

**Environmental Status Report
of Navi Mumbai Municipal
Corporation 2016-17**



नवी मुंबई महानगरपालिका

Navi Mumbai Municipal Corporation

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Foreword

Anthropogenic activities, population explosion and increasing demand for natural resources leads to exploitation and degradation of the environment. Realising this fact, various initiatives have been taken worldwide to track and maintain the status of the environment, so that the necessary action could be taken to appropriately mitigate the pressures. ESR (Environmental Status Report) is a tool that gives a complete picture of the status of the resources in a city. It is mandatory for A class ULB's to document an annual ESR (Environmental Status Report) as per the section 67 A of the Maharashtra Municipal Corporation Act, 1949.

NMMC has been documenting Navi Mumbai's Environmental Status Report for the ESR for more than 16 years. This year the report has been developed on the lines of DPSIR (Drivers, Pressure, Status, Impacts, and Responses), framework as endorsed by the MPCB (Maharashtra Pollution Control Board), Government of Maharashtra, released in 2009.

This year Navi Mumbai was ranked 1st in Maharashtra (West Zone) and 8th in country as the cleanest city as per Swachha Sarvekshan (Survey) -2017. This is not only a result of the efforts taken by the corporation but also the support extended by the citizens of the city. As part of Swachha Maharashtra Abhiyan, NMMC has constructed 20 smart E-Toilets, 6 smart She-Toilets, public (141) and community (347) toilets have collectively resulted in making Navi Mumbai an Open Defecation Free (ODF) city.

It is also worth appreciating that the overall air quality in Navi Mumbai has improved and the share of polluted days have reduced to just about 30 days in a year as compared to around 85 days in the last year. Air pollutants like SO₂, NO_x, Carbon monoxide, Ozone are all recorded under the standards prescribed by CPCB. It is only the PM (Particulate Matter) pollution that violated the standards on some days, but has relatively reduced as compared to previous year. This is majorly a collective result of the various initiatives taken in and around NMMC area such as completion of major roads projects, strict adherence to guidelines by quarries and crushers and change in fuel pattern to Piped Natural gas in industries as against the conventional fuel.

This year NMMC took a massive drive of installing AMR (Automatic Meter Reader), disconnecting Illegal water connections and addressed pipe burst cases and leakages promptly. This resulted in reducing the NRW (Non-Revenue Water) by 1%, translating to about savings of 3 Million Liters of water per day (1000 MLD/year).



“जन्म असो वा मरण आवश्यक नोंदणीकरण”

Navi Mumbai
Municipal Corporation

नवी मुंबई
प्रदेशीय नगरपालिका

Effective Solid waste management and segregation at source has further helped the city become a virtually dustbin free city, avoiding littering of waste as well as helping in efficient collection and disposal of waste at the Turbhe landfill site.

The initiatives to reduce the pressures on the natural resources by NMMC has ultimately resulted in improvement in the Environment Quality Index as well as Environmental Performance Index for Navi Mumbai city. I am sure this report will be a useful tool and reference document not only for the corporation but also for academia, researchers, media and the citizens of Navi Mumbai.

Dr Ramaswami N,
Municipal Commissioner,
NMMC



List of Awards

Awards Received in 2016-17

- Navi Mumbai was ranked 1st in Maharashtra (West Zone) and 8th in country as the cleanest city as per Swaccha Sarvekshan (Survey) -2017
- Under Swaccha Bharat Abhiyan, NMMC ranked first in Advanced Public Toilets and Information, Education and Behaviour Change Communication (IEBC) categories and received awards during 45th Skoch Award-2016 held in Hyderabad on 8th &-9th September, 2016.
- Award for Exceptional Performance in Waste Segregation on 5th May 2017 on the eve of Urban Development Day.
- Maximum Tax Recovery award on 5th May, 2017 on the eve of Urban Development Day.

Awards Received in previous years (2002-2015)

- HUDCO AWARD: For the Best Practices to Improve the Living Environment (2015-2016)
- JCB Clean Earth Award for Excellence in Solid waste Management (2015)
- 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/-

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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 ₂ | 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 |

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Executive Summary

Navi Mumbai is a planned township off the west coast of the Indian state of Maharashtra in Konkan division. Since it is a planned city, it is well equipped with the state of art facilities specially related to urban services like solid waste management, public transport, healthcare facilities, sewage treatment, well established road network, efficient storm water management system and many more. Navi Mumbai, in true terms has lived to its expectations of absorbing the population shock from the mega city of Mumbai which is evident from the fact that Navi Mumbai recorded a decadal population growth by more than 51% between 2001 and 2011.

The population of NMMC (Navi Mumbai Municipal Corporation) area was estimated to be about 14.69 lakhs 2016-17 which 1.4% more compared to last year as per the survey data of UHPs (Urban Health Posts), Health department NMMC. The total number of properties have also increased to 3,07,710 with residential properties having the highest share of 82% followed by commercial buildings (17%) and industrial properties (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 16 years. For the year 2016-17, the EQI has improved by 2.07% followed by UII by 1.47% (Figure No. 1). Overall improvement of EQI is attributed to the improvement in air and water quality, better management of water supply, effective segregation and maximum recycling of solid waste, Protection of mangroves, continuous monitoring of water quality, reduction in wastage of water by 1% and so on. While the increase in value of UII is attributed to increase in the development of road & footpaths, improvement in playgrounds, public Grievance Redressal and Participation. The improvement of EQI and UII has thus improved the QOLI for citizen of NMMC.

NMMC has recorded an improvement in the EQI, UII and EPI, owing to various pro-environment initiatives like effective waste segregation and maximum recycling, Mangrove protection, road and footpath development, Public grievance system and improvements in playgrounds.

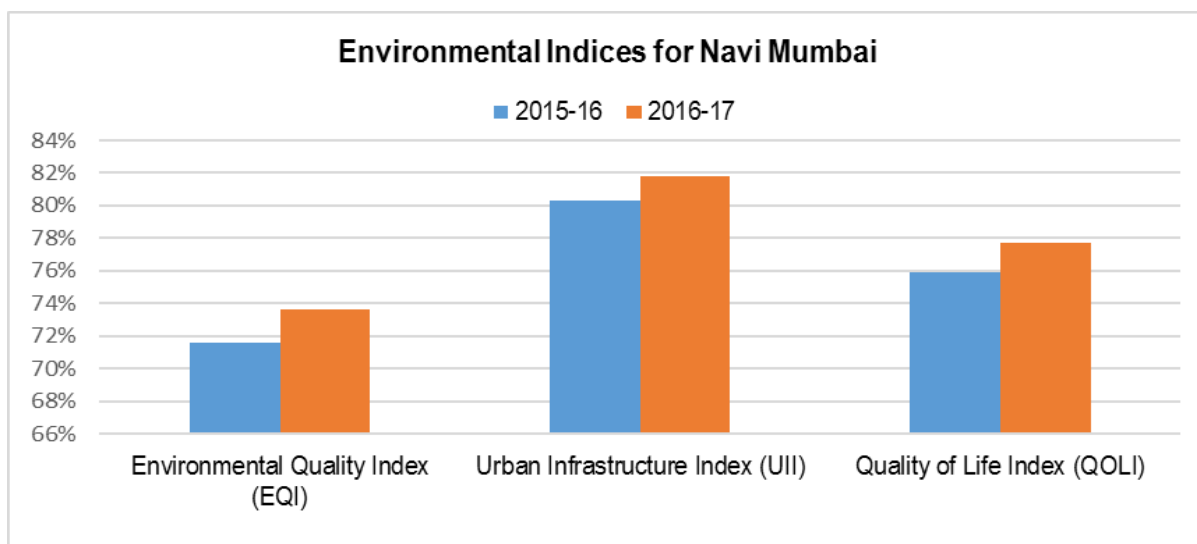


Figure No. 1: Environmental Indices for Navi Mumbai (2015-17)

This year NMMC has calculated the EPI (Environment Performance Index), endorsed by MPCB for the fourth consecutive year. 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 672.50 out of 944 and has registered an improvement of 7.6 compared to last year owing to three major initiatives undertaken for increasing awareness related to environmental issues, maximum and effective segregation of solid waste, mangrove protection and public grievance Redressal and Participation.

Air Pollution

NMMC has installed three CAAQMS (Continuous Ambient Air Quality Monitoring Stations), on each at Airoli (fire station), Turbhe (near landfill site) and Koparkhairne (near Teen Taki) to monitor air pollutants like SO₂ (Sulphur dioxide), NO_x (Oxides of Nitrogen), PM (Particulate Matter), Ozone, CO (Carbon Monoxide), Methane and so on. In the year 2016-17, these CAAQMS recorded 354, 365 and 362 observation days respectively indicating that the stations recorded the pollutions throughout the year.

The decreasing trend in all air pollutants) SO₂, NO_x, Particulate matter (2.5 and 10) levels in NMMC could be attributed to successful completion of concretization of roads, switch over to PNG by industries.

It is interesting to note that the city of Navi Mumbai has recorded a decreasing trend in the concentrations of criteria air pollutants of SO₂, NO_x, PM₁₀ & PM_{2.5} as compared to the past five years. In 2016-17, Navi-Mumbai recorded SO₂ and NO_x concentrations well within the standard indicating that is city is relatively clean from SO₂ and NO_x pollution. Even though concentration levels of PM violate the NAAQS (National Ambient

Air Quality Standards), the absolute concentration have decreased this year as compared to the last year. This decrease in the concentration of PM could be attributed to a cumulative impact of various initiative undertaken in Navi-Mumbai by NMMC and MPCB like:

1. Installation of water sprinkling system, dust suppression system, water sprinkling arrangement & metal road for all stone crusher units.

2. Completion of road construction activity along the MIDC patch leading to reduction in road traffic congestion
3. Change of fuel pattern to PNG (Piped Natural Gas) as fuel supplied by MGL (Mahanagar Gas Limited) by the Industries within TTC (Trans-Thane Creek) industrial belt, which has led to reduction in combustion of fuels which otherwise led to emissions
4. Closure of stone quarry sites within Navi Mumbai region on account of expiry of lease

The concentration of CO, as recorded by all stations, were relatable to seasonal pattern. The CAAQMS at Koparkhairne station recorded the highest eight hourly average of 5.1 mg/m³ and 3.4 mg/m³ in month of January followed by CAAQMS at Airoli 3.18 mg/m³ in month of November as against the eight hourly standard of 2mg/m³. Turbhe recorded the CO levels in range of 0.2 mg/m³ to 2.0 mg/m³ throughout the year which indicates that the area represented by the CAAQMS at Turbhe was non-polluted for carbon monoxide pollution. In terms of ozone, Navi Mumbai was non-polluted as the concentrations of O₃ were well within the standards and did not violate the standard for even a single day.

