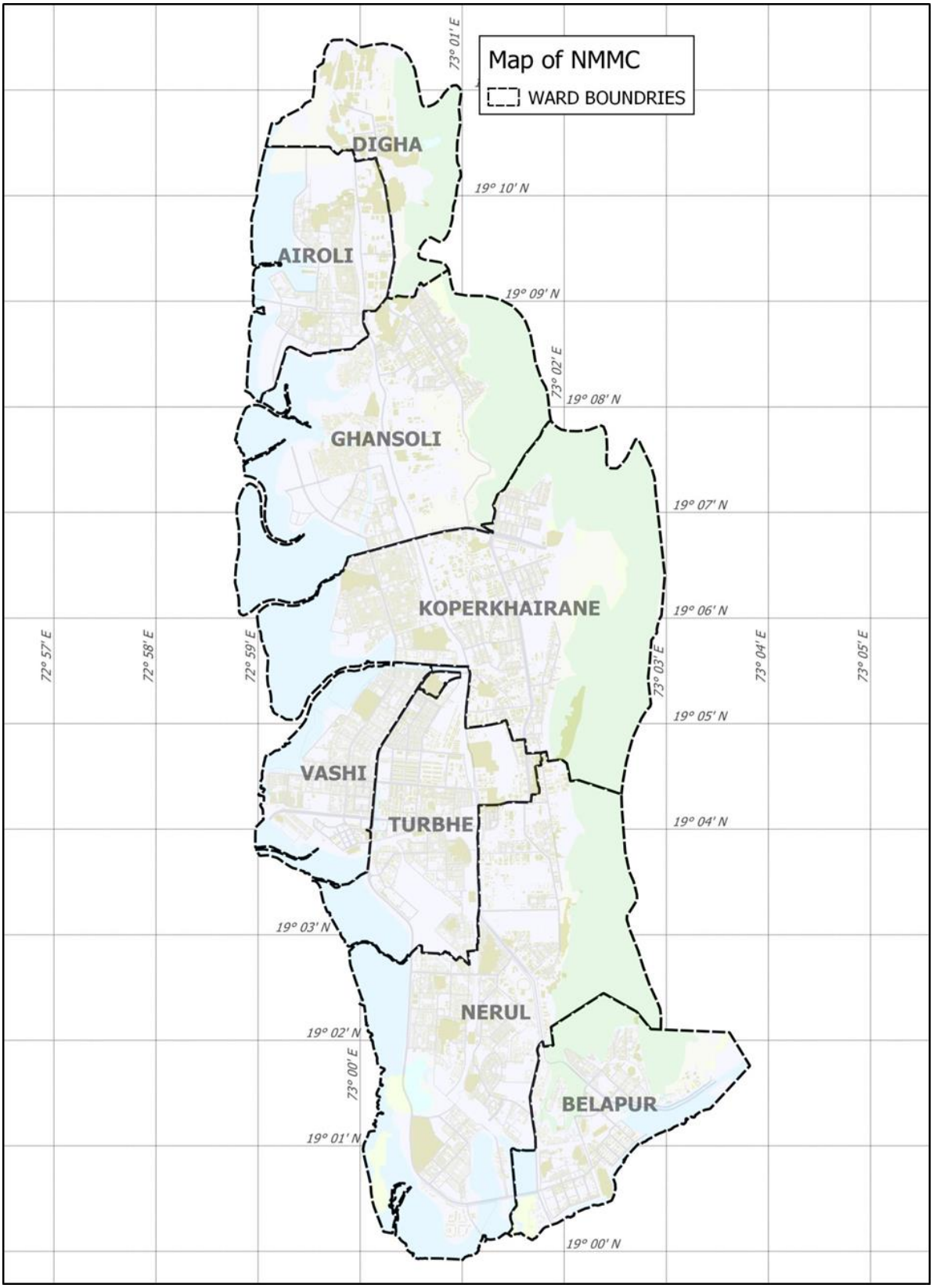
Table No. 2: Geographic and demographic highlights of Navi Mumbai

Heads	Attributes
Longitude Latitude	72°58′ to 73°03′E 19°00′ to 19°12′N
Mean Height above Sea Level	3.25 Metres
Nodes under NMMC	Belapur, Nerul, Turbhe, Vashi, Koparkhairane, Ghansoli, Airoli and Digha.
Total area under NMMC jurisdiction	108.63 Sq. km
Estimated Population (UHP Survey)	14,37,379
Population (Census of India-2011)	11,20,547
Population Density (Census data-2011)	10,315 persons per sq. km
Sex Ratio (As per census data-2011)	837 Females per 1000 Males,

Source: Census of India 2011

[4] CE, NMMC

Map No. 1: Wards of NMMC along with latitude and longitude



Climate

Navi Mumbai lies in the tropical climatic zone and has three seasons' summer, monsoon and winter. The annual temperature in Navi Mumbai varies from 22°C to 36°C while in summers the maximum temperature ranges between 36°C to 41°C and the minimum temperatures in winter ranges between 17°C to 20°C. The average annual rainfall is 2000-2500 mm and humidity is 61-86 %. Based on IMD's (Indian Meteorology Department) observations recorded at TBIA (Thane Belapur Industry Association) premises, the predominant wind direction in Navi Mumbai is southwest in monsoon and north-east during rest of the year.[5]

Based on the data recorded at the CAAQMS (Continuous Ambient Air Quality Monitoring Stations), for NMMC, the monthly average temperatures (Figure No. 4) were recorded to be between 25°C to 31°C for the year 2014-15. The highest maximum temperature of 31°C was recorded in the month of May and the lowest temperature of about 17°C was recorded in the January month. The maximum fluctuation of the temperatures was recorded in the August month.

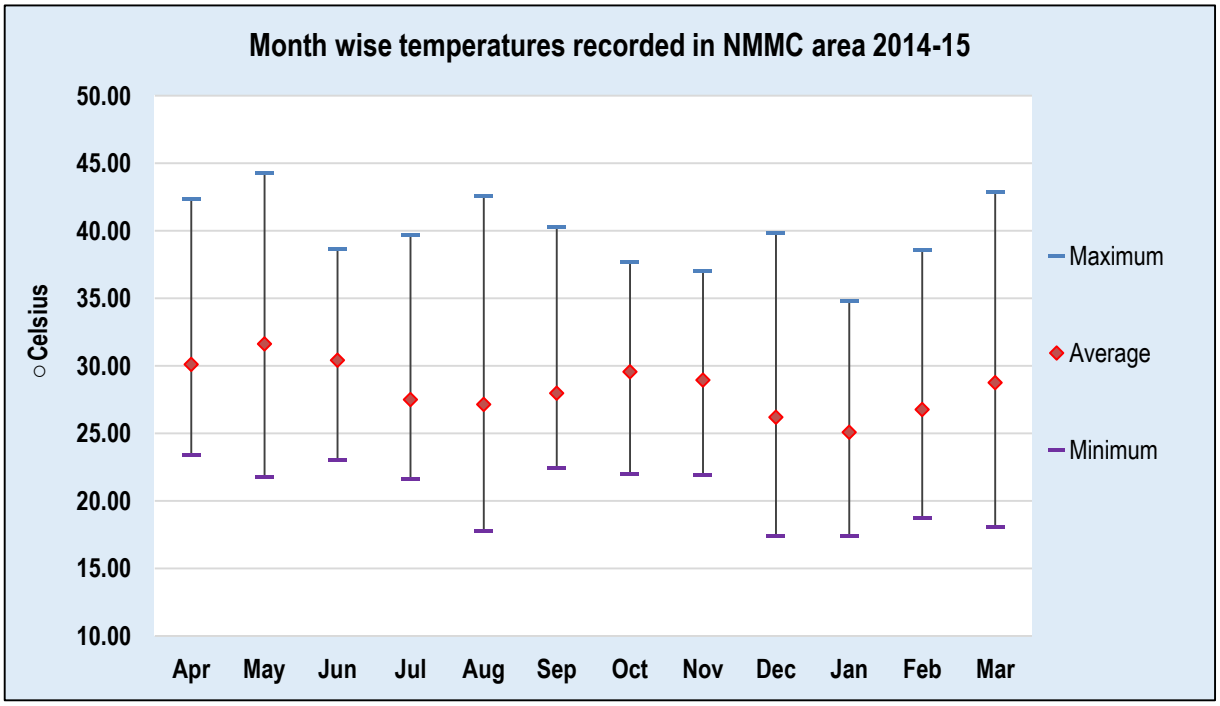


Figure No. 4: Month wise temperatures recorded in NMMC area 2014-15

Source: CAAQMS of NMMC at Airoli, Turbhe and Koparkhairne

[5] http://www.nmmconline.com/web/guest/climate

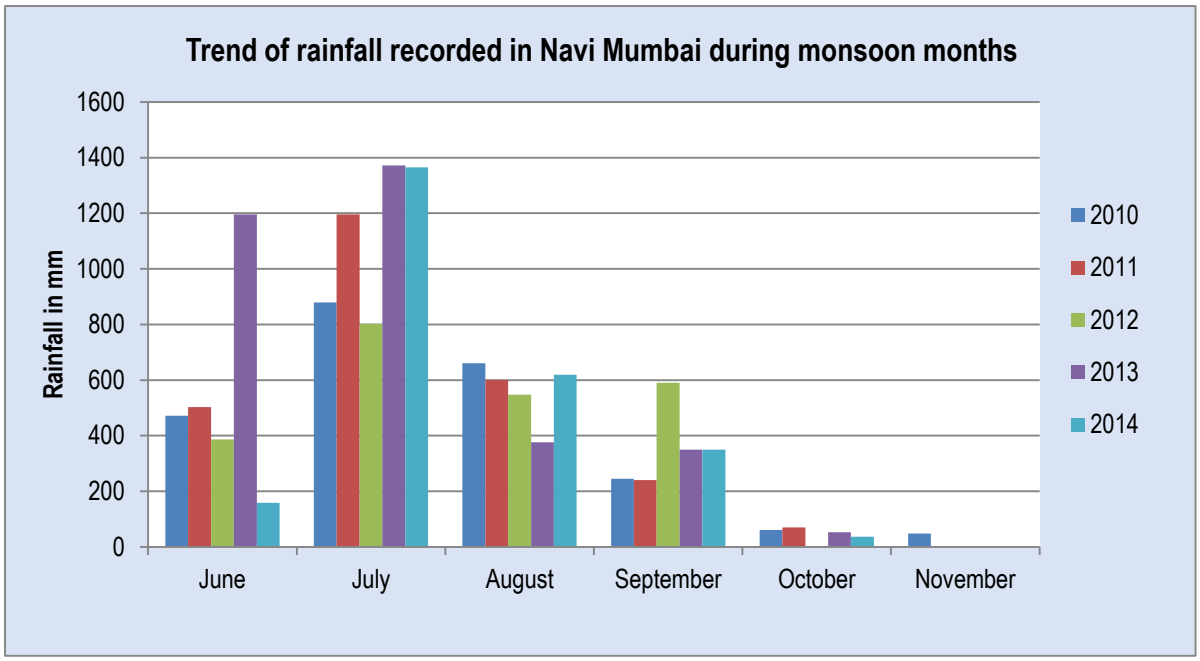


Figure No. 5: Trend of rainfall in Navi Mumbai

Source: Environmental Laboratory, NMMC

Table No. 3: Rainfall in Navi Mumbai

Month	Rain in mm				
	2010	**2011**	**2012**	**2013**	**2014**
June	471.9	502.88	386.02	1196.18	158.92
July	879.38	1195.22	802.26	1372.19	1365.39
August	660	600.05	548.23	376.55	619.17
September	244.62	239.9	589.87	350.07	349.61
October	61.25	70.45	-	52.29	36.57
November	47.65	-	-	-	-
Total	**2317.15**	**2608.5**	**2326.39**	**3347.28**	**2529.66**

Source: Environmental Laboratory, NMMC

The total annual rainfall for NMMC region in the year 2014 presented in Table No. 3 was recorded to be 2529.66mm. The month of July recorded the highest rainfall of 1365.39 mm while month of October recorded the least precipitation of 36.57mm. The month of June received less rainfall in 2014 as compared to last 4 years indicating delay in monsoons in the last year. As observed in Figure No. 5, the year 2013 recorded the highest annual rainfall in Navi Mumbai during last 5 years, whereas the month of July has been the month to receive the maximum rainfall throughout the last five years.

Connectivity

In terms of rail connectivity, Navi Mumbai has six rail corridors, 157 km railway system and an independent mainline rail terminal connecting the city directly to Chhatrapati Shivaji Terminus (town side) as well as western parts of Mumbai.[6] The city also has good accessibility to Pune and Pimpri regions through road as well as rail transport.

The road transport wing of Navi Mumbai includes connectivity from bus operators of Brihanmumbai Electric Supply and Transport (BEST), Navi Mumbai Municipal Transport (NMMT), Kalyan- Dombivali Municipal Transport (KDMT) and Khopoli Municipal Transport (KMT) which provide bus services to entire Navi Mumbai city as well as to certain parts of Mumbai, Thane, Kalyan, Dombivli, Badlapur, Taloja, Panvel and Uran.

The number of operational buses under NMMT was 360 in the year 2014-15. As seen in Figure No. 6, NMMT had four more buses plying in the year 2014-15 as compared to the previous year (356). As per the data records of NMMT, the number of passengers travelling by NMMT buses increased by 7% as compared to last year 2013-14. The distance travelled by per bus per day has reduced by 3% from 2013-14.

Many projects, like the Navi Mumbai Metro, trans-harbour link between Mumbai (Wadala) and Navi Mumbai (Ulwe), elevated corridor on Palm Beach road, as well as the ambitious international airport proposed near Panvel, are expected to enhance the connectivity as well as the status of the city.

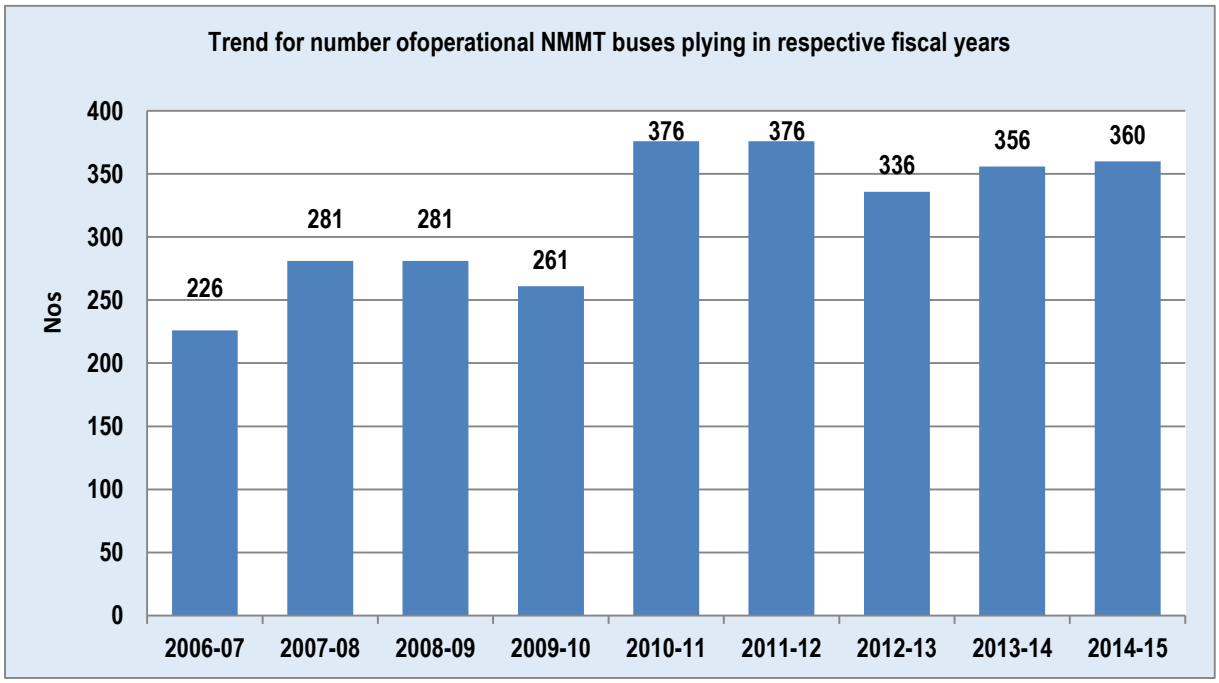


Figure No. 6: Trend for number of operational NMMT buses plying in respective fiscal years

Source: NMMT

[6] http://www.nmmconline.com/nmmt

Drivers

The process of urbanization is one of the most important dimensions of economic, social and physical change. Urbanisation provides opportunities for employment, better housing, education, knowledge and technology transfer, and ready markets for various products but also leads to enormous stress on natural resources. The population of India has increased by more than 22% (181 million) during the decade 2001-2011[7]. The increase in population directly increases the demand for land, water as well as other natural resources, indirectly impacting their natural status, thus population growth acts as crucial driver to urbanisation, which may impact various resources. The drivers like growth in industrial activities, urban facilities, educational facilities, infrastructure development and so on are the main reason for population growth, indirectly impacting the resources like air, water and land. These resources have been analysed in separate sections for their status, the—Pressures being exerted on them, the —Impact of various urban activities on these resources, and the —Response taken by the corporation to reduce the impacts.

Population growth

NMMC, formed in 1991, comprises 8 nodes developed by CIDCO from Airoli to CBD Belapur. NMMC estimates the population of the city every year based on the survey data of the UHPs (Urban Health Posts) in NMMC. In the year 2014-15 the population of NMMC was estimated to be about 14,37,379 and registered a growth of about 0.5% as compared to 2013-14. The development of industrial belt with ample job opportunities, higher income leading to better lifestyle, and other facilities has led to migration of people into the city. The population growth for last 5 years for Navi Mumbai has been represented in Figure No. 7.

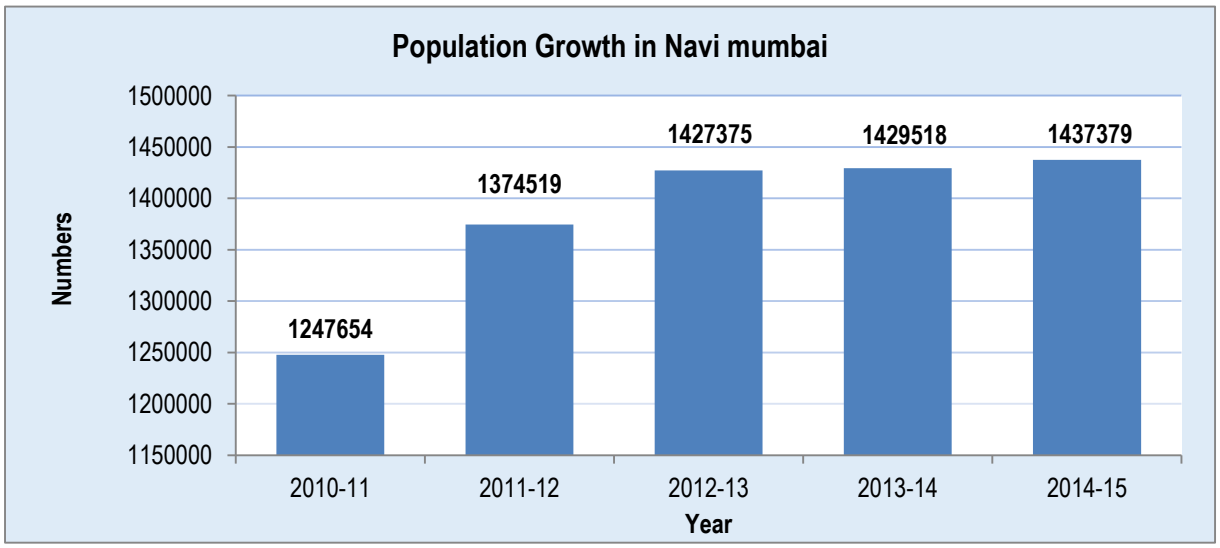


Figure No. 7: Population growth in Navi Mumbai

Source: UHP Survey, NMMC

[7] http://censusindia.gov.in/2011-prov-results/data_files/india/pov_popu_total_presentation_2011.pdf

Industrial and Commercial growth

Development of industrial belt in Navi Mumbai has led to rapid industrialization in the city which is the prime economic driver. About 16% of total area in Navi Mumbai falls under MIDC (Maharashtra Industrial Development Corporation) zone.*8*. The city is also known for its dedicated and planned space developed for corporate offices, government offices, educational centres, APMC (Agricultural produce market committee) market and so on. The key industrial growth centres have been discussed below.

MIDC areas

The Trans Thane creek (TTC) Industrial area and Taloja MIDC are main industrial zones in Navi Mumbai. The TTC industrial area accounts for more than 3000 industries while the Taloja industrial area consists of large, medium and small industrial units. Various types of processing industries including chemical, paper, plastic and so on are located in these industrial areas. Some of the well-known industries in these areas include Balmer Lawrie & Co. Ltd., Reliance Paper Products, E Merck (I) Ltd., Hindustan Lever Ltd. and Pidilite Industries Ltd, Pfizer, Lubrizol India Ltd., Polyolefins Industries Ltd., Herdillia Chemicals Ltd., BASF (India) Ltd., Star Chemicals, Indofil Chemicals Ltd., and Phoenix Chemical Works and so on[9].

Apart from industrial units, there exists a CBD (Central Business District) located at Belapur spreads over 575 hectare which has been developed to house various corporate as well as government offices. The area is known to account for country's most prominent IT- BPO establishments. Employments observed in CBD Belapur are around 32% while 37% jobs are IT-BPO establishments located in Vashi.[10]

Jawaharlal Nehru Port Trust

JNP, commissioned on 26th May 1989, is ranked 24th among the top 100 container ports in the world. It is considered as hub port on the western coast of India handling around 60% of the country's containerized cargo. It has three dedicated container terminals namely JNPCT (Jawaharlal Nehru Port Container Terminal), NSICT (Nhava Sheva International Container Terminal) & GTIPL (Gateway Terminal India Private Ltd). The port has handled 57.29 million tons of cargo in 2008-09 including 3.96 TEU's (Twenty foot Equivalent Units) containers and poised to handle 10 million TEUs of containers by the year 2015-16.[11]

APMC market

Built on a 7.92 hectare area, the APMC market at Navi Mumbai is one of the biggest agricultural markets in Asia and has given a unique identity to the city. After its establishment in 1996, about 13 major wholesale agricultural produce markets from Mumbai were shifted to APMC Vashi. The APMC has an estimated annual trade turnover of INR. 6000 crores, and generates employment for about 1 lakh people. APMC comprises of four markets divided into two phases.- Phase-I comprises Market-I which is the onion and potato market and Market-II which is the fruit and vegetable market whereas Phase-II has Market-I which is the commodity market and Market-II which is the grain, rice and oilseed market.

[8] http://www.nmmconline.com/web/guest/land-usage
[9] http://www.tbiaindia.org/Industry.html
[10] http://www.cidco.maharashtra.gov.in/NM_Commercial_Infrastructure.aspx
[11] http://www.cidco.maharashtra.gov.in/NM_Commercial_Infrastructure.aspx

International Infotech Park (IIP), Vashi

The government of Maharashtra has identified Vashi as one of suitable area for growth and development of IT (Information and technology) industry Picture No. 4. The International InfoTech Park is located in the commercial complex of Vashi Railway Station spread over more than 6 lakhs sq. ft. area. This magnificent complex is home to companies like STPI, VSNL, 3i InfoTech, TracMail (India) Pvt. Ltd., Sify, Cyquator Technologies Ltd., Inter-connected Stock Exchange of India, The Times Group, Mid-Day and many others.

Picture No. 4: International Infotech Park-Vashi

Source: https://roysaurav.files.wordpress.com/2012/07/day-197-15th-july-2012.jpg

Education Industry

A number of premier schools and colleges have been set up in Navi Mumbai. Each of the nodes is self-sufficient in terms of providing quality education. Navi Mumbai has all types of educational institutes including pre-primary (250), anganwadis (92), primary and secondary schools (468), junior & senior colleges (71), Engineering (10) and Medical (4) providing quality education in streams of Arts, Commerce and Science.

Malls & Retail Stores

There are 6 major operational malls in this zone. Vashi is clearly the dominant micro-market in this zone, housing 3 active malls such as Center One, Raghuleela Mall and Inorbit Mall. D-Mart has launched hypermalls in Navi Mumbai at Koparkhairne and Nerul In addition to this there is many medium to small format retail outlets in Navi Mumbai.

Urbanization and spatial growth

India is witnessing increasing levels of urban population. Nearly 31 percent of the country's population lives in cities and urban areas as per census of 2011. While cities are regarded as 'Engines of growth', they continue to face enormous challenges. Increasing urbanization has led to tremendous pressure on land, civic infrastructure, transport, open spaces and so on. It is projected that the urban population would grow to about 470 million in 2021 and 700 million in 2041[12]. The rapid expansion of urban areas due to rise in population and economic growth is increasing additional demand on natural resources thereby causing land-use changes especially in megacities.

The steady growth of humans, the current phase of economic growth and trade liberalisation, are exerting heavy pressures on India's limited land resources for competing uses in forestry, agriculture, pastures, human settlements and industries. This has led to very significant land degradation.

Navi Mumbai shows 0.5% increase in population in the year 2014-15 as compared to last year (2013-14) .The nodal areas of Navi Mumbai are expected to grow in population at faster rate which increase in use of land resource to accommodate the population.

The number of properties in NMMC has been increased by 36% since 2007-08 as observed in Figure No. 8 For the current year 2014-15, the residential properties mark the highest recording 80% of total 2,87,025 properties. This is followed by commercial buildings with 18% share and MIDC commercial with least of 2% share. The sector wise property for the year 2014-15 is shown in Figure No. 9.

[12] Ministry of Statistics & Programme Implementation, Government of India, Conference of Central and State Statistical Organisations (COCSSO), page 6

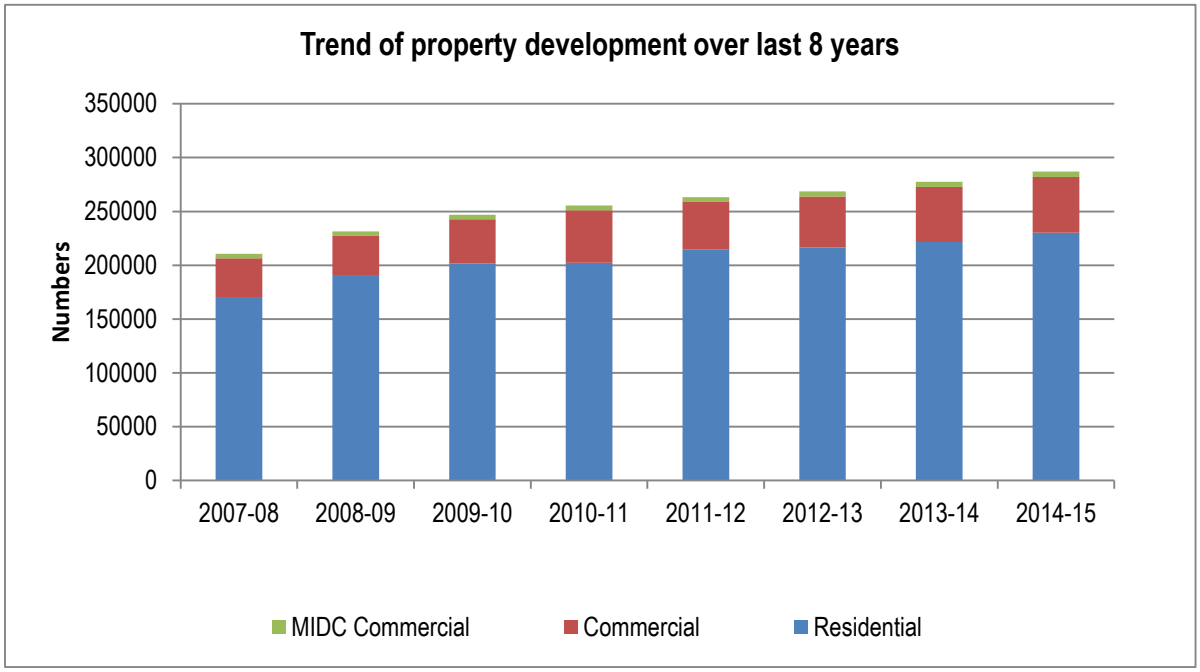


Figure No. 8: Trend of property development over last 5 years in Navi Mumbai

Source: Town Planning Department, NMMC

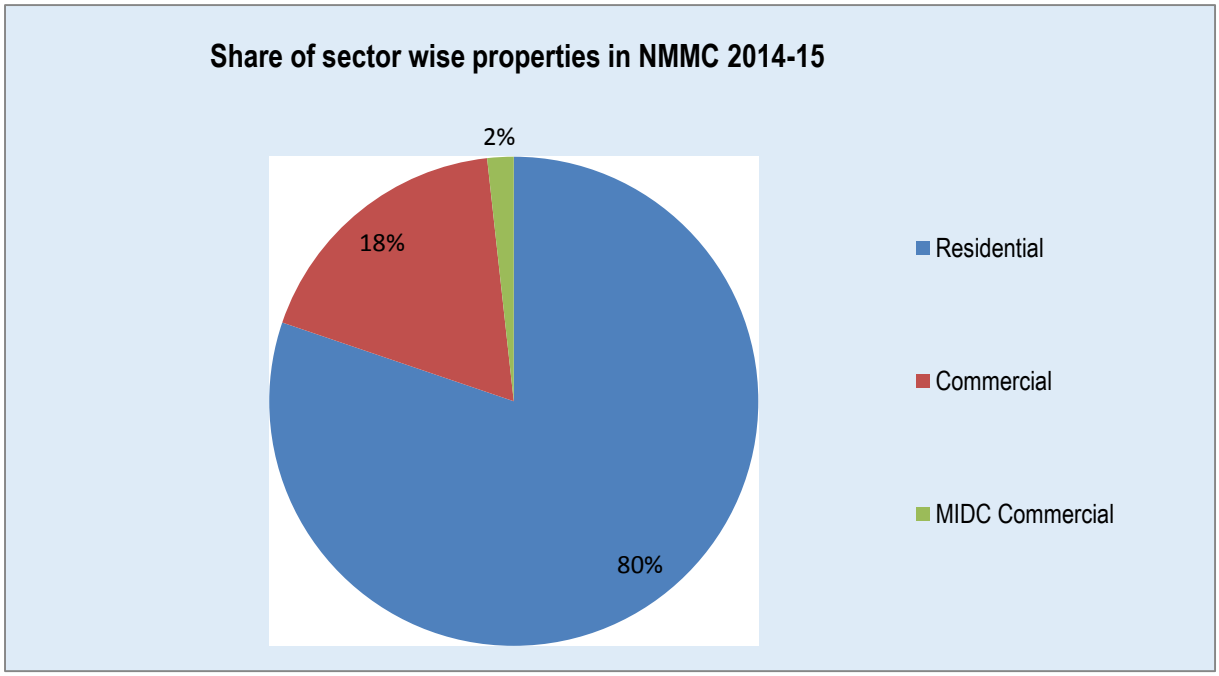


Figure No. 9: Sector wise breakup of property for year 2014-15

Source: Town Planning Department, NMMC

Air Quality

Among all the important resources around us air plays a crucial role in our environment. Good air refers to clean, dust-free, stench-free and unpolluted air. Poor air quality not only affects humans but is also known to severely impact the local flora and fauna. Air pollutants not only cause irritation to eyes and nose but may also enter human body through respiratory system and affect throat, bronchi and lungs.

WHO (World Health Organization) in its Ambient Air Pollution Database Report has cited that Air quality in most cities worldwide, which monitor ambient air pollution, fail to meet WHO guidelines for safe levels, putting people at additional risk of respiratory disease and other health problems. In April 2014, WHO issued new information estimating that outdoor air pollution was responsible for the deaths of around 3.7 million people under the age of 60 in 2012.

Monitoring of air quality is a prerequisite to the development of management strategies for safeguarding against damaging effects of air pollution. A network of air quality monitoring stations is chosen across a region for the purpose of vigilance of the spatial and temporal changes in air quality. At national level, CPCB (Central Pollution Control Board) periodically compares the status of air quality parameters which indicate the comparative status of various cities. In addition to this, at state level MPCB and at city level NMMC also monitors the air quality parameters. Presented below in Table No. 4 is a comparative performance of various cities in India as per monitoring done by CPCB collated in the year 2010 under the NAMP (National Air Monitoring Program). Although the SO_2 concentration in Navi Mumbai is below the permissible limit (50 µg/m³), it is still higher compared to other cities.

Table No. 4: Concentration of key pollutants in major cities of India

City	SO_2		NO_2		PM_{10}	
	Annual Average (µg/m³)	Air Quality	Annual Average (µg/m³)	Air Quality	Annual Average (µg/m³)	Air Quality
Annual Permissible limits	50		40		60	
Chandigarh	2	L	16	L	92 *	C
Noida	11	L	46*	H	132*	C
Bhubhaneswar	2	L	18	L	84*	H
Delhi	5	L	55*	H	261*	C
Ahmedabad	15	L	21	M	95*	C
Surat	16	L	24	M	76*	H
Mumbai	4	L	19	L	97*	C
Navi Mumbai#	20	L	39	M	113*	C

L: Low, M: Moderate, H: High, C: Critical; *: Exceeding NAAQS, # data considered for monitoring stations of MPCB monitoring stations

Source: State of Air Quality in India-2010; CPCB

Figure No. 10 gives a comparative analysis of performance of air pollution among major cities of India, including Navi Mumbai and Mumbai, under NAMP. Air quality in terms of Sulphur dioxide and Nitrogen dioxide was found to be within permissible limits in Navi Mumbai, whereas in terms of PM_{10} it ranked 6th among the eight cities of India in the year 2010.

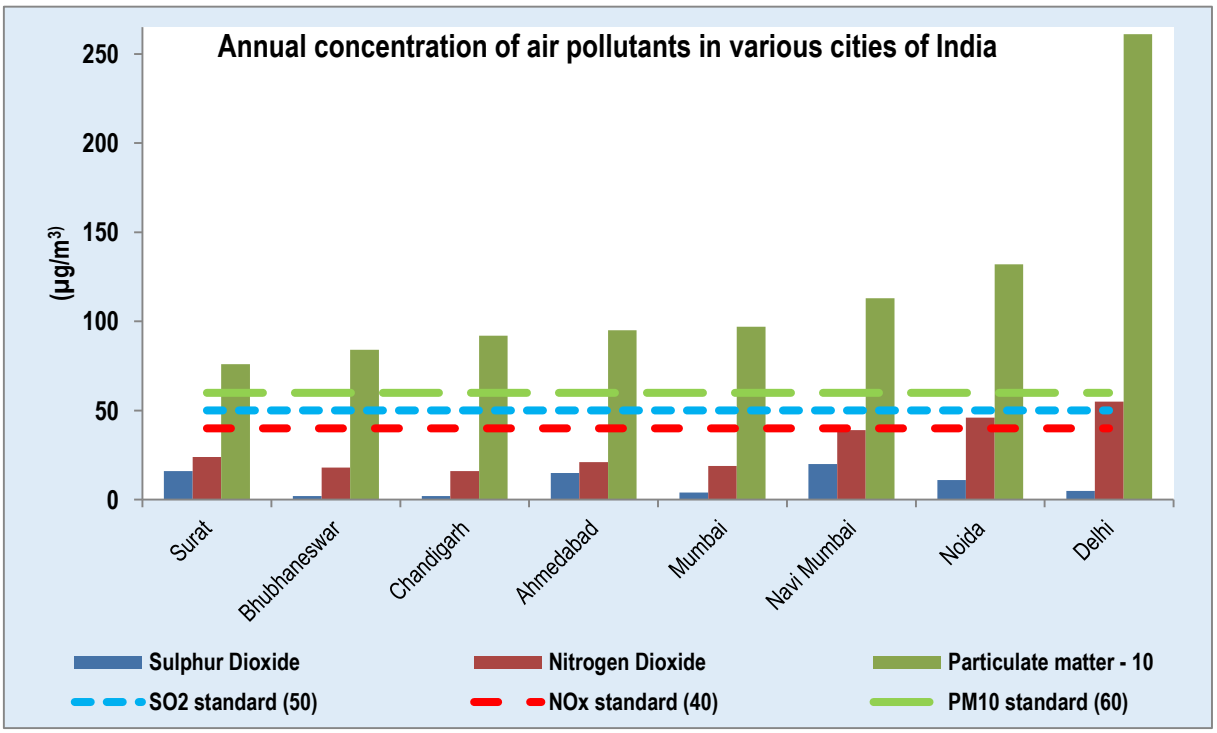


Figure No. 10: Annual concentration of air pollutants in various cities of India

Source: State of Air Quality in India-2010; CPCB[13]

13 http://www.cpcb.nic.in/upload/NewItems/NewItem_192_NAAQSTI.pdf

Status

Air Quality Monitoring Network

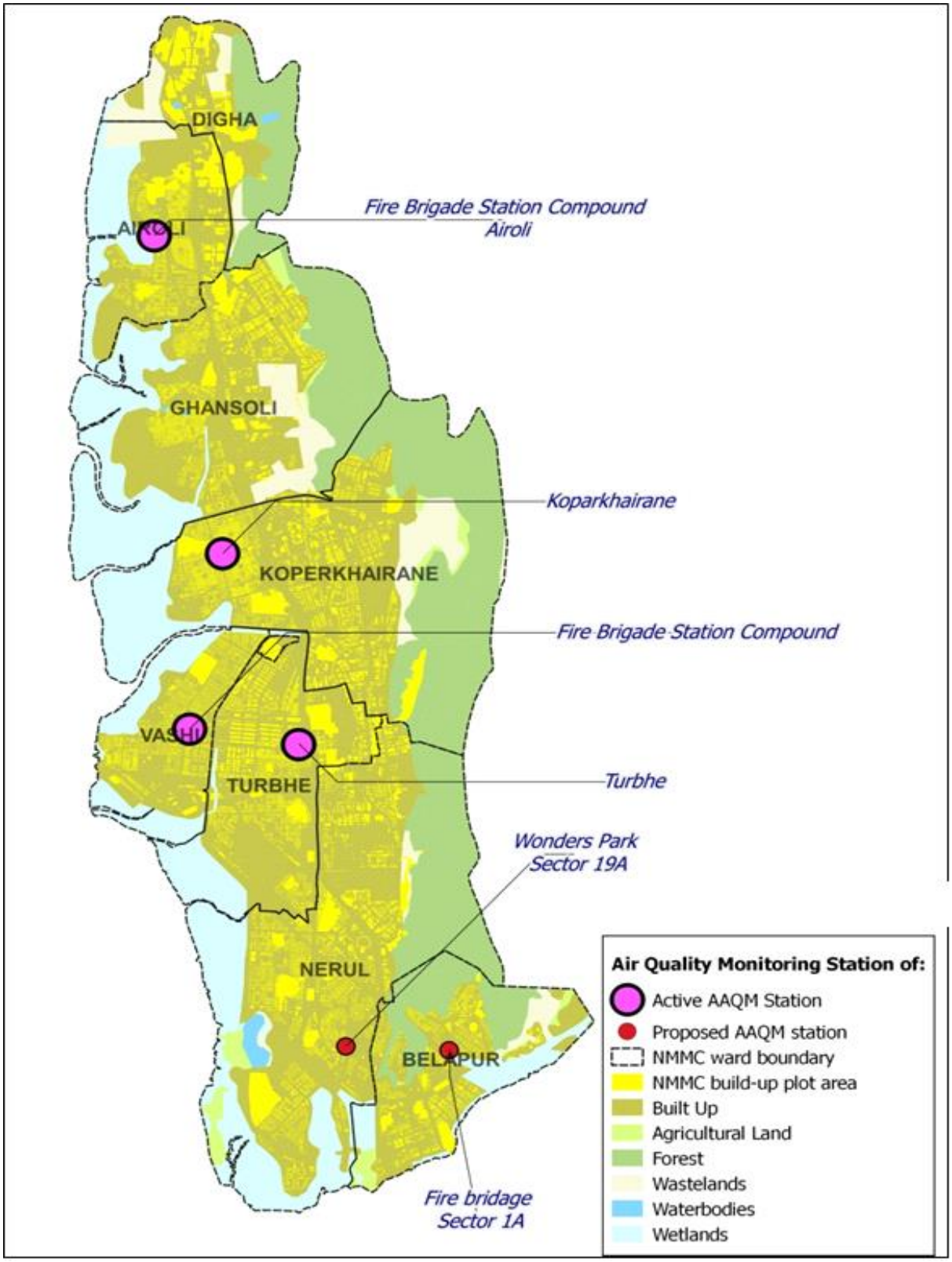
Presently there are 4 active CAAQMS (Continuous Ambient Air Monitoring Stations) at Airoli, Koparkhairane, Vashi and Turbhe in addition to an air monitoring mobile van. Data from continuous monitoring of NMMC for the fiscal year 2014-15 have been collated and analyzed to get an overview of the region's air quality status and trends over the past few years.

Table No. 5 provides the tally of active ambient air quality monitoring stations in NMMC region. Out of the four continuous monitoring stations maintained and operated by NMMC, which monitor air quality parameters in addition to climatological parameters, in the year 2014-15 only three CAAQMS were active while the Vashi CAAQMS was non-operational due to renewal of contract of the agency as well as maintenance of the machine. The spatial representation of these monitoring stations is depicted in Map No. 2. To have an appropriate representation of air quality in the city, NMMC has proposed installation of two CAAQMS, one each at CBD-Belpur and Nerul. Currently the mobile monitoring van is deputed at various locations in these nodes to monitor the air quality.

Table No. 5: Details of CAAQMS in Navi Mumbai Municipal region:

Station name	Location	Latitude and Longitude	Operating Agency	Status (2014-15)
Airoli	Airoli fire station	19° 09' 21.4" N 72° 59' 35.4" E	Chemtrols	Operating
Koparkhairne	Teen Taki Area	19° 06' 17.4" N 73° 01' 09.3" E		Operating
Turbhe	Turbhe Landfill site	19° 04' 42.5" N 73° 01' 34.6" E		Operating
Vashi	Fire Brigade compound	19° 03' 20.4" N 72° 55' 19.5" E	Thermo Fischer	Closed for Maintenance
Nerul (Proposed)	Wonders Park	19° 01' 32.0" N 73° 01' 36.0" E	IITM	Under Process
CBD Belapur (Proposed)	Belapur Fire station	19° 01' 28.7" N 73° 02' 25.1" E		

Source: Environment Laboratory, NMMC



Map No. 2: Spatial representation of existing and proposed CAAQMS in NMMC area

Source: Environment Laboratory, NMMC

Trend in SO_2 concentrations

SO_2 is highly reactive and a major air pollutant which is emitted by burning of coal, oil and other fossil fuels containing Sulphur. It reacts with the atmosphere to form sulfuric acid (H_2SO_4) causing acid rain which may lead to acidification in lakes, leaching of minerals from soil and other effects. Sulphur dioxide can also affect respiratory systems and cause reduced lung capacity.

As seen in Table No. 6 and Figure No. 11, the annual SO_2 concentrations for all the 4 continuous stations are well below the annual average standards for SO_2 (50 µg/m³) as per NAAQS (National Ambient Air Quality Standards) set by CPCB. Turbhe station just exceeds the limit by 0.08µg/m³ in the year 2012- 13 but the concentrations have decreased in the next 2 years. This indicates that SO_2 pollution in Navi Mumbai is well under control.

Table No. 6: Yearly trend of concentration of SO_2 at CAAQMS in Navi Mumbai

Year	Koparkhairne (µg/m³)	Airoli (µg/m³)	Vashi (µg/m³)	Turbhe (µg/m³)
Annual Permissible limit	50	50	50	50
2009-10	-	23	53	-
2010-11	-	27	19	-
2011-12	13.906	13	19	-
2012-13	32.245	21	27	50.08
2013-14	20.3	22	31	45
2014-15	14.46	17.92	-	42.79

Source: Environmental Laboratory, NMMC

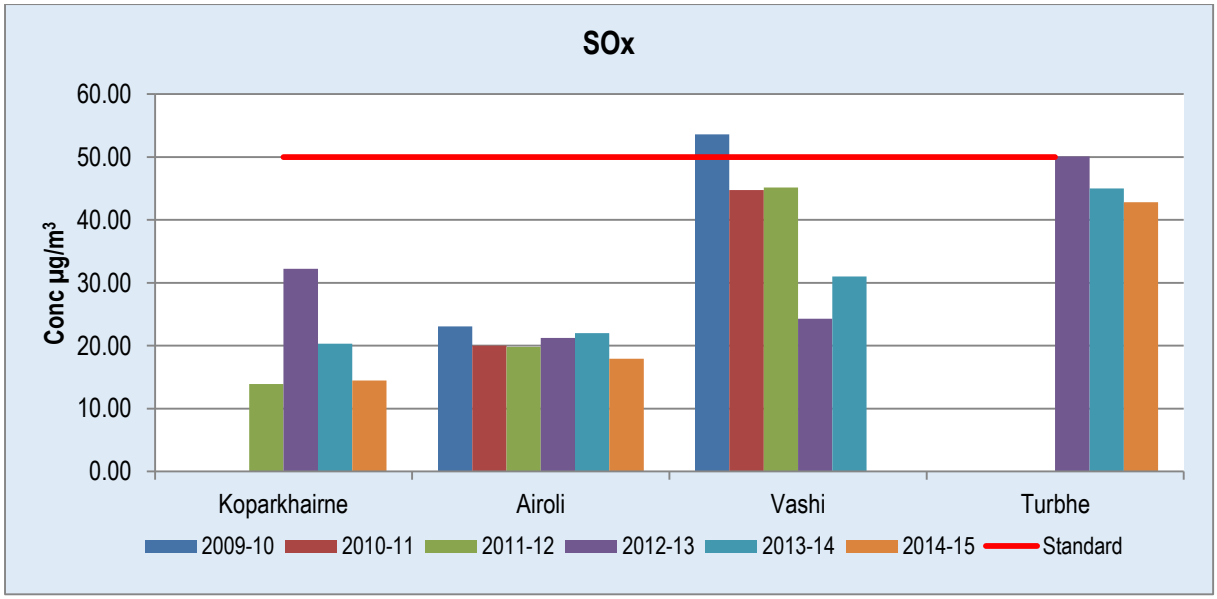


Figure No. 11: Yearly Trend in concentration of SO_2 at AAQMS in Navi Mumbai

Source: Environmental Laboratory, NMMC

Trend of NO_X concentrations

NO_X is an air pollutant emitted by combustion of fuel in vehicles, industrial processes, and domestic usage. Among the NO_X family, NO_2 has adverse effect on human health since it causes lung disorders. It is also a contributor to formation of secondary pollutants such as PM and Ozone. The yearly trend in concentration of NOx at 4 CAAQMS can be observed in Table No. 7 and Figure No. 12.

It can be clearly observed that, there is a decreasing trend for NOx concentrations at Koparkhairne and Airoli areas. These stations were previous recorded to violate the NOx standards but in the year 2014-15, these stations recorded improvement in air quality for NOx levels and the annual average at Koparkhairne was recorded in the borderline category (42µg/m³) and at Airoli was recorded clean (27µg/m³) which is well below the annual permissible limit. The AAQMS at Vashi and Turbhe have recorded the readings for NOx well below the standards for the past 5 and3 years respectively. Even though the readings at Turbhe are well below standards, an increasing trend can be observed in the past 3 readings which indicates that the station may record violation in future if the pollution is not controlled in time

Table No. 7: Yearly trend in concentration of NO_X at AAQMS in Navi Mumbai

Year	Koparkhairne (µg/m³)	Airoli (µg/m³)	Vashi (µg/m³)	Turbhe (µg/m³)
Annual Permissible Limit	40	40	40	40
2009-10	-	82.69	57	-
2010-11	-	66.56	45	-
2011-12	79.34	59.13	43	-
2012-13	80.34	77.69	56	22
2013-14	63.83	46.38	44	30
2014-15	42.53	27.25	-	35

Source: Environmental Laboratory, NMMC

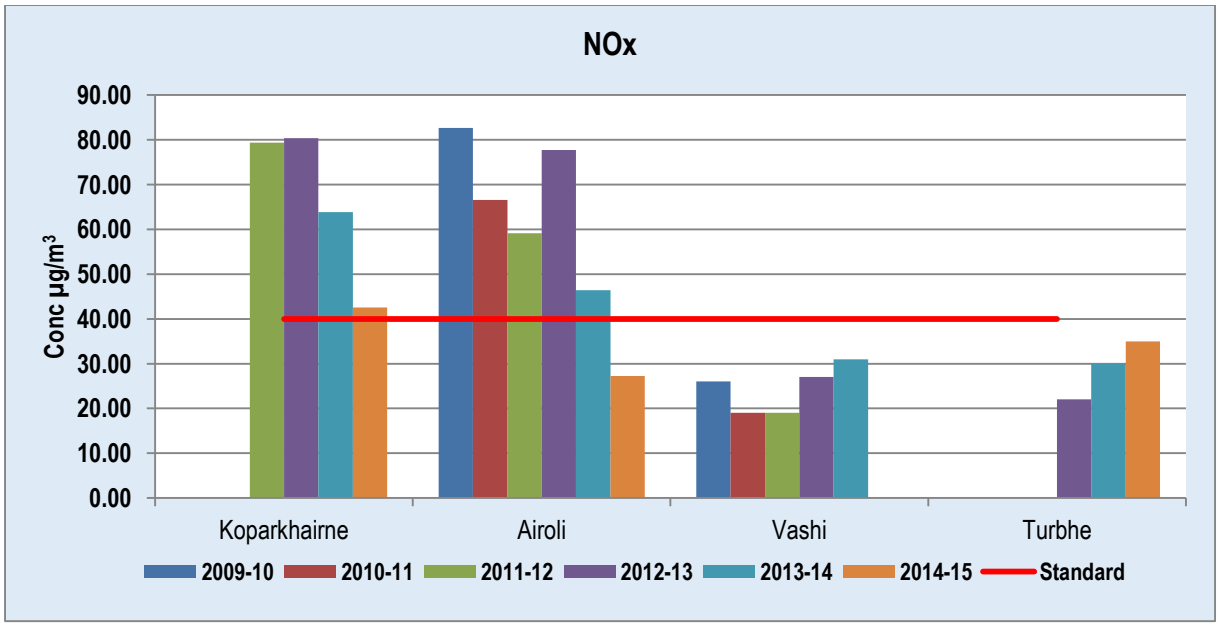


Figure No. 12: Yearly Trend in concentration of NOx at AAQMS in Navi Mumbai

Trend of PM_{10} concentrations

Particulate Matter is a complex mixture of fine particles and aerosols, and is also known as particle pollution. It is made up of a number of components, including acids (such as nitrates and sulphates), organic chemicals, metals, and dust particles. Particles that are 10 micrometers in diameter or smaller can pass through the throat and nose and enter the lungs and are commonly referred to as RSPM (Respirable Suspended Particulate Matter). Once inhaled, these particles can affect the heart and lungs and cause serious health effects. Table No. 8 and Figure No. 13 clearly indicates that all the 4 CAAQMS have recorded violation for PM_{10} for the past five years which indicates that Navi Mumbai is polluted with RSPM.

Table No. 8: Yearly trend in concentration of PM 10 at AAQMS in Navi Mumbai

Year	Koparkhairne (µg/m³)	Airoli (µg/m³)	Vashi (µg/m³)	Turbhe (µg/m³)
Annual Standards	60	60	60	60
2009-10			96.00	
2010-11		128.00	92.00	
2011-12	162.37	181.00	111.00	
2012-13	176.41	109.00	110.00	204.64
2013-14	135.53	53.00	108.00	151.20
2014-15	137.31	139.67		187.86

Source: Environmental Laboratory, NMMC

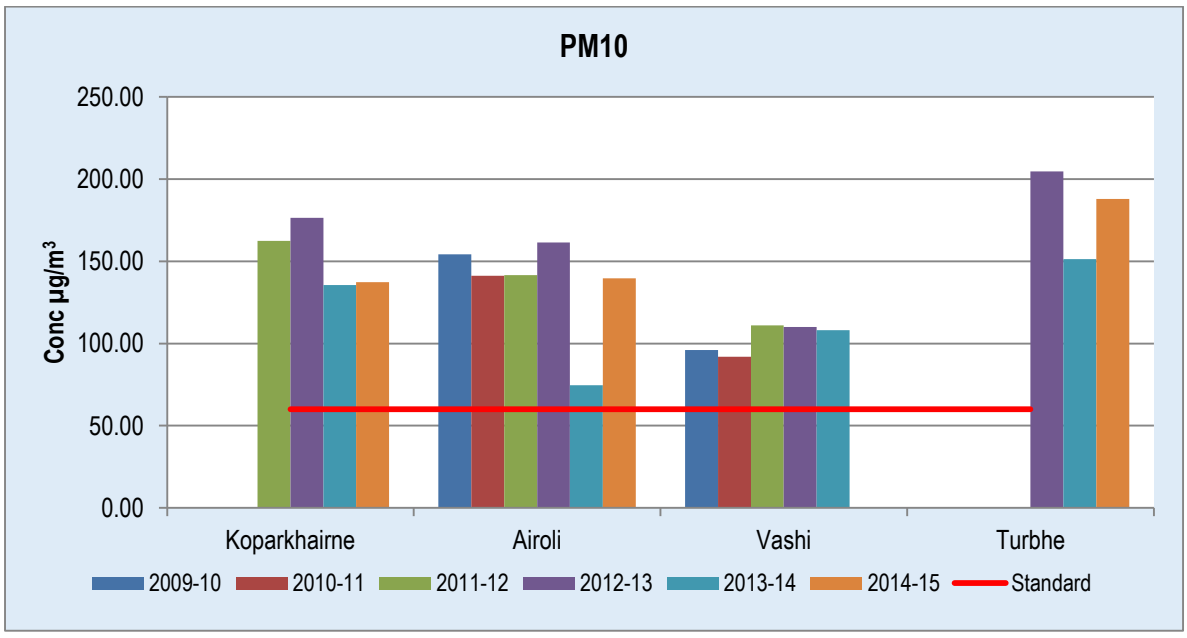


Figure No. 13: Yearly Trend in concentration of PM_{10} at AAQMS in Navi Mumbai

Trends in $PM_{2.5}$ concentrations

The particulate matter less than 2.5 micrometers (i.e. 10^{-6} meters), is the respirable fraction and is known to penetrate and accumulate deep inside the lungs. Hence is a more critical pollutant and has more stringent annual (40) and daily (60) standards as compared to other particulate matters. Since the last five years the $PM_{2.5}$ levels in Navi Mumbai have been higher than the standards at all regions. Koparkhairne and Turbhe areas have continuously violated the standards while Airoli region has a fluctuating trend for $PM_{2.5}$ emissions. As for the trend, Koparkhairne region has recorded a decreasing trend for PM concentrations. The trend for $PM_{2.5}$ concentrations have been presented below in Table No. 9 and Figure No. 14.

Table No. 9: Yearly trend in concentration of $PM_{2.5}$ at AAQMS in Navi Mumbai

Year	Koparkhairne (µg/m³)	Airoli (µg/m³)	Turbhe (µg/m³)
Annual Permissible limit	40	40	40
2009-10		41.57	
2010-11		39.38	
2011-12	78.40	33.11	
2012-13	74.88	50.45	71.15
2013-14	64.63	18.11	54.20
2014-15	63.97	42.81	71.57

Source: Environmental Laboratory, NMMC

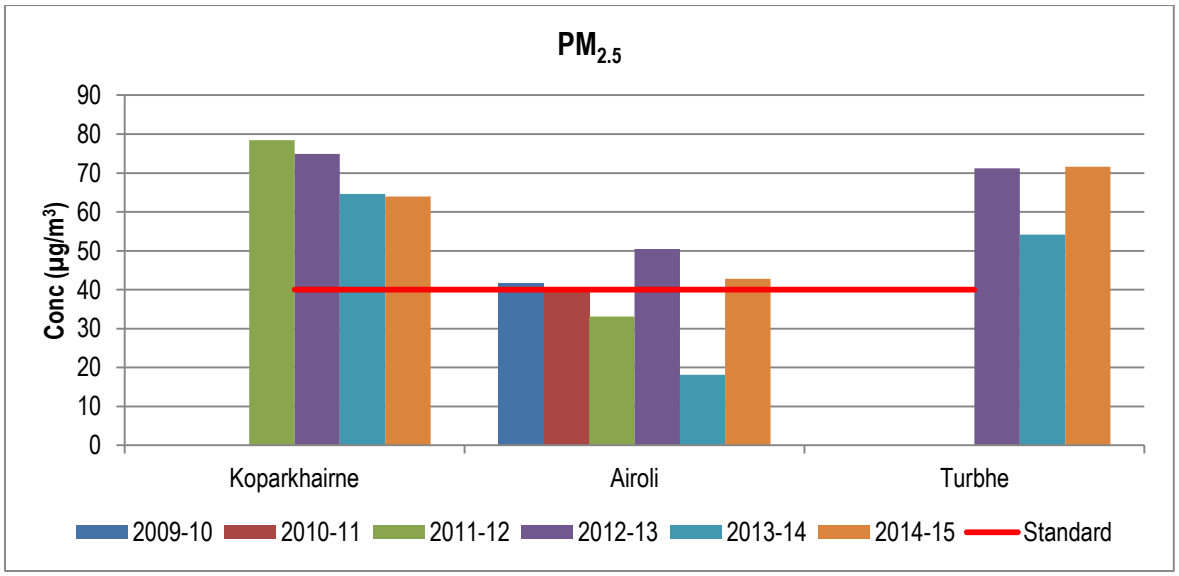


Figure No. 14: Yearly Trend in concentration of $PM_{2.5}$ at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

Inter Station Analysis

The interstation analysis of SO_2, NOx, $PM_{2.5}$ and PM_{10} have been presented below for 3 CAAQMS namely Airoli, Koparkhairane and Turbhe.

SO_2

The interstation analysis for concentration of SO_2 displayed in Table No. 10 and Figure No. 15 indicates that the SO_2 concentrations at all the 3 stations are under the annual standards (50µg/m³). Even the 98th percentile values for daily concentrations are well below the daily standards (80µg/m³). Even though all the annual averages are well below the daily standards, Turbhe stations records the daily peak value as 120.30µg/m³, more than 1.5 times the daily standards which means that on some days high SO_2 pollution is beyond the standards at Turbhe.

Table No. 10: Concentration of SO_2 across NMMC region (2014-15)

Station Name	Max of SO_2	98th Percentile	Average of SO2	Min of SO2	Daily Standard (µg/m³)	Annual Standard (µg/m³)
Airoli	49.81	32.78	17.98	2.25	80.00	50.00
Koparkhairne	32.77	28.61	14.59	4.12	80.00	50.00
Turbhe	120.30	68.69	42.79	13.90	80.00	50.00

Source: Environmental Laboratory, NMMC

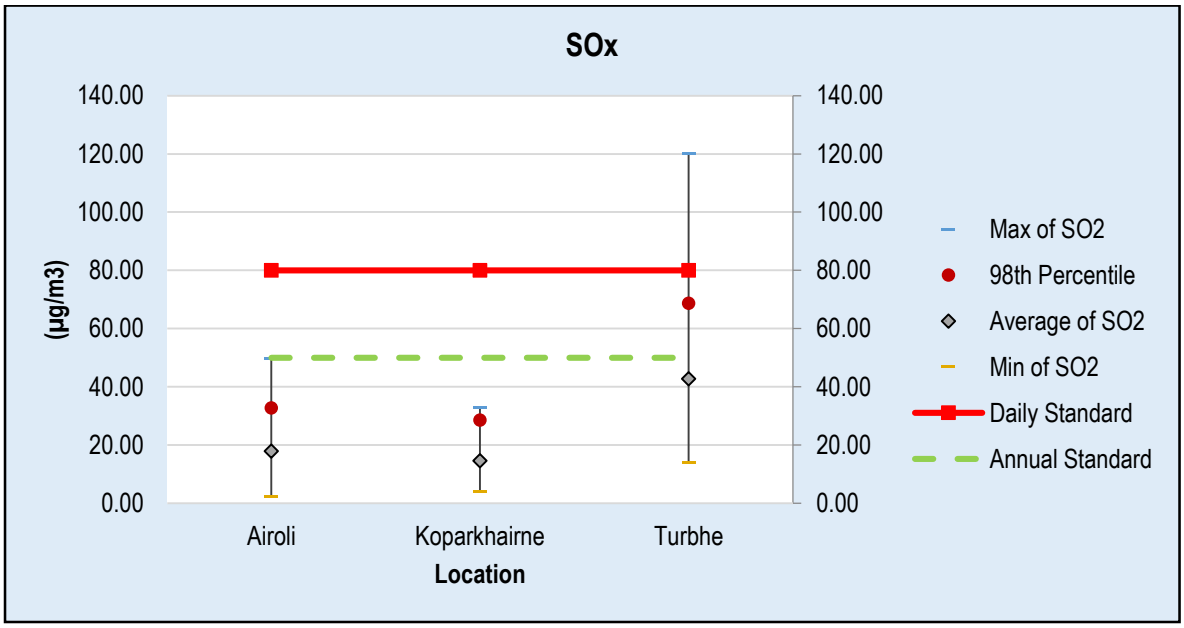


Figure No. 15: Concentration of SO_2 in NMMC region for the year 2014-15

Source: Environment Laboratory, NMMC

NOx

The interstation analysis for concentration of NOx displayed in Table No. 11 and Figure No. 16 indicate that the AAQMS at Koparkhairane recorded annual concentrations in the borderline category for the NOx concentration (42.55 µg/m³) violating the annual standards (40µg/m³) by a close margin. All the readings for 98th percentile were observed to be below the standards (80µg/m³). Although the maximum daily concentration of NOx at Koparkhairne was recorded to be (121.44µg/m³), it is a clear outlier since the 98th percentile values were within the daily standards (80µg/m³). The NOx levels at Navi Mumbai were well within control in the year 2014-15.

Table No. 11: Concentration of NO_X across NMMC region (2014-15)

Station Name	Max of NOX	98th Percentile	Average of NOX	Min of NOX	Daily Standard	Annual Standard
Airoli	47.03	41.68	27.16	11.60	80.00	40.00
Koparkhairne	121.44	78.40	42.55	7.94	80.00	40.00
Turbhe	68.30	58.15	34.80	11.70	80.00	40.00

Source: Environment Laboratory, NMMC

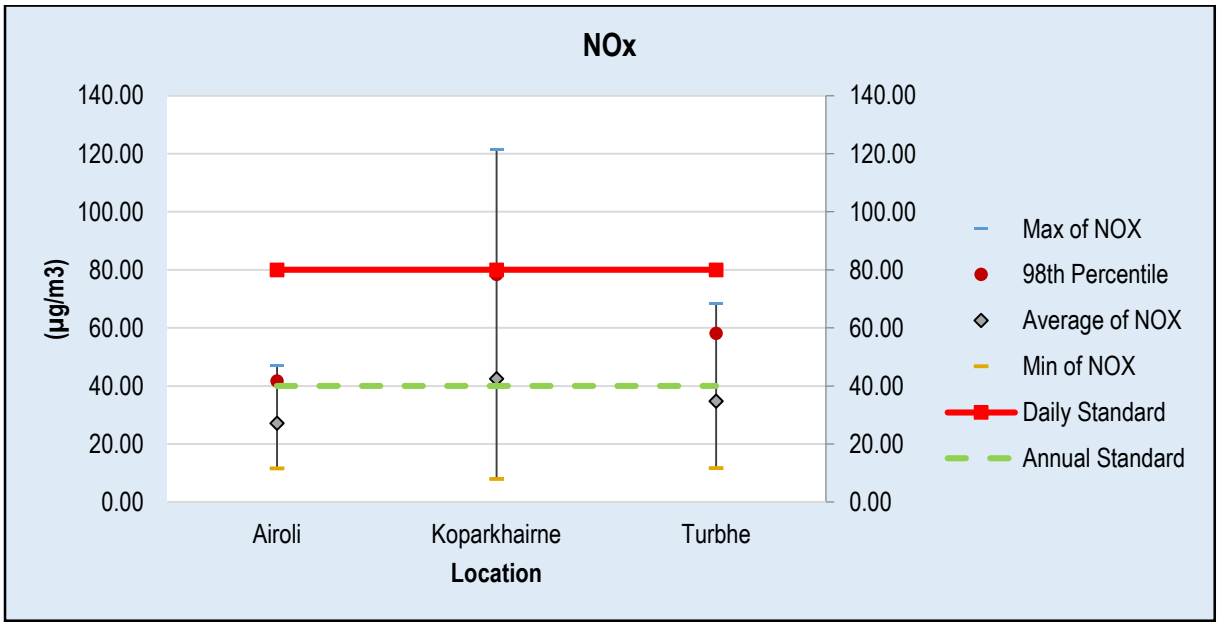


Figure No. 16: Concentration of NO_X in NMMC region for the year 2014-15

Source: Environment Laboratory, NMMC

$PM_{2.5}$

The interstation analysis for concentration of $PM_{2.5}$ are presented below in Table No. 12 and Figure No. 17. The analysis indicates that all the 3 CAAQMS recorded $PM_{2.5}$ above the annual standards (40µg/m³) clearly indicating high $PM_{2.5}$ pollution in all the areas. Highest pollution was recorded at Turbhe (71.57 µg/m³) followed by Koparkhairane (65.28 µg/m³) and Airoli (43.45µg/m³). The 98th percentile values also indicate a case of violation as the value highly exceed the 98th percentile daily standards (60 µg/m³). The Turbhe station records the 98th percentile value (144 µg/m³) to be almost 2.5times the daily standards, followed by Airoli and Koparkhairane. The daily peak values are also high for all the stations indicating high pollution of $PM_{2.5}$ in the area. The high pollution of $PM_{2.5}$ is mainly due to growing industrialization, quarry activities and increasing traffic congestions in the city.

Table No. 12: Concentration of $PM_{2.5}$ across NMMC region (2014-15)

Station Name	Max of PM 2.5	98th Percentile	Average of RSPM (PM 2.5)	Min of RSPM (PM 2.5)	Daily Standard	Annual Standard
Airoli	123.28	99.72	43.45	1.31	60.00	40.00
Koparkhairne	166.01	85.25	65.28	11.21	60.00	40.00
Turbhe	179.58	144.00	71.57	7.40	60.00	40.00

Source: Environment Laboratory, NMMC

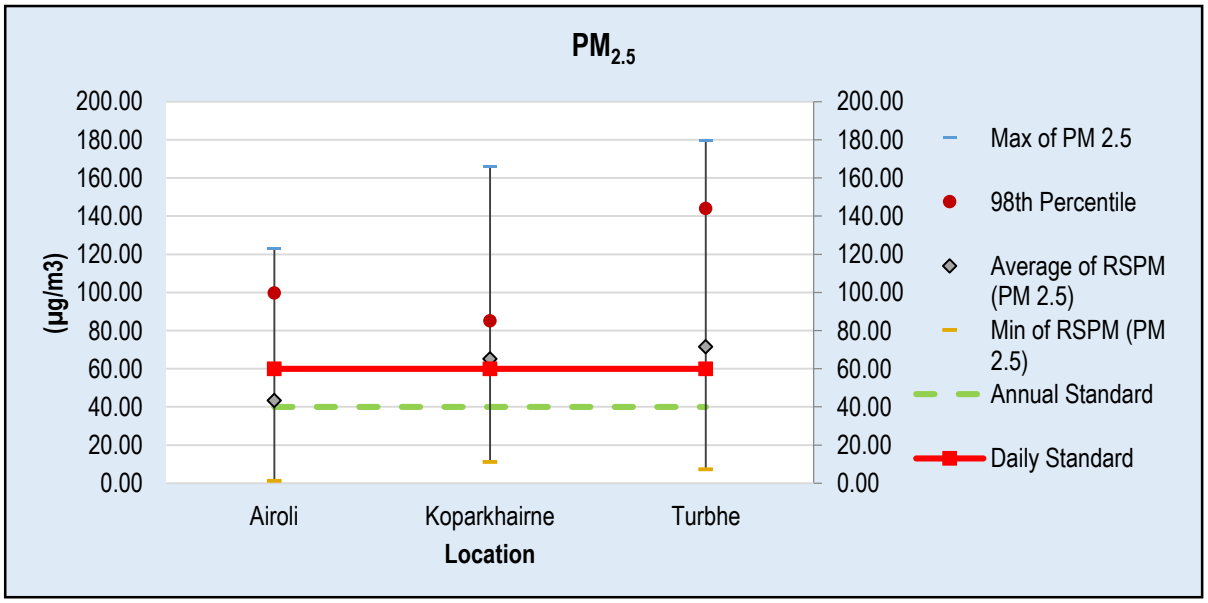


Figure No. 17: Concentration of $PM_{2.5}$ in NMMC region for the year 2014-15

Source: Environment Laboratory, NMMC

PM_{10}

The interstation analysis for concentration of PM_{10} are projected below in Table No. 13 and Figure No. 18. Concentrations of PM_{10} at all the CAAQMS are more than double the annual standards (60 µg/m³) indicating high levels of pollution. The concentration of PM_{10} was found to be highest at Turbhe (187.86µg/m³) followed by Airoli (141.61µg/m³) and Koparkhairane (139.78µg/m³).

The 98th percentile value are also exceeding for all the stations by almost 3 times the standards (100 µg/m³). Airoli stations (346 µg/m³) records the highest 98th percentile value followed by Turbhe (342.08µg/m³) and Koparkhairane (273.68µg/m³).