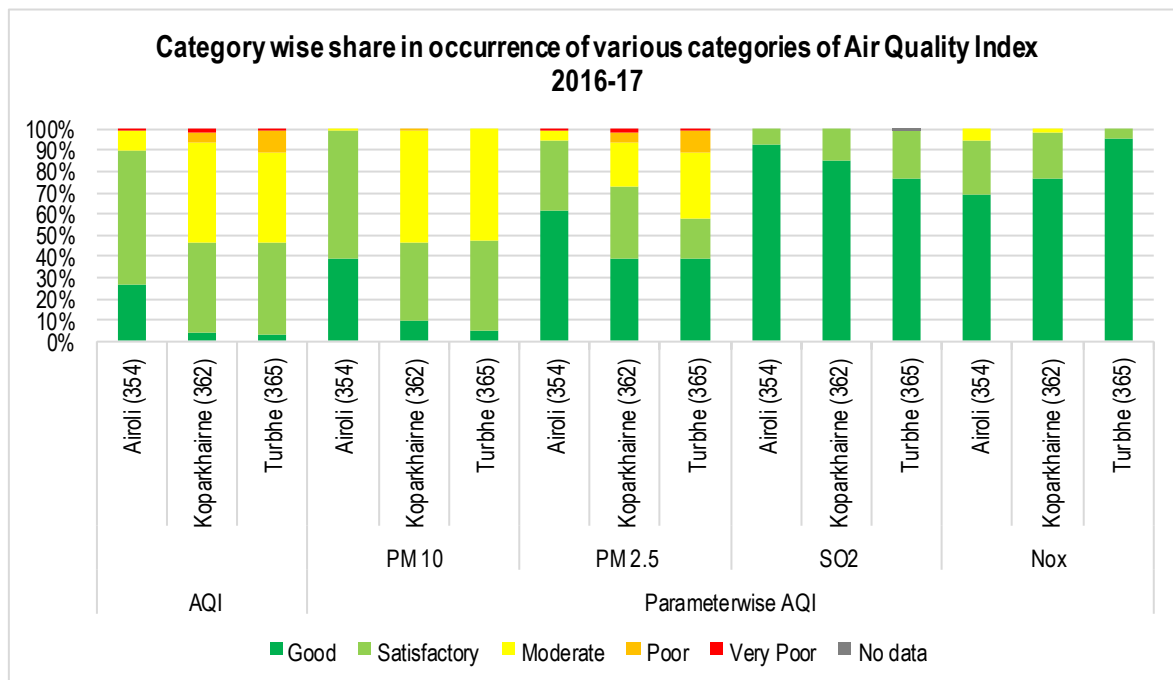


Figure No. 2: Category wise share in occurrence of various categories of Air Quality Index 2016-17

Based on the Air Quality Index it is determined that the air quality in the year 2016-17 was non-polluted for more than half at Koparkhairne and Turbhe and mere 10% or less observation days recorded air pollution in 'Poor' or 'Very Poor' category. However in Airoli area around 90% of the observation days has air quality in 'Good' and 'Satisfactory' quality. It is primarily the bias because of PM_{2.5} & PM₁₀ pollution near Turbhe and Koparkhairne as for the NO_x and SO₂ sub indexing, all the CAAQMS recorded air quality in either 'Good' or 'Satisfactory' category.

Noise Pollution

The residential areas and silence zones violated the day time standards except the commercial zones. The sound levels recorded across the city in different zones are presented below in Figure No. 3. The noise levels at Vashi Hospital, Sector 10 from residential area has increased by 6 % as compared to previous which recorded 58dB in 2015-16. The noise levels in traffic zones was recorded in range of 66-70 dB .Increase in vehicular population of the city and increase in honking & driving practices attributed to increase in noise levels.

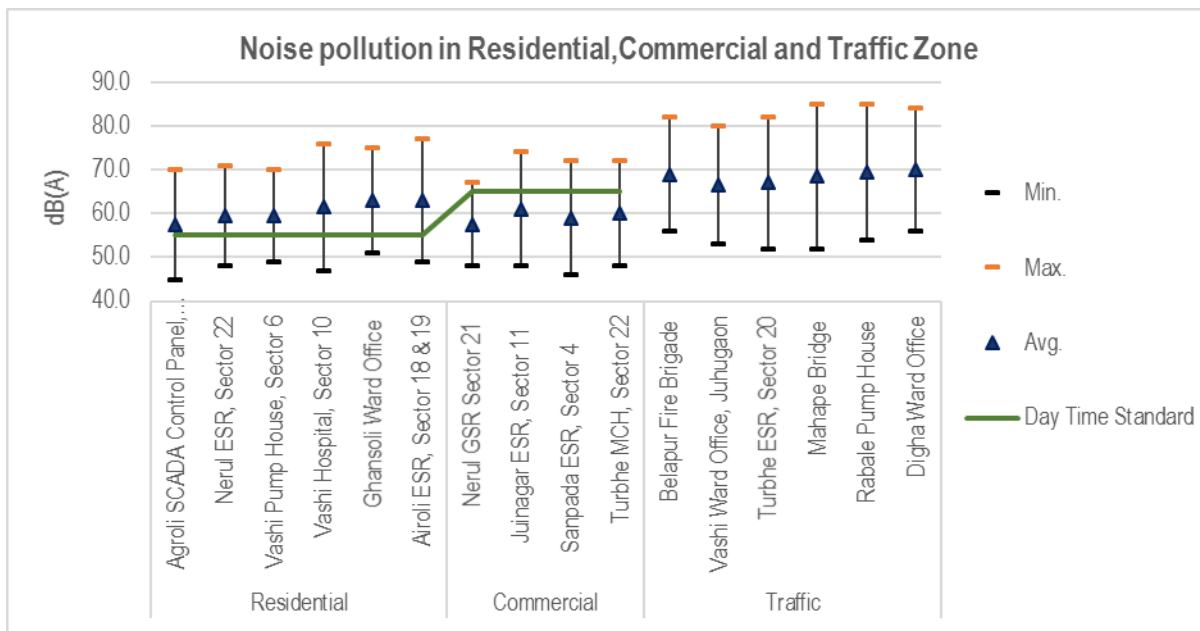


Figure No. 3: Zone wise Noise pollution levels in Navi Mumbai 2016-17

Water Resources and Quality

NMMC is blessed with abundant water resources in terms of both surface and ground water. The surface water resources include 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, and surface runoffs and so on.

The lakes in NMMC area are maintained properly by NMMC authority with all parameters except S.S. and DO exceeding in certain lakes. In case of Sulphates, only Vashigaon lake showed high amount (1198.97 mg/l) than the permissible limit (<1000 mg/l) while all other parameters were found to be within permissible limits. Major problem was seen in Creeks where all creeks except creek near Nerul Palm Beach road showed higher amount BOD. DO level was also exceeded in some creeks. All creek samples crossed the permissible limit for chlorides (<600 mg/l). This could be attributed to the release of untreated effluents from industrial area and other cities along the thane creek.

This year NMMC took a special drive to monitor nallah water quality along the industrial belt. The Kharine nallah was taken up for this drive. Effluent sample collection, from 84 potentially water polluting industries, was conducted and analysis was done in triplicates by laboratories of NMMC, the industry itself and a third party certified agency. The reports were submitted to MPCB for further action. NMMC plans to undertake many similar drives to curb unregulated release of effluents in the nallahs and drains in NMMC.

In terms of ground water resources there are 132 wells regularly monitored by NMMC for their water quality. Even though all the parameters were well within the limits for groundwater, the samples detected the presence of *Escherichia coli* and faecal coliforms.

Water supply

Morbe dam, situated on the Dhavri river (tributary of Patalganga river) near Khalapur, Raigad district is the source of fresh water for NMMC jurisdiction area. Around 392 MLD (Million Litres per Day) water is supplied from Morbe dam to the treatment plant at Bhokarpada in the year 2016–17. 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, thus ensuring 100% coverage.

1 % reduction in NRW, resulting in savings of 3 Million Liters of water per day. Achieved through stringent initiatives like installation of AMRs, disconnection of Illegal connections and prompt leakage redressal.

This year the share of Non-Revenue Water has reduced to 18.05% from 19% (3 MLD) be largely attributed to Installation of AMR (Automatic Meter Reader) and water supply disconnection against consumers failing AMR installation. A total of 4168 AMR were installed as on 30 March 2017. NMMC undertook active drive on disconnecting illegal water connections in the year 2016-17. Also NMMC was vigilant for prompt action and 100% addressal of complaints for pipe breaks and leakages in NMMC area, thus helping bring down the losses to a large extent.

In 2016-17, NMMC monitored 20,859 drinking water samples at the tap end, from all the nodes. Out of these about 4.72% (984) samples were detected to be non-potable which indicated high potability, ensuring that the water supplied by NMMC was of good quality. This is true for samples collected in rainy season and recurrently of some village & slum area which merit attention.

Sewage Treatment

NMMC has 7 active STPs (Sewage Treatment Plants) which have secondary treatment facilities with an aggregate capacity of about 454 MLD. The Aerated lagoon at Nerul 2 is now connected to Sanpada STP while NMMC has further taken over the charge of a 30MLD STP at Ghansoli from CIDCO. It is estimated that around 205 MLD of sewage is generated in the NMMC area and all the generated sewage is collected and treated, indicating that almost 100% of water is treated before releasing in the creek. NMMC has further proposed sewage network in slum pockets for collection and connect it to STPs. NMMC has prepared plan for Airoli and Ghansoli node. Plan for Turbhe, Digha and Nerul is under process.

NMMC regularly monitors the inlet and outlet water samples for bacteriological and chemical parameters. In the year 2016-17, the efficiency of the STPs 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. The average effluent water quality released from the STPs was well within the standards for all the parameters.

In case of Nallahs, all the parameters except Chlorides were found to be within the permissible limit. Chlorides level were found to be high. This may be due to effluent discharge into the nallahs from surrounding industries and settlements. NMMC also

performed water quality testing of Holding pond samples and this year the holding pond at Vashi sector 30 violated BOD level (121 mg/l). Higher DO levels (10.3mg/l) were found only at Belapur Sector 15A while Vashi sector 11 & 12 (2.0mg/l) and Vashi sector 30 (3.0mg/l) showed less DO levels. Rest all the parameters like pH, nitrite, nitrate and phosphates were well in the limits.

Land use and green cover

The total area under NMMC's jurisdiction is estimated to be approximately 108.63 sq. km. Out of the total area, 56% of land accounts for Built Up area followed by Forests (24%), Wetlands (12%) and the remaining area is broadly classified under water bodies or agriculture. There are a total of 163 gardens and 80 open spaces which support the biodiversity of the city. NMMC has proposed the Amusement park at Kopri village in Vashi, on the lines of the Old Woman's Shoehouse in Malabar Hill. The work is almost completed and NMMC plans to inaugurate it soon.

As per the provisional figures, Navi Mumbai has 8.5 Lakhs of tree cover across the city. Total 25,000 trees have been planted across various nodes in the year 2016-17.

Mangrove Ecosystem

Due to Navi Mumbai's geographical location along the coastline, Mangroves are important natural ecosystem for Navi Mumbai. 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. As per study conducted by TERI, it is predicted that about 0.26% carbon emissions per year are sequestered by the mangroves in Navi Mumbai. Around 14.71 sq. km of mangroves in Navi Mumbai have been notified as 'reserved forests' under NMMC limits.

Protection of Mangrove-Wetland ecosystem

NMMC has taken special initiatives to protect and conserve the mangrove forests and the highlights of the initiatives taken in 2016-17 include the following:

- Toll free hotline numbers for all wards for grievances against mangrove destruction has been initiated
- Construction of barricading using of curb stones for preventing access of vehicle for illegal dumping and trespassers
- Encroachments from mangroves of Vashi, Ghansoli and Airoli nodes were removed and replaced by putting fencing.
- 2 Anti-debris mobile squad for monitoring of illegal activities in mangroves region.

NMMC further proposes to install CCTV's in mangrove area to have surveillance check on illegal activities, mangrove plantation drives, develop a mangrove park and set up bird watching towers near the mangrove area for nature and bird lovers.