All the daily peak values for PM_{10} were also highly exceeding the daily standards indicating serious threat of PM_{10} pollution. The concentrations of PM_{10} are very high in the city mainly due to the growing industrialization and traffic congestion. Hence we can conclude that pollution due to dust/fine particulate matter poses a vital environmental issue for Navi Mumbai. But the continuous efforts, like mechanized sweeping of roads, concretization of major junctions, developing smooth surface roads and various other initiatives by NMMC have made it possible to curtail PM_{10} concentration in ambient air to a great extent compared to previous years.

Table No. 13: Concentration of PM_{10} across NMMC region (2014-15)

Station Name	Max of PM 10	98th Percentile	Average of SPM (PM 10)	Min of SPM (PM 10)	Daily Standard	Annual Standard
Airoli	394.53	346.13	141.61	27.44	100.00	60.00
Koparkhairne	319.00	273.68	139.78	31.41	100.00	60.00
Turbhe	461.74	342.08	187.86	19.02	100.00	60.00

Source: Environmental Laboratory, NMMC

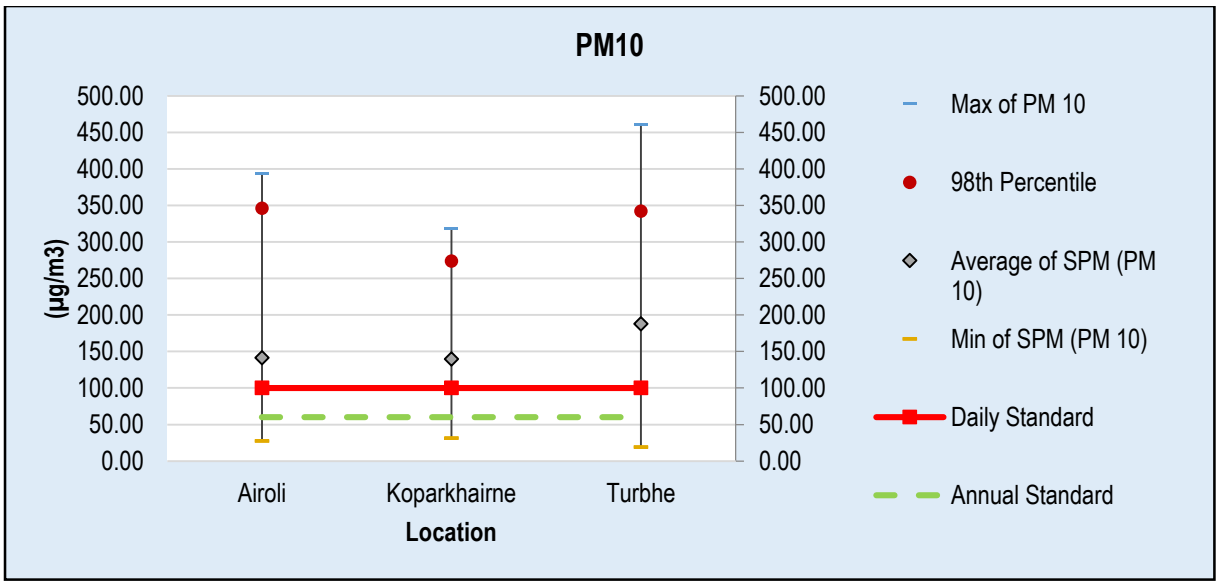


Figure No. 18: Concentration of PM_{10} in NMMC region for the year 2014-15

Carbon monoxide

It can be observed from Figure No. 19 that Koparkhairane has recorded the maximum readings (40 readings) which are violating the standards (2 mg/m^3). Airoli stations follows next but with just 8 readings which are found to be violating the standards. No violation is recorded at Turbhe station. Thus it can be said that Koparkhairane station area is relatively more polluted with CO pollution while Turbhe area has the least pollution of CO.

A seasonal variation can also be observed in the concentration of CO recorded by 3 stations. It can be observed that the concentration is increasing drastically from September to March which is considered as the winter season and the concentrations are dropping during the summer and rainy season. These observations could be significantly observed at Airoli and Koparkhairane station. Thus seasons also play an important role in the concentration of CO in the city.

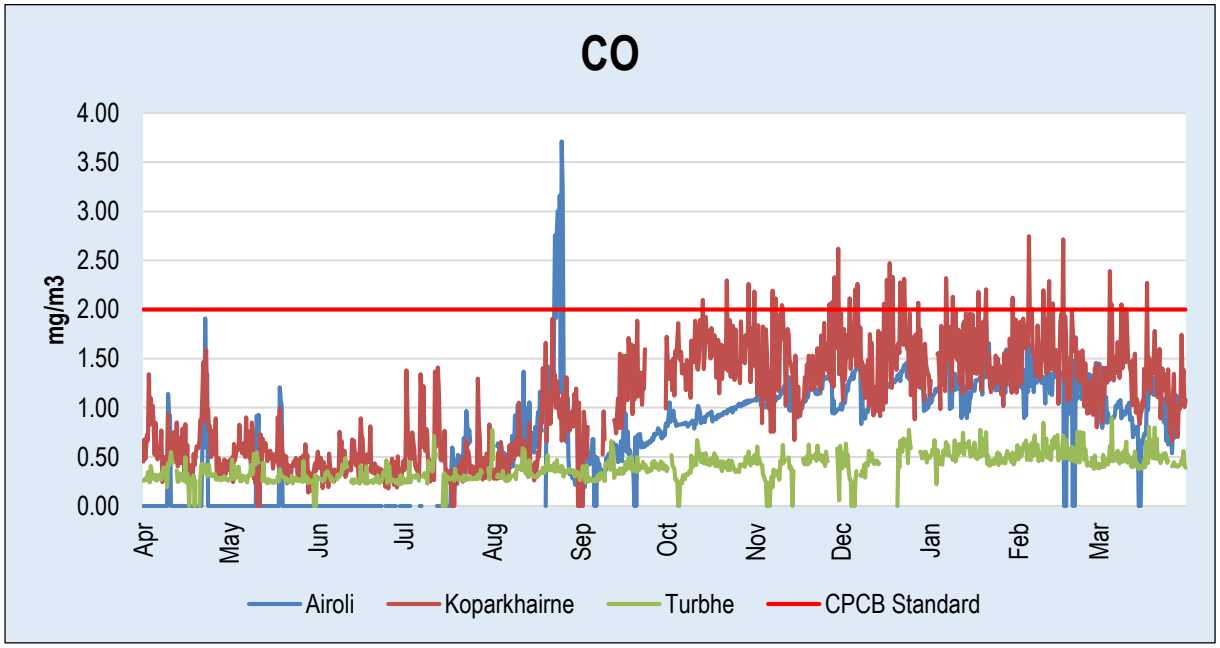


Figure No. 19: Concentration of CO in NMMC region for the year 2014-15

Ozone

The status of ground level Ozone for 2014-15 at Koparkhairne station is presented in Figure No. 20. Presently it is the only station which monitors Ozone. It can be clearly observed that for majority of the months the ozone concentrations are well below the standards (100 µg/m^3) but are observed to be on the rise from April to June which is the summer season. A sudden peak in the concentrations of Ozone can be observed in the month of August. Out of the total readings, only 10 readings are violating the standards which indicates that ozone concentrations are low in the monitoring area.

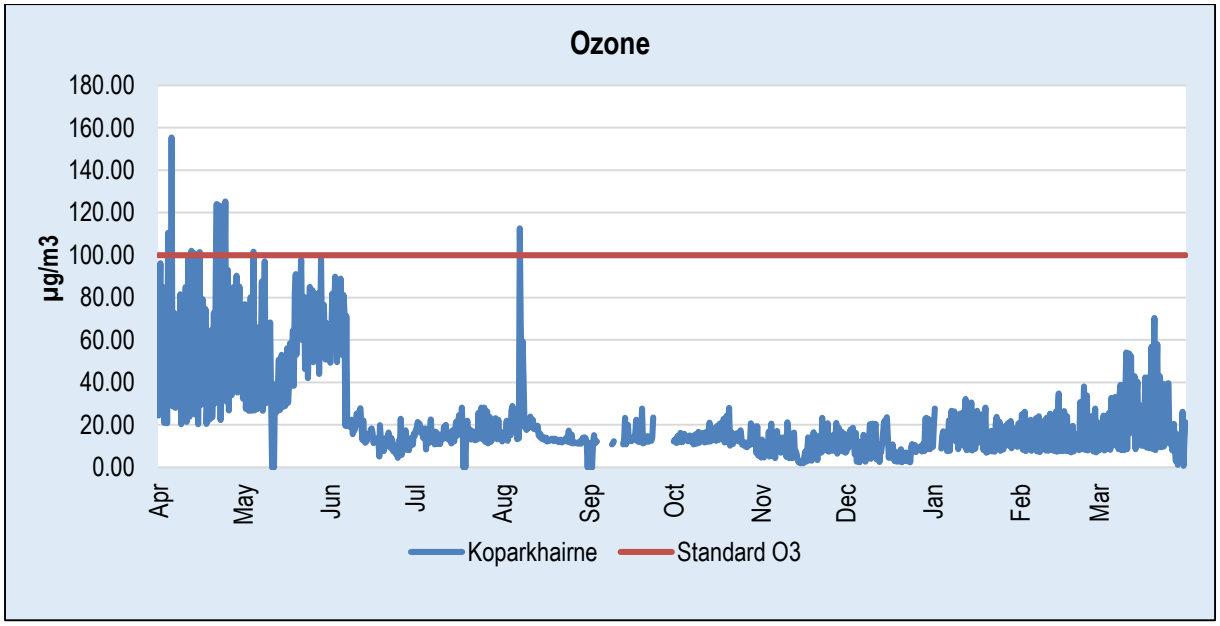


Figure No. 20: Concentration of Ozone in NMMC region for the year 2014-15

Methane

Methane is a greenhouse gas and not a pollutant and is known to impact the phenomenon of Global warming. It is naturally present in the atmosphere and the natural source includes volcanic eruptions and gases released from animals. Methane gas is 21 times more potent than carbon-dioxide in terms of its global warming potential. It is released from degradation of biodegradable waste. The concentration of Methane recorded at 3 AAQMS namely Airoli, Koparkhairane and Turbhe are presented below in Figure No. 21 and Table No. 14. Since the monitoring at Turbhe is in close proximity to the landfill site, the methane emissions in Turbhe are higher as compared to Airoli and Turbhe.

Table No. 14: 8-hourly mean concentration of ground level HC-Methane for 2014-15

Station Name	Duration of sampling	Max	8-hr Mean	Min
		µg/m³	µg/m³	µg/m³
Airoli	0-08 hr	3.80	1.93	1.35
	16-24 hr	3.19	2.21	1.50
	8-16 hr	3.54	2.37	1.55
Koparkhairne	0-08 hr	36.17	2.67	0.00
	16-24 hr	14.44	2.28	0.00
	8-16 hr	34.42	2.61	0.00
Turbhe	0-08 hr	46.21	12.52	0.00
	16-24 hr	32.15	9.81	0.00
	8-16 hr	27.64	10.18	0.00

Source: Environment Laboratory, NMMC

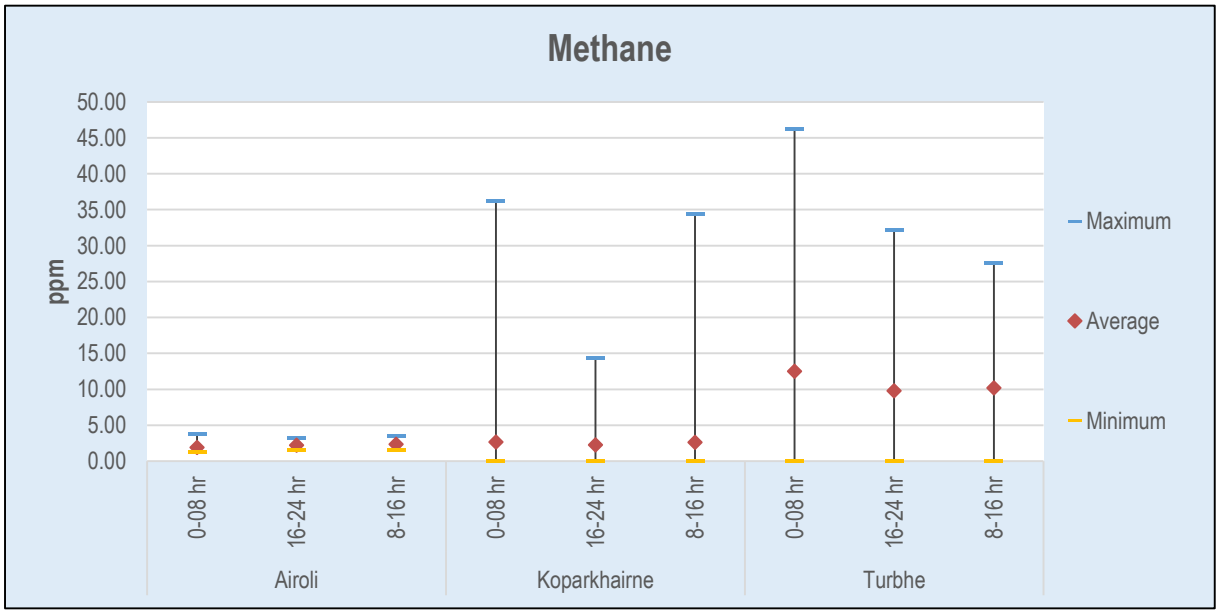


Figure No. 21: Concentration of Methane in NMMC region for the year 2014-15

Air Quality Index

Air Quality Index (AQI) is a tool for effective communication on the status of the air quality to people. AQI transforms complex air quality data of various pollutants into a single index value, which are easy to understand. The categories of the AQI usually are expressed in terms of the air quality being Good, Satisfactory, Moderate, Poor, Very Poor or severe based on the concentrations of various pollutants and their health impacts at various concentrations. The AQI for Navi Mumbai has been calculated based on the calculation of AQI developed, specifically for India, by CPCB in consultation with IIT (Indian Institute of Technology) Kanpur in the year 2014[14].

Based on the calculations (Figure No. 22), it was determined that the quality of air in Navi Mumbai is Severe and Very poor category for almost 70% of the observations days especially for PM_{10} pollution. The areas of Turbhe and Koparkhairne areas are highly polluted with PM pollution since most of the observation days are either moderate of poor. As for the pollutants the sub-index calculation reveals that the NMMC areas is clean for NOx, SOx, CO and Ozone pollutants and the sub-AQI for these pollutants is either Good or Satisfactory category. It may be concluded that the air in Navi Mumbai may cause respiratory illness to the people on prolonged exposure and people with lung and heart diseases may exhibit severe discomfort.

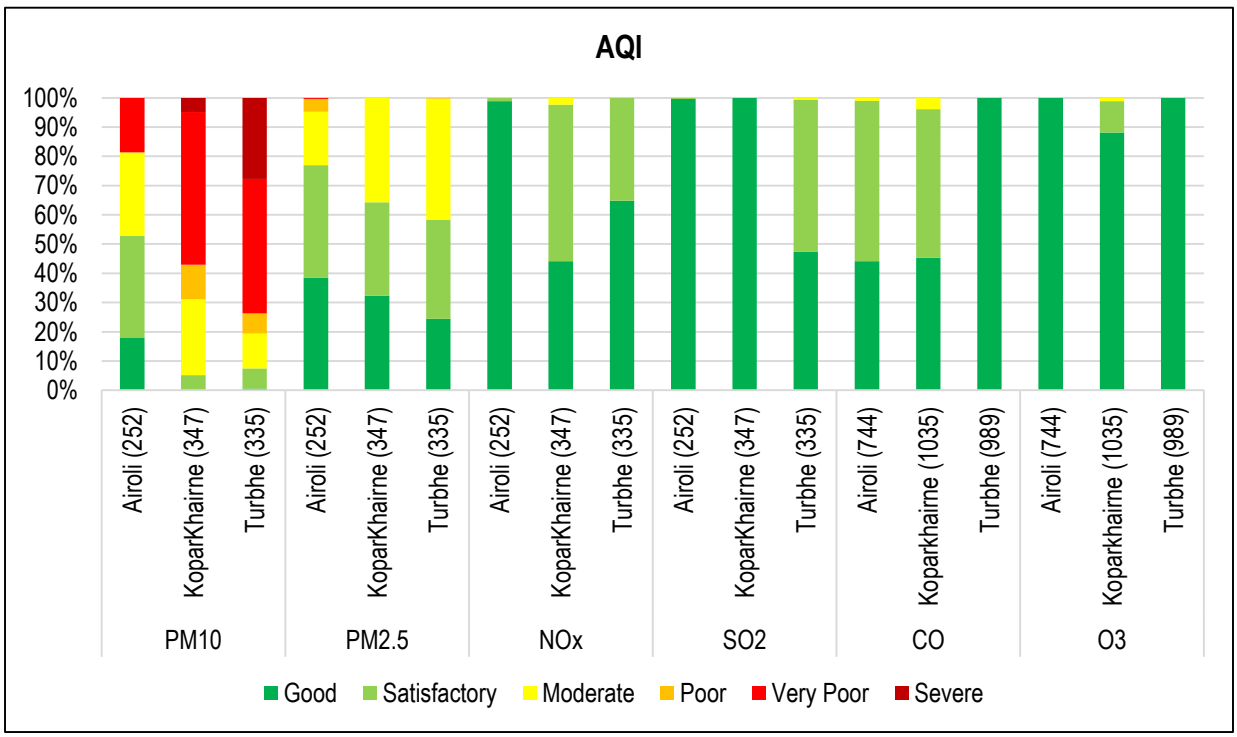


Figure No. 22: Occurrence of AQI classes for air pollutants in NMMC (2014-15)

[14] CPCB 2014, *National Air Quality Index*, Central Pollution Control Board, Ministry of Environment & Climate Change, Government of India

Noise Pollution

It can be observed from Figure No. 23 that almost all the readings from residential area are violating the day (55dB) and night (45dB) standards. Agroli SCADA Control area is the only station which has recorded the noise level (54.75 dB) just below the day time standards. Juinagar ESR, Sector 11 (60.25dB) area recorded the highest noise level followed by Turbhe MCH, Sector 22 (59.88dB) and Airoli ESR 18 and 19 (59.50dB). Rest of the stations have also recorded the noise level ranging between 55- 60 dB. The maximum daily peak value are also very high from the standards. Juinagar ESR, Sector 11 (69dB) has recorded the highest daily peak value while Agroli SCADA Control Panel station (61.33dB) has recorded the lowest daily peak value compared with the day standards. Even the minimum daily value are not below the day or night standards. Thus the readings indicate high noise pollution in the residential area.

All the 7 traffic areas have recorded high pollution levels, than the standards of residential areas. The main reason for such high pollution level is due to the movement of dense traffic at these areas. Digha ward office (69.88dB) has recorded the highest noise pollution reading while Vashi Ward Office, Juhugaon area (65.13dB) has recorded the lowest noise pollution level. Rest all the stations have readings between 65- 70 dB.

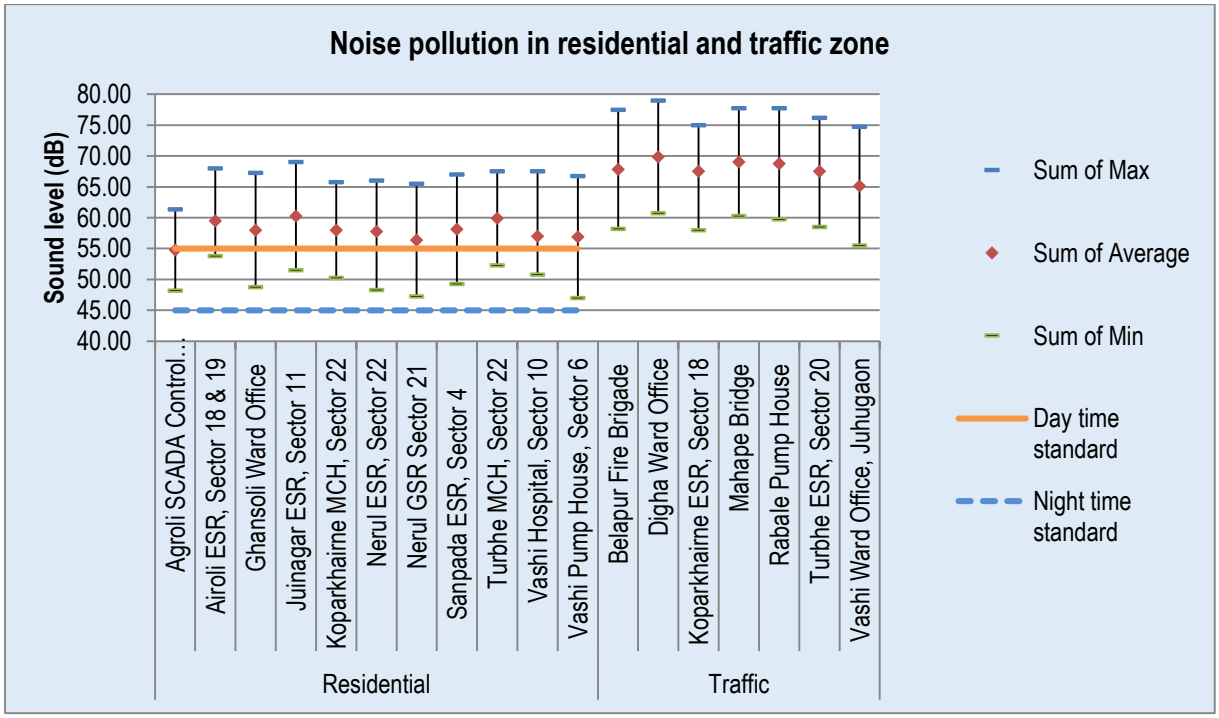


Figure No. 23: Level of noise pollution in various areas of Navi Mumbai

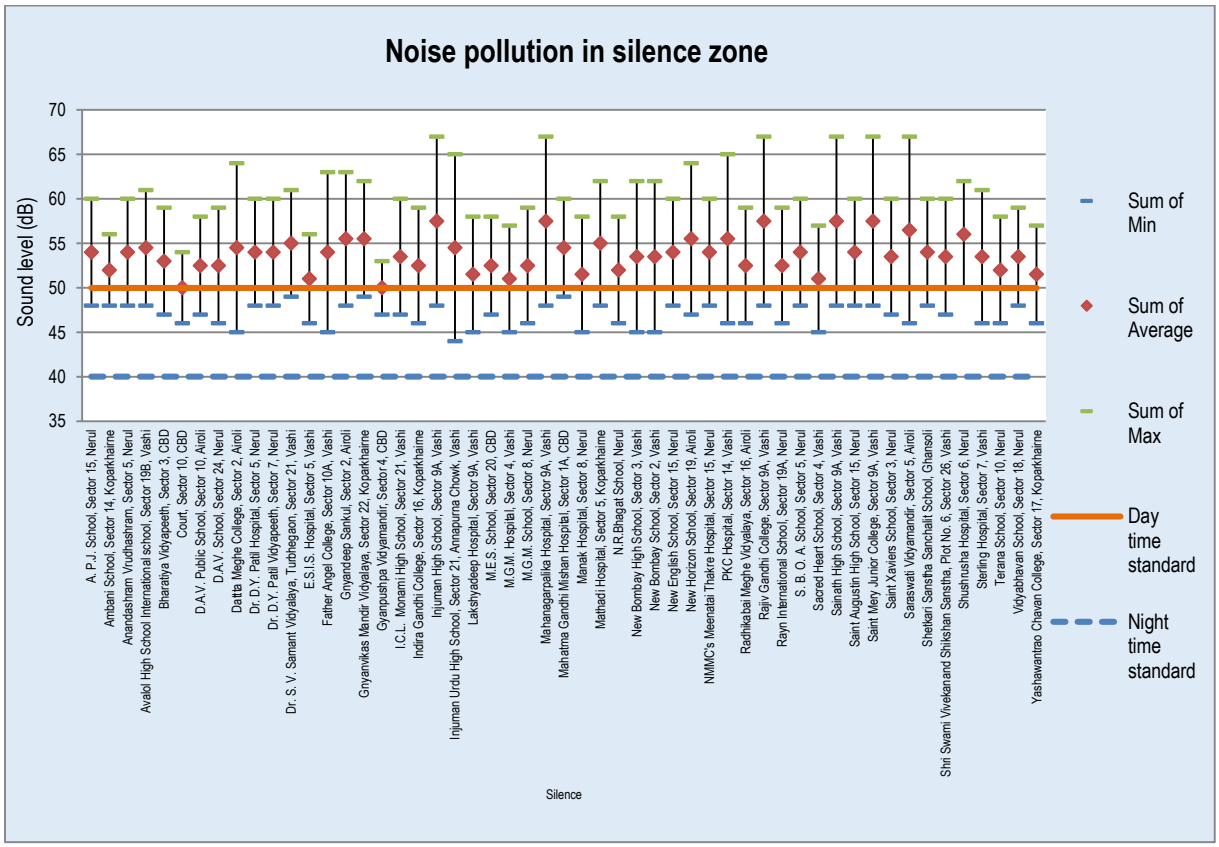


Figure No. 24: Level of noise pollution in silent areas NMMC area

Figure No. 24 represents the silence zones in NMMC area. In the year 2014-15, all stations in silence zones under NMMC exceeded the standard average limits of 50dB except for Gyanpushpa Vidyamandir station and Court Sector 10 of CBD Belapur which recorded 50dB. Vashi node recorded the highest average noise levels of 57.5 dB and maximum daily noise level of 67dB followed by Sarawati Vidya mandir station at Airoli with average noise level of 56.5dB and daily maximum noise level of 67dB among all stations in silence zones in NMMC region.

The average night standards for silent zones is 40dB and as it can be observed even the minimum daily peak value are exceeding the night average standards. Thus the readings indicate heavy noise pollution in silent zones.

Pressures

Vehicular Growth

Detailed statistics on the number of vehicles which were registered year wise at Vashi RTO are shown below. The following information was sourced from Motor Vehicle Department of Maharashtra in their report "*Motor Transport Statistics of Maharashtra*". A trend in total number of vehicles on roads is shown in Figure No. 25. As per the figure there has been a steady increase in the number of vehicle registrations, and an overall increase in vehicle population on road has increased to about 3.36 lakhs. The major increase in registered vehicles is observed in the four wheelers which recorded a growth of almost 1.5 times (Figure No. 26) the previous year and in the same year the registration of taxies and auto rickshaws increased by almost 100%, and the buses and carriages registration increased by more than 3.5 times. One may note that although the registration may have taken place at Vashi RTO, the actual usage of vehicle may not be in the city directly. The total number of vehicles registered in Navi Mumbai (Category wise) are presented in Annex –III

It was found in the year 2011-12 (2.5 Lakh vehicles on road) about 33% vehicles which undertook 'Pollution Under Control' (PUC) checking did not comply with the permissible emission norms. Studies have shown that emissions from vehicles are among the major contributors to the deterioration of air quality causing increase in the pollution of NOx, SOx and RSPM as discussed in the Inter Station Analysis section.

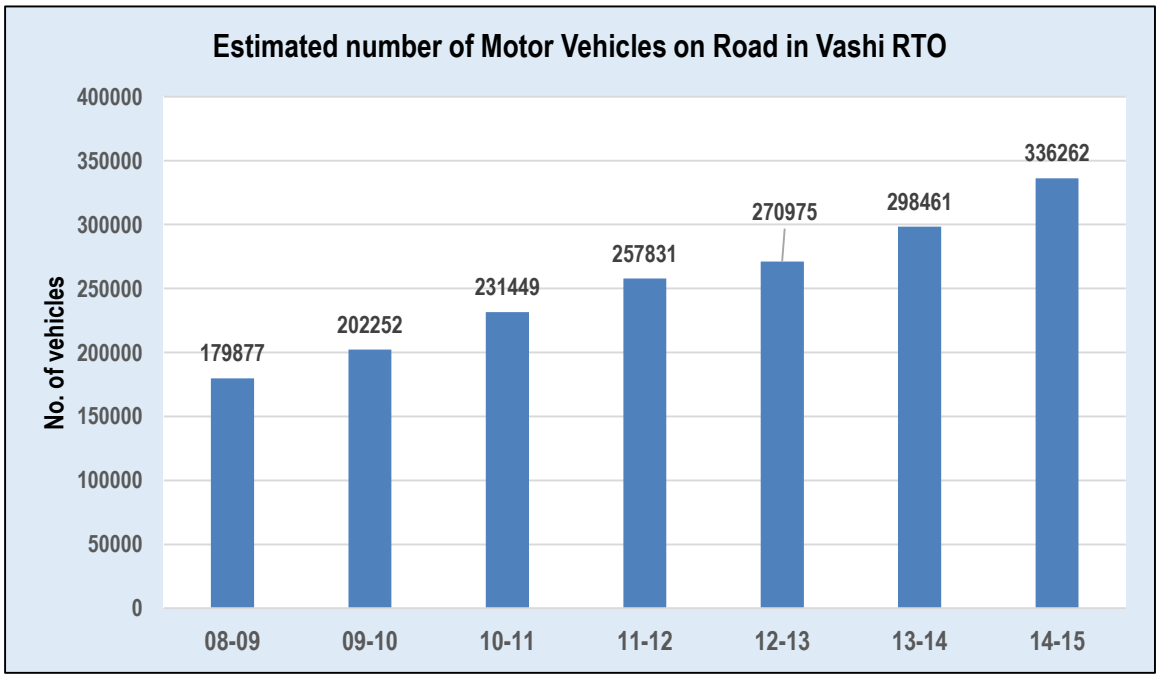


Figure No. 25: Estimated number of Motor Vehicles on Road in Vashi RTO

Source: RTO Publication 2013-14

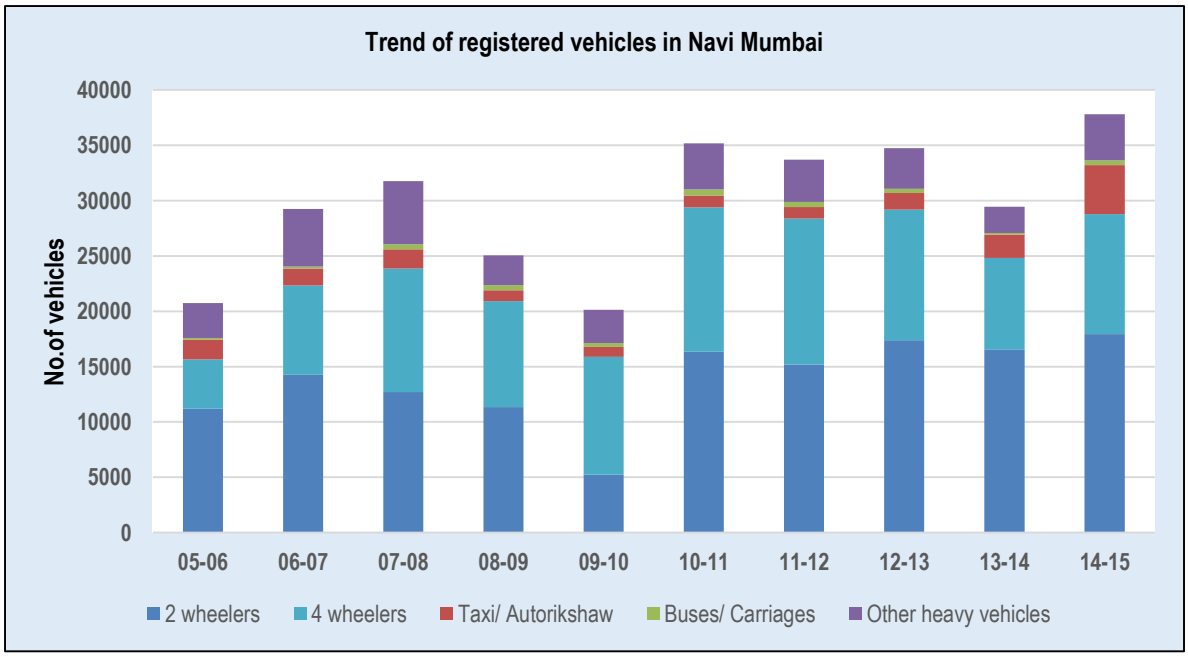


Figure No. 26: Decadal trend in annual vehicle registrations in Navi Mumbai

Source: RTO Publication 2013-14

Fuel Consumption in NMMC

TERI had conducted the Carbon footprint estimation in Navi Mumbai in the year 2010, as per the study, the fuel consumption for NMMC is given below. For the sake of convenience some important data pertaining to the fuel consumption in NMMC region has been reproduced below from the same report

Transport Sector

Motor Spirits (MS) commonly known as petrol, HSD, CNG and Auto-LPG are the commonly used fuels in the transport sector. The public transport modes in Navi Mumbai including taxies, auto-rickshaws, and busses owned by Navi Mumbai Municipal Transport (NMMT) either consumes CNG or Diesel. Increasing vehicular growth exerts demand for fuel and it is clearly reflected in Figure No. 27. The sale of petroleum products has increased with a CAGR (Compound annual growth rate) of almost 8% in the last 5 years. The total sale of petroleum products in transport sector for the year 2011-12 accounted to almost 164.55 thousand metric tons.

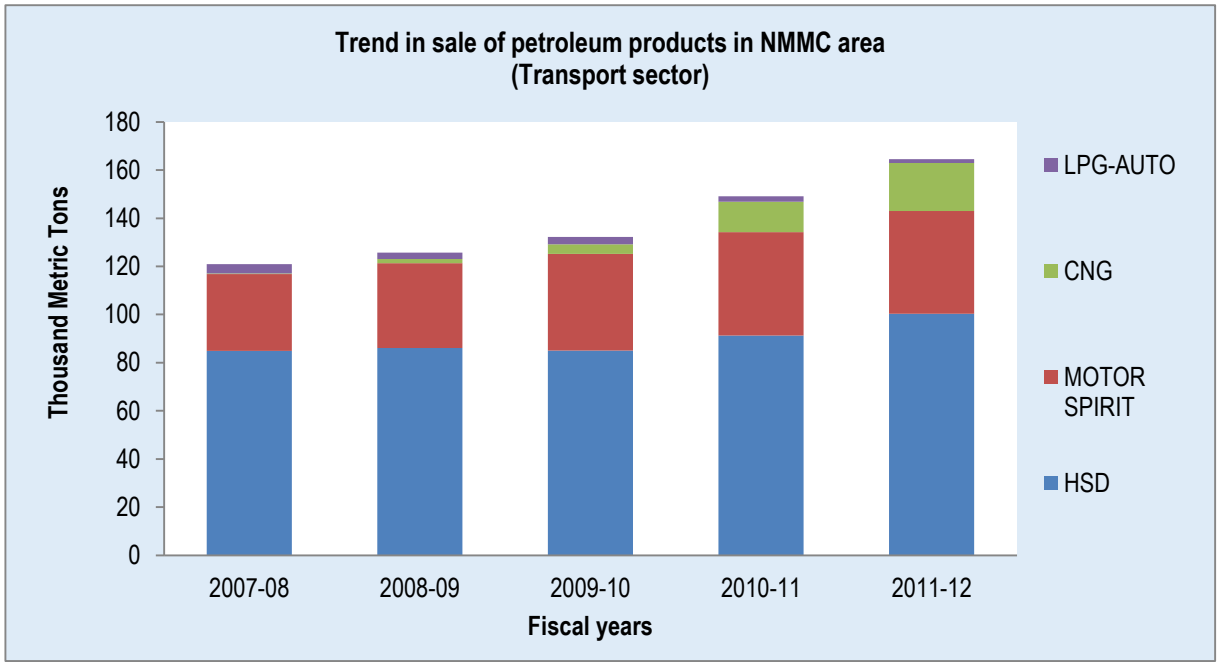


Figure No. 27: Trend in sale of petroleum products in Navi Mumbai (Transport sector)

Source: HPCL, BPCL, IOCL and Mahanager Gas

It is distinct that the sale of Auto LPG has decreased and there is a remarkable rise in the sale of CNG in Navi Mumbai city. The sale for CNG has increased almost 11 times in the last 4 years; i.e. between 2008-09 and 2010-12 whereas the sale for both Motor Spirits (MS) and High Speed Diesel (HSD) has grown by 33% and 18% respectively in the last five years. The increase in sale of CNG can be attributed to the switching option to dual fuel types and it being mandatory for auto rickshaws, taxis and many busses owned by NMMT to use CNG.

Industrial sector

Owing to the presence of TTC industrial belt within NMMC limits, there is a huge demand for petroleum products like LDO, FO and HSD in industries. The total sale of petroleum products in 2011-12 was around 41.03 thousand metric tons and the sale in Navi Mumbai has grown at a CAGR of 10.16% between fiscal years 2007-08 and 2011-12. With only a slight dip in the year 2009-10, there has been an increasing trend in consumption of fuels in industrial sector.

It is remarkable to note from Figure No. 28 that there has been a decline in the sale of LDO and Kerosene by almost 63% and 93% respectively in last five years. These fuels have been replaced by LPG and PNG. The sale of LPG during the same time has more than doubled and the sale of CNG has been significant in the same period. The annual sale of HSD in industrial sector has also decreased by 6%in last five years. However the sale of furnace oil has registered a growth of more than 50%.

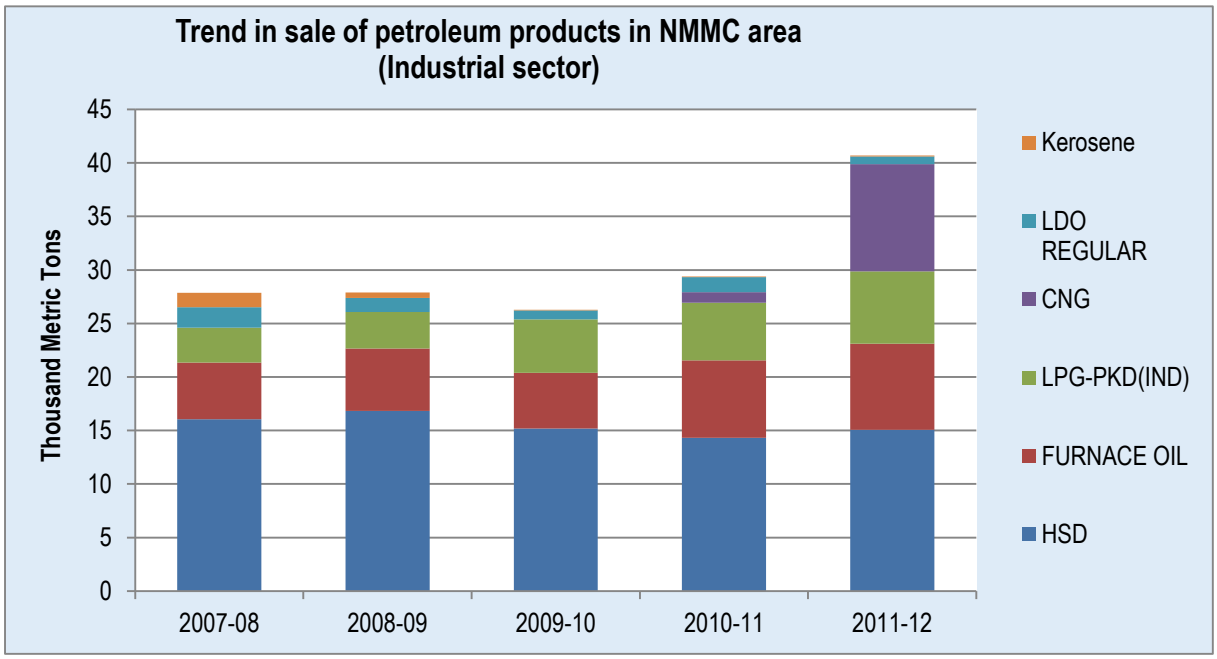


Figure No. 28: Trend in sale of petroleum products in Navi Mumbai (Industrial sector)

Source: HPCL, BPCL, IOCL and Mahanagar Gas

Note: The sale of CNG includes both industrial and commercial & institutional sale of CNG as categorized by Mahanagar gas. HSD sale includes bulk sales made by fuel companies.

Residential sector

LPG, Kerosene and Piped Natural Gas (PNG) are the main fuels used in the residential sector. Together they aggregated for a sale of 39.70 thousand metric tons in the year 2011-12. PNG was introduced in Navi Mumbai in the year 2010 and hence its sales are reflected significantly only in the year 2011-12. However, being economical and cheap, its demand has increased dramatically in the residential sector and has already registered a growth of more than 4 times in two years.

In case of LPG sales, there has been a growth of almost 18%, from 27 thousand MT in 2007-08 to 32.03 thousand MT in the year 2011-12. Kerosene is supplied in Navi Mumbai through the Public Distribution System and it is used predominantly by urban poor. Vashi and Thane office under the Thane division are responsible for supplying kerosene to the Authorized Rationing Shops from Belapur to Digha. Almost 68.14 thousand MT of kerosene was distributed in Navi Mumbai in the year 2011-12. The total sale of fuel in residential sector has increased by 21% between 2007-08 and 2011 (Figure No. 29).

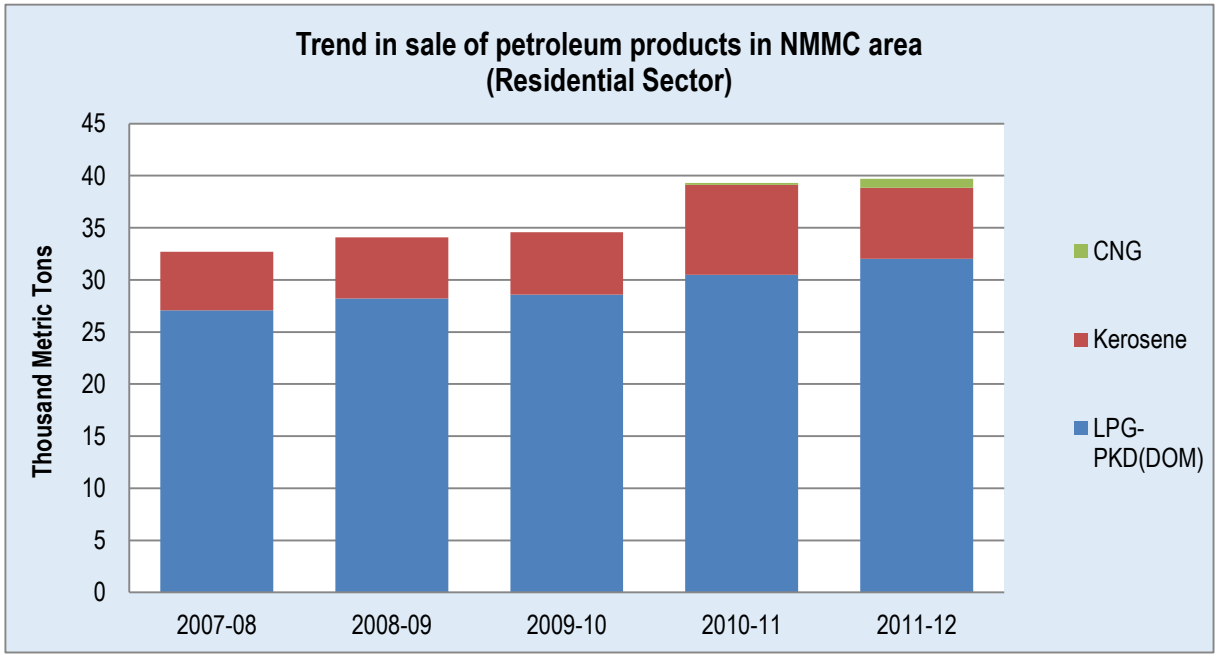


Figure No. 29: Trend in sale of petroleum products in Navi Mumbai (Residential sector)

Source: HPCL, BPCL, IOCL and Mahanagar Gas

Note: LPG includes supply of LPG to agencies of respective oil companies within Navi Mumbai

Impact

Diseases caused by air pollution

Air pollution is playing a significant role in deteriorating the health quality of the urban dwellers as they are more prone towards its ill effects. According to the NIEHS (National Institute of Environmental Health Sciences[15]) long-term exposure to air pollutants increases a person's risk to acquire respiratory illnesses. NIEHS notes that children and the elderly are especially vulnerable to the detrimental health effects of ozone, fine particulate matter (PM) and other airborne toxicants. The cases of respiratory disorders like Asthma, COPD (Chronic Obstructive Pulmonary Disorder) such as chronic bronchitis and emphysema and lung cancer are increasing day by day due to air pollution. As per WHO, 80% of outdoor air pollution-related premature deaths were due to ischaemic heart disease and strokes, while 14% of deaths were due to chronic obstructive pulmonary disease or acute lower respiratory infections; and 6% of deaths were due to lung cancer[16]. Hence it is necessary to keep a check on diseases like bronchitis and asthma.

Monitoring of these diseases is an important parameter to know the status of the health conditions of a developing city, however there are gaps in collection and maintenance of the data regarding the above mentioned diseases in NMMC area. Hence it is recommended that NMMC could coordinate and maintain data for patients suffering from these disorders through a joint effort between the private and public hospitals. A survey could also be conducted to determine the baseline and formulate new guidelines to regulate air pollution in the city.

Response

NMMC has taken various measures to tackle the issue of air pollution in the region contain levels of key pollutants below the permissible limits. The chief reasons behind these improvements in air quality as well as steps taken by the corporation have been highlighted below:

- NMMC has successfully completed the concretization of roads at 19 junctions which has largely helped to reduce the issue of traffic congestion. Also the work of Sion-Panvel highway has been completed by NMMC which has resulted in diverting a large amount of traffic from entering the city. These initiatives have resulted in the reduction of NOx level in the city, minimizing the issue of air pollution.
- Timers have been installed at traffic signals to reduce the idling period and thus the emissions.
- NMMC has also completed renovation of underpass at Rabale, Ghansoli, Koparkhairne and Airoli (Picture No. 6) and installed LED (Light Emitting Diode) lights at the Airoli-Diva skywalk.
- Within the Navi Mumbai municipal limits completion of activities related to stone quarrying has resulted in decline of dust pollution

[15] http://www.niehs.nih.gov/
[16] http://www.who.int/mediacentre/factsheets/fs313/en/

- Replacement of chemical industries by engineering and IT companies has also resulted in lesser air pollutants being emitted into the ambient atmosphere.
- Greening/plantation along roadsides and on the dividers has also contributed in reduction in dust pollution (Picture No. 5).
- Sweeping machines are used to along Palm Beach road, Thane-Belapur and other major roads for vacuum suction of dust/fine particles, which has resulted in drop of air pollutants along these roads.

Picture No. 5: Smooth surface roads and green cover along the roadside and under the bridge

Picture No. 6: Underpass at Bharat Bijlee Airoli (left) and Ghansoli station (right)

Proposed initiatives

Indoor Air Quality

NMMC would take necessary measures to monitor and improve the indoor air quality of various places in the city. Lower respiratory infections (Asthama, Bronchitis and so on) are highly associated with indoor air pollution related largely to household solid fuel use and possibly to second-hand tobacco smoke, as well as to outdoor air pollution. In developed countries, an estimated 20% of such infections are attributable to environmental causes, rising to 42% in developing countries.

Identifying this significance, CPCB has drafted several monitoring guidelines to measure the pollutant levels in an indoor environment. NMMC plans to undertake a study to monitor indoor air quality across residential, commercial and industrial units in NMMC area.

Water Resources

Water is one of the vital renewable resources on earth. Globally, 1600 million cubic km of water is available on earth out of which 97.5% is saline water and remaining 2.5% is fresh water. Two thirds of this fresh water is frozen in glaciers and polar ice caps and about 0.26% of water is readily available for mankind.[17] Water resources include lakes, rivers, streams, groundwater and oceans. Water is used for drinking, cleaning, agriculture, transportation, industry, recreation, animal husbandry and so on. It is also used for producing electricity for domestic, industrial and commercial use. Due to its multiple benefits and the problems by its shortages and quality deterioration, water as a resource requires special attention.

Status of Water Resources

Water resources in terms of surface and groundwater are available within NMMC region. The surface water resources include ponds, creeks, lakes, dams and reservoirs whereas groundwater resource includes wells and bore wells. The population of Navi Mumbai depends on these water resources for daily water supply and other activities. Realising this fact, NMMC regularly monitors the water resources in order to check and record the quality of water.

Surface Water

Dam (Reservoir)

The Navi Mumbai Municipal Jurisdiction area has Hetwane, Barve and Morbe dam within its vicinity, out of which NMMC selected Morbe dam as source of water supply. Morbe Dam, located on Dhavri River, tributary of river Patalganga in Karjat Taluka stands at a height of 194 ft. above sea level with surface area of around 9,780 sq km. It was constructed by MJP (Maharashtra Jeevan Pradhikaran), Government of Maharashtra in 1999, who then granted possession of Morbe dam to NMMC in November 2002. Morbe dam supplies about 360 MLD of water to NMMC[18]. The silent features of Morbe dam is presented in Table No. 15.

Table No. 15: Speciation of Morbe Dam

Specifications	Attributes
Name of the Dam	Morbe
Distance from city (NMMC Jurisdiction)	31 km
Type of dam	Gravity
Impounds	Dhavari river
Height	53.40 m
Length	3,250 m
Dam volume	18,075 x 10^3 m^3
Total capacity	19,089 x 10^3 m^3
Surface area	978 hectares

Source: Central water commission [19]

[17] K.Chatterjee, Climate Change Centre,Water Resources of India
[18] http://www.nmmconline.com/water-supply
[19]http://www.cwc.nic.in/main/downloads/National%20Register%20of%20Large%20Dams%202009.pdf

NMMC monitors the water quality at the reservoir daily before supplying the water to the city. The raw water from the dam is initially pumped to the water treatment plant at Bhokarpada for treatment. Chlorine is added as a disinfectant at source as well as at water treatment plant and is maintained at desired level of 0.2mg/l. NMMC, thus elaborates water quality checking and monitoring system at Morbe dam. The Table No. 16 below represents the average water quality of raw and treated water supplied by NMMC as per BIS standards.

Table No. 16: Average water quality of raw and treated water before supply

Sr. No	Test Parameters	Units	Raw Water (Bhokarpada)		Pure Water (W.T.P)		BIS Specifications 10500:2012 Normal Values	
			10/6/2014	9/9/2014	10/6/2014	9/9/2014	Desirable Limits	Permissible Limits
1	Physical Appearance		Clear	Clear	Clear	Clear		
2	Odour		Odourless	Odourless	Odourless	Odourless	Agreeable	Agreeable
3	Turbidity	N.T.U	0.67	1.1	0.44	0.64	1	5
4	pH Value		7.8	8.3	7.9	8	6.5 to 8.5	No relaxation
5	Chlorides (as Cl)	mg/l	16	18.15	20	18.15	250	1000
6	Nitrates (as NO_3)	mg/l	nil	0.49	nil	0.48	45	No relaxation
7	Total Hardness ($CaCO_3$)	mg/l	76	68	80	56	200	600
8	Alkalinity ($CaCO_3$)	mg/l	160	45.6	86.24	38	200	600
9	Total Dissolved Solids	mg/l	124	103	130	94	500	2000
10	Iron (as Fe)	mg/l	0.001	0.09	0.05	0.09	0.3	No relaxation
11	Fluoride (as F)	mg/l	0.002	0.003	nil	0.003	1	1.5
12	Other Tests (if any)	mg/l						
13	Calcium (as Ca)	mg/l	14.42	8.016	11.22	4.8	75	200
14	Magnesium (as Mg)	mg/l	9.72	11.33	12.63	10.69	30	100
15	Sulphate (as SO_4)	mg/l	nil	nil	nil	nil	200	400
16	Residual Chlorine	mg/l	nil	nil	nil	nil	0.2	1

Nil: *Analysis of parameters not done in year 2014-15*

Source: District Public Health Laboratory, Konkan Bhavan, Belapur, Navi Mumbai

Lakes and ponds

Accounting for 0.26% of the Earth's surface, lakes and ponds are vital habitats, and provide essential resources for a wide range of species, including humans. There are total 24 lakes with coverage area of 2.23 Lakh sq.m area within NMMC. The belapur node accounts 28% of the share area with maximum number of lakes. This is followed by Ghansoli node with 25% of share area and having 4 lakes within the node. The Gothivali Lake in Ghansoli is recorded as biggest lake having surface area of 32,635 sq m. The Mahape Lake in Koparkhairne node is smallest lake with area of 1,338 sq m. Node wise details of the lakes with coverage area are described in the Table No. 17 below. Most of the lakes are observed to be surrounded by residential areas and have Gabion wall structures.

Table No. 17: Node wise details of lakes and their coverage in NMMC area

Node	Name of Lake	Riparian zone	Surrounding area	Area of lake (Sq m)
Airoli	Airoli Naka	Concrete wall	Residential	3,988
	Diva	Gabion wall	Residential	2,042
Belapur	Agroli	Gabion wall	Trees and Garden	12,693
	Belapur	Concrete wall	Residential and a temple	17,905
	Darave	Gabion wall	Residential	5,724
	Karave	Concrete wall	Residential	23,506
	Killegaonthan	Gabion wall	Residential	2,650
Digha	Borol			1,500
	Khokad	Gabion wall	Residential and Highway	17,842
Ghansoli	Gothivali	Gabion wall	Residential and Informal hutments	32,635
	Gumali	Concrete wall	Residential	3,596
	Rabada	Gabion wall	Residential and Highway	7,823
	Talvali	Gabion wall	Residential	11,590
Koparkhairne	Khairne	Concrete wall	Residential	13,870
	Koparkhairne	Concrete wall	Residential	2,231
	Mahape	Concrete wall	MIDC area	1,338
	Savaligaon	-	Slums	6,060
Nerul	Nerul Sector 20	Gabion wall	Residential	9,894
	Shirvane	Gabion wall	Residential	13,686
Turbhe	Sanpada	Natural	Residential	2,500
	Turbhegaon	Gabion wall	Residential	8,482
Vashi	Juhugaon	Concrete wall	Dense residential area on all four sides	1,486
	Kopari	Gabion wall	Trees and Garden	10,000
	Vashigaon	Gabion wall	Residential	10,620
Total				**2,23,661**

Source: Environmental Laboratory, NMMC

NMMC monitors the water quality of lakes at frequent intervals. On analysing the samples it is observed that annual average values for all the lakes in NMMC area are well within the standards except for Karave Lake. The Karave Lake in Belapur node was seen to exceed the standard value in terms of suspended matter while the Airoli Naka Lake and Gothivali Naka Lake recorded slightly lower level of D.O than the standards, thus indicating stressful aquatic environment (Table No. 18 and Table No. 19).

Table No. 18: Annual average water quality of lakes in NMMC area (1 of 2)

Node	Lake	PH	S.S	TDS	D.O	B.O.D	C.O.D
			(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
		5.5-9.0	<100	<2100	4.0-7.0	<100	<250
Airoli	Airoli Naka Lake	7.26	39.20	539.60	3.67	4.86	51.02
	Diva Lake	7.34	53.60	636.40	4.05	5.15	42.58
Belapur	Belapur Lake	7.40	103.60	476.00	4.26	8.07	63.55
	Darave Lake	7.29	63.20	905.20	4.44	6.43	55.28
	Karave Lake	7.55	140.60	891.60	5.26	19.50	124.99
	Killegaonthan Lake	7.60	63.00	438.00	5.95	3.75	28.49
	Agroli Lake	7.46	40.00	589.40	4.95	3.52	28.06
Digha	Khokad Lake	7.41	56.57	712.57	4.34	4.21	35.49
Ghansoli	Rabada Lake	7.29	48.40	837.40	4.30	2.76	26.94
	Gumali Lake	7.30	46.40	818.00	4.12	5.29	43.47
	Talvali Lake	7.35	44.27	684.53	4.89	6.66	59.40
	Gothivali Lake	7.41	51.73	445.47	3.71	3.76	32.42
Koparkhairne	Koparkhairne Lake	7.28	48.00	367.60	7.14	7.47	67.28
	Khairne Lake	7.38	38.40	734.00	4.02	5.05	35.52
	Kopari Lake	7.17	41.20	1202.00	5.50	5.02	38.80
	Mahape Lake	7.14	53.60	1041.20	4.87	5.83	51.67
Nerul	Shirvane Lake	7.10	93.40	1388.40	3.98	9.04	67.99
	Nerul Sector 20 Lake	7.40	93.80	789.40	4.86	7.16	52.10
Turbhe	Turbhegaon Lake	7.23	46.00	902.80	3.48	7.66	62.12
	Sanpada Lake	7.46	50.00	555.20	7.08	3.49	27.85
Vashi	Vashigaon Lake	7.20	53.20	1309.60	4.46	4.41	37.97
	Juhugaon Lake	7.10	52.80	833.60	5.06	8.08	62.54

Source: Environmental Laboratory, NMMC

Table No. 19: Annual average water quality of lakes in NMMC area (2 of the 2)

Node	Lake	Nitrate	Nitrite	Phosphate	Chloride	Hardness	Sulphate
		(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
		<45		<5	<1000	-	<1000
Airoli	Airoli Naka Lake	0.50	0.19	0.15	73.23	307.64	41.52
	Diva Lake	0.86	0.18	0.14	147.75	349.62	35.90
Belapur	Belapur Lake	0.69	0.79	0.27	58.08	245.42	26.14
	Darave Lake	1.41	0.36	0.24	62.47	488.32	57.87
	Karave Lake	0.66	0.26	0.49	856.24	446.18	33.16
	Killegaonthan Lake	0.58	0.14	0.56	43.62	241.28	19.94
	Agroli Lake	1.30	0.11	0.09	50.46	406.05	64.94
Digha	Khokad Lake	0.90	0.51	0.17	61.54	355.68	42.11
Ghansoli	Rabada Lake	0.87	0.41	0.08	134.10	435.07	56.01
	Gumali Lake	1.61	0.87	0.12	65.15	556.84	50.72
	Talvali Lake	0.91	0.13	0.18	93.42	343.91	45.18
	Gothivali Lake	0.60	0.16	0.18	53.95	248.79	19.36
Koparkhairne	Koparkhairne Lake	0.53	0.50	0.47	43.55	318.72	19.51
	Khairne Lake	1.15	0.48	0.21	72.76	276.78	8.59
	Kopari Lake	1.34	0.09	0.13	154.58	500.79	25.87
	Mahape Lake	1.80	0.53	0.15	181.38	521.66	59.49
Nerul	Shirvane Lake	1.32	0.57	0.11	143.29	849.21	71.05
	Nerul Sector 20 Lake	0.83	0.22	0.15	42.46	395.67	46.46
Turbhe	Turbhegaon Lake	1.95	0.35	0.12	40.52	543.15	55.48
	Sanpada Lake	0.93	0.13	0.08	34.70	285.86	43.93
Vashi	Vashigaon Lake	1.91	0.27	0.05	152.70	944.05	82.33
	Juhugaon Lake	1.01	0.60	0.41	77.00	405.68	55.37

Source: Environmental Laboratory, NMMC

Creek

Monitoring of water samples from creeks is carried out at 6 locations by NMMC (Map No. 3).The annual average values for the water quality tests indicate that the creek water has high BOD (Biochemical Oxygen Demand) and COD (Chemical Oxygen Demand) levels. The samples from Airoli and Turbhe creek violated the COD standards by more than 5 times. This has led to decrease in oxygen levels in the creek ecosystem which is clearly reflected from the low DO (Dissolved Oxygen) levels in the water samples.

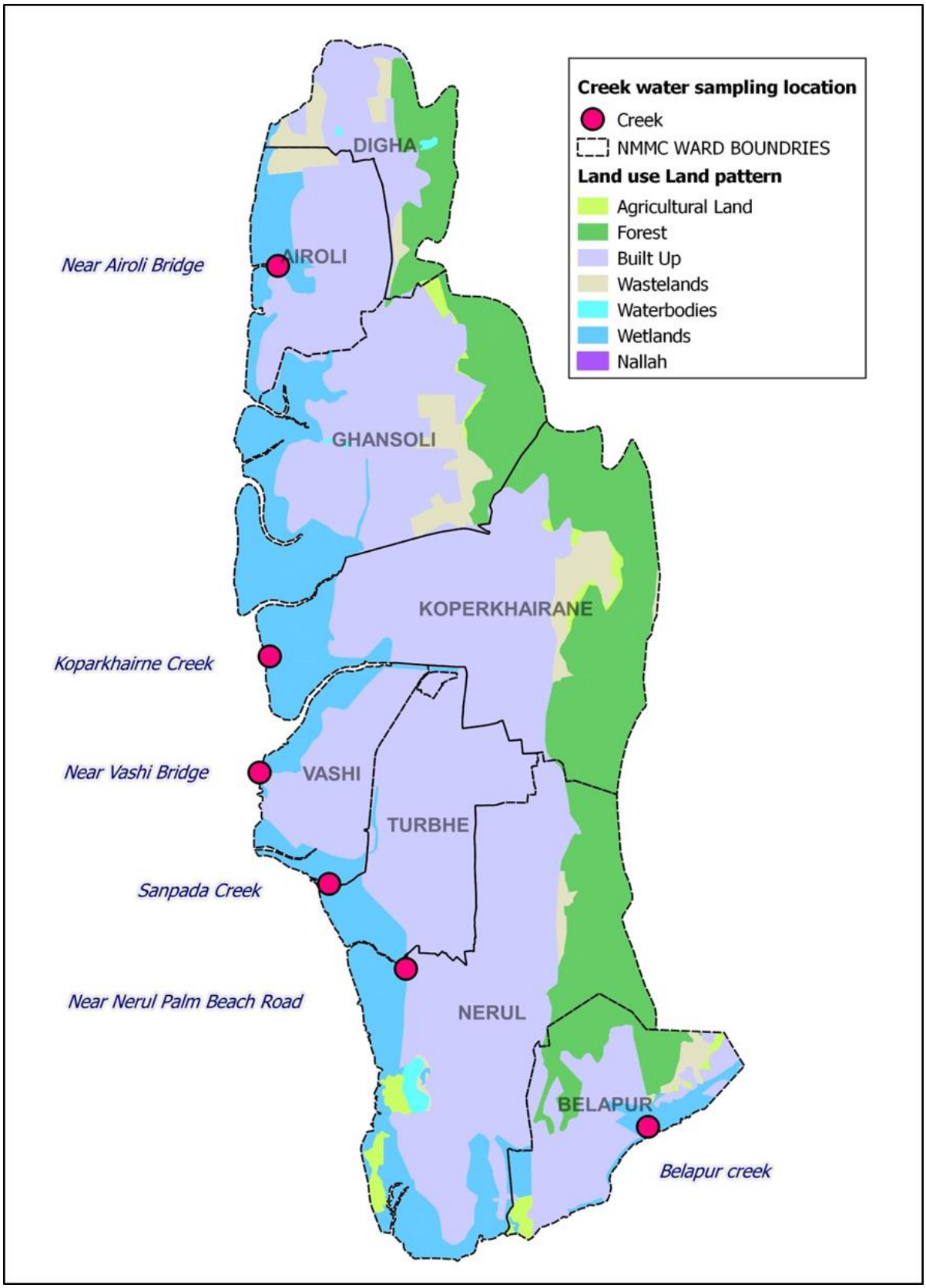
The creek water samples recorded high Chloride pollution. All the samples exceed the standards (600 mg/l) by more than 15 times. Airoli node is recorded to be adversely affected by chloride pollution with 11396mg/l. Similarly, suspended solids were also noted to be high in the creek water samples and the violation across all the monitoring locations were more than 10 times the standards (100 mg/l).The annual average water quality of creek in NMMC area is tabulated below in Table No. 20.

Table No. 20: Annual average water quality of creek water samples in NMMC area

Zone	**Name of Creek**	**Parameters**								
		pH	S.S.	D.O	B.O.D	C.O.D	Nitrate	Phosphate	TKN	Chloride
			(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
	LIMITS	**5.5-9.0**	**<100**	**4.0-7.0**	**<100**	**<250**		**<45**	**<5**	**<600**
Belapur	Belapur Creek	7.24	926.00	3.91	205.32	924.47	1.07	0.39	2.70	9005.72
Nerul	Near Nerul Palm Beach Road	7.30	1028.80	3.78	123.87	579.33	0.97	0.35	1.65	1790.84
Vashi	Near Vashi Bridge (Sagar Vihar)	7.26	1098.00	4.54	186.83	822.34	1.27	0.18	2.63	8932.98
Turbhe	Sanpada Creek	7.08	1083.60	4.35	256.82	1041.86	0.94	0.13	1.49	7895.15
Koparkhairne	Koparkhairne Creek	7.28	1051.60	4.79	224.03	991.82	1.24	0.16	1.94	7834.52
Airoli	Near Airoli Bridge	7.34	1058.00	3.28	295.29	1304.21	1.57	0.65	1.55	11396.76

Source: Environmental Laboratory, NMMC

Map No. 3: Water Quality Monitoring Stations along creeks in NMMC area



Ground Water

The NMMC region hardly depends on ground water for its activities due to established systematic water supply. However there are 132 wells in NMMC area. The analysis of samples from well water is regularly carried out for the parameters of pH, DO, BOD, residual chlorine, alkalinity, and faecal coliform. In the year 2014-15, NMMC conducted water quality test for around 22 wells in NMMC area (Table No. 21 and Table No. 22). All the parameters were detected to be within limits but the samples revealed presence of E-coli and faecal coliform in all the water samples.

Table No. 21: Well water quality recorded in NMMC area in 2014-15 (1 of 2)

Sr. No.	Location	PARAMETERS								
		pH	Turbidity	Residual Chlorine	DO	BOD	COD	Chloride	Hardness	MPN Count/ 100ml
			NTU	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	
1	Agroligaon, Sector 29	7.7	2.1	Nil	3.77	2.79	15.84	44.92	461.1	23
2	Shahabazgaon, Sector 19	7.4	0.3	Nil	2.44	2.04	11.88	44.92	269.7	23
3	Shiravane, Sector 1, Nerul	6.7	7.3	Nil	3.48	3.71	36	111	319.2	23
4	Sarsole, Sector 6, Nerul	7.7	7.8	Nil	1.74	13	83.16	51.33	287.1	23
5	Karavegaon, Near Lake, Nerul	7.7	1.7	Nil	4.53	5.11	27.72	160.4	243.6	23
6	Daravegaon, Sector 23, Nerul	7.6	0.7	Nil	3.66	6.5	39.6	32.08	269.7	23
7	Turbhegaon, Sector 21	7.3	6	Nil	2.39	2.79	16	51.33	156	23
8	Ganpatipada, Turbhe	6.8	10.8	Nil	3.56	1.86	16	308.4	184.8	23
9	Tin Taki, Sector 18,Koparkhairne	7.6	0.4	Nil	4.39	5.57	31.28	38.5	261	23
10	Infront of P.C.Patil's House, Sector 19, Koparkhairne	7.6	1.2	Nil	4.8	8.36	47.52	70.58	252.3	23
11	Near Ganesh Mandir, Sector 19, Koparkhairne	7.6	0.2	Nil	5.93	4.64	31.68	51.33	252.3	23
12	Anant Patil, Chinchali, Ghansoli	7.2	2.5	Nil	2.88	1.86	20	382.4	504	23
13	Old Video Center. Talvalinaka, Ghansoli	7	3.2	Nil	3.58	2.32	23.5	104.9	512	23

Table No. 22: Well water quality recorded in NMMC area in 2014-15 (2of 2)

Sr. No.	Location	PARAMETERS									
		pH	Turbidity	Residual Chlorine	DO	BOD	COD	Chloride	Hardness	MPN Count/ 100ml	E.Coli
			NTU	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)		
14	Rabadagaon behind GSR/ESR, Rabada	7.1	13.2	Nil	3.18	2.79	31.36	209.7	722	23	+ve
15	Near Vitthal Mandir, Divagaon, Airoli	7.2	11.6	Nil	2.13	3.71	32	38.5	139.2	23	+ve
16	Vitbhatti, Airoligaon, Airoli	7.1	4.1	Nil	2.98	2.32	19.6	176.4	296	23	+ve
17	Near Hanuman Mandir, Chinchpada, Airoli	7.2	7.1	Nil	3.07	0.74	11.76	268.8	141.9	23	+ve
18	Ilathanpada, Digha	7	8.8	Nil	7.01	2.32	28	89.83	243.6	23	+ve
19	Subhashnagar, Digha	7.2	10.6	Nil	3.81	2.79	28	51.33	208.8	23	+ve
20	Sanjay Gandhi Nagar, Digha	6.9	5.2	Nil	2.99	1.86	15.68	277.2	117.9	23	+ve
21	Juhugaon, Sector 11, Vashi	7	15.4	Nil	0.92	7.43	64	77	269.7	23	+ve
22	Vashigaon, Sector 6, Vashi	7.9	4.5	Nil	3.93	6.5	44	32.08	430	23	+ve

Source: Environmental Laboratory, NMMC

Water Resource Management

Water supply (Network)

As of 2014-15, the NMMC supplied around (421 MLD) of water in NMMC area to more than 1,22,143 connections via its 972 km long distribution network facilitated by 132 booster pumps. The NMMC provides 24 hours water supply to almost 75percent while in the remaining 25% of the NMMC area water is supplied for about 4 to 8 hours (Table No. 23).