Biodiversity

Navi Mumbai is bestowed with high biodiversity due to presence of several habitats ranging from low hills with tropical semi-evergreen to mangroves forests. Part of Thane Creek and Uran Creek are the key biodiversity hotspots to observe migratory birds whereas Nerul's Talave, Airoli & Ghansoli mudflats are also home to some exotic birds. Various migratory

birds such as the Lesser Flamingos are observed to visit mangrove and mudflats of the city for breeding and feeding purposes increasing the bio wealth of the 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, and Airoli. Mangrove cell, Forest Department- Government of Maharashtra has developed a Coastal and Marine Biodiversity Centre (CMCB) at Airoli node in Navi Mumbai to improve knowledge of citizens about local coastal and marine habitat.

Restoration of Stone Quarries and Protection of Hills

The abandoned stone quarries in Navi Mumbai have affected the aesthetic beauty of the city, more over the lease of the sites have also expired in 2016 rendering all the sites vacant. Towards this NMMC has proposed actions for restoration of abandoned quarries and protection of hills by using them as follows

- Use of abandoned quarries for Rainwater harvesting
- Planting trees for restoration of land under abandoned quarries
- Abandoned quarries can be restored by sanitary land filling

Municipal Solid Waste

Generation and Collection

NMMC has designed a specific solid waste management strategy for effective disposal of municipal waste. In the year 2016-17, the daily average MSW was 725 Metric Tonnes (MT) which has increased by about 30 tons as compared to the last year. The major share of about 92% (672 MT) of the total waste is generated from residential areas of which the Turbhe node generated the maximum MSW, more than 105 MT/day while Digha node generated about 33 MT/day of MSW. The waste generated from the city comprises mainly of biodegradable waste (54%).

NMMC has achieved more than 60% waste segregation at source through various awareness drives.

Waste from the roads is collected through sweeping while household waste is mechanically collected and loaded in refuse transportation vehicles by transportation contractors. Each node is provided with green and blue dustbins. The green bins are used to collect the wet waste while the blue for dry waste. About 56% of solid waste is segregated at source in NMMC regions.

Along with green and blue dustbins, NMMC has started disseminating red bins for e-waste collection. Eco Friend Industries has been appointed by NMMC to collect e waste as sample on demo stage from red bins placed at NMMC headquarters at CBD Belapur, Wonders Park at Nerul and at Inorbit mall, Vashi.

MSW Disposal

In the year 2016-17 the Turbhe landfill site received around 725 MT waste per day. The MSW at disposal site is segregated into dry, wet and mixed waste. The plastic is segregated and transferred to baling unit which converts plastic pieces into small beads which is then supplied to plastic recycling vendors and other industrial applications. Waste LDPE (Low Density Polyethylene) collected by NMMC is converted to granules and then processed to

use as replacement for Bitumen for road construction. This year NMMC, on a sample basis undertook 10 pilot projects under this initiative. The dry waste like paper, cardboard, plastic and other corrugated materials are used to produce a homogenous material known as RDF (Refuse Derived Fuel), while waste like glass, metal are recycled. The wet waste is converted to compost using windrows technology and the compost is sold to various clients. NMMC had organized 'Anti-Plastic Drive' at Jewel of Navi Mumbai (Nerul) on 8th January, 2017 for awareness of harmful effects of plastic. Under this drive, plastic waste from each node is collected and transferred to Turbhe Solid Waste Management site for scientific processing.

Biomedical and Hazardous Waste

In the year 2016-17 around 13,200kgs (13.2 tons) of biomedical waste was generated in NMMC area from various hospitals and dispensaries. The collection and disposal is managed by MWML (Mumbai Waste Management Limited), a private contractor empaneled by MPCB (Maharashtra Pollution Control Board) and disposed of at the hazardous waste disposal facility at Taloja. The TTC industrial areas houses more than 3000 industrial units, which generates hazardous waste like spent oil, ETP sludge, pesticides, lead batteries and so on. It is estimated that around 7216 MT of landfill able hazardous waste was generated and collected in the year 2016-17. Out of which 6945MT of waste was disposed by TTCWMA (Trans Thane Creek Waste Management Association) in their land fill site. The incinerable waste is managed by MWML.

Health

Navi Mumbai has diverse health care services and facilities including clinics, hospitals, super speciality hospitals, private and government dispensaries and so on. There are 6 NMMC (Municipal hospitals) along with 198 private hospitals, 22 NMMC (municipal) dispensaries and 1 mobile dispensary. Apart from these facilities there are around 315 Ayurvedic, 191 homeopathic, 75 pediatrics and 83 gynaecologists' clinics as well. Hospitals are equipped with latest technologies and specialist doctors, experienced staff are competent to handle emergency cases. Day and night pharmacy and medical services are also available in the city. NMMC's health department monitors the status of each disease every year and maintains an inventory of the cases recorded and the subsequent deaths, if any, for keeping a track on the health status of the city.

Water borne diseases

Diseases like Gastroenteritis, dysentery, Hepatitis-B, Typhoid are commonly occurring water borne diseases in Navi Mumbai. In 2016-17, occurrence of gastroenteritis decreased by almost 90% with only 35 reported cases compared to 351 in last year. The percentage of Dysentery decreased by 98% from 65 cases in 2015-16 to just 1 in 2016-17. Similarly, Typhoid cases went down from 54 in 2015-16 to 19 in 2016-17. Only Hepatitis B showed an upward trend by double the number of cases from 6 in 2015-16 to 12 in 2016-17.

Tuberculosis

Tuberculosis is a major air borne disease in the world and of major concern in India. The number of cases of Tuberculosis grew by 6.3% and almost 1909 Person were detected with TB as against 1795.patients last year. NMMC is undertaking necessary measures to reduce the diseases in the city. To eradicate TB, NMMC started providing DOTS (Directly observed treatment, short course), also known as TB-DOTS everyday instead of 3 days in a week from

current year. These DOTS are available in NMMC affiliated hospitals, NGOs, health posts. Also Conduction of Cartridge Based Nucleic Acid amplification Test (CB-NAAT) on MDR (Multi-Drug Resistance) and XDR (Extensively Drug-Resistant) TB patients and providing medicines free of cost.

Vector borne diseases

Mosquitoes, ticks and fleas are the major vectors which carries infectious pathogens like bacteria, protozoa which are responsible for vector borne diseases. Such diseases are more prevalent in tropical and sub-tropical climate. Malaria and dengue are more common vector borne diseases in the world. Health department monitors spread of these diseases and continuously works towards prevention and control of these diseases.

Malaria and Dengue

Through the bite of female Anopheles mosquito, *Plasmodium* parasite enters the human body and causes malaria. Similarly, mosquito species *Aedes aegypti* is the vector for dengue fever. Both diseases are more prevalent in the areas having high rainfall, lack of proper hygienic and sanitation facilities and unplanned urban growth. The disease could be prevented by following good practices like covering, cleaning domestic water storage tanks periodically, preventing mosquito breeding sites through proper environmental management. 2016-17 recorded decrease in number of malaria and dengue cases than the previous year. In 2016-17, Malaria cases went down from 301 in 2015-16 to 242 in 2016-17. Similarly, 54 cases of dengue were registered this year than 76 in 2015-16. Along with regular control measures like anti-larval spraying and fogging, NMMC's health department took following effective measures in 2016-17 to control spread of vector borne diseases,

- Conduction of malaria camps, student's March, society meetings and private medical workshops in June 2016 as a part of an initiative of Malaria Prevention Month.
- Collection of blood samples and treatment on patients in July 2016 as a part of Dengue Prevention Month.
- During Ganesh-Utsav and Mahashivratri festival in 2016, awareness was done through camps, banners, hoardings.
- Survey of Guppy fish sites as an effective biological control against mosquito larvae and spraying of anti-Mosquito powder in Government, private schools and colleges

Conclusion

The necessary initiatives taken by NMMC to improve the air quality, water quality effective segregation of solid waste, protection of ecosystem, development of road & footpaths and playgrounds has increased the EQI and UII of Navi Mumbai. The improvement of EQI and UII has thus improved the QOLI for citizen of NMMC. Realising the further pressures on resources, NMMC is undertaking the necessary initiatives to conserve the resources in the city.

Environmental Indices for Navi Mumbai

The Environment is something we all are familiar with. It's everything that makes up our surroundings and affects our ability to live on the earth. An Environment is a very broad and complex term which covers a wide range of areas. For a common man, Understanding environment, its types, various factors and parameters involved in each type is very difficult and technical. The aim of assessing status of environment is sustainable development while maintaining environment quality. 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 for necessary factors and then set up a trend for those factors that could be analysed for 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). 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 improvement in air and water quality, effective segregation and maximum recycling of solid waste, Protection of mangroves, continuous monitoring of water quality, and so on. While the increase in value of UII is attributed to increase in the development of road & footpaths, improvement in playgrounds, public Grievance Redressal and Participation. 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 five years is presented in Figure No.1 and Table No.1.

Table No. 1: Environmental Indices of Navi Mumbai

| Sr. No | Index | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 |
|--------|-----------------------------------|---------|---------|---------|---------|---------|
| 1 | Environmental Quality Index (EQI) | 70.02% | 70.69% | 71.38% | 71.59% | 73.66% |
| 2 | Urban Infrastructure Index (UII) | 78.94% | 79.06% | 79.65% | 80.29% | 81.76% |
| 3 | Quality of Life Index (QOLI) | 74.48% | 74.88% | 75.52% | 75.94% | 77.71% |

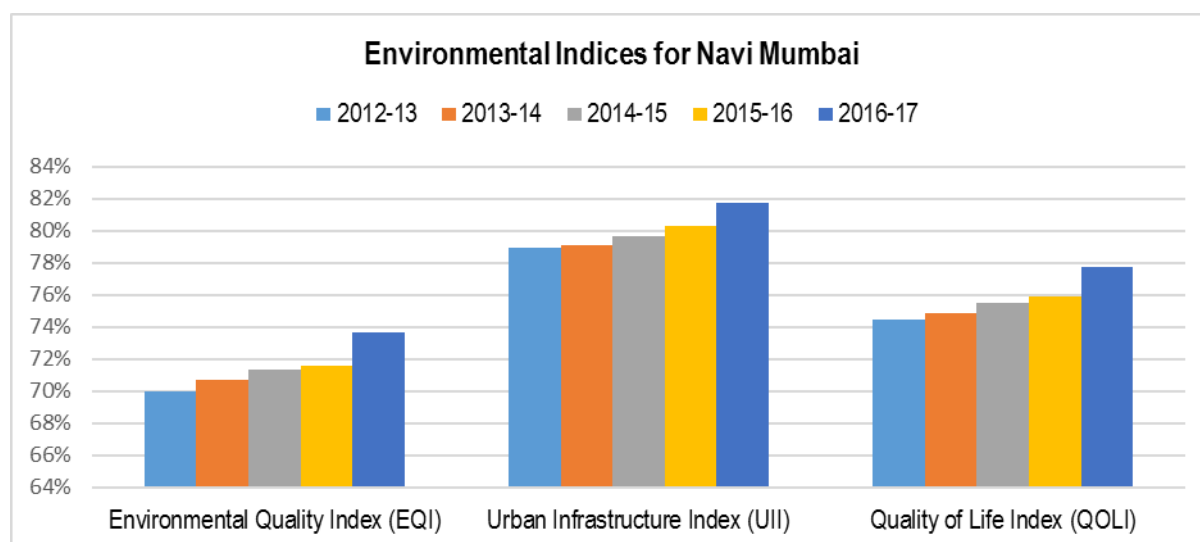


Figure No. 4: Environmental Indices of Navi Mumbai

Environmental Performance Index

The EPI (Environmental Performance Index) is a method of quantifying and numerically marking the environmental performance of a city. As per MPCB framework there are 65 data variables which are translated into indicators under various thematic group. The 4 thematic group (Growth of city, State of resources, Urban services and Initiatives taken to improve the city environment) are then added up to give unique score which is considered as the Environmental Performance Index. The maximum of the score will show the best environmental performance of the city.