Table No. 23: Number and size of pipes for water supply connections in NMMC area

Type	Connection size								Total
	15	20	25	40	50	80	100	150	
Domestic	1,09,486	1,350	1,269	1,003	556	133	20	8	1,13,825
Commercial	6715	484	659	250	166	27	9	8	8,318
Total									**1,22,143**

Source: Environmental Laboratory, NMMC

The Ministry of Urban Development, Government of India, is nodal Ministry in charge of various aspects of Urban Development including Urban Water Supply and Sanitation in the country. The service level benchmarks set by Ministry of Urban Development, Government of India is 100%. From the Figure No. 30 it is observed that the coverage of water supply in NMMC areas is 100% which meets the standarad.On other hand, the Municipal Corporations of Thane, Mira-Bhayander and Ulhasnagar have around 90% coverage while Vasai Virar and Kalyan Dombivali municipal corporations have around 70 and 40% coverage only.

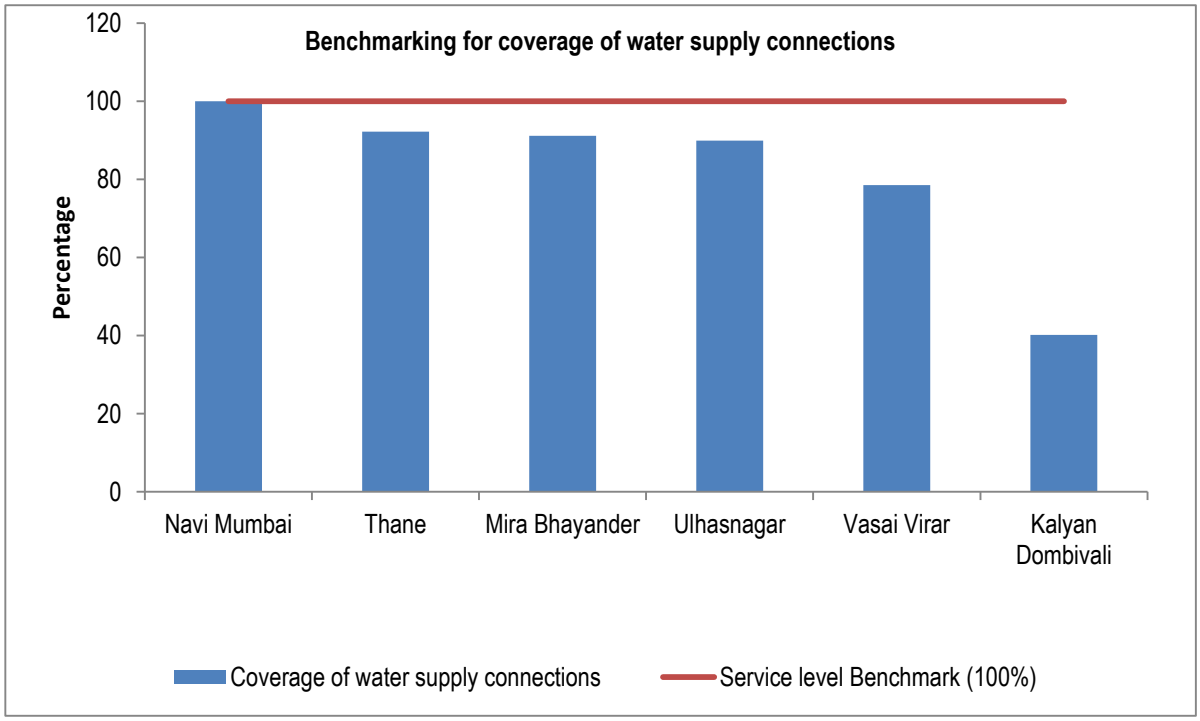


Figure No. 30: Benchmarking for water supply connections across major ULBs in MMR

Source: Performance Assessment System[20]

[20] http://www.pas.org.in/

Per capita water consumption

The per capita water supplied indicates the ability of the municipal water supply system in being able to source, treat water to potable standards and supply it into the distribution system. It is expressed in LPCD -Litres Per Capita per Day.

According to CPHEEO (Central Public Health and Environmental Engineering Organization), Ministry of Urban Development, Government of India[21], the benchmark water supply is 135 LPCD including losses. It is estimated that per capita water supply in NMMC area is about 240 LPCD which is almost 1.85 times higher than the designated benchmark. The NMMC supplies the highest LPCD water supply as against the other ULB's in MMR (Figure No. 31).

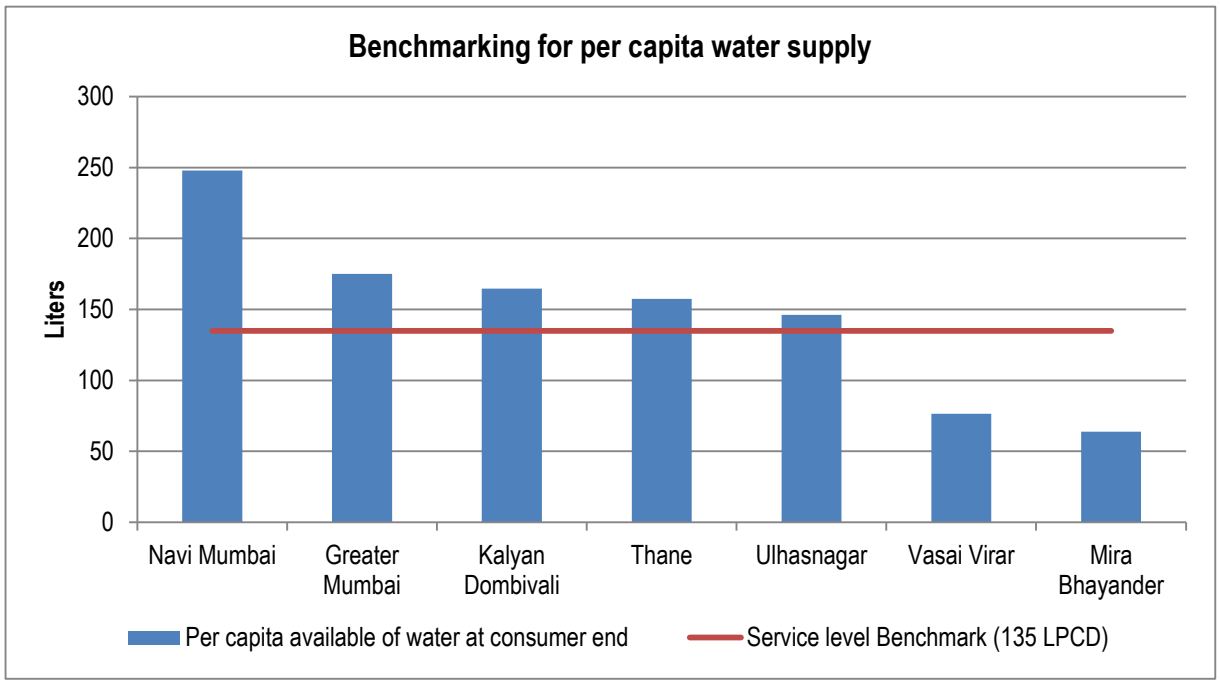


Figure No. 31: Benchmarking for per capita water supply for major ULBs in MMR

[21]http://saiindia.gov.in/english/home/Public_Folder/Professional_Practices_Group/State_Local_Manual/PUDUCHERRY_MANUAL/Wad%20Manual/Water%20Supply.pdf

Drinking water quality at tap end

Regular monitoring of drinking water samples at various points are carried out by NMMC to analyse the water quality for its potability. Consumption of contaminated water may lead to severe diseases in individuals which can result in epidemic, if not treated. All necessary quality controls are taken by NMMC in order to supply potable water to citizens. If any contamination is detected, corrective measures are taken. In the year 2014-15, total 22,382 samples were analysed out of which 2.3% (547) samples were detected to be non- potable (Figure No. 32).

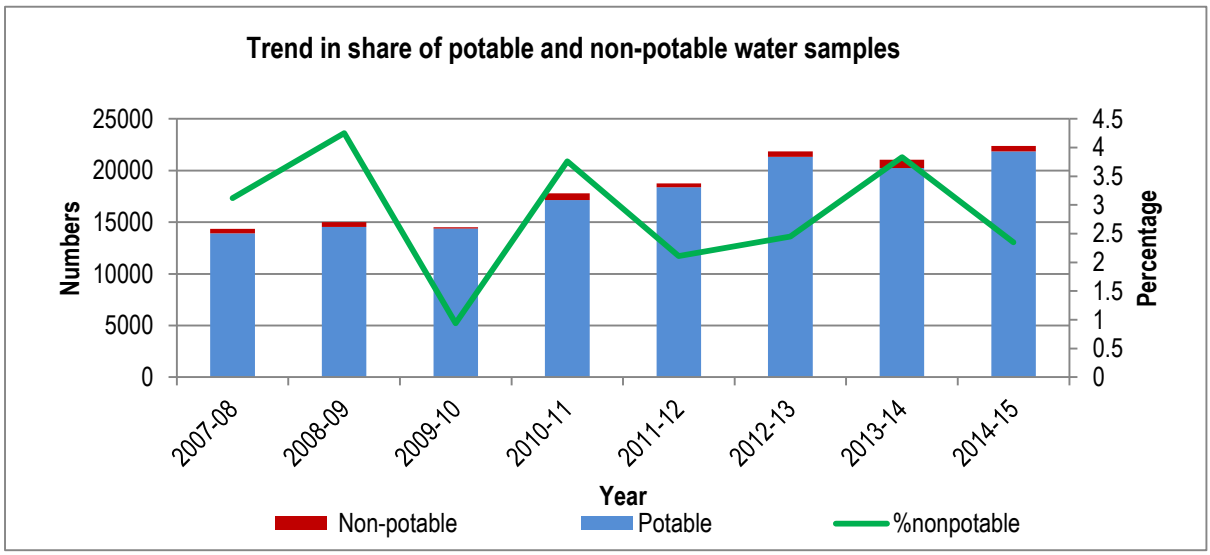


Figure No. 32: Trend in share of potable and non-potable water samples in NMMC area

Source: Environmental Laboratory, NMMC

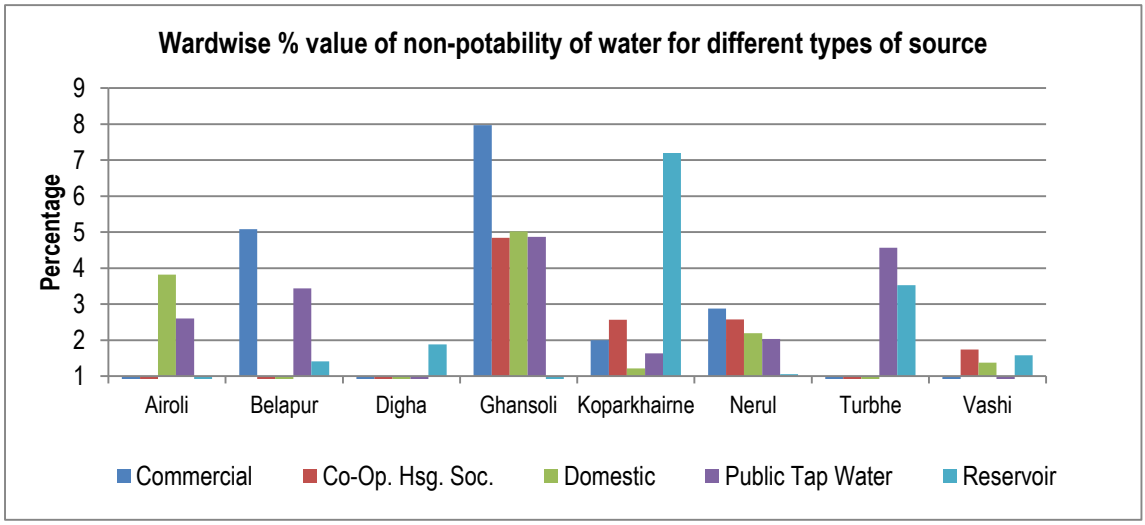


Figure No. 33: Ward wise % non-potablity for different types of water in NMMC area

Source: Environmental Laboratory, NMMC

From the Figure No. 33, it is observed that the domestic water samples from Airoli, Ghansoli were non-potable for about 4-5%, while the domestic water at tap end in Belapur and Turbhe was always potable. The commercial water samples collected from Ghansoli ward registered to have highest non potability of 8%. The highest non potablity for reservoir samples was recorded at Koparkhairane node.

Sewage treatment and public toilets

NMMC has well planned underground sewage network which covers about 99% in NMMC area and has about 2,28,923 connections. The total length of sewer lines is 448.273 km. There are about 416 public toilets with equal distribution for men and women.

Sewage Treatment Facilities

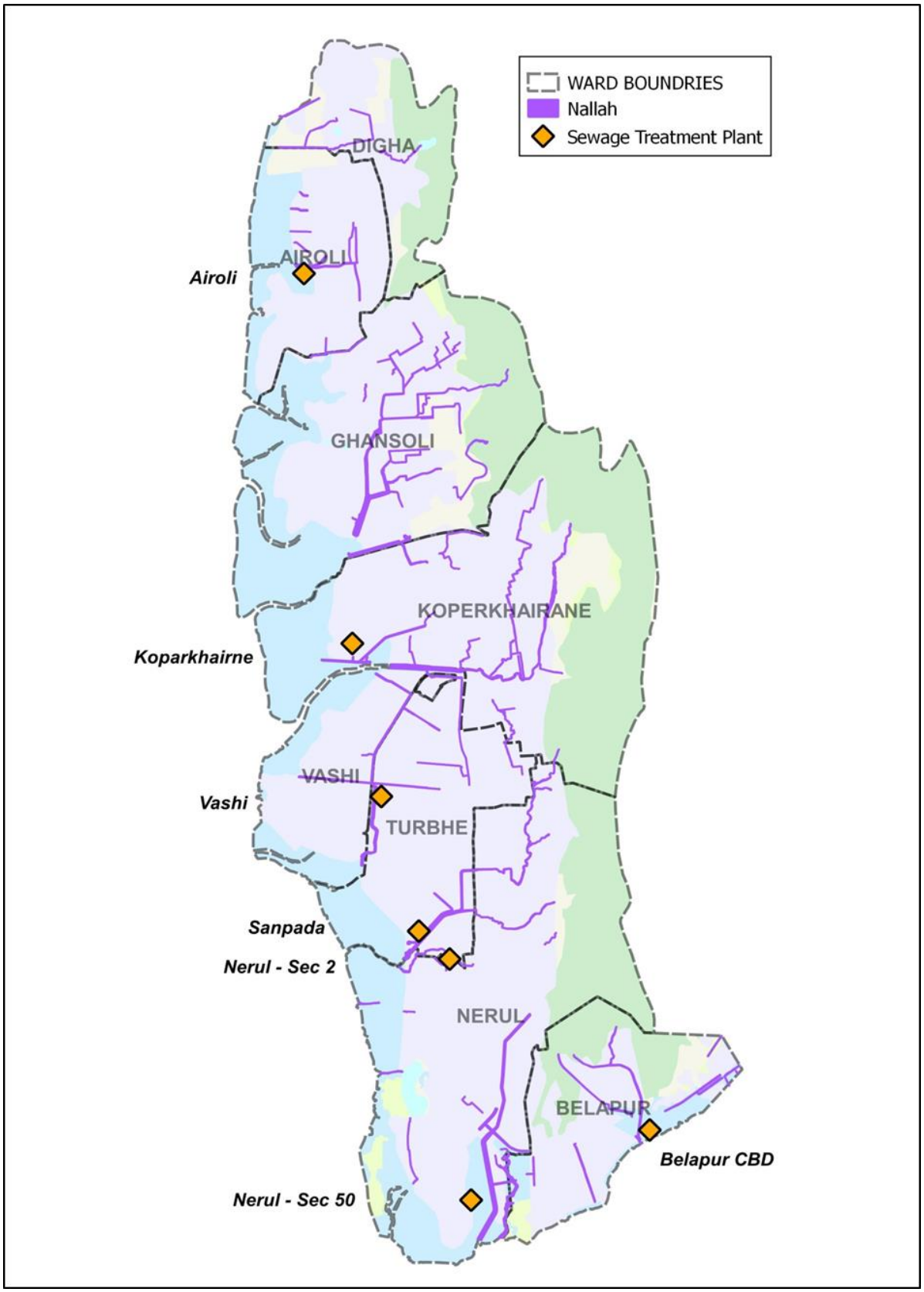
The sewage generated in NMMC area is treated with 6 sewage treatment plants and one aerated lagoon (Map No. 4). The total capacity of STPs accounts for 434 MLD. The total sewage generated in NMMC area is 180 MLD and 100% of the sewage gets treated. The STP's work on principle of on the Cyclic Activated Sludge Treatment (C-TECH) using advanced Sequencing Batch Reactor (SBR) process. The system operates in a batch reactor mode which eliminates all the inefficiencies of the continuous processes. The complete process takes place in a single reactor, within which all biological treatment steps take place sequentially. Special suction units are installed to clean the sewage from public toilets. There are around 10 suction units having capacities of 2000 liters (7 Nos) and 6000 liters (3 Nos). They are responsible to collect and dispose of the sewage to the treatment plants. A brief detail of the STP's in Navi Mumbai under NMMC is provided in Table No. 24

Table No. 24: List of functional Sewage Treatment Plants in NMMC area (2014-15)

Sr. No.	Node & Sector	Design Capacity, (MLD)	Treatment Scheme
1	CBD Belapur - 12	19	Cyclic Activated Sludge Process (SBR Tech)
2	Nerul - 50	100	
3	Sanpada - 21	37.5	
4	Vashi - 18	100	
5	Koparkhairne - 14	87.5	
6	Airoli - 18	80	
7	Nerul - 2	17	Aerated Lagoon

Source: Environmental Laboratory, NMMC

Map No. 4 Location of STP's in NMMC area



Performance of Sewage Treatment plant

Regular monitoring of water quality from STPs is done by NMMC before the water is released into the creek. This also helps to monitor the efficiency of treatment plants. The data for the inlet and outlet is presented in Table No. 25. It is noted that all water samples from 7 STPs are well within the standard for all parameters.

Table No. 25: Average performance and efficiency of STPs in NMMC area (1 of 2)

	PH		**D.O**		**B.O.D**		**C.O.D**		**S.S**	
Name of STP			**(mg/l)**		**(mg/l)**		**(mg/l)**		**(mg/l)**	
	6.5-8.5		**4.0-7.0**		**<100**		**<250**		**100**	
	In	Eff	In	Eff	In	Eff	In	Eff	In	Eff
Airoli Sector 18	7.02	7.22	Nil	5.97	34.08	5.83	188.39	50.94	174.40	78.00
Koparkhairne Sector 14	6.98	7.16	1.58	5.39	*61.57*	*5.89*	259.90	47.08	153.60	71.60
Nerul Sector 2	7.06	6.96	0.78	1.25	45.97	29.43	203.90	141.52	162.00	115.60
Nerul Sector 50	6.86	7.38	0.85	5.78	35.84	2.90	176.41	33.03	177.20	67.20
Vashi Sector 18	7.42	7.30	Nil	6.36	37.98	3.46	168.26	31.62	129.20	79.20
Sanpada Sector 21	6.90	7.16	1.27	5.85	24.84	4.07	114.13	28.34	154.40	62.00
Belapur Sector 12	6.80	6.92	0.97	4.92	29.30	5.14	155.47	35.85	224.00	80.40

Source: Environmental Laboratory, NMMC

Storm water Management

Navi Mumbai has storm water drain networks of total 550 km (Table No. 28) in length. The ratio of length of storm water drains to total length of major roads in NMMC area is 84% and covers almost the entire city except for the MIDC area where the ratio is about 50% (Table No. 28).

The main features of the storm water drains are the Nallahs and the unique holding ponds of the city which prevent flooding of water in the city. NMMC regularly monitors the water quality in the Nallahs as well as the holding ponds.

Nallahs

There are 10 major nallahs which collect and discharge storm water in creek area (Map No. 5). These nallahs originate in MIDC area and carries industrial effluent to the creek. These carry mixed wastewater during dry season. The list of nallahs is tabulated in Table No. 26 and the water quality is determined in Table No. 27. The water samples of nallahs (Table No. 27) from Turbhe node shows highest chloride pollution with 1479.79mg/l which is 1.5 times higher than the standard (1000mg/l) prescribed by CPCB. The water samples from nallahs exceed the COD levels and thus show low oxygen levels.

Table No. 26: Details of open Nallahs in NMMC area

Sr. No	Nallah	Node	From	To	Length (meters)
1	Nalla No-1	Belapur	Sector-1	Sector-12	2418
			Artist Village Branch		726
			Sector-1a Nalla		430
	Nalla N0-2		CBD Railway St- Sector-15		1105
2	Nalla N0-3	Nerul	Sector-9	Palm Beach Marg	4273
			Sector-15a		2661
3	Nalla N0-4	Sanpada	MIDC	Sector-4	7233
			Railway Branch		1418
			Sector-4 Branch		1403
			Herdilia Branch		1550
			MIDC Branch		1875
4	Nalla N0-5	Vashi	Sector-12	Vashi R/W Station	7310
5	Nalla N0-6	Koparkhairane	Khairane Nalla		7990
			Branch-1		3709
			Branch-2		739
			Branch-3		1678
			Branch-4		1470
6	Nalla No-7		Mahpe Nala		2036
7	Nalla No-8	Ghansoli	NOCIL Nalla		4690
			Branch-1		1360
			Branch-2		2937
			Branch-3		1615
			Branch-4		1620
8	Nalla No-9	Airoli	Bharat Bijlee Nalla		1891
			MSEB Nalla		1911
			Branch-1		732
			Branch-2		670
9	Nalla No-10	Digha	Ilthanpada Nalla		3500
			Thane Boundry-Digha		3332
				Total	**74282**

Source: Environmental Laboratory, NMMC

Table No. 27: Annual Average water quality of water samples collected from nallahs

Holding Pond	PARAMETERS							
	pH	S.S	D.O	B.O.D	C.O.D	Nitrate	Nitrite	Phosphate
		(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
LIMITS	*5.5-9.0*		*4.0-7.0*	*<100*	*<250*	*<45*		*<5*
Belapur Sector 12	7.18	540.8	5.23	39.47	215.84	0.38	1.63	0.52
Belapur Sector 15A	7.56	596.8	8.19	108.27	568.17	0.95	0.58	0.20
Vashi Sector 8	7.36	622.4	4.47	52.92	287.9	0.87	0.98	0.05
Vashi Sector 10A	7.38	628.4	6.90	89.7	512.72	0.87	0.13	0.10
Vashi Sector 11 & 12	7	626	3.15	55.71	390.89	0.84	0.64	0.07
Vashi Sector 30	7.16	655.2	2.55	59.61	439.14	1.12	0.22	0.35
Koparkhairne Sector 14	7.08	746	2.27	44.66	235.62	0.91	0.20	0.39
Koparkhairne Sector 19	7.42	654	5.61	107.1	535.11	2.22	0.30	0.10
Airoli Sector 18	7.16	717.2	3.59	102.14	547.85	0.70	0.32	0.26
Airoli Sector 19	7.1	761.6	6.21	200.57	1049	1.66	0.33	0.26
Sanpada Sector 18, 19 & 20	7.16	614.8	4.34	83.01	400.31	1.08	0.58	0.13

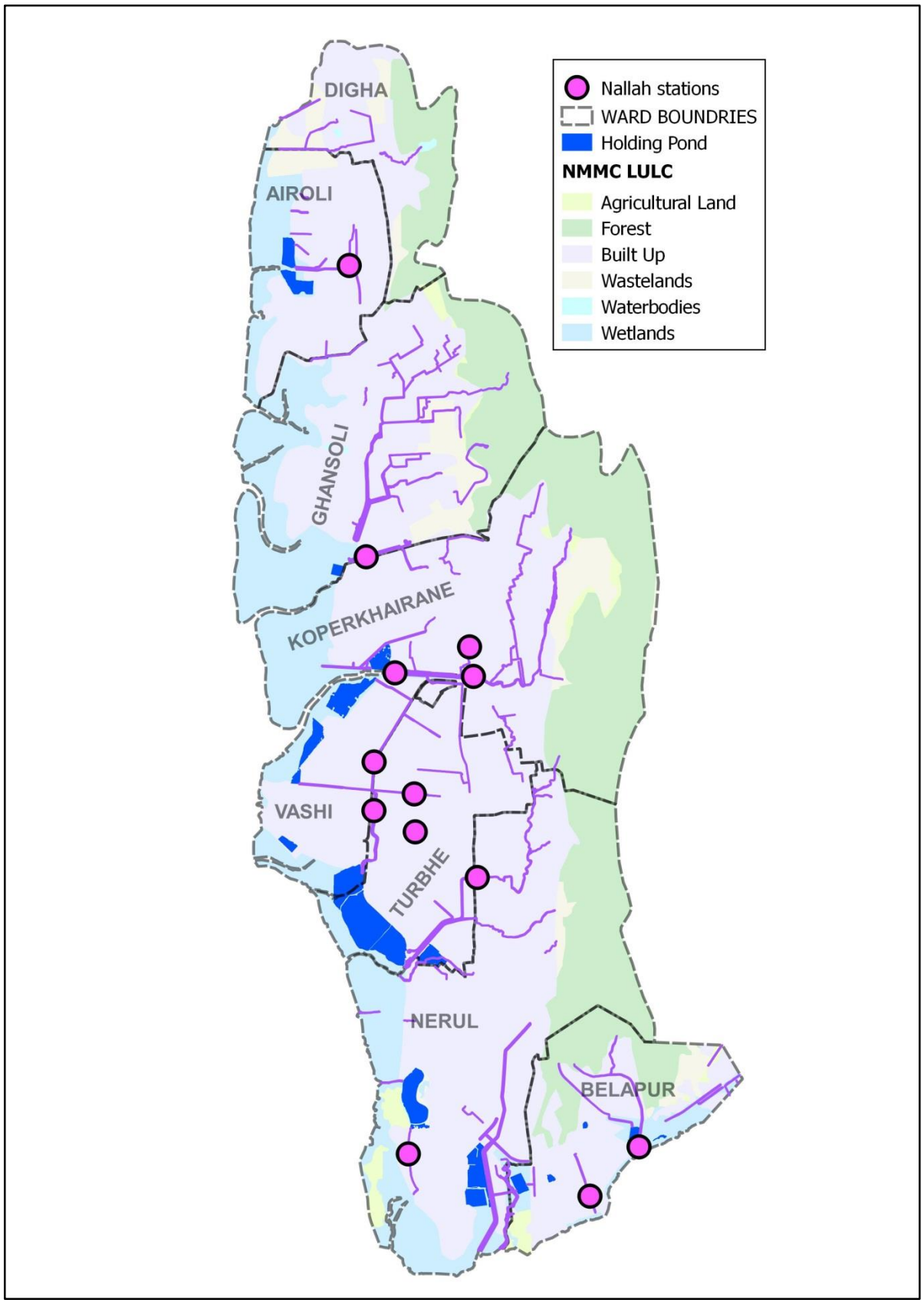
Source: Environmental Laboratory, NMMC

Table No. 28: Ward wise length of storm water drains in NMMC area

Sr.No	Ward Name	Ward Number	Storm Water Drain Length (Km)
1	Belapur	A	82.00
2	Nerul	B	111.00
3	Vashi	C	90.15
4	Turbhe	D	82.00
5	Kopharkhirane	E	79.00
6	Ghansoli	F	40.00
7	Airoli	G	65.85
8	Digha	H	0
9	MIDC		0
Total			**550**

Source: Environmental Laboratory, NMMC

Map No. 5: Water Quality Monitoring stations along Nallahs in NMMC area



Holding Ponds

CIDCO use the Dutch technology for flood control to optimise the reclamation levels of the city as Navi Mumbai is located below the High tide level. This method involves construction of bunds rising above the Highest Waterline to block entry of tidewater in the area proposed to be reclaimed. These entities, more commonly known as the Dutch dykes, have been especially designed and installed with unidirectional flap gates along the bund wall. They help restrict the intrusion of sea water during high tide and open only when the tide level recedes, thus allowing the release of water accumulated due to surface runoff (Figure No. 34 and).Picture No. 7

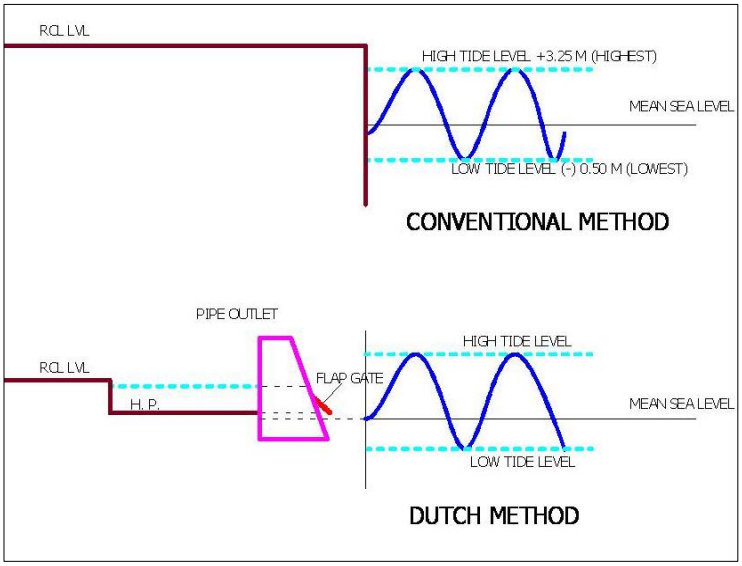


Figure No. 34: Schematic of the Dutch dyke used for land reclamation in Navi Mumbai

Picture No. 7: Dutch dyke (Holding ponds) with open flap gates at Vashi.

For disposal of rainwater, total 11 holding ponds have been constructed in Belapur, Vashi Turbhe, Koparkhairane and Airoli nodes under NMMC. Bunds have been constructed around these ponds and control mechanism for release of water during low tides has been installed. Monitoring of water samples at holding ponds is done five times in year by NMMC (Table No. 28).

Table no. 32 depicts the water quality monitored at the holding ponds in the year 2014- 15. It reveals that the level of dissolved oxygen at 5 locations was recorded to be below the minimum desired limits. Whereas, the COD levels across all the locations was recorded to be more than 2-3 times higher than the prescribed limits. Rest all the parameters like BOD, nitrite, nitrate, phosphates and pH were well in the limits.

Table No. 29: Details of holding ponds in NMMC area

Sr. No.	Node	Location	Area in hectare
1	Belapur (CBD)	Sector 12	5.5
2	Belapur (CBD)	Sector 15A	13.85
3	Vashi	Sector 8A	2.3
4	Vashi	Vashi Gaon	1.93
5	Vashi	Sector 10A	15
6	Vashi	Sector 12	24
7	Koparkhairne	Sector 14	9
8	Airoli	Sector 18	16
9	Airoli	Sector 19	14
10	Vashi	Behind Rly. Station	77
11	Sanpada	Sector 30A	22
Total			**200.58**

Source: Environmental Laboratory, NMMC

Table No. 30: Annual average quality of water samples collected from holding ponds

ZONE	Holding Pond	PARAMETERS									
		pH	S.S	D.O	B.O.D	C.O.D	Nitrate	Nitrite	Phosphate	Chloride	Sulphate
			(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)
		5.5-9.0		4.0-7.0	<100	<250	<45		<5	<1000	<1000
Belapur	Belapur Sector 12	7.18	540.8	5.235	39.47	215.84	0.384	1.6366	0.5232	8029.15	85.795
	Belapur Sector 15A	7.56	596.8	8.198	108.3	568.17	0.9523	0.5894	0.2004	7839.64	93.384
Vashi	Vashi Sector 8	7.36	622.4	4.472	52.93	287.9	0.8724	0.9874	0.05	5602.83	51.803
	Vashi Sector 10A	7.38	628.4	6.904	89.7	512.72	0.8725	0.1342	0.106	10063.5	99.696
	Vashi Sector 11 & 12	7	626	3.158	55.71	390.89	0.8472	0.642	0.077	7789.39	43.148
	Vashi Sector 30	7.16	655.2	2.552	59.61	439.14	1.1284	0.2254	0.351	5265.33	53.544
Koparkhairne	Koparkhairne Sector 14	7.08	746	2.274	44.66	235.62	0.9135	0.2052	0.3928	956.048	32.179
	Koparkhairne Sector 19	7.42	654	5.612	107.1	535.11	2.2291	0.3048	0.10388	6072.8	86.751
Airoli	Airoli Sector 18	7.16	717.2	3.598	102.1	547.85	0.7036	0.3258	0.2684	7086.45	61.271
	Airoli Sector 19	7.1	761.6	6.21	200.6	1049	1.6672	0.3342	0.2666	13930.6	92.748
Turbhe	Sanpada Sector 18, 19 & 20	7.16	614.8	4.346	83.01	400.31	1.0842	0.5834	0.13048	5686.42	56.795

Source: Environmental Laboratory, NMMC

Pressure and Impacts

Various pressures exist on water as resource. These pressures are in form of increase in water demand, water pollution (industries and domestic) and water losses due to theft and leakage. The pressures on water resource in Navi Mumbai city are presented in this section.

Owing to rapid urbanization in NMMC area there has been increase in demand for water. The demand for water supply is increased about 55% from 272MLD to 421 MLD for last six years. The Figure No. 35 shows increase in water supply in all nodes of Navi Mumbai. Water requirement for NMMC jurisdiction is estimate to be about 500MLD by the year 2042.

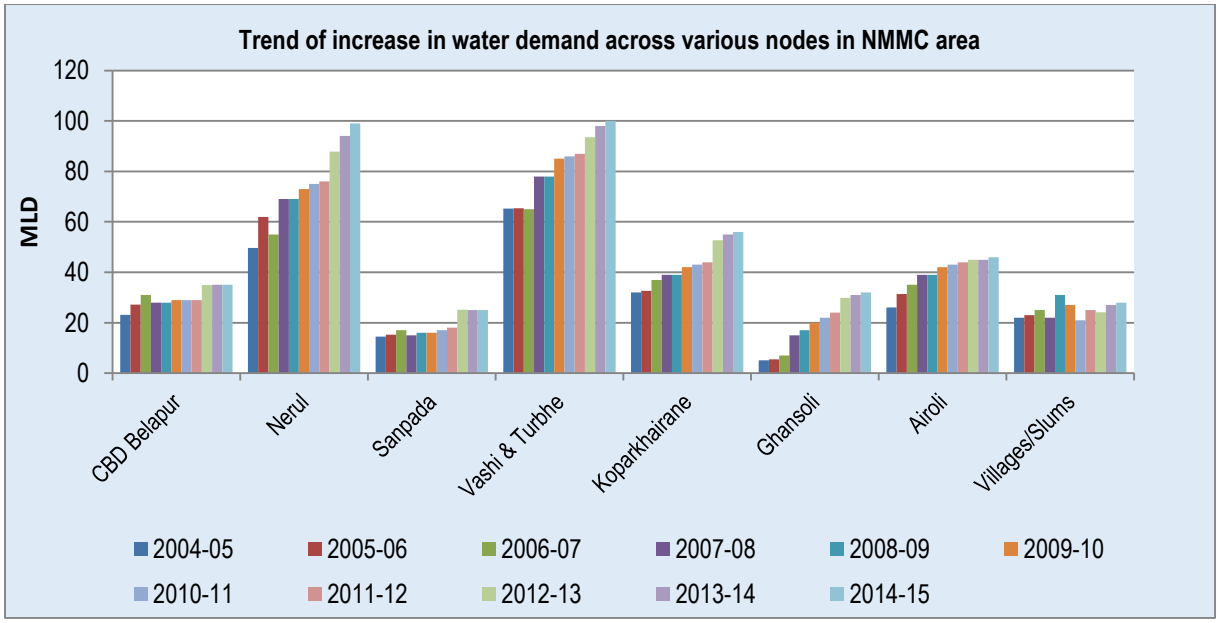


Figure No. 35: Trend of increase in water requirements in NMMC

Distribution losses and Leakages

The losses incurred due to distribution losses and leakages induce pressure on the water supply system. They not only cause losses in terms of absolute water requirements but also losses in terms of energy requirements at the pumping stations, booster pumps treatment consumables and so on.

From Figure No. 36, it is noted that the year 2006-07 shows the distribution losses for about 36 MLD about 13% of the total water distributed in city while in 2014-15 the distribution losses accounted for 19% MLD of daily water supplied to NMMC area (421 MLD).

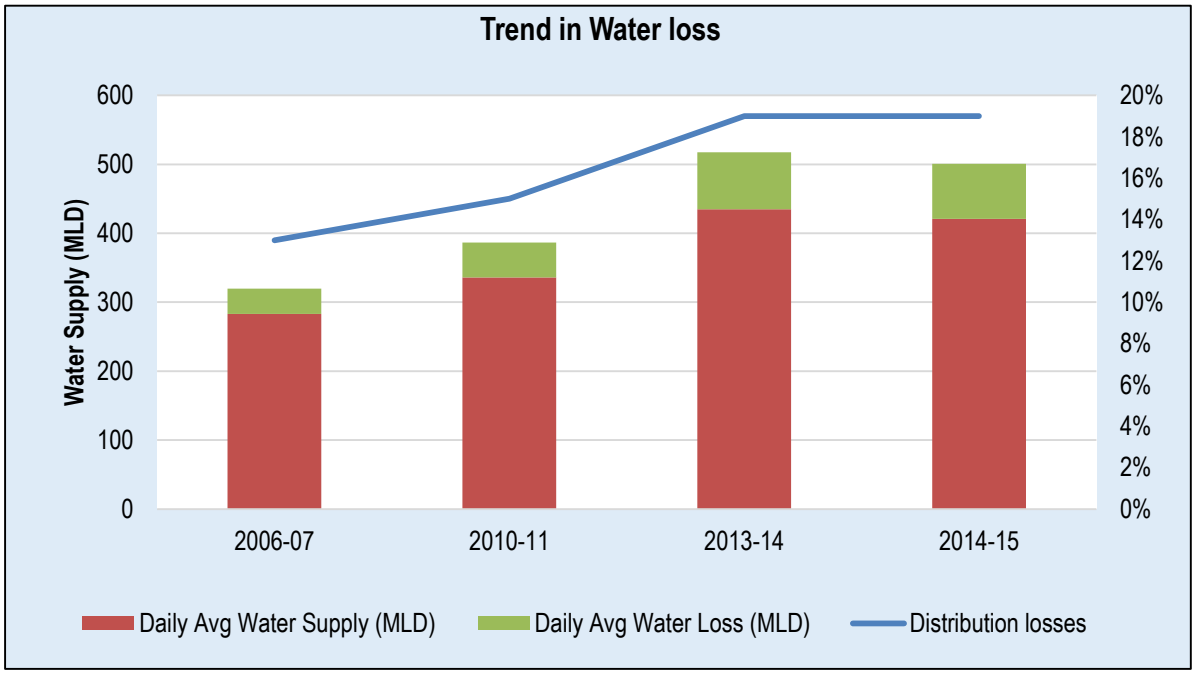


Figure No. 36: Trend of water supply and distribution losses in NMMC

Response

- Around 823 complaints were received for water supply and all were addressed by the corporation within 24 hours
- NMMC conducts regular water audit for water supply schemes.

Release of Sewage and industrial effluents

As per CPHEEO, about 70-80% of total water supplied for domestic use gets generated as wastewater[22]. The waste water from industries and domestic activities accounts for major source of water pollution. Navi Mumbai being coastal region, any release of polluted water can lead to water pollution affecting the aquatic ecosystem. With rapid expansion of city from last few years and increase in water supply, the quantity of wastewater generated has increased in the same proportion. From the Figure No. 37, it is observed that the sewage generated from last six years shows increase by 40 MLD, however in 2014-15 the sewage generated has been reduced. The water supplied for the year 2014-15 is 421 MLD which is cut off by 14 MLD as compared to 2013-14 (435 MLD). The total sewage generated for the year 2014-15 accounts for 276MLD.

[22]R Kaur, SP Wani, AK Singh and K La, Wastewater production, treatment and use in India,

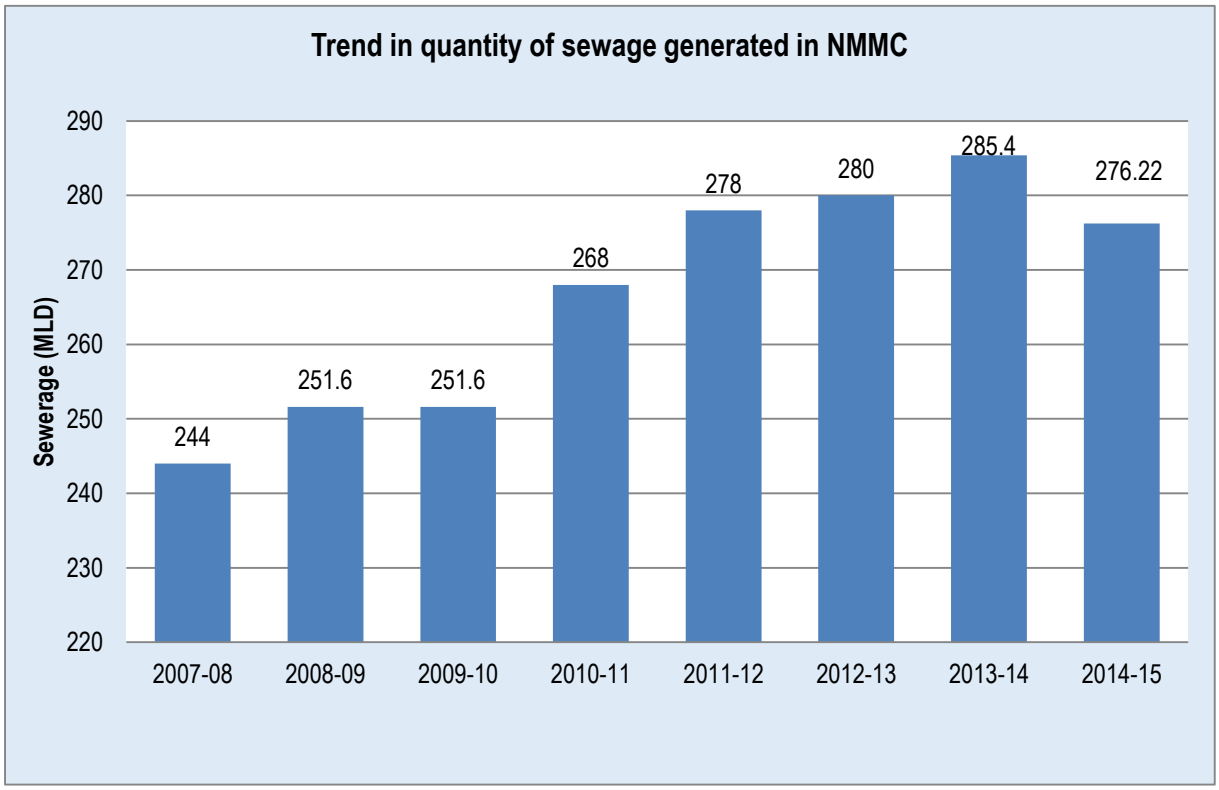
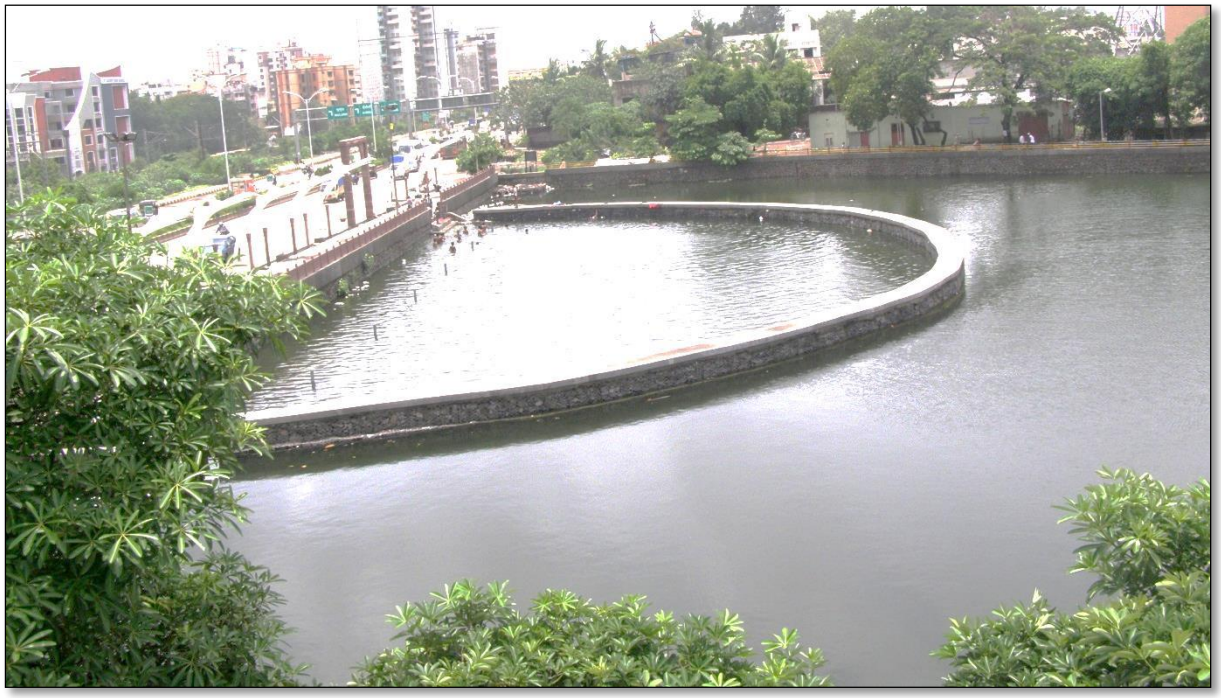


Figure No. 37: Trend in quantity of sewage generated in NMMC

Illegal dumping of debris and other waste in water bodies

Dumping of solid waste like plastics, demolition and construction wastes, garbage (animal and vegetable wastes), rubbish, yard debris, ashes, wood waste and so on leads to water pollution. Many religious offerings are also dumped into the holding ponds and lakes adding to water pollution. In order to prevent such pollution for lakes and ponds, NMMC has undertaken Lake Vision project in 2009-10 which has the following objectives:

- Decorative lights, flowerpots, cobal stone path way, stamp concrete for Ghat.
- Periodic dewatering and de-silting of lakes to increase the water holding capacity
- RCC Nirmalyakund, Washing area & idol immersion partition to the lake in order to control the entry of pollutants.
- Aeration system and central fountain in the lakes to improve water quality.
- Construction of Gabion retaining wall along periphery & partition wall for Idol Immersion tank
- Washing areas have been designed such that the run off from the washing (soap lather and waste water) does not enter the water body and is released into the storm water drains.
- Beautification of lake surroundings by ultra-modern infrastructure



Picture No. 8: Gabion wall partition for restricting idols immersion at Rabale lake

Silting of holding ponds

Holding ponds lies between the creek and the land where there is movement of water in and out of the holding pond owing to the tidal currents. The tidal currents cause effective transportation of mangrove propagules in the holding ponds which have increased the growth of mangrove in the holding ponds. The growth of mangroves in the holding ponds causes silting which further reduces their capacity to hold water. Due to this reason holding ponds are not serving the purpose of their construction. The silting of holding ponds may lead to flooding during rains and high tides in the city.

Response:

NMMC filed a petition on 18th December 2005 to carry out repair work of holding ponds. In 2006, the high court granted permission to carry out regular work which included:

1. Installation of new flap gates.
2. Repairing of bunds and repairing of service roads used to take machinery if necessary
3. Pipe outlet repairing and small repair works.
4. Flap gate repairing

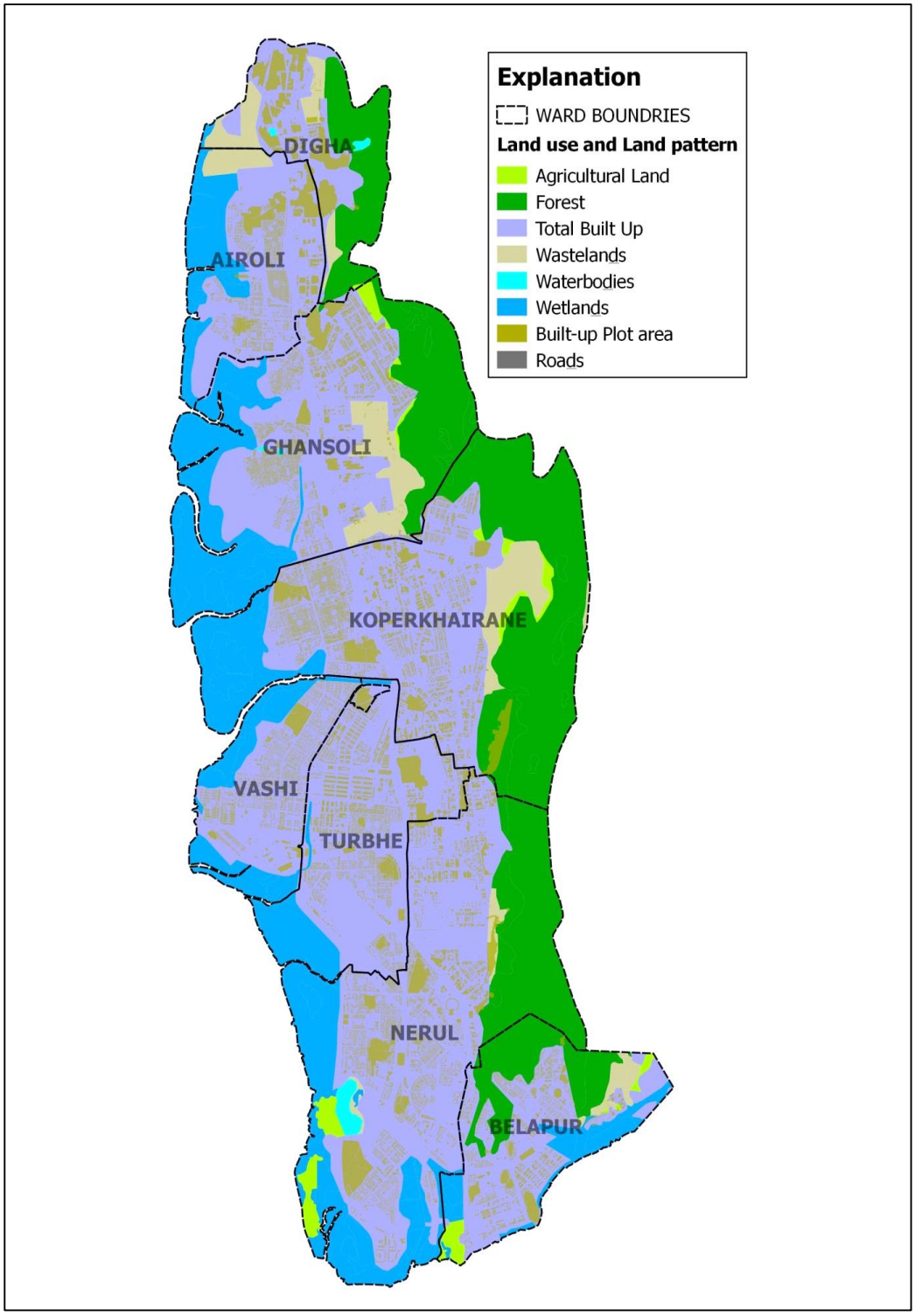
In 2010, it was decided that NMMC should apply for the requisite permissions of de-siltation to MCZMA before applying to High court. Accordingly NMMC has applied to MCZMA of Govt. of Maharashtra on 30th August 2012 which was passed on 4th March 2013 to develop action plan. A detailed action plan has been submitted on 5th August 2013 by NMMC proposing treated silt to be used for quarry slope refill. The addition of artificial soil in steep quarry slopes needs to be carried out using specialized technologies. The hearing in this case is awaited from the Hon'ble High court

.

NMMC further proposes to develop a nursery for mangroves and the propogules, using this silt. Given that the soil is very saline it shall not be suitable for cultivation of any other tree species since they would not be able to adapt to saline conditions. As there are very few nurseries, the saplings could be distributed across the city and also in other areas of MMR. It will not only save the cost for treating the large quantity of soil but also it could be a unique feature for the Corporation. The citizen groups may be informed about these nurseries so that the mangrove patches destroyed along the coast may be restored

Picture No. 9: Growth of mangroves at holding pond in Vashi

Land Resource



Map No. 6: Land Use Land Cover pattern of Navi Mumbai

Land resources refer to a delineable area of the earth's terrestrial surface, encompassing all attributes of the biosphere immediately above or below this surface, the soil and terrain forms, the surface hydrology (including shallow lakes, rivers, marshes and swamps), the near-surface sedimentary layers and associated groundwater and geo hydrological reserve, the plant and animal populations, the human settlement pattern and physical results of past and present human activity.

Since, Navi Mumbai is a planned city, CIDCO (City and Industrial Development Corporation) has already put a lot of planning and thought into its development. Appropriate plans were formulated for industrial belt, residential zones and open spaces while designing the city. This section highlights the present status of land resource in NMMC area and also discusses the threats faced by them.

Status

As per the data recorded by MRSAC (Maharashtra Remote Sensing Application Centre) the land use pattern of the city consists of built up area, agricultural land, forests, wastelands, water bodies, roads, and so on (Map No. 6). NMMC's jurisdiction is spread across 108.63 sq. km (Table No. 31). Majority of the area (56.16%) is built up area which is spread across 61 sq.km. This comprises residential, commercial, industrial, administrative constructions and infrastructure such as crematoriums, water supply, sewage disposal, roads, and railways. Wetlands are an important feature of the city with 13.46 sq. km area under lakes, mangroves, wetlands, creeks, mudflats and manmade water bodies.

Table No. 31: Break up of Land Use Land Cover pattern in NMMC

Sr. No	Land Use Land Cover	%Share of land cover	Area in km²
1	Built Up	56.16	61.01
2	Forest	24.44	26.55
3	Wetlands	12.39	13.46
4	Wastelands	05.39	05.85
5	Agricultural Land	01.29	01.40
6	Water Bodies	00.33	00.36
Grand Total		**100**	**108.63**

Source: MRSAC

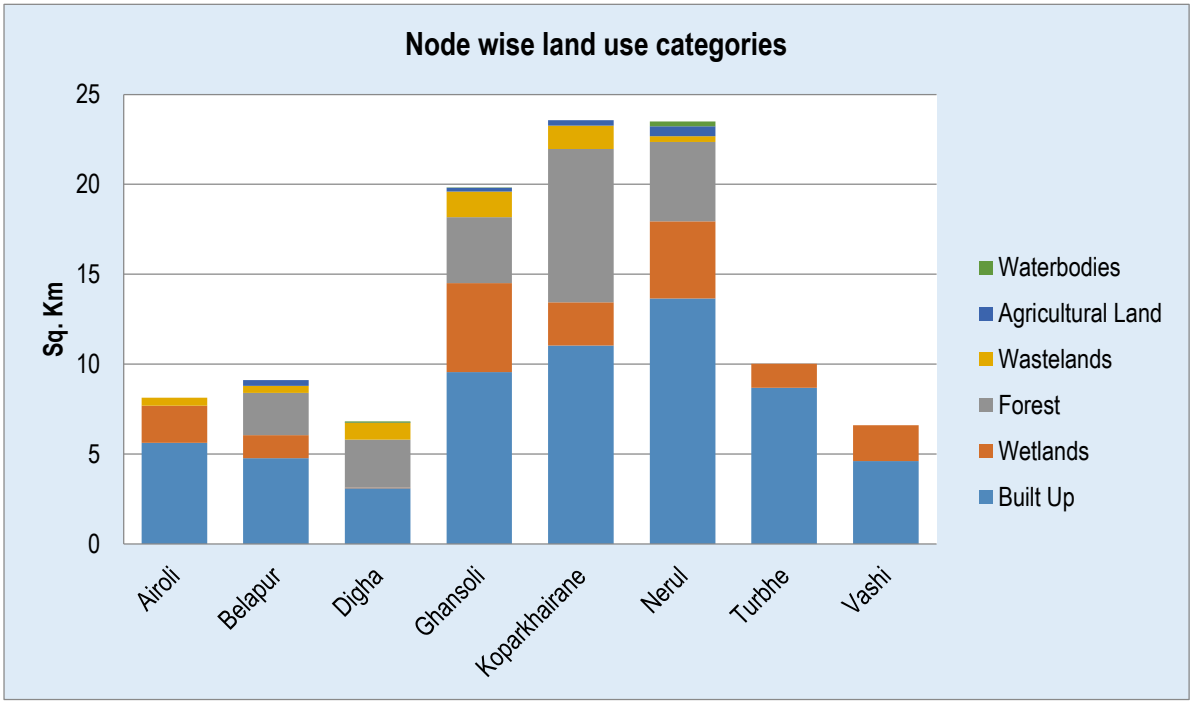


Figure No. 38: Ward wise land use categories in NMMC

Source: MRSAC

It can be clearly observed from Figure No. 38 that almost 3/4th of the total area in Turbhe and Vashi is built up area which indicates that the population density in these areas is higher compared to other areas.

Forest areas can be observed at Belapur, Digha, Ghansoli, Koparkhaine and Nerul which indicates need for protection of these areas to conserve the green spaces of the city. Wetlands can be observed in all the wards except Digha. Marginal farm lands can be observed in Belapur, Ghansoli, Koparkhairane and Nerul which indicates that agricultural practices are still carried out in the city but at a very small scale.

Built up Area

Built up area is an important land use for any city. More than 60% of the area in Navi Mumbai is under built up area for residential, commercial, and industrial purposes in each node. Residential area comprises of majority of the built up area of the city to accommodate the ever increasing population. The current status and the threats exerted by growth in the residential, commercial and industrial area have been discussed in the Drivers section of the report. The built up area in the city is also under various infrastructural development projects such as roads, railways, WTP & STP (Water and Sewage Treatment Plants), SWM (Solid Waste Management) & so on. The status of these infrastructural projects is further elaborated in their respective sections.

Wetlands

As defined by Ramsar convention, wetlands are areas that are seasonally or perennially covered by water[23]. Wetlands usually consist of water structures like lakes, rivers, mangroves, coral reefs and so on. Artificial man-made wetlands consist of paddy fields, dams, saltpans and so on. Navi Mumbai is rich in several wetland areas such as lakes, ponds, holding pond, mangrove wetlands, marshlands & so on.

Water Bodies

Navi Mumbai consists of several water bodies such as 24 lakes, dams, creeks, ponds, wells & so on. The water bodies are used for various domestic and industrial purposes in the city. These water bodies have been further explained in the Water resources section of the report.

Mangroves

Mangroves are a taxonomically diverse group of salt tolerant, mainly arboreal, flowering plants that grow primarily in tropical and subtropical regions[24]. They are distributed in the inter-tidal region between the sea and land (Picture No. 11)[25]. Mangrove wetlands are ecologically important since they serve as a home for a variety of diverse plants and animals. Increase in mangroves has also been observed from 15.50 sq. km to roughly 49.78 sq. km since the last 2 decades[26] but only few areas are under the jurisdiction of Municipal Corporation. The mangrove species recorded in the area included *Avicennia marina* and a mangrove weed, *Acanthus ilicifolius* and *Sonnertia alba* (Picture No. 10). Research studies of NMMC area documents species of true mangroves representing approximately 3 genera and 3 families while 10 species of mangrove associates belonging to 8 genera under 6 families and 1 species of non-mangrove halophytes have been recorded[27]. As mangroves play a valuable role as natural barrier against cyclones, floods and tsunamis, they tend to act as a lifeline for citizens of Navi Mumbai. They also play a vital role by providing breeding and feeding habitat for various birds and fishes of the city.

Picture No. 10: Roots (Pneumatophores) of Mangroves and leaves of *Acanthus ilicifolius*

Source www.niobioinformatics.in

[23] Ramsar Convention
24 http://cmsdata.iucn.org/downloads/managing_mangroves_for_resilience_to_climate_change.pdf
25 http://www.marineclimatechange.com/marineclimatechange/bluecarbon_2_files/Girietal2011.pdf
26http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue40/news/toi_mangroves_cidco.pdf
27 Pawar (2011). Floral Diversity Of Mangrove Ecosystem From Coastal Environment Of Uran (Raigad), Navi Mumbai, Maharashtra. Electronic Journal of Environmental Sciences Vol. 4, 113-117 (2011) ISSN: 0973-9505

Picture No. 11: Dense mangroves cover at Sagar vihar-Vashi Sector 8

Carbon sequestration by mangroves in NMMC

Mangrove forests are one of the most promising means of carbon sequestration, having the highest net carbon productivity among all ecosystems. Mangrove species are able to reduce the amount of excess carbon in the air by sequestering carbon dioxide and thereby reducing the concentration of greenhouse gases[28]**.** Studies have found that mangroves have the potential to store more carbon in their biomass compared to tropical and temperate forests[29]. It is found that mangroves sequester approximately 1.5 metric tons/hectare/year of carbon[30]. Considering the total mangrove area of Navi Mumbai (4978 hectare), the sequestration due to mangroves can be estimated to be approximately 7467 metric tonnes per year.

As the Carbon footprint of Navi Mumbai is estimated to be about 2.8million metric tonnes/year as per study conducted by TERI, it could be predicted that almost 0.26% carbon emissions are sequestered by the mangroves of Navi Mumbai per year.

[28] http://www.mangrovesforfiji.com/mangroves/carbon-sequestration

[29] http://www.wetlands.org/News/tabid/66/ID/3503/Not-all-mangroves-are-identical-new-study-reveals-hotspots-for-mangrove-biomass.aspx

[30] Singh et al (2012). Carbon Sequestration In Mangroves Ecosystems, Journal of Environmental Research And Development, Vol. 7 No. 1A.

Open Spaces

Natural Areas

Natural forests are an important component of the green areas in Navi Mumbai and about 16.35 % of total NMMC area (26.55 sq. km) is forest area. The city encompasses various habitats ranging from low hills with tropical semi-evergreen, tropical moist deciduous, tropical dry deciduous, to marshlands, estuary and mangroves. Around 1,471 hectares (14.71 sq. km) of mangroves on government land in Navi Mumbai have been notified as "reserved forests". Such areas with a high green-coverage have ecological and environmental importance & can also improve the urban climate, abate the urban heat-island effect and reduce environmental damage.

Navi Mumbai city has a good area under tree cover. A study by NASA (National Aeronautics and Space Administration) indicates that it takes 17.5 trees per person to produce sufficient oxygen for survival but it takes 20 trees per person to consume the CO_2 each person generates. Thus trees play a vital role in regulating the city environment and maintaining a proper balance. NMMC has carried out tree plantations in every block consecutively as per the requirement which can be observed in Table No. 24. Out of the total trees present in the city 1.14 Lakhs (1,14,931) have been planted on road dividers. As per the tree census conducted in 2006, the total tree count of the city is around 4.79 Lakhs (4,79,120).

As these green areas work not only as lungs for the city but also provide various environmental services, conservation of these areas is of key importance in order to ensure sustainable environment of the city.

Man-made Areas

Growing urbanisation which has resulted in loss of natural areas of the city has exacerbated the process of air, water and land pollution. Gardens act as small regulators to clean the environment of the city. They not only help in reducing the pollution of the city but also contribute to the environment by providing oxygen, enriching the climate, conserving water, preserving soil, and acting as micro habitats for a variety of city dwelling fauna such as birds and butterflies. Also they create a peaceful, aesthetically pleasing environment. Gardens further play a significant role in enhancing the physical, emotional and spiritual well-being necessary to build healthy and socially sustainable communities. Realizing the importance of these green components for the city, NMMC has taken various initiatives in the form of afforestation programs and proposing new gardens for effective conservation of the environment.

A total of 199 gardens are present in the city. These gardens have had a large contribution towards the increasing green cover of the city (Table No. 32). Maximum number of gardens can be observed in the Belapur node with a total of 45 gardens. Some gardens in the city are developed based on a special theme in order to provide aesthetic value to area and also to increase the beauty of the city (**Error! Reference source not found.**).

Table No. 32: Ward wise total gardens in NMMC

Sr. No	Node	Total Gardens	Total Area (Sq. m)
1	Belapur	45	166987
2	Nerul	42	173398
3	Sanpada	11	60521
4	Vashi	44	179252
5	Koparkhairane	21	61917
6	Ghansoli	7	19684
7	Airoli	29	100903
	Total	199	732662

Source: Garden Department, NMMC

Biodiversity of NMMC

Biological diversity refers to the full range of variety and variability within and among living organisms and the ecological complexes in which they occur. It encompasses ecosystem or community diversity, species diversity, and genetic diversity. Biodiversity of an area is an indicator of the rich environment of the area & Navi Mumbai is one such area with a variety of habitats. Being a tropical ecosystem, it is bestowed with a high biodiversity. Navi Mumbai is currently home to more than 168 species of birds, 80 species of reptiles and amphibians, 140 species of butterflies, 125 species of marine fish, 800 species of flora & so on. Despite such a high biodiversity, no legal protection for the area in the form of a 'protected area' has been granted except for mangroves. Karnala bird sanctuary is the nearest protected area located at a distance of 30 km. The important highlights of biodiversity of the Navi Mumbai area are as follows:

Birds

Navi Mumbai is a famous spot for observing birds due to the presence of the coastal and mangrove wetland ecosystem. Different species of water birds, local and passage migrants & so on are spotted at several places in Navi Mumbai. More than 168 species of birds are present in the area out of which many are migratory in nature. Part of Thane Creek and Uran Creek are the key biodiversity hotspots to observe migratory birds. Nerul's Talave, Airoli & Ghansoli mudflats are also home to some exotic birds. A total of 77 species of birds belonging to 35 families and 14 orders were recorded from Uran mudflats. The recorded avifauna comprised of resident (48%), local migrant (23%) and migrant (29%) bird species but Pawar (2011) observed a total of 56 species of birds representing 11 orders, 29 families and 46 genera from the mangroves of Uran mudflats. Migratory and threatened birds such as Lesser Flamingos visit Navi Mumbai in large numbers. Flocks of flamingos can be observed from Belapur to Airoli in high numbers along the mangrove patches from November to May. Ornithologists have also observed a substantial rise in their population and attribute the reason for this to availability of sufficient food and conducive habitat (Picture No. 12).

Picture No. 12: Lesser flamingos at Navi Mumbai

Other Taxa

Other lesser known taxa of Navi Mumbai have been studied to an extent. The data on species diversity of fin fishes from Uran coast revealed the presence of 31 species of which 3 species of Chondricthyes (Cartilaginous fish) representing 2 genera and 2 families and 28 species of Osteicthyes (Bony fish) representing 28 genera and 23 families were recorded. Pawar (2012) have also studied the decapod and molluscan diversity of the Uran Coast where 26 species of decapods were found and 55 species of molluscs representing 13 orders, 30 families and 39 genera were also recorded.

Pressure & Impact

Mining and Quarrying

Mining and stone quarrying is a major pressure exerted on land resources. It is the main reason for degradation of many natural areas of India. Extensive mining causes air, water and land pollution impacting the biodiversity around it and ultimately affecting human beings. Navi Mumbai also faces pressures from mining and quarrying activities. A total of 80 leases have been provided in 7 different regions of the city which account to a total area of 966151 sq. m (0.96 sqkm). The operators are permitted to carry out mining activities in the area till the year 2016. Air pollution with high RSPM level can be observed in the area near the mining sites as explained in Air section. This is one of the important factors accelerating air pollution in the city. Exposure to such polluted air may result in acute respiratory diseases which may cause chronic bronchitis and decreased lung function. Population in city living near mining areas is more vulnerable to the effects of high RSPM.

Table No. 33: Mining in Navi Mumbai

Sr. No	Region	No. of Lease/Operator	Area in (Sq.m)
1	Bonsari	15	179792
2	Kukshet	11	115450
3	Pavane	12	136365
4	Sirvane	10	103125
5	Turbhe	28	344344
6	Bonsari	2	64800
7	Pavane	2	22275
	Grand Total	**80**	**966151**

Source: http://www.thane.nic.in/pdf/sand_mining/khanipatta_list.pdf

Dumping of Debris

Dumbing of debris is currently a serious issue faced by the city. Illegal dumping of debris is being carried out on a large scale in various wards. Not just construction debris from the city but also debris from nearby regions is randomly dumped in the city at various locations. The dumping is carried out in mangrove areas and holding ponds creating a pressure on these areas. Mangrove area proves to be an important habitat for the migratory birds such as flamingos and other wader birds which visit the city during the winter season. Dumping of debris in these areas will impact the activities of these birds, possibly causing them to migrate to other areas.

Destruction of Mangroves

Mangroves are also being impacted on a large scale by the growing pressures. Overexploitation and unsustainable demand has resulted in considerable degradation of mangrove areas. Deforestation is major threat to mangrove forests and the land is being reclaimed for construction purposes. Sometimes mangroves also face the threats from oil spills due to accidents. Illegal deforestation and burning of mangroves is also observed in some areas. A steady decrease in the mangroves of Thane Creek has been observed to an extent which may affect the local environment of the area if conservation and restoration measures are not taken in time. Thus as Navi Mumbai is identified to be a vulnerable city which may face impacts of sea level rise due to climate change, conservation of mangroves is the need of an hour to avoid future losses.

Poaching of Flamingos

Poaching of Flamingos has also reported in some parts of Navi Mumbai for consumption purposes. Important habitats such as Uran are also seen to be facing various threats from the present SEZ and erosion which has resulted in migration of various species in large numbers.

Other Projected Impacts

Urban Heat Island Effect

An Urban Heat Island (UHI) is a metropolitan area that is significantly warmer than its surrounding rural areas due to human activities. The main reason for this effect is the concretization of buildings and houses which indirectly act as insulators of heat. This insulation makes the areas around buildings warmer. The UHI effect has been observed for cities like Mumbai, Chennai, Kolkata and Pune with effects in the form of heat stress and rising precipitation which has impacted the urban life of the city. Temperature rise due to climate change in the city can also add to the threats on biodiversity. Studies in various cities have recorded migration of wildlife to areas with cooler temperatures, although Navi Mumbai is currently not facing any such effect of the rising urban heat. But in future such effects may be observed considering the growing trend of urbanization and rise in built up area in the form of concrete structures in the city.