The bench mark is set according to the national, state or the defined average as per international standards. Against this benchmark, a definite score has been allotted to the 65 data variables 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 MSTM Excel software. The EPI score for NMMC area was determined to be 672.50 out of 944 in the year 2016-17 and recorded an improvement of 7.6 as compared to last year 2015-16 which was 664.90. This improvement is attributed to the initiatives taken by NMMC for increasing awareness related to environmental issues, waste management and increasing sanitation and sewerage facilities in slums.

Table No. 2: Environmental Performance Index

| Gap Analysis | | |
|--|------------------|----------------|
| Environmental Score | Achievable Score | Achieved Score |
| Thematic Indicators | 944 | 672.50 |
| Growth of cities | 250 | 140.00 |
| State of natural resources | 300 | 225.60 |
| Urban Services | 250 | 198.50 |
| Initiatives for improving city environment | 144 | 108.40 |

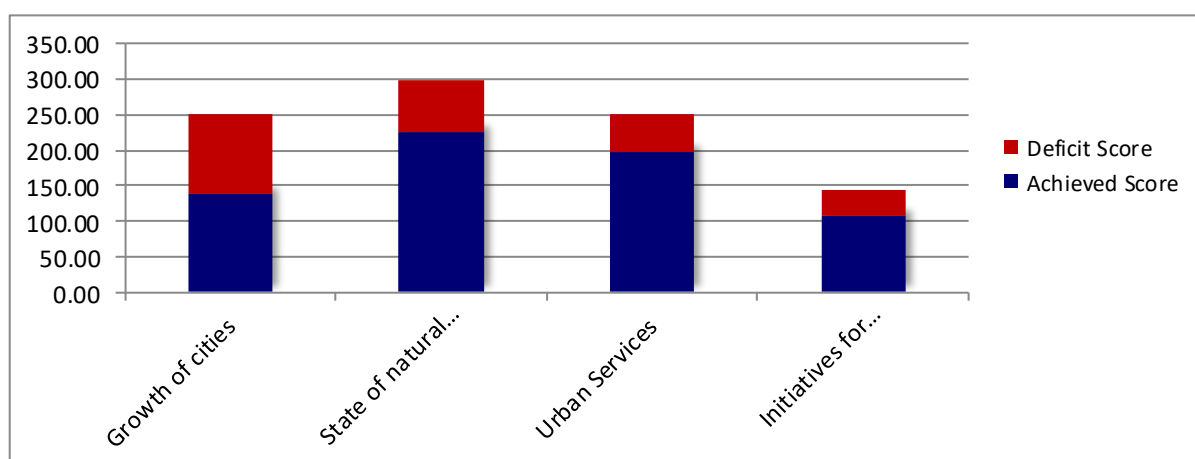


Figure No. 5: Environmental Performance Index

Initiatives under Swaccha Maharashtra Abhiyan & Eco-City Program

As per the guidelines of Swaccha Bharat Mission (Urban), all the urban local bodies have to provide toilet facility to all households having no latrines within premises and an effective solid waste management. Towards this, Government of Maharashtra launched 'Swaccha Maharashtra Abhiyan' with its own ambitious target of achieving this feat by 2nd October, 2019.

The objectives of this abhiyan includes elimination of Open defecation, eradication of manual scavenging, provision of modern and scientific solid waste management, awareness about sanitation and public health, capacity augmentation for ULB's and creating healthy environment for private sector participation in Capital expenditure, Operation and maintenance. Swaccha Maharashtra Abhiyan in urban areas is being implemented by Urban Development Department (UDD) through a dedicated Swaccha Maharashtra Mission Directorate. At city level, the mission is being implemented by Urban Local Bodies¹.

Infrastructure and Facilities developed by NMMC

1. As per the guidelines under Swaccha Bharat Abhiyan and declaration of Swaccha Maharashtra Abhiyan by state government on 15 May 2015, 'Project Execution Cell' for Swaccha Maharashtra Abhiyan (Civilian) was established on NMMC Municipal Commissioners' order on 06 August, 2015.
2. Under Swaccha Bharat Mission/Swaccha Maharashtra Abhiyan, Famous singer and musician Mr. Shankar Mahadevan was appointed as the Swaccha Brand Ambassador for Navi Mumbai.
3. 20 Smart E-Toilets and 6 Smart She Toilets (Table No. 4) have been constructed in NMMC's jurisdiction. Smart she toilets have facilities like sanitary vending machine, mirror, baby feeding room, diaper changing room and rest room. Such initiative is modern in state as well as in country. Toilet manufacturer Eram Scientific has declared this concept as 'NMMC Model'. Construction of 4 more smart she toilets are proposed.
4. To make Navi Mumbai an Open Defecation Free (ODF) city, NMMC has a policy of construction of individual household, public and community toilets under Swachha Maharashtra Abhiyan. Under this policy, NMMC provides a grant of INR 17,000/- to eligible beneficiaries for construction of Individual House Hold Latrines (IHHL). Out of INR 17,000, Central government gives 4000, State government 8000 and NMMC gives 5000 rupees.
5. NMMC has proposed construction of 1935 Individual household toilets and 719 community toilets to make NMMC and OD free city.
6. Under Swachha Maharashtra Abhiyan, NMMC got funding of Rs. 621.54 Lacs from central and state government. Out of this, Rs. 310.38 lacs is already spent as on 13th June, 2017.

¹ <https://swachh.maharashtra.gov.in/1110/About-SMM>

7. Under CSR (Corporate Social Responsibility), various corporates have built toilets in NMMC. The Shelter Associates of Pune built 54 Individual household toilets in Ramabai Ambedkar nagar (Belapur) and 334 in Samta nagar, Airoli naka (Airoli). While the Shipping Corporation of India constructed 20 seating public toilets in Bhimanagar (Rabale). Lubrizol India constructed a modern NAMMA (initiative of Commissionerate of Municipal administration, Chennai) smart toilet with capacity of 7 seats at Pfizer road, Hanuman nagar, Turbhe. Similarly, the construction of SS (Stainless Steel) twin bins has been done using CSR funding.
8. Under MLA's (Member of Legislative Assembly) Local Development Program 2015-16, construction of 2 modern community toilets have been complete out of 4 proposed toilets near Belapur Vidhan sabha. Similary 1 mobile toilet is set up in Airoli vidhan sabha area.
9. During the financial year 2017-18, construction of community smart toilets at gardens, playgrounds and other public places is proposed.

Awareness, Outreach and Feedback

1. Between April 2016 to March 2017, around 170 thematic Cleanliness Drives were successfully conducted which included around 165781 man hours.
2. An Android based toilet Locator app has been developed to track all public/community toilets located in NMMC jurisdiction area.
3. Immediate actions of cleanliness related issues through Swachhta APP and NMMCs App. Information related to Swaccha Abhiyan and public response can be monitored through Whatsapp/Facebook/Twitter.
4. Installation of Citizen Feedback Unit in selected public toilets for recording public opinions.

Awards and Recognition received by NMMC for initiatives under Swacchatta Abhiyaan

1. Navi Mumbai was ranked 1st in Maharashtra (West Zone) and 8th in country as the cleanest city as per Swaccha Sarvekshan (Survey) -2017.
2. Under Swaccha Bharat Abhiyan, NMMC ranked first in Advanced Public Toilets and Information, Education and Behaviour Change Communication (IEBC) categories and received awards during 45th Skoch Award-2016 held in Hyderabad on 8th & 9th September, 2016.
3. Committee from Quality Council of India declared NMMC jurisdiction area as Open Defecation Free (Hagandari-mukta) area in December 2016. The report has been submitted to the government.
4. The Smart E-Toilet and She -Toilet initiative received an award by "Washroom Beyond" (Wb) magazine in 2016.

Table No. 3: Number and Locations of Smart E Toilets (Single seated, unisex)

| Sr.No. | Node | Number | Locations |
|--------|--------------|--------|---|
| 1 | Belapur | 4 | Near T. S Chanakya Signal, Palm Beach Road |
| 2 | | | Near NRI Signal, Sector 50 Bus Terminal, Palm Beach Road |
| 3 | | | At Uran Junction, Sector 15, CBD Belapur, Palm Beach Road |
| 4 | | | Near DAV School, Sector 48, Nerul |
| 5 | Nerul | 3 | Near Vajrani Sports Signal, Palm Beach Road |
| 6 | | | Near D Y Patil Sports Stadium, Sion Panvel Highway |
| 7 | | | Opp. Nerul Bus Terminus, Sector-3 |
| 8 | Vashi | 2 | Mini Sea Shore (North), Sector 10-A |
| 9 | | | Mini Sea Shore (South), Sector 10-A |
| 10 | Turbhe | 2 | Opp. Gokul Dairy, Palm Beach Road |
| 11 | | | Near Moraj Signal, Palm Beach Road |
| 12 | Koparkhairne | 5 | Near Lokmat Bus Stop Thane Belapur Road |
| 13 | | | Mahape over Bridge, Thane Belapur Road |
| 14 | | | Pawane near Zydus Company, Thane Belapur Road |
| 15 | | | Near Pawane Police Chowki, Thane Belapur Road |
| 16 | | | Near Bawkaleshwar Temple, Pawane MIDC |
| 17 | Ghansoli | 3 | Near Rabale Police Station, Thane Belapur Road |
| 18 | | | Talavali Naka, Thane Belapur Road |
| 19 | | | Ghansoli Naka, Thane Belapur Road |
| 20 | Airoli | 1 | Near Reliable Company, Thane Belapur Road |



Picture No. 1: E-Toilet with a detailed instruction of its usage displayed at each toilet

Table No. 4: Smart She Toilets with rest room (Exclusively for Women)

| Sr.No. | Node | Location |
|--------|--------------|---------------------------------------|
| 1 | Belapur | CBD Belapur Bus Terminus, Sector 6 |
| 2 | Nerul | R.R.Patil Udyan, Nerul |
| 3 | Vashi | Opp Center One Mall, Sector-30, Vashi |
| 4 | Vashi | Vashi bus terminus, Sector-9 |
| 5 | Koparkhairne | Near D-mart circle, Sector-7 |
| 6 | Airoli | Near Airoli bus terminus, sector-3 |



Picture No. 2: She-toilet with restroom facilities installed by NMMC

Table No. 5: Summary of Public/Community Toilets in areas under NMMC jurisdiction

| Sr.No. | Node | Public Toilet | | Community Toilet | | Total Toilets | |
|--------|--------------|---------------|------------------|------------------|------------------|---------------|------------------|
| | | Toilet Nos. | Seating Capacity | Toilet Nos. | Seating Capacity | Toilet Nos. | Seating Capacity |
| 1 | Belapur CBD | 23 | 92 | 48 | 675 | 71 | 767 |
| 2 | Nerul | 17 | 77 | 38 | 503 | 55 | 580 |
| 3 | Vashi | 48 | 329 | 0 | 0 | 48 | 329 |
| 4 | Turbhe | 18 | 111 | 39 | 558 | 57 | 669 |
| 5 | Koparkhairne | 13 | 133 | 41 | 558 | 54 | 691 |
| 6 | Ghansoli | 10 | 85 | 77 | 969 | 87 | 1054 |
| 7 | Airoli | 12 | 73 | 38 | 521 | 50 | 594 |
| 8 | Digha | 0 | 0 | 66 | 766 | 66 | 766 |
| | Total | 141 | 900 | 347 | 4550 | 488 | 5450 |



Picture No. 3: Community toilet facilities installed by NMMC

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, TERI developed the carbon inventory to estimate the carbon footprint of the city and subsequently developed a comprehensive action plan. The highlights of the initiatives undertaken in the year 2016-17 is presented below.

Eco-City Forum

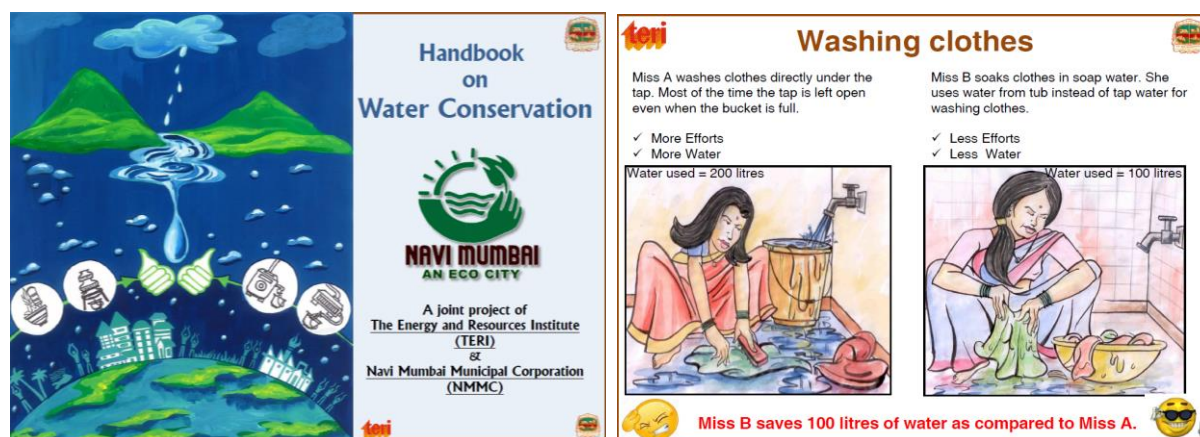
Under the Eco-city project, TERI and NMMC launched the Eco-city Forum on 29th July 2016. The forum has been launched with the following objectives

- To generate a movement where all the concerned stakeholders would be involved at various stages to make Navi Mumbai an Eco city
- To encourage dialogues on the right challenges, with right people and at right time.
- To derive appropriate actions leading towards implementable solutions.

The program was witnessed participation of around 160 citizens, who were introduced to the concept of the program and was followed by a panel discussion to seek support of the citizens. The activities of the forum would initially focus on the themes of Green Buildings, Urban Farming, Energy Conservation and Water Conservation.

The event also witnessed the release of the book '*Handbook on Water Conservation*' (Picture No. 4) developed under the project. The book presents easy to understand illustrations highlighting simple techniques to conserve water in our day to day life. The book and been uploaded on TERI's website and can be accessed on the following weblink

http://www.teriin.org/files/water_handbook.pdf



Picture No. 4: Snapshot of the cover page and a sample illustration from the handbook

Urban Farming Forum and Initiatives

Urban areas are highly dependent on rural areas to get their food supplies every day. In Mumbai we get our food stock from as far as 200 to 500kms every day, which leads to a huge carbon foot print on account of emission from the transport of these products. Transportation not only leads to losses as products may succumb to mis-handling and in appropriate packaging while in transit it also reduces the shelf life of perishable products. Further in the era of chemically induced food products the nutritive integrity of the food we consume is also at time questionable.

Towards these concerns TERI had promoted the concept of urban farming for cultivating part portion of the food locally by utilizing compost made from biodegradable waste generated daily. To propagate the idea further TERI constituted an urban farming forum, to have a structured program, on 29th of September, 2016, under the Navi Mumbai Eco-city project. A core committee has been set up to play an advisory role and help in guiding the activities under the forum. The committee is chaired by Shri. Jayant Banthia (Ex- Chief Secretary, Govt. of Maharashtra), Mr. G S Gill (Distinguished advisor, TERI), Shri Mohan Dagaonkar, (City Engineer, NMMC), Dr P N Pabrekar, (Principal ICLE's college, Navi Mumbai) and Shri M S Bisht, (Chief Manager (Reservoir), ONGC).

- A demonstration workshop on the Cultivation of Oyster mushrooms was conducted on 25th October, 2016.
- Two demonstration workshops on 'Growing organic vegetables in windows & balconies' on 26th November, 2016.

The workshops, interspersed with practical demonstrations involving volunteers from the audience, included tips and guidelines on potting, sowing & growing fresh vegetables in containers. More than 200 participants including urban farmers, residents, senior college students, professors, owners of startups and so on, participated in these workshops.



Picture No. 5: Hands on demonstration and lectures organized under urban farming initiative

Navi Mumbai – City Profile

In Mumbai, the total landmass available for development is limited due to its geographic location and this was already realised in the late 60's by the developers and planners. Hence, exploring other options to divert and to control population of Mumbai was suggested, by city planners, by constructing a twin city, Navi Mumbai, as an alternative to address the issue of space crunch in Mumbai.

Conceived in the year 1972, Navi Mumbai is one of the largest planned cities of India and was designed to decongest Mumbai. In 1970 CIDCO (City & Industrial Development Corporation), a state public sector undertaking, was incorporated with purpose to plan, develop and maintain the city of Navi Mumbai under 'Companies Act' of 1956. CIDCO prepared development plan for Navi Mumbai covering 95 villages from Thane to Raigad district with an estimated area of 343.70 sq.km². 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 east 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 NMMC³. As per UHP (Urban Health Post) estimate for the year 2016-17 the population residing within NMMC, area is more than 14 lakhs (14,69,302) with an average population density of about 13,525 persons per sq. km. The geographic and demographic profile of Navi Mumbai is represented in Table No. 6.

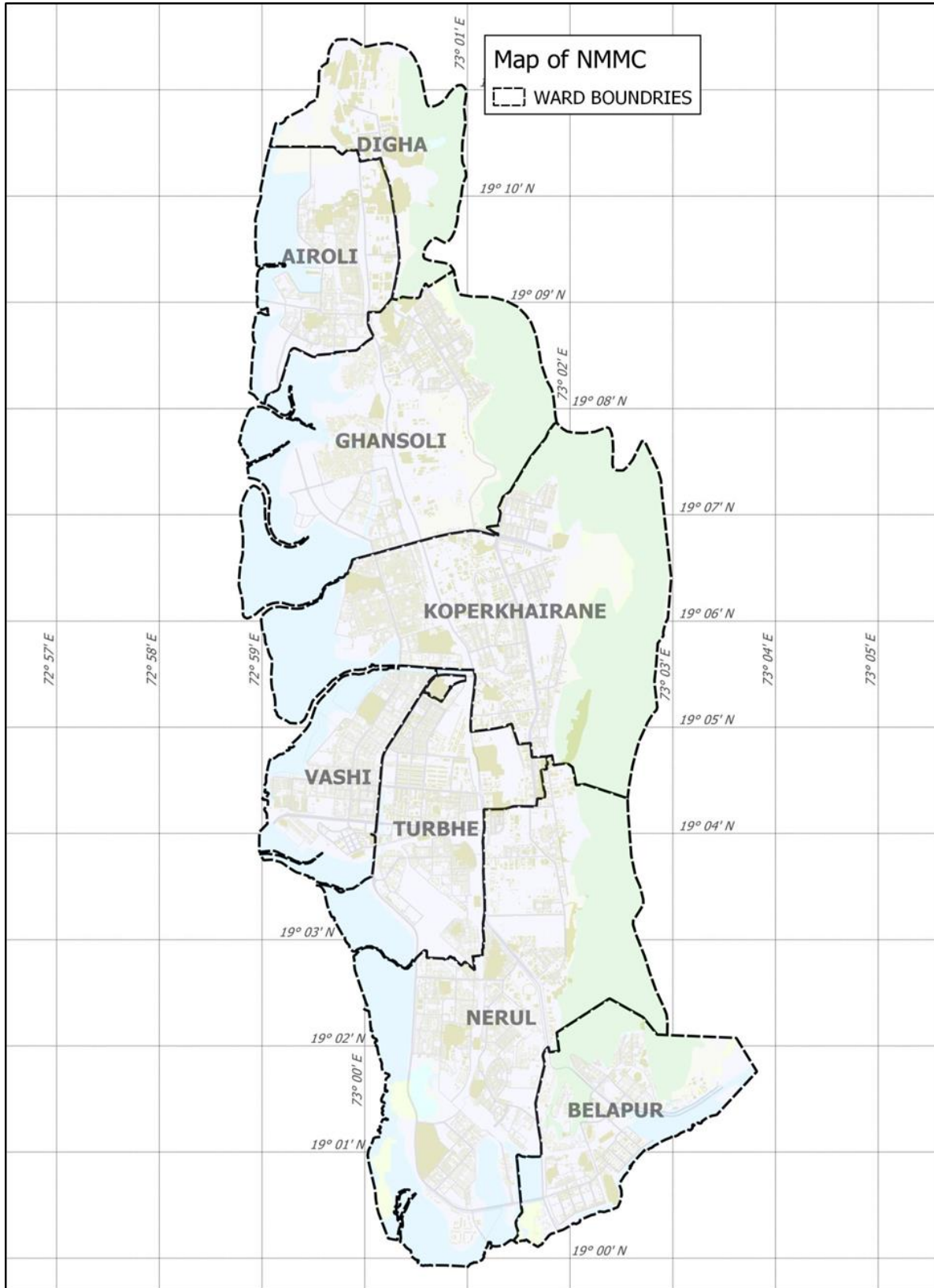
Table No. 6: Geographic and demographic highlights of Navi Mumbai

| Heads | Attributes |
|---|---|
| Longitude | 72°58' to 73°03'E |
| Latitude | 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 2016-17 (UHP Survey) | 14,69,302 |
| 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

² <https://www.nmmc.gov.in/history>

³ City Engineering Department, 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's (Thane Belapur Industry Association's) premises, the predominant wind direction in Navi Mumbai is southwest in monsoon and north-east during rest of the year.⁴

Based on the data recorded at the CAAQMS (Continuous Ambient Air Quality Monitoring Stations), for NMMC, the monthly average temperatures (Figure No. 6) were recorded to be between 25°C to 31°C for the year 2016-17. The highest maximum average temperature of 31°C was recorded in the month of May (summer season) and the lowest temperature of about 25°C was recorded in the January month.

In the year 2016 Navi Mumbai received around 2706.44 mm of rainfall (Figure No. 7). As seen in the same figure Navi Mumbai has experienced high rainfall in the months of July (1080.85mm) and August (465.08mm) and September (470.65mm), compared to previous year 2015. The month of June recorded relatively low rainfall (635.23mm) compared to the year 2015 (709.33) and was also the third highest rainfall (635.23) recorded in in June compared to the years. In this year, the July month recorded the highest rainfall (1080.85) while there was no rainfall in November (Figure No. 8).