Compounded Impacts

Increase in building permissions and rise in the number of properties would increase the pressure on resources to a great extent. All buildings may not be resource efficient and may depend directly on them to fulfil their needs. Thus a rising number of properties will directly impact the land resources leading to over exploitation of the same. This will impact the sustainable development of the city leading to scarcity of resources in future. Also rise in properties in a particular area would lead to congestion in that area which would also indirectly impact the resources of that particular area.

Response

Green Buildings

In order to contribute to the sustainable development of the city, NMMC is promoting the concept of Green Buildings under their ongoing project titled "Navi Mumbai: An Eco City" in collaboration with TERI (The Energy and Resources Institute). Adoption of the green building concept would lead to conservation and efficient use of limited resources like land, water, energy and so on. Given the need of the hour and to set an example for the building & construction industry, NMMC has constructed its own headquarters at Belapur. The building has received LEED's Gold rating from IGBC (Picture No. 13) owing to the following green features implemented and integrated in the building design.

- Rainwater harvesting system consisting of 13 pits with a capacity to store up to 80,000 liters of water.
- Reflective tiles fitted on the terrace to reduce the load on electric consumption by air-conditioners.
- STP of 0.15 MLD capacity to treat sewage generated in the building.
- Recycled water is used for toilet flushing & gardening purpose.
- Biomethanation Plant for scientific disposal of canteen waste.
- Grass pavers are fitted on the ground to allow percolation of water.
- Use of Double Glazed Unit glass to reduce heat transfer & increase energy efficiency
- Pneumatic plumbing system to reduce load on water flow.
- Recycled wood has been used for furniture in the building

Picture No. 13: New NMMC Headquarters- A green building

Vigilance against illegal dumping of debris

Realizing the seriousness of the issue NMMC has established a special flying squad for monitoring the activity of illegal dumping of debris in the city. For the year 2014-15, almost 179 vehicles carrying illegal debris were caught by the department carrying approximately 2685 tonnes of debris.

Addition of Open Spaces

As open spaces in the city helps in reducing the impacts of UHI, NMMC and CIDCO plan to increase the area by adding various open spaces in future. NMMC is also taking various steps to avoid misuse of the open spaces through organizing anti- encroachments drives and sending legal notices to concerned agencies.

Raising awareness about Bio wealth of City

In order to increase awareness and sensitize citizens about the local biodiversity of the city, NMMC in collaboration with TERI has installed biodiversity panels at Nisarga Udyan, Koparkhairane highlighting the importance of flora and fauna to the city. The garden was transformed from a garbage dumping site and now the garden proves to be a habitat for many bird species (Picture No. 14).

Picture No. 14: Biodiversity lecterns at Nisarga Udyan, Koparkhairane

- The forest department and the CIDCO are undertaking a joint survey of mangroves in the area with the plan of creating a mangrove wetland centre for Navi Mumbai. Several initiatives have been taken by the citizens of Navi Mumbai which include afforestation drives and generation of awareness among the stakeholders regarding significance of mangroves.
- NMMC has carried out tree plantations in every block as can be seen in Table No. 34. As the last Tree Census was conducted in 2006, NMMC felt the need to conduct a fresh census in order to maintain details and progress of the present & planted tree in the city. Thus tenders have been invited by NMMC in order to undertake Tree Census.

Table No. 34: Tree plantation data for 6 years in NMMC

Sr. No	Node	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
1	CBD Belapur	10235	5950	4500	3000	0	3100	250
2	Nerul	3940	9250	4743	0	0	800	120
3	Juinagar	1582	1050	0	0	0	0	0
4	Sanpada	3248	650	0	0	0	0	0
5	Vashi	5100	7250	0	1500	0	0	0
6	Koparkhairane/Ghansoli	1704	4300	10800	1500	67500	65000	4650
7	Airoli	3428	9500	2962	1000	0	0	2400
	TOTAL	**29237**	**37950**	**23005**	**7000**	**67500**	**689000**	**7420**
**65000 Proposed Tree Plantation on Adwali Bhutawli forest Area*								

Source: Garden Department, NMMC

Restoration of Stone Quarries and Protection of Hills

Gravel and stone quarry operations result in extensive manipulation of the landscape and ecosystems. Quarrying results in accelerated erosion because the topsoil environment required for establishment of vegetation is eliminated. Once quarry resources are exhausted or operations ceases, the landscape is extensively degraded and renders to be of no use. Such degraded lands lead to safety, ecology, and aesthetics-related concerns. The intrinsic impact of quarrying is the exposure of the bare soil and underlying strata which vary in stability and do not support vegetation, contrasting sharply with the adjacent undisturbed landscape features. There are over 200 quarries in NMMC area (Nerul-106, Turbhe-92, Koparkhairane-8, and Digha-3). In view of land degradation due to stone quarrying in NMMC, restoration of these areas is a challenge for NMMC. The actions proposed by NMMC for restoration of such sites are as follows:

- Assessing feasibility of using abandoned quarries for rainwater harvesting;
- Planting trees for restoration of land under abandoned quarries
- Quarries in operation to implement better handling operational facilities with pollution control facilities.
- Abandoned quarries can be restored by sanitary land filling with innocuous inorganic wastes, especially construction debris by adopting suitable slopes from stability angle and with due compaction.

Proposed Activities

- NMMC proposes to set up bird watching towers near the mangrove area for the citizens of Navi Mumbai in order to increase awareness among citizens regarding significance of migratory birds (Picture No. 15). This initiative will also allow citizens to connect with nature.

Picture No. 15: Proposed watch tower at mangroves area for Bird watching

- NMMC has proposed several gardens in order to increase the aesthetic beauty and green cover of the city. The list of the proposed gardens is given below in Table No. 35.

Table No. 35: Gardens proposed for Navi Mumbai

Sr. No	Name of the garden	Node
1	Scientific Park	Airoli
2	Zen (Buddha Garden)	Airoli
3	Sane Guruji Park	Digha
4	Botanical Garden	Belapur
5	Navras	Koparkhairane
6	Amusement Park	Vashi

Source: Garden Department, NMMC

Solid Waste Management

NMMC is responsible for the collection, transportation as well as disposal of solid waste generated in NMMC area. Solid waste collection is carried out in 81 zones through private contractors. NMMC took over Thane Belapur Industrial Area of MIDC in November 2004 and is providing SWM services in MIDC areas. This has increased 4 zones making total zones 85. NMMC collects and disposes the solid waste at the Turbhe scientific landfill site after appropriate segregation and processing of the leachate collected.

Source and Composition

The daily average of solid waste generated and collected by the NMMC in the year 2014-15 was about 675 Metric Tonnes (MT) translating about 470 grams of solid waste per capita. The main source of solid waste is from the residential areas comprising of waste from household and commercial areas, accounting to more than 87% (590 MT) of the total waste generated and collected in NMMC area. Also considering the breakup of the amount of waste generated from the residential sector (Table No. 36), highest amount of waste is generated and collected from Koparkhairane ward (102 MT/day) while lowest amount of waste is generated from Digha ward (22 MT/day). The presence of APMC right within the city is also a major source of solid waste, and accounts to about 8% (58 MT) of the total solid waste generated in the city. NMMC is also responsible for collecting and disposing the non-hazardous waste generated by the industries in the MIDC area. In the year 2014-15 MIDC area generated about 21 MT of solid waste per day.

As seen in Figure No. 39, the solid waste in NMMC mainly consists of biodegradable waste from the residential and commercial areas followed by plastic, paper and so on. Metal waste possess the lowest share in total composition of solid waste.

Table No. 36: Quantity of daily average MSW generated from NMMC in 2014 -15

Node	Ward Number	2014-15 (Metric Tons)
Belapur	A	91
Nerul	B	89
Vashi	C	101
Turbhe	D	86
Koparkhairane	E	102
Ghansoli	F	38
Airoli	G	61
Digha	H	22
Sub-total		**590**
APMC		58
MIDC		21
Others		5
Total		**675**

Source: Environment Laboratory, NMMC

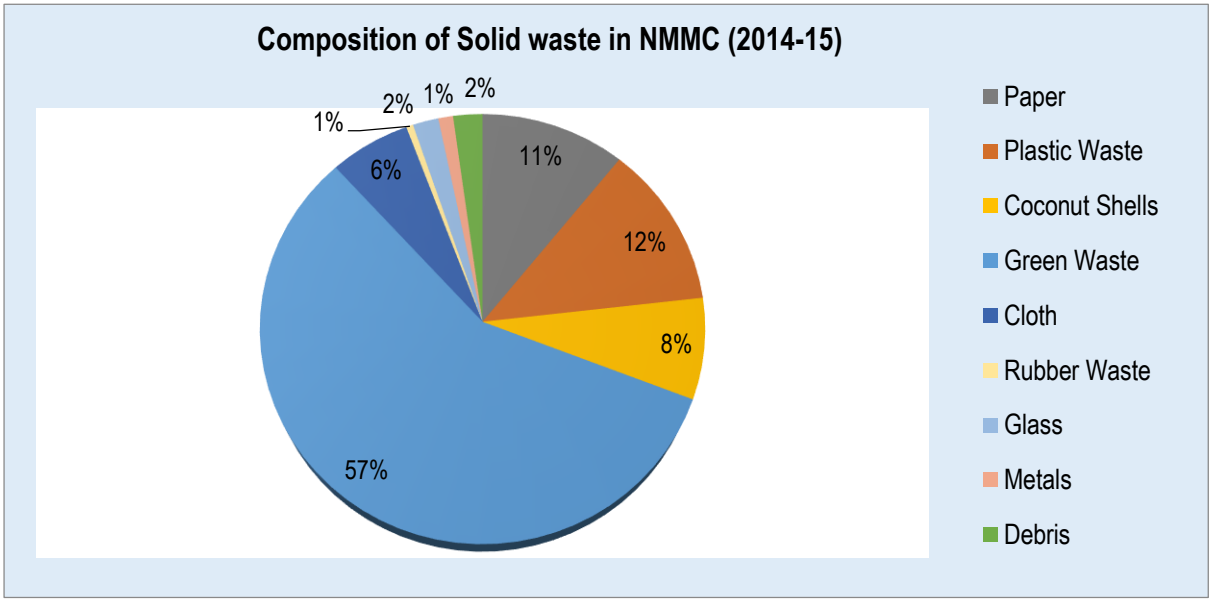


Figure No. 39: Composition of solid waste in NMMC

Source: Environment Laboratory, NMMC

Collection

About 108.63 (sq. km) of area is covered for the collection of solid waste. The total number of households covered for collection is around 2,77,622 out of which 2,21,776 are covered through door to door collection (bell ringing) while the rest of the waste for 55,846 households collected through common facilities like public trash bins. Domestic solid waste from houses is mechanically collected and loaded in refuse transportation vehicles by transportation contractors. Community bins are provided at market places. There are total 2,100 bins present in the city with varying capacities (Table No. 37) mainly of closed type. In the year 2014-15 NMMC spent around INR 53.06 crores for cleaning and sweeping while about INR 22.11 crores were spent on transporting the solid waste.

Table No. 37: Number of bins across NMMC area to collect solid waste

Capacity of the bins	80L	120L	240L	340L	1.1 m^3
No of bins	300	800	500	300	200

Source: Solid Waste Department, NMMC

Biomedical Waste

The city also generates considerable amount of biomedical waste due to presence of hospitals and various other health facilities in the city. The average biomedical waste generated by the government run hospitals in NMMC, this year was around 12,887 Kg (Table No. 38). Biomedical waste is collected from various hospitals and dispensaries by private contractors and disposed of at the Hazardous Waste Disposal facility at Taloja.

Table No. 38: Composition of biomedical waste generated by NMMC hospitals

Categories (% evalution)	Disposal Method	Vashi Hospital Vashi	Mata bal Hospital Turbhe	Mata bal Hospital Kopar Khairne	Mata bal Hospital Airoli	Total
Needle, Lancet, Scalpel Veinflor, Discarded Glass wares- Tube, Pipettes, Syringes, Slides, Coverslips, Disposal Waste- IV Sets, Disposal syringes, Injection Vials, Amp. Glass, Bio Catheters, Plastic Bottles	Autoclaving & Shredding	7702.96	374.98	363.78	130.27	8571.99
Microbial Waste, Highly Infectious Waste, Isolate, Discarded Medicines, Solid Waste, Liquid Waste	Incineration	3747.82	252.62	241.99	73.12	4315.53
Total		**11450.78**	**627.6**	**605.77**	**203.29**	**12887.4**

Source: Health Department, NMMC

Note: Mata bal Hospital Nerul is under renovation and hence there was no biomedical waste generated from that hospital in the year 2014-15

Sweeping

NMMC undertakes daily sweeping of roads to clear of the waste on the roads. The total length of road swept accounts to 1317.19 km and on an average one sweeper sweeps 700 running meters of road length. NMMC has now introduced 8 mechanical sweepers for efficient sweeping of roads. About 196.16 km road is swept by the sweeping machines per day. The sweeping machines are fitted with suction technology, water sprinklers and brushes which are used to collect dirt, sand, pebbles and scattered leaves from the road. The total number of sweepers employed for this purpose is 2461, mainly on a contract basis. Sweeping is conducted daily for about 8 hours starting in the morning. The sweepers are provided with around 2100 waste collection bins/ containers and 8 mechanical sweeping machines for the purpose of effective sweeping & collection of waste.

Processing & Scientific Disposal

NMMC is collecting domestic solid waste (wet & dry) from all the nodes and transporting it to the sanitary landfill at Turbhe. The separation is done at sanitary landfill site. The landfill site is spread over 65 acres and 675 MT waste is received daily for processing. The expected life expectancy of the landfill site is for around 69 years. The waste is processed daily using the Wind Rows composting & Refused Derived Fuel technology. Recyclable waste is separated and recycled (Figure No. 18). Wet waste is used for production of Refuse Derived Fuel (RDF) and compost. The rejects are disposed off into the sanitary landfill. Out of the total intake of waste, a majority of the part is moisture.

While disposing solid waste, de-odorant is sprayed to minimize fly and odour nuisance. The operation & management of landfill is through Public Private Partnership basis (PPP). The sanitary landfill is protected from stray dogs and trespassers by constructing compound wall all around. A green belt is constructed and planted with various plants around the periphery of the site. Completed phases of sanitary landfill are covered with grass and methane is flared and burnt to reduce the "Green House'' effect. Air Quality Monitoring Station present at this site helps to monitor air pollution from this integrated solid waste disposal facility at Turbhe. The landfill site is responsible for generation of a lot of leachate due to the degradation of solid waste. The Leachate treatment plant was commissioned in 2011-12 and is one of the environmental achievements. The leachate water is regularly sampled and the quality of water is tested each year (Table No. 39). NMMC has also undertaken the proximate and chemical analysis of the solid waste samples from a third party and the report is presented in Annex - IV

Table No. 39: Leachate analysis report at Turbhe site in NMMC

	Parameters						
	pH	D.O	B.O.D	C.O.D	Chloride	Sulphate	Hardness
	5.5-9.0						
Influent	7.9	0.2	1582	4649	1566.07	159.20	1889
Effluent	7.4	6.4	91	388	824.82	106.81	697

Note: All Values are in mg/l except pH

Source: Environment Laboratory, NMMC

Picture No. 16: RDF plant and windrow composting facility at Turbhe landfill site

Picture No. 17: Nisarg *Udyan* developed by scientific closure of open dumping site

Initiatives

Scientific Closure of Old Wild Dumping Ground at Koparkhairne

Scientific closure of an old wild dumping ground at Koparkhairne, having an area of 17 hectare containing 20 lakhs M.T garbage was completed by NMMC. A network of wells to collect trapped landfill gas (LFG) was laid and a flaring unit was installed at site to burn the LFG. Leachate collection tank was also constructed to collect the leachate which is being treated before disposal. Treated sewage water from nearby Sewerage Treatment Plant is being used for watering the lawn through Sprinkling System. NMMC has set a leading example in closing existing open dumping ground and converting into lush green garden. In the year 2013-14, grass layer for 22000 sq. mt area was laid to increase the green cover of the garden. As part of the development of Phase II, a jogging track has also been set up which is highly appreciated by the citizens residing in the nearby localities. The closure of Koperkhairne dumping ground and the sanitary landfill at Turbhe are ideal projects as per Municipal Solid Waste (Management & Handling) Rules September 2000 and appreciated by visitors from World Bank, foreign missions, municipal commissioners from various state and other visitors.

Proposed Initiatives

- Budgetary provisions has been set for procurement of dustbins in NMMC area.
- NMMC is planning to set up a debris recycling plant realizing the need for conservation of environment. The recycled debris would be further used for restoration of quarry sites.
- Scientific closure of Phase 4 at Turbhe landfill site.
- Setting up of an E-waste recycling plant has been proposed by NMMC.
- NMMC also plans to setup up a waste to energy plant based of biomass gasifier technology to process coconut shell waste and generate electricity. A pilot plant of 20kWe is proposed at the Turbhe land fill site and the power thus generated would be used to illuminate the high masts at the site.

Health

Environment and Health

The interaction between the environment and human health are highly complex and difficult to assess. The best-known health impacts are related to ambient air pollution, poor water quality and insufficient sanitation.

WHO (World Health Organization) has estimated that 24% of the global burden of disease, healthy life years lost, (Annex-V), and 23% of all deaths (premature mortality) were due to modifiable environmental factors (for example, pollution, occupational risks, land use practices and lack of sanitation)[31]. As per a research by WHO, environmental factors are responsible for spreading more than 80% of the diseases. Globally, nearly one quarter of all deaths and of the total disease burden can be attributed to the environment[32]. Diseases with the largest absolute burden from environmental exposure included diarrhoea, lower respiratory infections, Dengue and Malaria.

The status of health of residents is one of the most crucial indicators of the environmental status of a city. But in addition to good environmental conditions, a city also needs to have good healthcare facilities. The following section presents the status of various diseases recorded in NMMC in the year 2014-15 and the actions taken in the sensitive wards/ UHPs (Urban Health Posts) in NMMC area.

Navi Mumbai has diverse health care services and facilities including clinics, hospitals, super speciality hospitals, private and government dispensaries and so on. NMMC hospitals are equipped with necessary aid for emergency cases. It has recently introduced the service of super specialty wards at hospitals with the help of private operator. There are plenty of private hospitals and government hospitals in the city which are equipped with the latest instruments and specialist doctors. Given below is the list of current health care facilities of Navi Mumbai in comparison with the previous years and as evident in Table No. 40, since last year there is an increase in the health related facilities in NMMC area The density of hospital beds is an indicator of the availability of inpatient services at any location in case of emergency or any epidemic outbreak. The global standard for the same is 3.5 beds per 1000 population[33]. As seen in Figure No. 40 Navi Mumbai (3.3)[34] has better density of hospital beds as compared to national (0.7) as well as the global average (2.7) per 1000 population.

[31] http://www.who.int/quantifying_ehimpacts/publications/preventingdisease.pdf?ua=1
[32] http://www.who.int/quantifying_ehimpacts/publications/preventingdisease/en/
[33] WHO Guidelines
[34] This involves private as well as government hospital beds

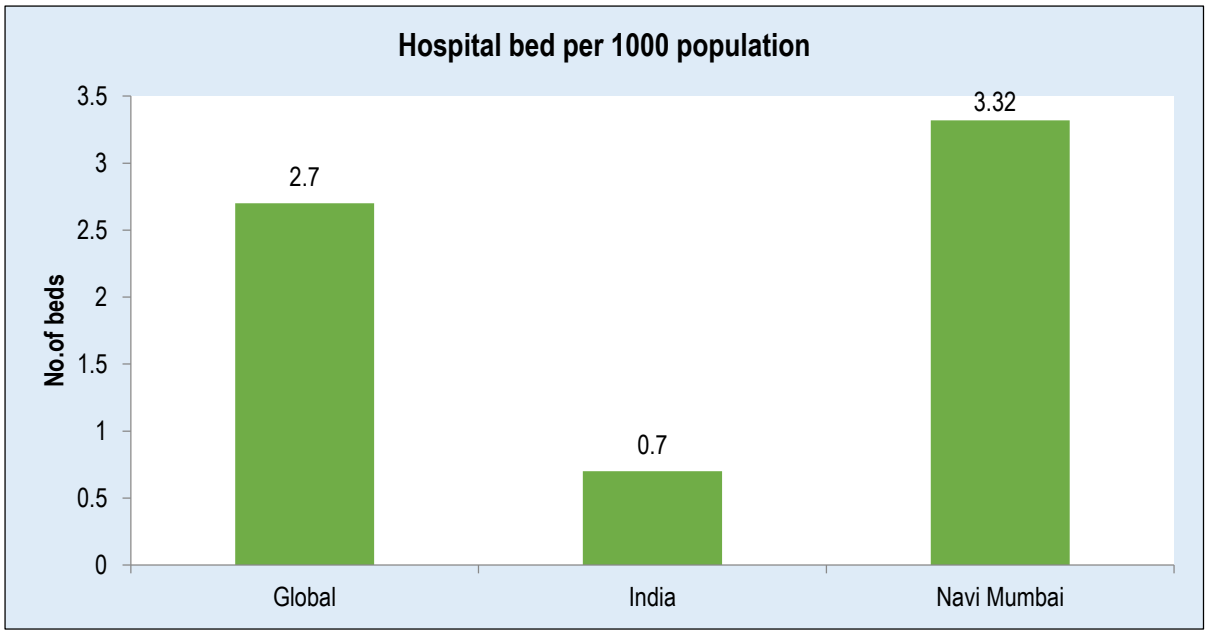


Figure No. 40: Benchmarking of hospital bed density per 1000 persons for Navi Mumbai

Source: World Health Statistics, 2013 and Health Department, NMMC

Table No. 40: Health care facilities in NMMC

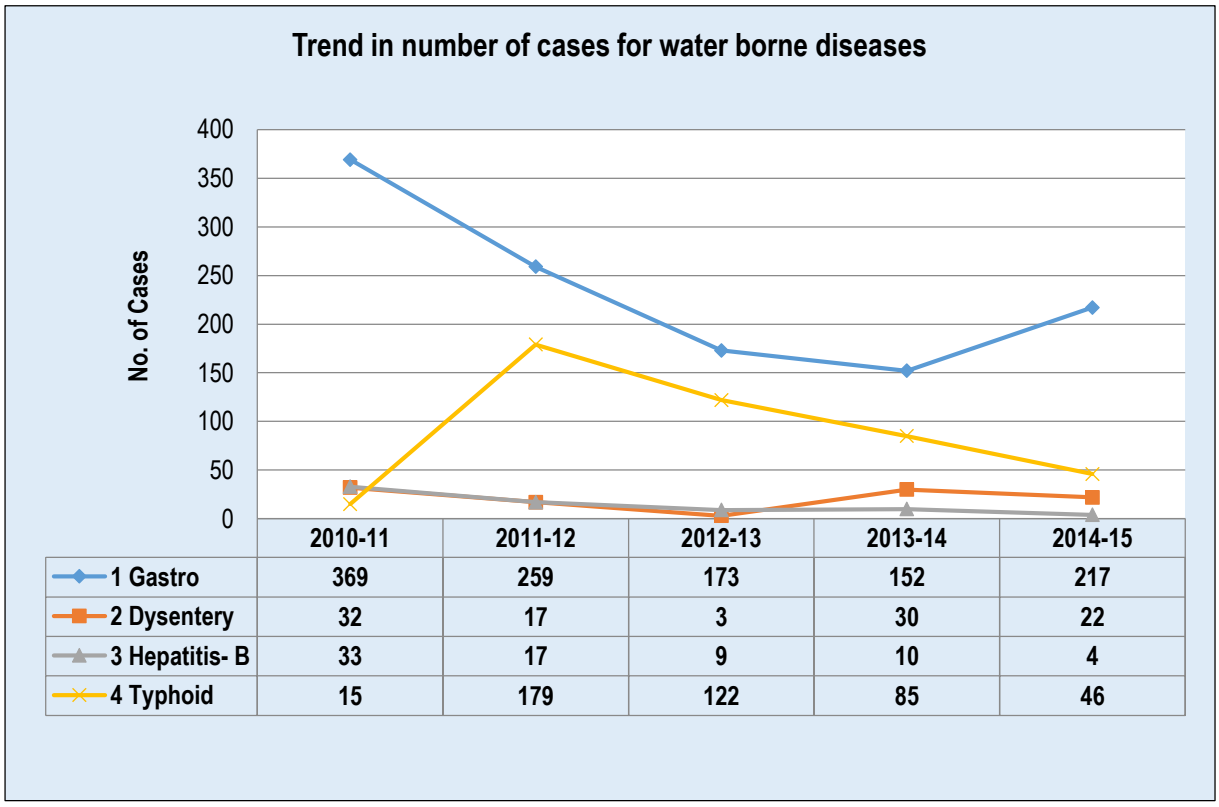
	2011-2012	2012-2013	2013-2014	2014-15
No. of Private Hospitals	180	184	184	188
Registered With NMMC	173	180	181	186
Dispensaries	163	158	184	191
Ayurvedic Clinics	336	351	377	386
Homeopathy Clinics	190	144	152	158
Bachelor of Dental Surgery	83	54	80	85
Pediatricians	75	75	75	75
Gynecologists	83	83	83	83
NMMC Hospitals	5	5	5	5
NMMC Dispensaries	20	20	21	21
NMMC Mobile Dispensaries	2	2	2	2
Private Dispensaries	772	797	865	920
Private Nursing Homes	64	76	81	81

Source: Health Department, NMMC

Water Borne Diseases

Water borne diseases are caused by pathogenic microorganisms, which are directly transmitted when contaminated water is consumed. Gastroenteritis, diarrhoea, hepatitis and typhoid are some of the commonly occurring water borne diseases in Navi Mumbai. The status and occurrence of the diseases is presented below in Figure No. 41.

As seen in Figure No. 41, there is a continual and remarkable decrease in all the water borne diseases however, in the year 2014-15 the number of cases for gastroenteritis registered an increase of almost 42 percent. Norovirus, is known to cause gastroenteritis and commonly occurs due to consumption of contaminated food and water. It is also contagious and may be caused upon being in contact with an infected person. Although the total number of cases for water borne diseases has decreased the area under the UHPs of Belapur, Karave, Sanpada, Turbhe and Indiranagar have recorded an increase in the cases of water borne diseases and needs special attentions.



	2010-11	2011-12	2012-13	2013-14	2014-15
1 Gastro	369	259	173	152	217
2 Dysentery	32	17	3	30	22
3 Hepatitis- B	33	17	9	10	4
4 Typhoid	15	179	122	85	46

Figure No. 41: Trend in cases of water borne diseases reported in NMMC area

Source: Health Department, NMMC

Vector Borne Diseases

Vectors are organisms that transmit pathogens and parasites from one infected person (or animal) to another, causing serious diseases in human populations. These diseases are commonly found in the regions where access to safe drinking-water and sanitation systems is a challenge. According to WHO, vector-borne diseases account for 17% of the estimated global burden of all infectious diseases, with dengue and malaria at the top of the list.

Malaria

Malaria, a parasitic infectious disease, is transmitted by mosquitos which breed in fresh or occasionally brackish water. The species of *Plasmodium*, a causal parasite of malaria resides in the body of *Anopheles* mosquito, which acts as a vector in transmission of the malarial infection. Table No. 41 enlists UHP wise total number of malaria cases reported by NMMC's health department in the last 5 years. As seen in the table, the total number of malaria cases reported in NMMC was less (356) as compared to the previous year (396).

Table No. 41: UHP wise reported malarial cases in past five years in NMMC area

Nodes/Year	2010-11	2011-12	2012-13	2013-14	2014-15
CBD Belapur	88	53	14	18	20
Karave	43	36	14	33	34
Nerul	49	30	13	19	18
Nerul II	121	87	17	39	27
Shiravane	58	40	12	23	26
Sanpada	93	61	13	24	20
Turbhe	61	47	16	13	26
Pawane	69	55	7	27	24
Indiranagar	69	56	22	54	39
Juhugaon	20	7	0	2	3
Vashi	26	19	2	5	5
KoperKhairne	94	76	17	21	20
Mahape	79	39	6	8	6
Ghansoli	32	39	10	21	16
Rabade	31	18	5	8	6
Katkaripada	37	12	9	12	14
Airoli	44	28	4	10	8
Chinchpada	45	23	4	10	9
Digha	37	27	14	20	16
Ilthanpada	42	22	8	12	13
Nokilnaka	0	0	0	0	6
Total	**1138**	**775**	**207**	**396**	**356**

Source: Health Department, NMMC

Dengue

Dengue fever, also known as breakbone fever, is a tropical disease caused by the dengue virus. The *Aedes* sp. of mosquito acts as the vector for transmission of dengue infection. Symptoms of Dengue include fever, headache, muscle and joint pains, and a characteristic skin rash that is similar to measles. Dengue and dengue hemorrhagic fevers could be prevented by following good practices like managing water containers and avoiding accumulation and stagnation of freshwater in and around houses.

As shown in the Figure No. 42, the number of cases for Dengue fever has a decreasing trend as compared to 2003 when 93 positive cases were recorded in NMMC area. In the year 2014 and 2015 (up to May, 2015) 74 and 15 suspects were tested for Dengue however only 24 and 2 were reported positive for Dengue respectively.

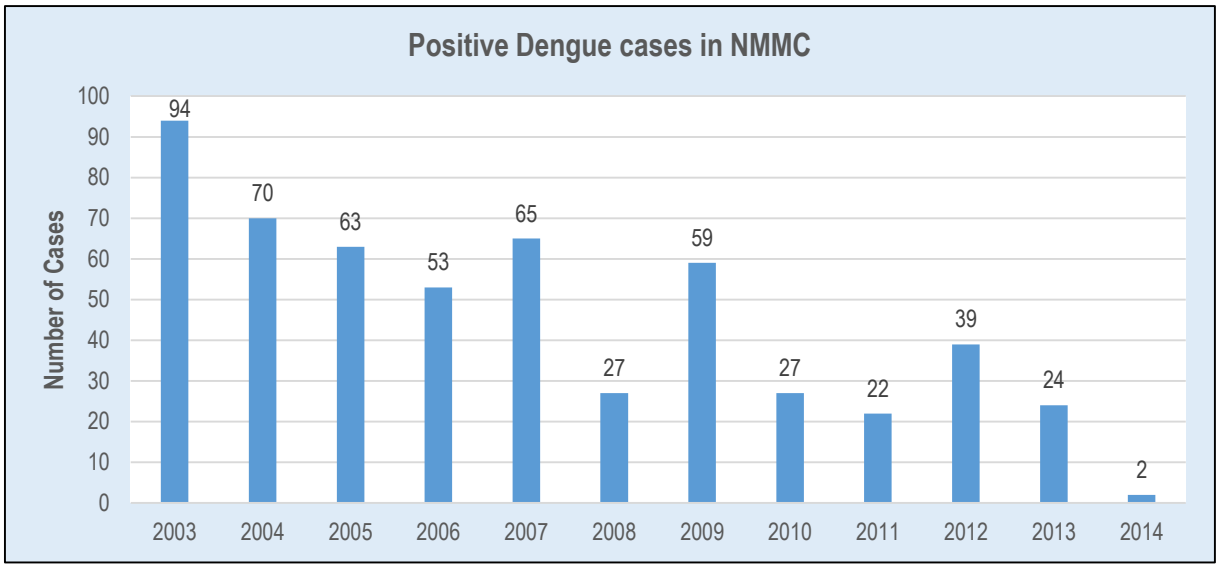


Figure No. 42: Total number of cases reported in Navi Mumbai between 2008-2014

Source: Health Department, NMMC

Response

NMMC's Health Department is vigilant enough to check and initiate effective measures for the control and eradication of vector-borne diseases like Malaria & Dengue and water borne diseases. There is a special wing under the expert medical team established by NMMC for detection, prevention, surveillance of these diseases and they actively run a control program for the same. The NMMC has undertaken preventive as well as therapeutic measures to eradicate the vector-borne diseases.

Preventive measures

1. Chemical spraying and fumigation of the breeding sites
2. Direct surveys by visiting the patient's home, collecting blood samples and providing medication
3. Indirect surveys by examining the blood samples of the patients suffering from fever and visiting the primary health care centers, women and child hospitals and other government hospitals.

Therapeutic measures

NMMC hospitals and health care centres are providing medicines to the patients.

Action Plan

1. Development of a yearly calendar and action plan for eradication of the diseases.
2. Identification and mapping of household level mosquito breeding sites
3. Special assessment of areas with higher parasite loads, collection of blood samples of patients and CRT (Chloroquine resistance transporter) distribution
4. Random assessment of 2 to 3 PHC's for effective assessment of action plan.
5. Special notice given to all type of hospitals and labs in the area to share information and data about new recorded cases
6. Mass awareness programs during festivals like Ganesh-utsav and Navratris.

Apart from the above measures, MPCB and NMMC have also proposed different industries situated in the MIDC areas in Navi Mumbai to upgrade/improve existing effluent treatment systems[35]. Provision of good drainage systems as well as good treatment systems may reduce the number of casual water pools, which would contribute to the control of vectors such as mosquitos.

Air Borne Disease - Tuberculosis

Airborne diseases are caused by pathogens and transmitted through the medium of air. As per Directorate General of Health Services, Ministry of Health & Family Welfare, Government of India, TB (Tuberculosis) is considered as the prototypic disease of airborne transmission. TB causing bacteria spread from person to person in tiny microscopic droplets when a TB patient coughs, sneezes, speaks, sings, or laughs. TB is caused by bacteria (*Mycobacterium tuberculosis*) that affects the lungs and the condition is known as pulmonary tuberculosis whereas when the infection is outside the lungs and affects other internal body parts it is known as extra pulmonary TB.

NMMC is continuously implementing a TB eradication program in the region. As a result, total number of cases and deaths reported in the region are more or less constant from the past few years (Figure No. 43), however percentage of cases which registered a relapse[36], of the previously positive cases is very high and is on a rise. The relapse rate for smear based studies of TB cases in Navi Mumbai was recorded to be around 13 percent[37] which is higher than the global and Indian average of around 3-3.5 percent[38] and 10 percent respectively.

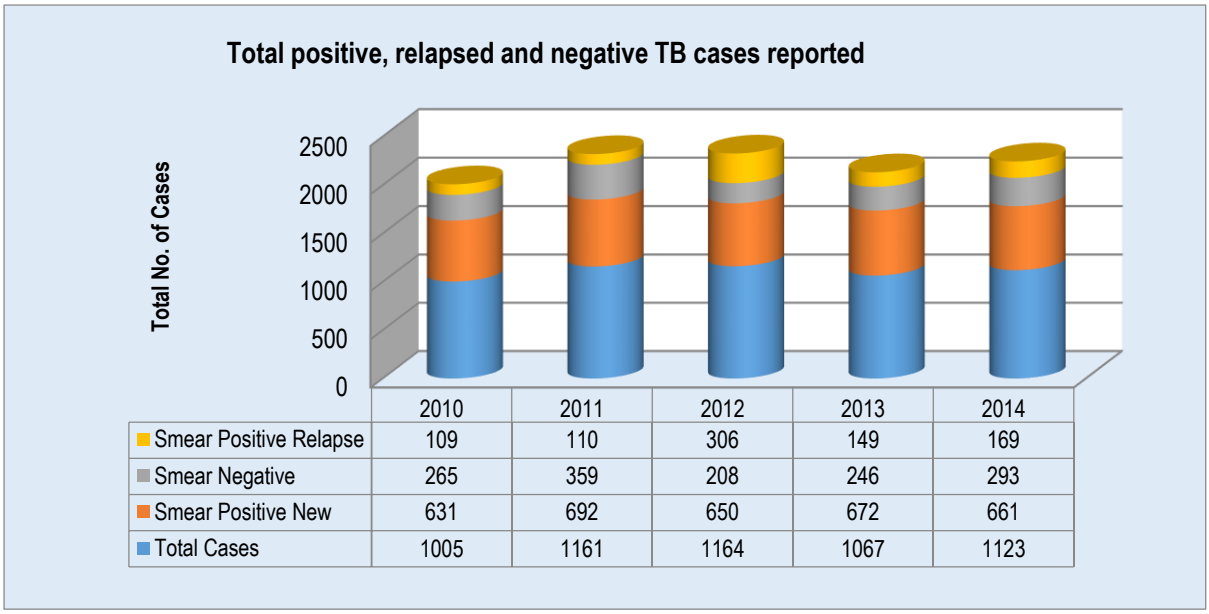
Along with preventive measures, NMMC is also planning to have awareness programs to sensitize the citizens about the impacts and threats of TB. All civic hospitals in NMMC are well equipped to treat TB patients.

[35] http://mpcb.gov.in/CEPI/pdf/Action%20Plan%20CEPI-Navimumbai.pdf

[36] Relapse is defined as a TB patient who was declared cured or treatment completed by a physician, but who reports back to the health service and is now found to be sputum smear positive.

[37] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3354489/

[38] Effectiveness of directly observed therapy (DOT) for tuberculosis: a review of multinational experience reported in 1990-2000.Hill AR, Manikal VM, Riska PFMedicine (Baltimore). 2002 May; 81(3):179-93.



	2010	2011	2012	2013	2014
Smear Positive Relapse	109	110	306	149	169
Smear Negative	265	359	208	246	293
Smear Positive New	631	692	650	672	661
Total Cases	1005	1161	1164	1067	1123

Figure No. 43: Total number of cases and deaths reported due to TB in the past five years

Source: Health Department, NMMC

Health services and facilities by NMMC

NMMC regularly carries out the following measures for the well-being of citizens:

- 4-tier hospital services including Homeopathic/Ayurvedic / Dental care & treatment
- 24 hour ambulance
- Post mortem facility
- TB eradication programme
- Management & control of communicable diseases
- AIDS detection and guidance centre
- Registration of private practitioners, sonography centre and hospitals
- Action against unauthorized practitioners
- Sterilisation of stray dogs
- Malaria/Dengue detection, prevention and control programme

Other

For animal health care in Navi Mumbai, veterinary doctors are available. The NMMC takes care of the health of stray dogs by vaccinating them against various diseases.

Actions taken/Proposed by NMMC for health related projects

Table No. 42: List of actions by NMMC for health

Department	Environmental related projects	Remarks
Health	Construction of 100 beds hospital each at Nerul and Airoli	Nearing Completion
Health	Pulse polio, Malaria reduction programme.	Under Implementation
Health	Reproductively & Child health Project-sponsored by GOI	Under Implementation
Health	Construction of two new 50 beds hospital at Ghansoli	Proposed
Health	Free Medical check-up & health card for slum dwellers	Under Implementation

Health Department, NMMC

Annex–I: Calculation of indices

Approach

The information on environmental parameters is often too complex and non-comprehendible to non-environmental professionals. The problem is further complicated as environment covers broad spectrum of areas from air quality to biomedical waste management. The goal of assessing status of environment is planning for sustainable development by ensuring that quality of life of the people is maintained and, if possible, improved while maintaining quality of environment.

The findings of present environmental assessment are discussed in details in the earlier sections and same have been used in this section for computations of indicators. The basis has been maintained same to assess the change in environmental status in NMMC area for the current year.

Methodology

Three indicators have been used in the present assessment:

Environmental Quality Index (EQI);

Urban Infrastructure Index (UII); and

Quality of Life Index (QOLI).

For computation of EQI, ambient air quality (in residential areas & traffic junctions), noise levels in residential areas & traffic junctions), quality of drinking water, quality of surface water, quality of ground water, adequacy of sewage treatment, adequacy of solid waste treatment, and adequacy of biomedical waste treatment are used as parameters. While air quality, noise levels and drinking water quality affects human health both in short term as also in long-term, impact of changes in other parameters are comparatively less important in short-term. Hence, while computing EQI following procedure has been used:

Out of total score of 100, scores have been assigned to individual parameter based on importance. This is termed as Parameter Importance Unit (PIU).

For assessing status of individual parameter, a scale has been developed by assigning zero score to totally un-acceptable parameter measurement and 1 score to desired parameter measurement. This is termed as Parameter Environmental Quality (PEQ). For various measurements of parameter in NMMC, PEQ has been estimated based on data collected for ESR, and values have been averaged to estimate overall PEQ for NMMC area.

Environmental Quality Index (EQI) for an individual parameter has been worked out by multiplying PEQ and PIU.

Values of EQI for all parameters have been added to compute EQI.

Using this method, if values of all parameters are as desired ones the value of EQI will be 100.

For assessing UII, population density, water supply system, sewerage system and storm water collection system, solid waste collection system, slum development, health facility, educational facility, public transport, employment opportunity, parks & gardens, roads network, entertainment facilities, and public grievance redressal mechanism have been used as parameters. As assessment of infrastructure facility is more a subjective judgment than quantitative evaluation, a seven-point scale has been used for evaluation of UII for individual parameters as follows:

Very Poor: 0.0

Poor: 0.20

Satisfactory: 0.40

Good: 0.60

Very good: 0.80

Excellent: 0.90

Outstanding: 1.00

Values of UII for individual parameters have then been converted into percentage for easy comprehension. Quality of Life Index has been computed as average of EQI and UII.

Estimation of Environmental Quality Index

The importance assigned to various parameters selected for computing EQI and scale used for assessing the present status is presented in Table No. 43: Assignment of importance units and PEQ scale for parameters selected for computing EQIPEQ for individual parameters have been computed based on data collected for ESR. Overall EQI is summarised in Table No. 43 while details of computation are presented in Table No. 44 EQI computed for various nodes of NMMC and it has been found out that present EQI in NMMC area is 71.38%.The detailed parameters for EQI is tabulated in Table No. 45.

Estimation of Urban Infrastructure Index

In the case of urban infrastructure, mere numbers may be misleading (e.g. average per capita water supply may be satisfactory but due to uneven distribution satisfaction level may be low). Hence, for computing UII subjective assessment has been used. Results of computation are presented in Table No. 46

It has been found out that present UII in NMMC area is 79.65 %.

Estimation of QOL

Quality of environment and availability of infrastructure facilities together decide quality of life. As the impact of these considerations is synergistic, equal importance needs to be given to both. Hence, QOL has been computed as average of EQI and UII. Present QOL Index for NMMC area has been worked out as 75.52%.

Table No. 43: Assignment of importance units and PEQ scale for parameters selected for computing EQI

Sr. No.	Parameter	Parameter Importance Unit (PIU)	Parameter Measurement for	
			PEQ = 0.0	**PEQ = 1.0**
A.	Ambient Air Quality	15		
A.1	Air Quality Index-Residential Area (RSPM)	10	200	0
A.2	Air Quality Index-Traffic Junctions (RSPM)	5	200	0
B.	Ambient Noise Levels	15		
B.1	Noise Level : Residential Area	10	100	0
B.2	Noise Level : Traffic Junctions	5	100	0
C.	Ambient (Surface/Ground) Water Quality	15		
C.1	Surface (drains) Water Quality, BOD mg/l	3	100	0
C.2	Surface (Lake) Water Quality, BOD mg/l	3	10	0
C.3	Ground (Well) Water Quality, BOD mg/l	3	10	0
C.4	Efficiency of Sewage Treatment Plants	6	0	100
D.	Solid Waste Management	15		
D.1	Solid Waste Collected, percentage	3	0	100
D.2	Solid Waste Segregation at Household Level, percentage	2	0	100
D.3	Solid Waste Segregation at Disposal Site, percentage	2	0	100
D.4	Solid Waste Recycle at Household Level, percentage	2	0	100
D.5	Solid Waste Recycle at Disposal Site, percentage	2	0	100
D.6	Biomedical Waste Collected, percentage	2	0	100
D.7	Road/Public Places Cleanliness *	2	0	1
E.	Protection of Ecosystem	20		
E.1	Protection of mangroves*	10	0	1
E.2	Protection of hills and quarry restoration*	10	0	1
F.	Public Health	20		
F.1	Drinking Water Quality, % samples fit for drinking	5	0	100
F.2	No. of cases of water borne diseases in node(cholera, Jaundice, Hepatitis)	5	100	0
F.3	No of cases of malaria in node	5	100	0
F.4	Cases of TB, percentage population affected	3	1	0
F.5	Control of Street Dogs*	2	0	1
	Total	100		

Note: (*) Measured as V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding=1.0

Table No. 44: Estimation of Environmental Quality Index

Sr. No.	Parameter	Environmental Quality Index, %				
		Max	**Average 2013-14**	**Average 2014-15**	**Variat -ion**	**Remarks**
A.	Ambient Air Quality					
A.1	Air Quality Index-Residential Area (RSPM)	10	7.23	7.35	0.12	Due to Concretization of major junctions vehicular traffic has reduced to significant extent in residential zone.
A.2	Air Quality Index-Traffic Junctions (RSPM)	5	3.26	3.11	-0.15	Due to rapid industrialization and increase in population, vehicular population in the city is increased at major traffic junctions.
B.	Ambient Noise Levels					
B.1	Noise Level: Residential Area	10	4.39	4.32	-0.07	Increase in Population of the city and change of life style attributed to increase in noise levels.
B.2	Noise Level: Traffic Junctions	5	1.79	1.60	-0.19	Due to rapid industrialization and increase in population, vehicular population in the city is increased.
C.	Ambient (Surface/Ground) Water Quality					
C.1	Surface (Drains) Water Quality, BOD mg/l	3	1.59	1.92	0.33	Decrease in pollution level of Nallahs
C.2	Surface (Lake) Water Quality, BOD mg/l	3	1.54	1.58	0.04	Construction of Gabion Wall structure restricting for idol immersion areas.
C.3	Ground (Well) Water Quality, BOD mg/l	3	2.10	2.40	0.30	Major wells are enclosed with net providing no access to external pollution along with regular de-siltation.
C.4	Efficiency of Sewage Treatment Plants	6	5.84	5.84	0.00	
D.	Solid Waste Management					
D.1	Solid Waste Collected, percentage	3	2.70	2.70	0.00	
D.2	Solid Waste Segregation at Household Level, percentage	2	1.40	1.40	0.00	
D.3	Solid Waste Segregation at Disposal Site, percentage	2	1.80	1.84	0.04	Plastic is separated from segregated solid waste and is used to produce agglomerated plastic sheets on large scale.

Sr.	Parameter	Environmental Quality Index, %				
D.4	Solid Waste Recycle at Household Level, percentage	2	1.80	1.80	0.00	
D.5	Solid Waste Recycle at Disposal Site, percentage	2	1.00	1.10	0.10	Segregation of Plastic is being done on large scale.
D.6	Biomedical Waste Collected, percentage	2	1.40	1.40	0.00	
D.7	Road/Public Places Cleanliness	2	1.80	1.80	0.00	
E.	Protection of Ecosystem					
E.1	Protection of mangroves	10	8.00	8.00	0.00	
E.2	Protection of hills and quarry restoration	10	6.00	6.00	0.00	
F.	Public Health					
F.1	Drinking Water Quality, % samples fit for drinking	5	4.81	4.88	0.07	Augmentation of WTP plant at bhokarpada.
F.2	No. of cases of water borne diseases in node(cholera, Jaundice, Hepatitis)	5	4.31	4.31	0.00	
F.3	No of cases of malaria in node	5	4.06	4.19	0.13	Strengthening disinfectant spraying programme .improving hydraulic of the surface drains, specifically with regards to High tide/Low tide and preventing the ponding due to accumulation of solid waste, muck and plastic bags etc.
F.4	Cases of TB, percentage population affected	3	2.67	2.64	-0.03	Continuous monitoring programme is required with special attention.
F.5	Control of Street Dogs	2	1.20	1.20	0.00	
	Total	**100**	**70.69**	**71.38**	**0.69**	

Table No. 45: Measurement of Parameters for calculation of EQI of NMMC area

Sr. No.	Parameter	Parameter Measurement							
		1	2	3	4	5	6	7	8
A.	Ambient Air Quality								
A.1	Air Quality Index-Residential Area (RSPM)	50.5	50.6	52.4	52.7	53.2	54.0	55.1	55.9
	EQI	7.48	7.47	7.38	7.37	7.34	7.30	7.25	7.21
A.2	Air Quality Index-Traffic Junctions (RSPM)	68.3	73.0	73.7	73.8	73.8	78.7	81.2	
	EQI	3.30	3.18	3.16	3.16	3.16	2.88	2.97	
B.	Ambient Noise Levels								
B.1	Noise Level : Residential Area	54.8	56.4	56.9	57.0	57.8	58.0		
	EQI	4.52	4.36	4.31	4.30	4.22	4.20		
B.2	Noise Level :Traffic Junctions	65.1	67.5	67.5	67.8	68.8	69.0	69.9	
	EQI	1.75	1.63	1.63	1.61	1.56	1.55	1.51	
A.	Ambient Air Quality								
A.1	Air Quality Index-Residential Area (RSPM)	50.5	50.6	52.4	52.7	53.2	54.0	55.1	55.9
	EQI	7.48	7.47	7.38	7.37	7.34	7.30	7.25	7.21
A.2	Air Quality Index-Traffic Junctions (RSPM)	68.3	73.0	73.7	73.8	73.8	78.7	81.2	
	EQI	3.30	3.18	3.16	3.16	3.16	2.88	2.97	
B.	Ambient Noise Levels								
B.1	Noise Level : Residential Area	54.8	56.4	56.9	57.0	57.8	58.0		
	EQI	4.52	4.36	4.31	4.30	4.22	4.20		
B.2	Noise Level :Traffic Junctions	65.1	67.5	67.5	67.8	68.8	69.0	69.9	
	EQI	1.75	1.63	1.63	1.61	1.56	1.55	1.51	

Sr. No.	Parameter	Parameter Measurement							
		1	2	3	4	5	6	7	8
C.	Ambient (Surface/Ground) Water Quality								
C.1	Surface (drains) Water Quality, BOD mg/l	19	21	23	27	28	31	54	85
	EQI	2.43	2.37	2.31	2.19	2.16	2.07	1.38	0.45
C.2	Surface (Lake) Water Quality, BOD mg/l	3	4	4	4	5	5	6	7
	EQI	2.1	1.8	1.8	1.8	1.5	1.5	1.2	0.9
C.3	Ground (Well) Water Quality, BOD mg/l	1	2	2	2	2	2	3	3
	EQI	2.7	2.4	2.4	2.4	2.4	2.4	2.1	2.1
C.4	Efficiency of Sewage Treatment Plants	96.00	97.77	97.94	97.37	97.29	97.73		
	EQI	5.76	5.87	5.88	5.84	5.84	5.86		
D.	Solid Waste Management								
D.1	Solid Waste Collected, percentage	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
	EQI	2.70	2.70	2.70	2.70	2.70	2.70	2.70	2.70
D.2	Solid Waste Segregation at Household Level, percentage	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
	EQI	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
D.3	Solid Waste Segregation at Disposal Site, percentage	92.00	92.00	92.00	92.00	92.00	92.00	92.00	92.00
	EQI	1.84	1.84	1.84	1.84	1.84	1.84	1.84	1.84
D.4	Solid Waste Recycle at Household Level, percentage	90.00	90.00	90.00	90.00	90.00	90.00	90.00	90.00
	EQI	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8

Sr. No.	Parameter	Parameter Measurement							
		1	2	3	4	5	6	7	8
D.5	Solid Waste Recycle at Disposal Site, percentage					55.00			
	EQI					1.10			
D.6	Biomedical Waste Collected, percentage	70.00	70.00	70.00	70.00	70.00	70.00	70.00	70.00
	EQI	1.40	1.40	1.40	1.40	1.40	1.40	1.40	1.40
D.7	Road/Public Places Cleanliness, V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding =1.0	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
	EQI	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80
E.	Protection of Ecosystem								
E.1	Protection of mangroves, V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding =1.0		0.8	0.8		0.8			
	EQI		8.0	8.0		8.0			

Sr. No.	Parameter	Parameter Measurement							
		1	2	3	4	5	6	7	8
E.2	Protection of hills and quarry restoration, V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding=1.0				0.6	0.6			
	EQI				6.0	6.0			
F.	Public Health								
F.1	Drinking Water Quality, % samples fit for drinking	97.65	97.65	97.65	97.65	97.65	97.65	97.65	97.65
	EQI	4.88	4.88	4.88	4.88	4.88	4.88	4.88	4.88
F.2	No. of cases of water borne diseases in node(cholera, Jaundice, Hepatitis)	8	14	24	7	29	14	11	3
	EQI	4.60	4.30	3.80	4.65	3.55	4.30	4.45	4.85
F.3	No of cases of malaria in node	20	26	28	4	17	9	10	15
	EQI	4.00	3.70	3.60	4.80	4.15	4.55	4.50	4.25
F.4	Cases of TB, percentage population affected	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
	EQI	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.64
F.5	Control of Street Dogs, V.Poor =0, Poor =0.2 Satisfactory = 0.4, Good = 0.6, V. Good = 0.80, Excellent = 0.90, Outstanding= 1.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
	EQI	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2

Table No. 46 Estimation of Urban Infrastructure Index for NMMC Area

Sr. No.	Infrastructure Facility/Amenity/Service	Status*	Score		Remarks
			2013-14	**2014-15**	
1.	Drinking water supply	Excellent	0.96	0.96	No major change
2.	Sewerage	Excellent	0.93	0.93	No major change
3.	Storm water Drainage	Excellent	0.93	0.93	No major change
4.	Public toilets	Good	0.70	0.72	Portable toilets in slum areas
5.	Solid Waste Collection and transportation	Excellent	0.82	0.84	Solid waste transportation by closed refuse compacter is partially started
6.	Health Services	Good	0.66	0.66	No major change.
7.	Public Transport	Good	0.67	0.67	No major change.
8.	Road Network & footpaths	Good	0.82	0.84	Improvement in footpath for physically challenged persons.
9.	Education Facilities	Excellent	0.93	0.93	No major change
10.	Parks/gardens & Tree Plantation	V. Good	0.88	0.90	Improvement in gardens and road side greenery.
11.	Entertainment	Good	0.65	0.65	No major change.
12.	Public library	Good	0.61	0.61	No major change.
13.	Playgrounds	Good	0.60	0.62	Improvement in playground
14.	Fire Fighting	V. Good	0.88	0.88	No major change
15.	Slum Development	Good	0.65	0.65	No major change
16.	Public Grievance Redressal and Participation	Excellent	0.90	0.90	No major change
17.	Employment Opportunities	V. Good	0.85	0.85	No major change
	Total		13.44	13.54	
Urban Infrastructure Index for NMMC Area = (13.54/17)*100 = 79.65%					

***Based on data available for overall NMMC area**

Annex–II: Details for determining Environmental Performance Index

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
Growth of cities	Demographic growth (% 2001)	Population growth rate	%		Census	59.18	2
		% of slum population to total population	%		Census	16.66	10
	Economic growth	Work participation ratio	%		Census	260	10
		% of people below poverty line.	%		Statistical Handbooks	0.17	10
		% of budget spent on Environmental Infrastructure		Budget spent on Bio Medical Waste, Municipal Solid Waste and Sewage Treatment Plants to be considered.	ULB Budget	15	2
	Industrial growth	% of polluting industries to total industries	%	Number of polluting industries is the number of orange and red category industries. % of these industries to the total number of industries to be	MPCB Regional Offices	51.84	4

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
				entered.			
	Spatial growth (Decadal)	Population density	Persons/sq Km		Census	10472	2
		% of slum area to city area	%		Census	21	2
State of Natural resources	Landuse	% of green area to the total city area	%		Town planning department	38	10
		Green area per 1000 persons	Ha/person	To be calculated from total green area of the city and total population of the city.	Town planning department	3.72	10
	Air	Ambient air quality	Score	Refer to Box A in Scoring Details worksheet for assigning values	MPCB Regional Offices	B	8
	Noise	Noise levels				B	8
	Water	Water quality				B	8
	Energy	Per capita energy consumption	Kwh/ Annum		Maharashtra Energy Development Agency	930	2
		Share of renewable energy in total energy consumed	%			0	0
		Number of hours for load shedding	hours			0	10
	Human	Crude death	%		Census	4.32	8

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		rate					
		Infant mortality rate	%		Census	11.1	10
Urban services	Water Supply	Net LPCD supplied	lpcd		Water supply department	293	10
		% of households connected by service connection	%			100	10
		Unaccounted for water	%			19	6
		Duration of water supply	hours			24	10
		Staff per 1000 connections	Persons			5.4	2
	Sewerage Sanitation	% of population catered to by underground sewer network	%		Sewerage Department	85	10
		% area covered with collection to total city area	%			85	10
		Staff per 1000 connections	Persons			1.05	2
	Solid Waste Mgmt	Total SW generated per capita	gm		Solid Waste Management Department	463.5	4
		Life of landfill site	Years			68	10
		% of waste disposed into landfill site to total waste generated	%			100	10
		% of waste collected to total waste generated	%			100	10
		% biomedical waste treated	%			100	10

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		to total BM waste					
	Transport	Road area as % of city area	%		Town Planning Department	13.6	8
		% of population travelling by public transport	%		Regional Transport Authority	60	4
Initiatives for improving city environment	Environmental awareness and education	Are the training programmes for school teachers on Environmental education adequate?	Score	Qualitative values to be assigned based on extent of initiative in the City/Town as given below: VH for Very High H for High M for ModerateL for Low A for Absent		M	4
		To what extent are awareness programs on evironment launched during festivals or other times of the year?				M	4
		To what extent exhibitions / street plays etc organized to spread environmental				H	6

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		awareness?					
		To what extent does the city/town have any local Television channel running programs, advertisements related to environment sponsored by the respective ULB?				M	4
		To what extent do the local newspapers include a section on environment sponsored by the ULB?				H	6
	Waste Management	To what extent has the segregation of dry and wet waste substantially reduced the volume of waste disposed to the landfill?				VH	8
		To what extent is waste management decentralized to NGO / CBO?				L	2

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		To what extent is the activity of recycling of waste by ragpickers formalized by the ULB?				VH	8
		To what extent is management of demolition and construction waste addressed in the policy and regulations of the ULB?				M	4
		To what extent is the city/town responding to PPP efforts in managing hazardous waste, plastic, electronic waste and waste oil?				VH	8
	Slum Improvement	To what extent are the regularised slum areas formally provided with sanitation and sewerage facilities?				VH	8
		To what extent do the residents of slums have access to public health				VH	8

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
		centres and regular health checkups?					
		To what extent are adult education programs run by the ULB in slum areas?				H	6
		To what extent is the solid waste in slum areas managed by the ULB?				VH	8
		To what extent does the ULB have regulations on use of fuel like banning firewood and providing alternate fuel?				L	2
	Traffic	To what extent are paths dedicated to bicycle or pedestrian movement?				M	4
		To what extent are steps taken to prevent adulteration of fuel?				L	2
		To what extent are clean fuels like CNG used?				M	4

Thematic Indicators	Primary indicators	Data variables	Unit	Instructions	Source	Value	Score
	Water	To what extent does the ULB have regulations/ schemes encouraging Rain Water Harvesting?				M	4
		To what extent do building codes have regulations for using water saving fittings and fixtures?				M	4
		To what extent has the ULB taken measures to identify leaks and reduce water losses?				VH	8
		To what extent does the ULB check whether the water quality is satisfactory at the consumers end?				VH	8

Annex-III: Category wise No of Vehicles Registered in Navi Mumbai RTO

Sr. No	Category	Type	Financial Year					
			09-10	10-11	11-12	12-13	13-14	14-15
1	2-Wheelers	Motor Cycles	5235	16361	15188	17395	16525	17953
2		Scooters	7547	271	81	-	0	0
3		Mopeds	0	0	0	-	0	0
4	4-Wheelers	Cars	10665	13042	13184	11808	8298	10841
5		Jeeps	160	222	104	-	0	0
6		Station Wagons	0	0	0	-	0	0
7(A)	Taxi/ Autorickshaw	Taxi meter fitted	0	0	187	-	-	0
7(B)		Taxi Tourist Cabs	283	630	548	851	439	917
8		Auto-Rickshaws	606	444	493	628	1663	3487
9	Buses	Stage carriages	49	116	11	4	1	43
10		Contract carriages	209	314	251	-	35	248
11		School Buses	23	35	136	180	99	96
12		Private Service Vehicles	21	43	32	171	5	14
13		Ambulances	35	39	28	10	16	37
14		Arti.& Muli. Vehicles.	0	2	0	30	-	0
15	Other Heavy Vehicles	Trucks & Lorries	934	1717	1067	901	725	1655
16		Tankers	257	168	220	249	155	226
17		Delivery Van (4 wheelers)	256	309	643	512	213	302
18		Delivery Van (3-wheelers)	1095	1237	1462	1565	1019	1602
19		Tractors	0	0	0	-	0	0
20		Trailers	460	694	381	438	230	351
21		Others	10	20	57	7	15	25
		Total	**27845**	**35664**	**34073**	**34749**	**29438**	**42639**

Source: RTO, Navi Mumbai

Annex-IV: Proximate and Chemical analysis

SGS

Test Report

Print Date : 24/04/2015

SAMPLE DRAWN BY SGS INDIA PVT. LTD.

Report No : CE15-001430.001 JOE No : CE15-001430

Report Control No : CER0000015759

Sample Described by Customer as : MUNICIPAL SOLID WASTE

Client Name	:	NAVI MUMBAI WASTE PROCESSING CO PVT LTD
Client Address	:	SURVEY NUMBER - 376-379, NMMC DUMPING GROUND,
	:	BEHIND LUBRIZOL FACTORY,
City	:	TURBHE, NAVI MUMBAI
Postal Code	:	400703
State	:	MAHARASHTRA
Country	:	INDIA
Sample Type	:	MUNICIPAL SOLID WASTE
Received	:	11/04/2015
Sample Qty. Recd.	:	2.5KG
Sampling Location	:	NMMC DUMPING GROUND
Sampling Date	:	30.03.15
Test Start/End Date	:	11/04/2015 - 23/04/2015

Analysis	Method	Result	Unit
Ash content (as dry basis)	IS 10158 : 1982	12.6	%
Volatile matter	IS 10158 : 1982	74.0	%
Sulphur as S (as dry basis)	ASTM D4239 - 12 (Method B)	0.24	%
Carbon as C (as dry basis)	ASTM D5373 - 08	45.77	%
Hydrogen as H (as dry basis)	ASTM D5373 - 08	6.40	%
Nitrogen as N (as dry basis)	ASTM D5373 - 08	1.86	%
Oxygen as O (as dry basis)	Balance	33.10	%
GCV (dry basis)	IS 10158 : 1982	4125	KCal/kg
Silica as SIO2	IS 13624 : 1993	4.838	% (w/w)
Arsenic and arsenic compounds as As	AOAC 990.08 : 2005	BDL(DL:10)	mg/kg
Cadmium and cadmium compounds as Cd	AOAC 990.08 : 2005	BDL(DL:10)	mg/kg
Total chromium compounds as Cr	AOAC 990.08 : 2005	37	mg/kg
Copper compounds as Cu	AOAC 990.08 : 2005	106	mg/kg
Lead and lead compounds as Pb	AOAC 990.08 : 2005	18	mg/kg
Nickel compounds as Ni	AOAC 990.08 : 2005	28	mg/kg
Zinc compounds as Zn	AOAC 990.08 : 2005	322	mg/kg

Page 1 of 2

Test Report

Print Date : 24/04/2015

SAMPLE DRAWN BY SGS INDIA PVT. LTD.

Report No : CE15-001430.001

JOE No : CE15-001430

Report Control No : CER0000015759

Analysis	Method	Result	Unit
Manganese-silicate as Mn	AOAC 990.08 : 2005	523	mg/kg
Mercury and mercury compounds as Hg	USEPA 200.8	BDL(DL:10)	mg/kg
Moisture content	IS 2720 (Part 02) : 1973	71.7	%
Fixed Carbon	ASTM D3172 - 07a	13.4	%
Chloride as Cl	USEPA 9212	781773.3	mg/kg
Fluoride as F	USEPA 9214	46.0	mg/kg
Sulphuric anhydride as SO3	IS 1727 : 1967	0.346	% (w/w)
Phosphorus as P2O3	USEPA 200.7/Conversion	23515	mg/kg
Strontium as SrO	USEPA 200.7/Conversion	339	mg/kg
Titanium as TiO2	USEPA 200.7/Conversion	2235	mg/kg
Aluminum as Al2O3	AOAC 990.08 : 2005/Conversion	21517	mg/kg
Iron as Fe2O3	AOAC 990.08 : 2005/Conversion	45235	mg/kg
Calcium as CaO	AOAC 990.08 : 2005/Conversion	124322	mg/kg
Magnesium as MgO	AOAC 990.08 : 2005/Conversion	30414	mg/kg
Sodium as Na2O	AOAC 990.08 : 2005/Conversion	41361	mg/kg
Potassium as K2O	AOAC 990.08 : 2005/Conversion	82066	mg/kg
Manganese as Mn3O4	AOAC 990.08 : 2005/Conversion	726	mg/kg
Copper as CuO	AOAC 990.08 : 2005/Conversion	133	mg/kg

Remark : BDL - Below Detection Limit, DL - Detection Limit.

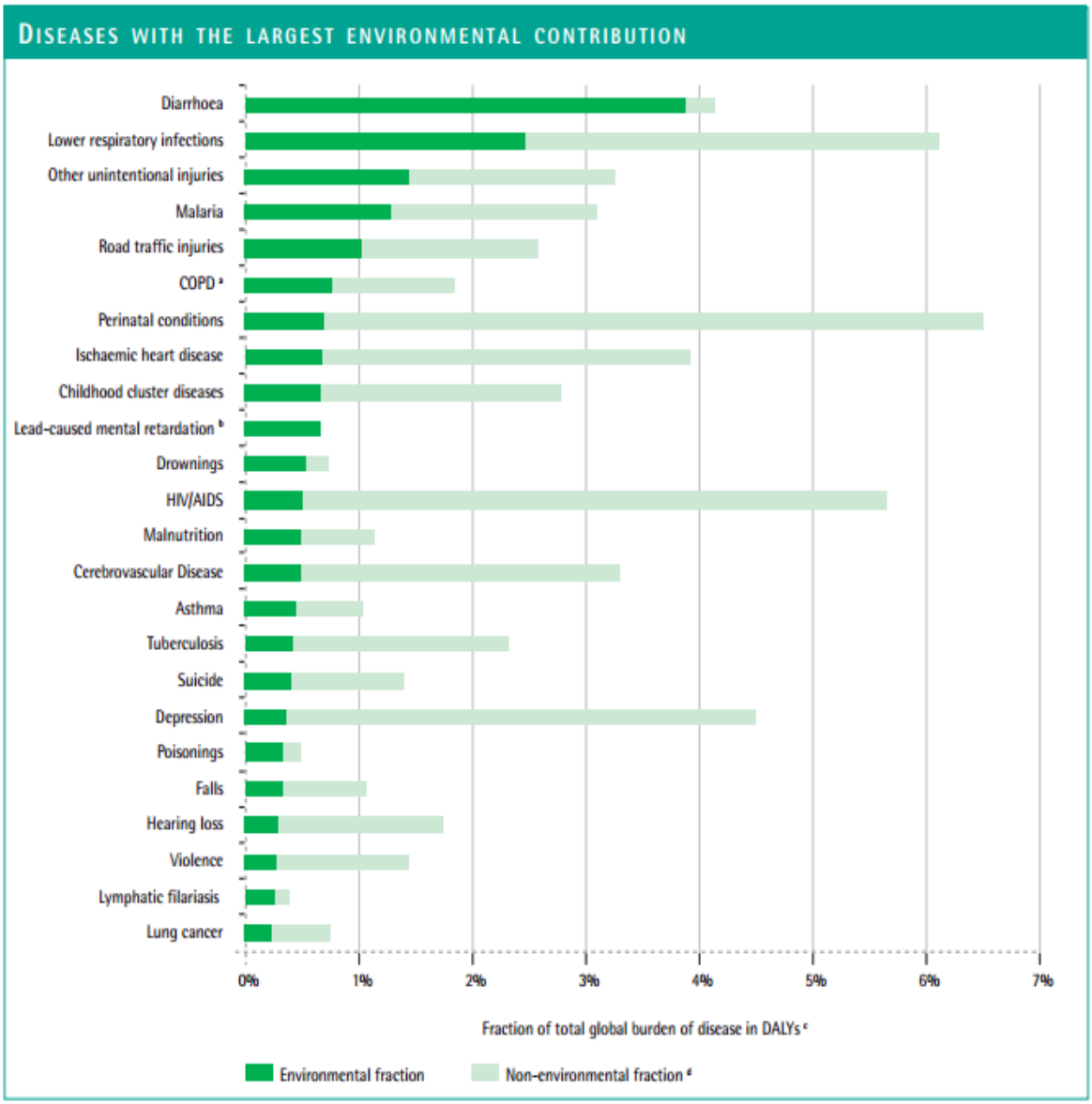
Per pro SGS India Private Ltd

V_MUTHUKUMAR

Authorized Signatory

****End of Report****

Annex -V: Diseases with largest environmental contribution



[a] Abbreviations: COPD = Chronic obstructive pulmonary disease.
[b] Lead-caused mental retardation is defined in the WHO list of diseases for 2002, accessed at: www.who.int/evidence.
[c] DALYs represents a weighted measure of death, illness and disability.
[d] For each disease the fraction attributable to environmental risks is shown in dark green. Light green plus dark green represents the total burden of disease.

Source: WHO Report: Preventing disease through healthy environments