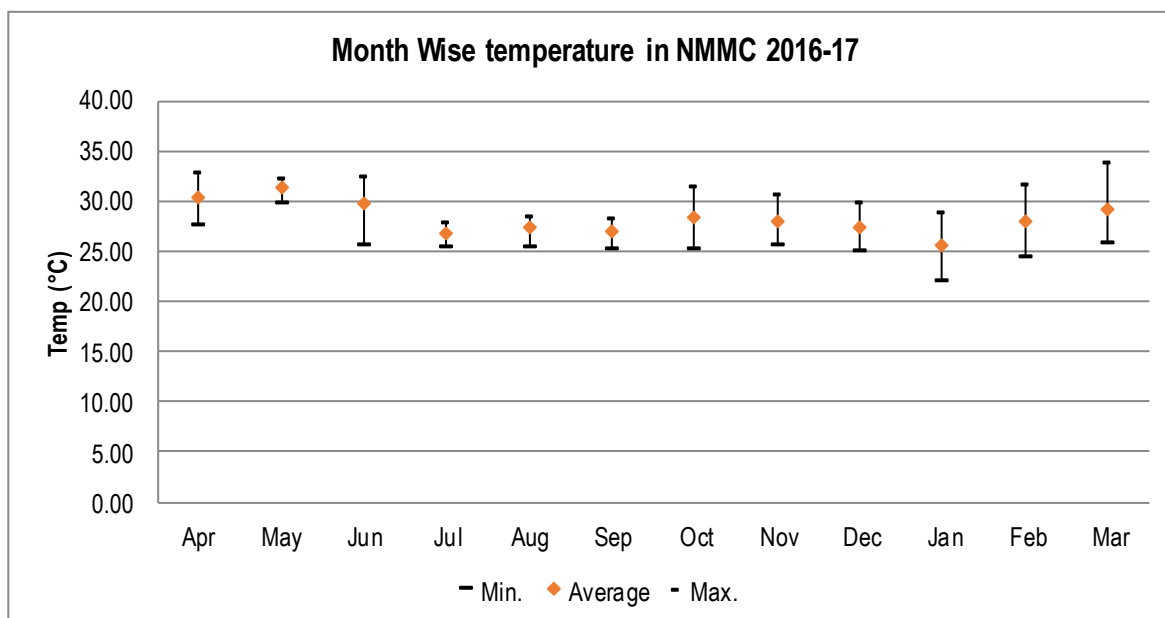


Figure No. 6: Month wise temperatures recorded in NMMC area 2016-17

Data source: CAAQMS of NMMC at Airoli, Turbhe and Koparkhairne

⁴ <http://www.nmmconline.com/web/guest/climate>

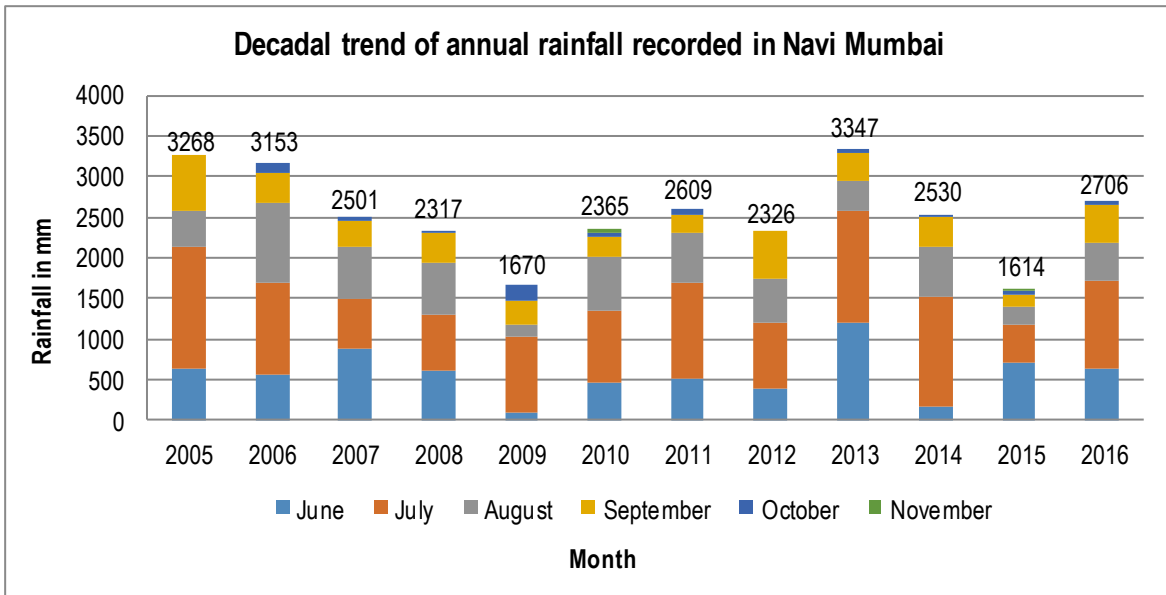


Figure No. 7: Decadal trend of annual rainfall recorded in Navi Mumbai
Source: Environmental Laboratory, NMMC

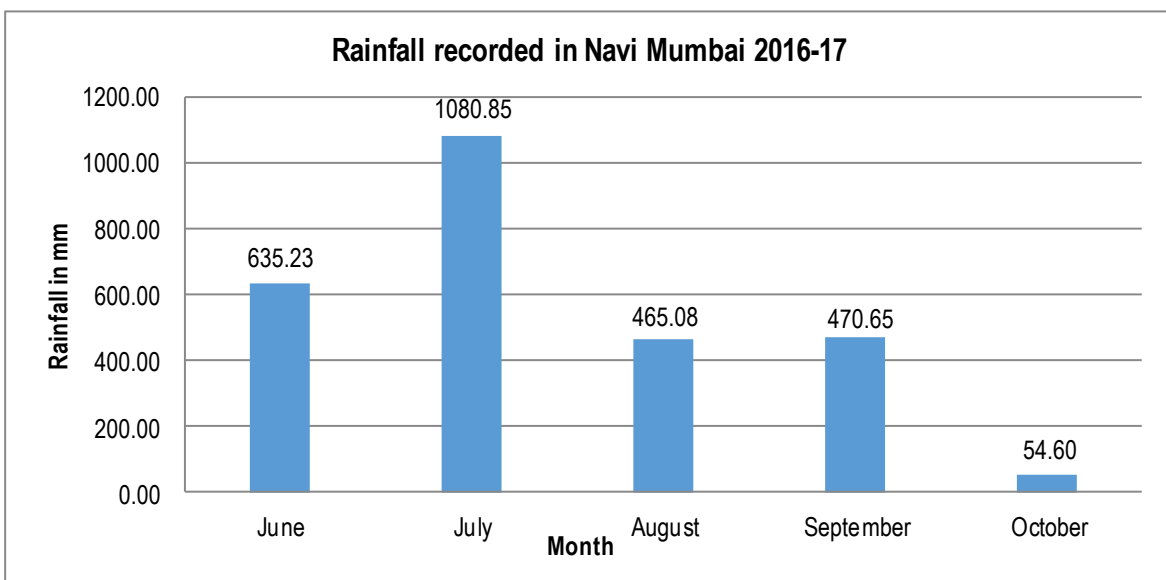


Figure No. 8: Rainfall recorded in Navi Mumbai
Source: Environmental Laboratory, NMMC

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 Maharaj Terminus (town side) as well as western parts of Mumbai.⁵ The city also has good accessibility to Pune and Pimpri regions through road as well as rail transport.

The NMMC area is served by 4 bus transport agencies operation between Mumbai-NMMC area, within NMMC area, Thane-NMMC area and surrounding areas. The road transport wing of Navi Mumbai includes connectivity from bus operators of BEST (Brihanmumbai Electric Supply and Transport), NMMT (Navi Mumbai Municipal Transport), KDMT (Kalyan- Dombivli Municipal Transport) and KMT (Khopoli Municipal Transport) 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.

NMMT has 3 Depots and buses runs on 70 routes daily. The number of operational buses under NMMT was 480 in the year 2016-17. NMMC has a fleet of both AC (82) and Non AC (398) buses in its inventory. Buses runs either on Diesel or CNG. As seen in Figure No. 9, NMMT had 90 more buses plying in 2016-17 (480) as compared to the previous year (390). As per the data records of NMMT, the average monthly earnings from passenger tickets is around INR 75 Lakhs. The distance travelled by buses per day is on an average 275.94 km. for both CNG and Diesel buses.

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.

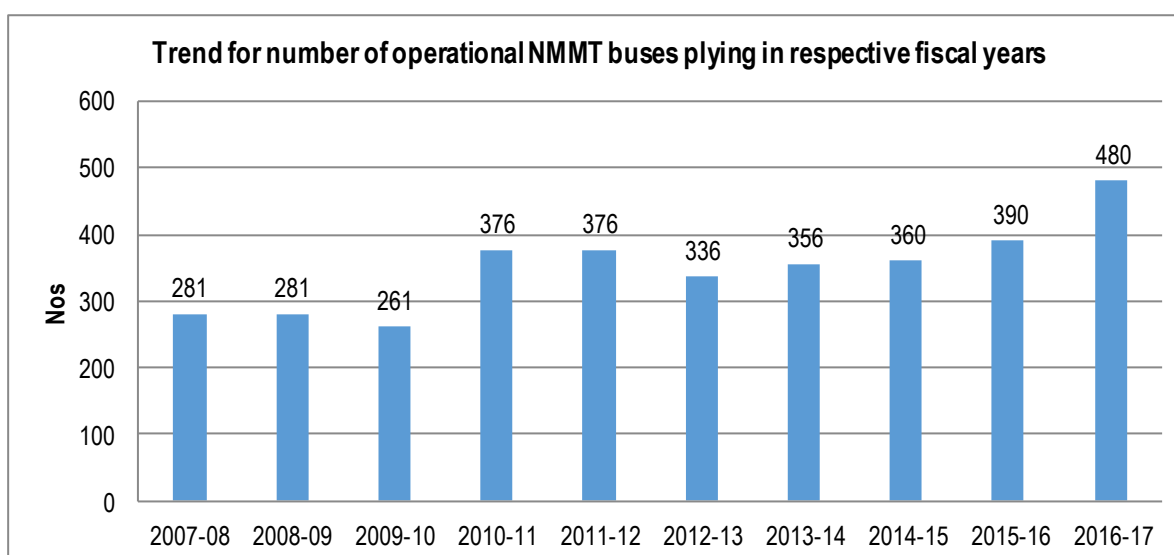


Figure No. 9: Trend for number of operational NMMT buses plying in respective fiscal years

Source: NMMT

⁵ <http://www.nmmconline.com/nmmt>

Drivers

All over the world, urban population is increasing after the industrial revolution. There is rapid migration of people from rural to urban areas for jobs and better living which has led to rapid urbanization globally. The convenience of access to goods, better education, employment, medical services, lifestyle, connectivity, employment opportunities and so on are some of the benefits of urban areas. Hence, the process of urbanization forms one of the most important dimensions of economic, social and physical change. However, urbanization is also a challenge which leads to variety of problems. Continuous influx of people from rural to urban areas creates pressure on natural resources like land and water. It also leads to pollution due to discharge of various untreated by products in water as well as air.

Due to urbanization, all developing countries including India is witnessing increasing levels of urban population. Indian urban population is increased from 17.9% to 33.14% in 2016 and the trend is rising continuously⁶. 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 2041⁷. 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 population of India has increased by more than 22% (181 million) during the decade 2001-2011⁸. In India, share of urban population has increased from 29.24% in 2005 to 32.75% in 2015 and is continuously increasing year on year⁹. The increase in population directly leads to increase in 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. 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 estimates the population of the city every year based on the survey data of the UHPs (Urban Health Posts) in NMMC. In the year 2016-17, the population of NMMC was estimated to be about 14,69,302 and registered a growth of about 1.4% as compared to 2015-16 (14,48,506). 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. 10.

⁶ <http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS?locations=IN>

⁷ Ministry of Statistics & Programme Implementation, Government of India, [Conference of Central and State Statistical Organisations \(COCSSO\)](#), page 6

⁸ http://censusindia.gov.in/2011-prov-results/data_files/india/pov_popu_total_presentation_2011.pdf

⁹ <https://www.statista.com/statistics/271312/urbanization-in-india/>

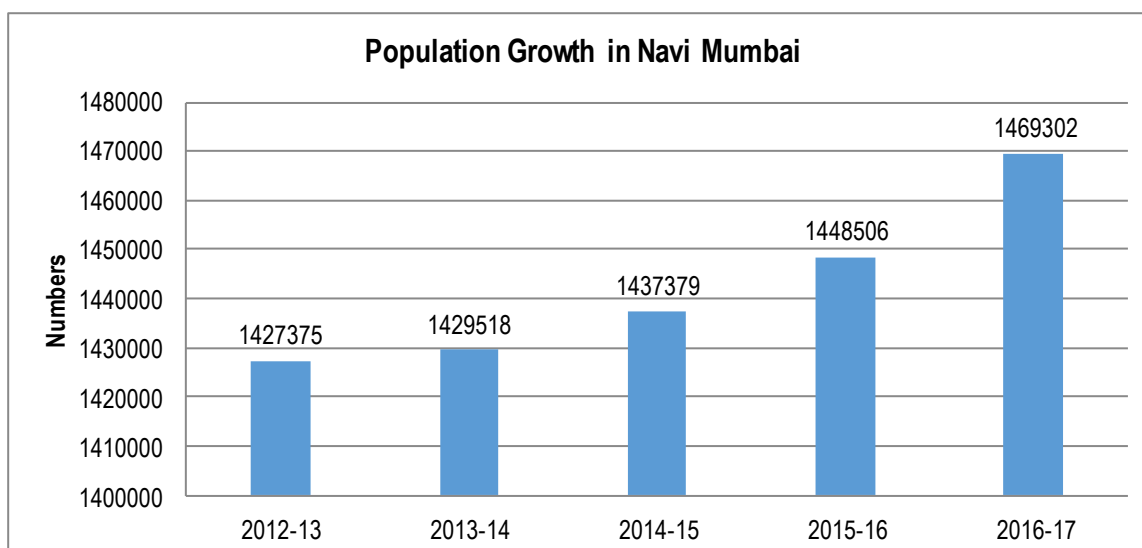


Figure No. 10: Population growth in Navi Mumbai

Source: UHP Survey, NMMC

Industrial and Commercial growth

The policy adopted by The Maharashtra Government lead to the development of an industrial area in Navi Mumbai which resulted in migration/re-location of people to Navi Mumbai for better lifestyle and job opportunities. Development of industrial belt in Navi Mumbai has led to rapid industrialization in the city which has been one of the prime economic driver for the city. About 16% of total area in Navi Mumbai falls under MIDC (Maharashtra Industrial Development Corporation) zone¹⁰. The city is also home to various educational institutes which offer variety of courses. Various MNC's (Multi-National Companies) have their offices/branches in the city which makes this city an attractive business destination. It has various recreational and public places which makes it an ideal city for living. The key industrial growth centres have been discussed below.

MIDC areas

The Trans Thane creek (TTC) Industrial area lies within the NMM C limits while the Talaja MIDC area lies in close proximity of NMMC area. The TTC industrial area accounts for more than 3000 industries while the Talaja 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 on¹¹.

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

¹⁰ <http://www.nmmconline.com/web/guest/land-usage>

¹¹ <http://www.tbiaindia.org/Industry.html>

establishments. Employments observed in CBD Belapur are around 32% while 37% jobs are IT-BPO establishments located in Vashi.¹²

Jawaharlal Nehru Port Trust

The Jawaharlal Nehru Port Trust, located within the Mumbai harbour on the west coast of India, was commissioned on 26th May 1989, is one of the most modern major ports in India. It is country's largest container port which handles around 60% of the country's containerized cargo. 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). As on 2016, it is connected with 34 Container Freight Stations (CFSs) and 46 Connected Inland Depots (ICDs). The port has handled 62.15 million tonnes of cargo in financial year 2016-17, out of which Containerized cargo constituted around 54.53 million tonnes, liquid cargo 6.78 million tonnes and remaining 0.84 million tonnes was of miscellaneous types of dry bulk cargo¹³.

APMC (Agriculture Produce Marketing Committee) market

The APMC market established at Vashi node of NMMC, spread across almost 8 hectares, is one of the biggest agricultural markets in Asia and has given a unique identity to the city. Agricultural produce from various parts of the country arrives at APMC which attracts a lot of wholesalers as well as retailers as it gets distributed to various suburbs of the city. Since 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 and Market -II for wholesale dealing of onion & potato and fruit & vegetable respectively whereas Phase-II has Market-I which is the commodity market and Market-II which is the grain, rice and oilseed market¹⁴.

CBD (Commercial Business Districts) of Belapur

CBD Belapur is a chief business district of Mumbai after Vashi, Bandra-Kurla Complex, Nariman Point and Worli. CBD Belapur houses several economic and government administrative and private companies' offices (including government offices and banks). Konkan Bhavan building houses several state government offices, like the Director of Town planning and Public Works Department.

The CGO (Central Government Office) Complex has offices of Chief Commissioner of Central Excise, Special Crime Branch, MTNL (Mahanagar Telephone Nigam Limited) and Court. Other government offices include Cotton Corporation of India Ltd and the headquarters of Konkan Railway. Various banks like The Reserve Bank of India, State Bank of India, Bank of India, Punjab National Bank, and Industrial Development Bank of India Limited and other nationalized banks have their presence here. CBD Belapur is home to several call centres, shipping companies, eateries, restaurants as well as educational institutions.

¹² http://www.cidco.maharashtra.gov.in/NM_Commercial_Infrastructure.aspx

¹³ <http://www.jnport.gov.in>

¹⁴ <http://www.navimumbai.com/apmc.aspx#>

IT parks at Airoli and Mahape

Navi Mumbai is also a major hub for corporate offices and multinational companies. It is one of the most preferred destination for booming IT industry. Mahape has the largest and modern state of the art Software Park called 'Millennium Business Park', spread over 20 lakh sq. Feet. Similarly, the 'Airoli Knowledge Park' is an ideal location for many IT and BPO companies due to its vicinity to Mumbai. Both these major IT parks are well connected by road and easily accessible from other major metropolis like Thane and Mumbai.

Malls & Retail Stores

There are adequate utility services, malls, retail shops, multiplexes in Navi Mumbai. Vashi is the leading node compared to others having big and famous malls like Centre One, Raghuleela mall and Inorbit mall which are the best shopping destinations with stores like CROMA Electronics, Pantaloons Fashion store, Food Bazaar, Shoppers stop and many more. There are 6 major operational malls in this zone. 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 and this year the Seawoods central station complex (Picture No. 6) has launched a mall facility with several brands and retails outlets.



Picture No. 6: The partially completed Seawoods Grand Central Station

Source: <https://az810817.vo.msecnd.net/data/LNTR Realty/images/projects/seawoods/img1-seawood.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 (245), Primary and Secondary schools (471),

Junior & Senior colleges (71), Engineering (9), Law colleges (3) and Medical (2) providing quality education in streams of Arts, Commerce and Science.

Urbanization and spatial growth

Due to better and modern infrastructure facilities, job opportunities, healthcare facilities, Navi Mumbai shows 1.4% increase in population in the year 2016-17 as compared to last year (2015-16). 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 almost 25% since 2009-10 as observed in Figure No. 11. For the current year 2016-17, the residential properties mark the highest recording 82% of total 3,07,710 properties. This is followed by commercial buildings with 17% share and MIDC commercial with least of 1% share.

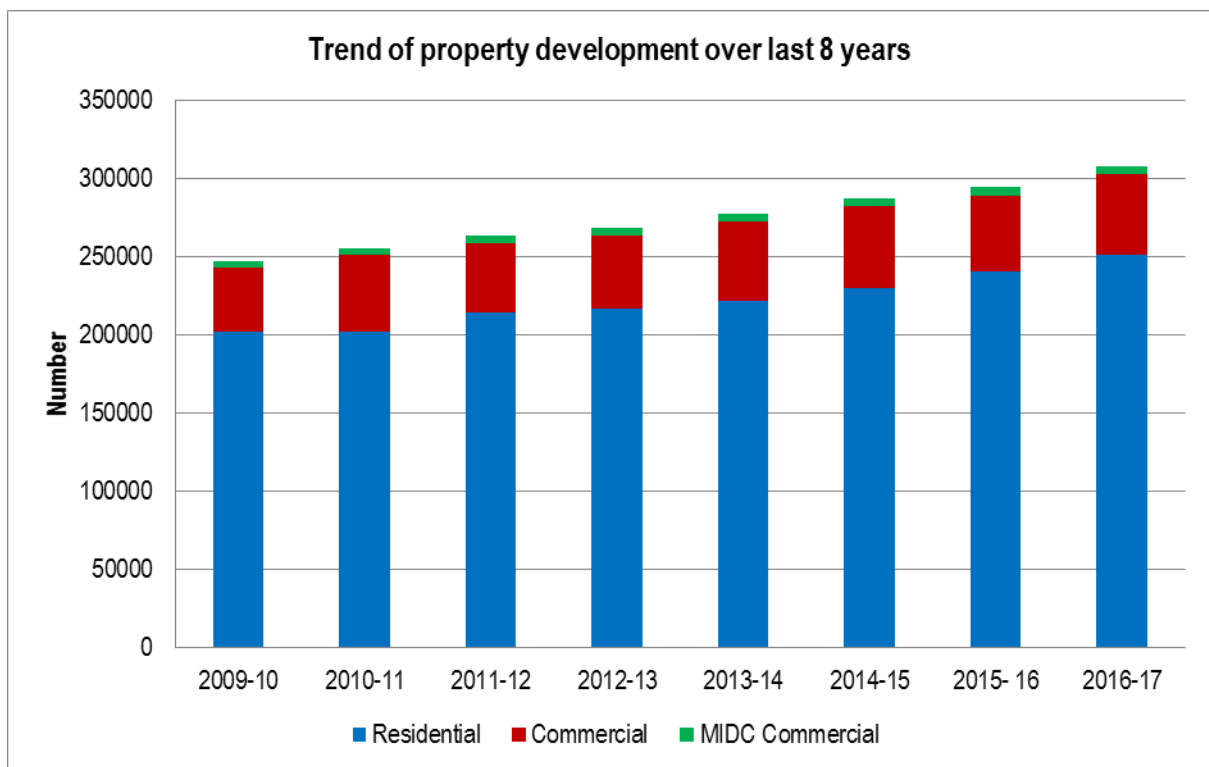


Figure No. 11: Trend of property development over last 8 years in Navi Mumbai
Source: Town Planning Department, NMMC

Air Quality

The Earth's atmosphere is a layer of gases surrounding the planet. This mixture of gases which envelopes the earth is commonly known as Air. The composition of pure air consists majorly of Nitrogen (78%) and Oxygen. (21%) while other gases like Argon, Carbon-dioxide, methane and so on are present in trace amounts. Any change in natural composition of air due to addition of undesirable elements arising from anthropogenic activities like combustion of fossil fuels. Emissions from Power plants, industries, automobiles, construction activities and so on emit tonnes of air pollutants (any solid, liquid or gaseous substance, including noise) in the atmosphere which deteriorates the air quality and expose citizens to great health risks. Higher concentrations of air pollutants may be or tend to be injurious to human beings or other living creatures or plants or property or environment¹⁵.

The Global Burden of Disease (GBD) stated about 4.2 million deaths due to exposure of PM_{2.5} (Particulate Matter <2.5 microns) have occurred thus ranking fifth for total deaths worldwide. In 2015, about 17.1% of deaths are occurred from ischemic heart disease, 14.2% from stroke, 16.5% from lung cancer, 24.7% from LRIs (Lower Respiratory tract Infections), and 27.1% from COPD (Chronic Obstructive Pulmonary Disease) were recorded due to exposure for Particulate Matter¹⁶. As per the WHO (World Health Organization), almost 80% of urban population are exposed to air quality which fails to meet the WHO guidelines thus resulting in respiratory disease and other health problems¹⁷.

Thus in order to monitor the air quality CPCB (Central Pollution Control Board) at national level 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. The following sections discusses the status of the network and the air quality thus recorded for various air pollutants and the pressures inducing air pollution.

Status

Air Quality Monitoring Network

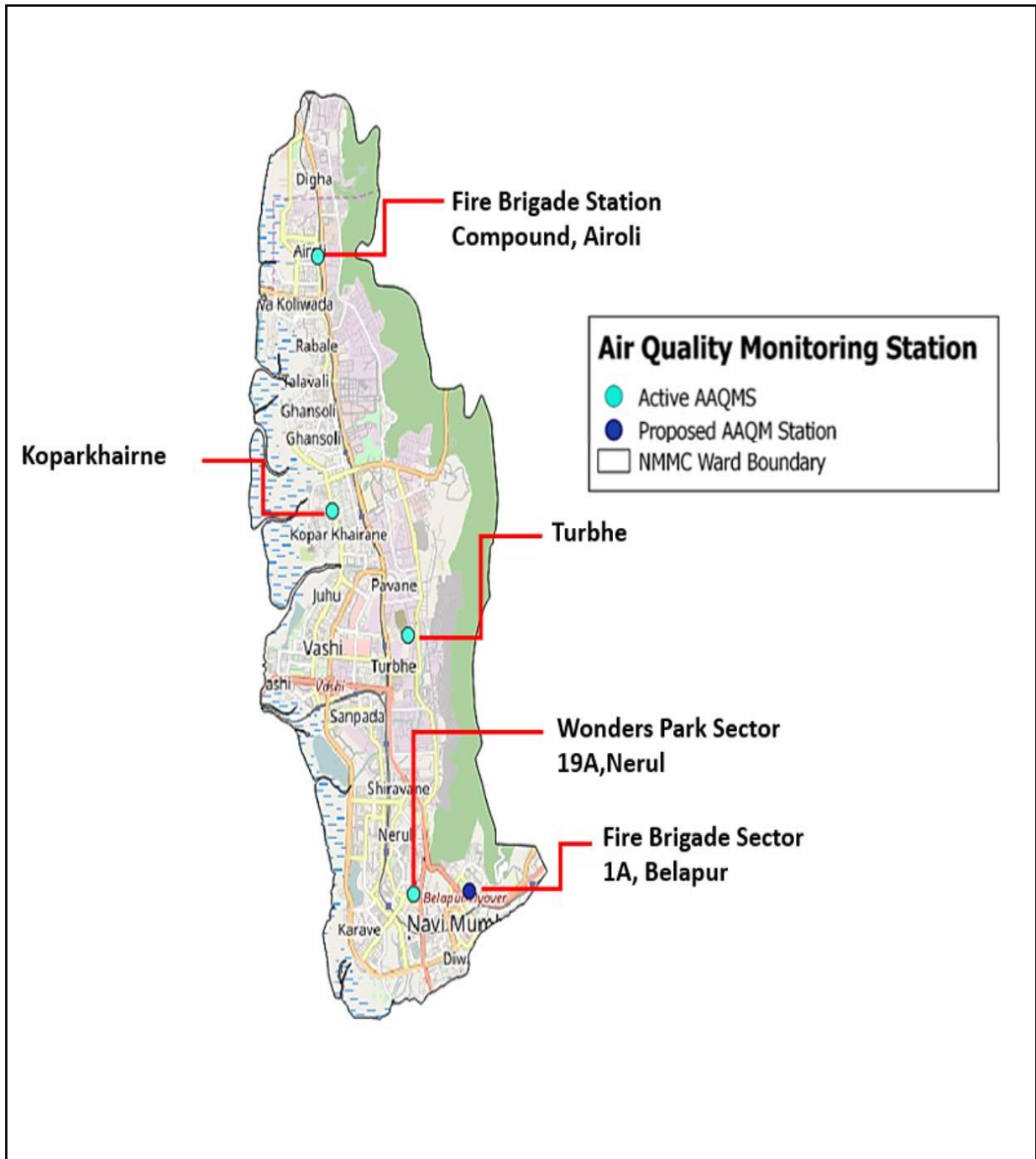
At present there are 4 CAAQMS (Continuous Ambient Air Monitoring Stations) installed at Airoli, Koparkhairane, Turbhe, and Nerul. NMMC has also proposed installation of a CAAQMS at CBD-Belapur. NMMC operates a mobile monitoring van which is deputed at various locations in the nodes of Navi Mumbai to monitor the air quality.

The tally of active ambient air quality monitoring stations and their spatial representation is depicted in Map No. 2. These AAQMS monitor various parameters like SO₂ (Sulphur-dioxide), NO_x (Oxides of Nitrogen), PM (Particulate Matter), Methane, CO (Carbon Monoxide) and so on.

¹⁵ <http://www.moef.nic.in/legis/air/air1.html>

¹⁶ [State of Global Air/2017](#), Institute for Health Metrics and Evaluation's Global Burden of Disease Project and the Health Effects Institute

¹⁷ <http://www.who.int/mediacentre/news/releases/2016/air-pollution-rising/en/>



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

Source: Environment Laboratory, NMMC

Trend in SO₂ concentrations

Sulfur dioxide is a highly toxic, colorless, nonflammable gas with a pungent odor. SO₂ belongs to sulfur oxides (SO_x) group. Among the oxides, SO₂ is of major concern related to human health as compared to other gases within the group. Sulfur dioxide (SO₂) is primarily emitted from anthropogenic sources like burning of fossil fuels by power plants and other industrial facilities as well as fuel combustion in mobile sources such as locomotives, ships, and other equipment^{18,19}As seen in Table No. 7 and Figure No. 12 the annual SO₂ concentrations for all the 3 continuous stations are well below the annual average standards for SO₂ (50µg/m³) as per NAAQS (National Ambient Air Quality Standards) set by CPCB. The SO₂ concentration levels in Koparkhairne is decreased by 1.3 times as compared to previous year 2015-16 which recorded 37.36 µg/m³. Similarly SO₂ concentration at Turbhe recorded a decrease by 1.2 times as compared to previous year (44.46 µg/m³).

Table No. 7. Yearly trend of concentration of SO₂ at CAAQMS in Navi Mumbai

| Year | Koparkhairne (µg/m ³) | Airoli (µg/m ³) | Vashi (µg/m ³) | Turbhe (µg/m ³) |
|-----------------|--------------------------------------|--------------------------------|-------------------------------|--------------------------------|
| Annual Standard | 50 | 50 | 50 | 50 |
| 2009-10 | | 23.05 | 53.60 | |
| 2010-11 | | 20.01 | 44.72 | |
| 2011-12 | 13.906 | 19.82 | 45.14 | |
| 2012-13 | 32.245 | 21.25 | 24.28 | 50.08 |
| 2013-14 | 20.3 | 22.00 | 31 | 45 |
| 2014-15 | 14.46 | 17.92 | Site shifting | 42.79 |
| 2015-16 | 37.36 | 26.05 | under process | 44.46 |
| 2016-17 | 28.84 | 25.50 | | 36.24 |

Source: Environmental Laboratory, NMMC

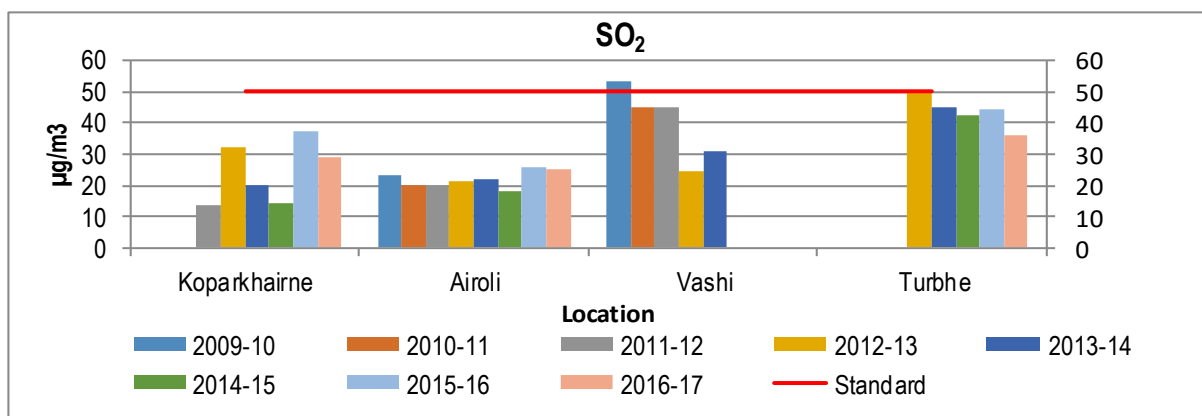


Figure No. 12: Yearly Trend in concentration of SO₂ at AAQMS in Navi Mumbai

Source: Environmental Laboratory, NMMC

Trend of NO_x concentrations

NO_x represents seven compounds (N₂O, NO, N₂O₂, N₂O₃, NO₂, N₂O₄ and N₂O₅). Among the NO_x family, NO₂ has adverse effect on human health since it causes lung disorders and also

¹⁸ <https://www.pca.state.mn.us/air/sulfur-dioxide>

¹⁹ <https://www.epa.gov/so2-pollution/sulfur-dioxide-basics>

acts as contributor in formation of secondary pollutants such as Ozone and acid rain. NO_x is majorly emitted from combustion of fuel automobiles and mobile sources (50%), electric power plants (20%) and other domestic usage (30%)²⁰.

From Table No. 8 and

Figure No. 13 it is observed that NO_x concentrations were found to be within permissible limit (40 µg/m³) in 2016-17 across all the CAAQMS. The No_x levels showed a decreasing trend at all locations. The NO_x levels at Koparkhairne has decreased almost twice the readings as compared to previous year 2015-16. Airoli lies on borderline recording 40 µg/m³ equal to standards.

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

| Year | Koparkhairne (µg/m ³) | Airoli (µg/m ³) | Vashi (µg/m ³) | Turbhe (µg/m ³) |
|-----------------|--------------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Annual Standard | 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 | Site shifting under process | 35 |
| 2015-16 | 57.40 | 42.35 | | 33.30 |
| 2016-17 | 27.72 | 39.74 | | 28.61 |

Source: Environmental Laboratory, NMMC

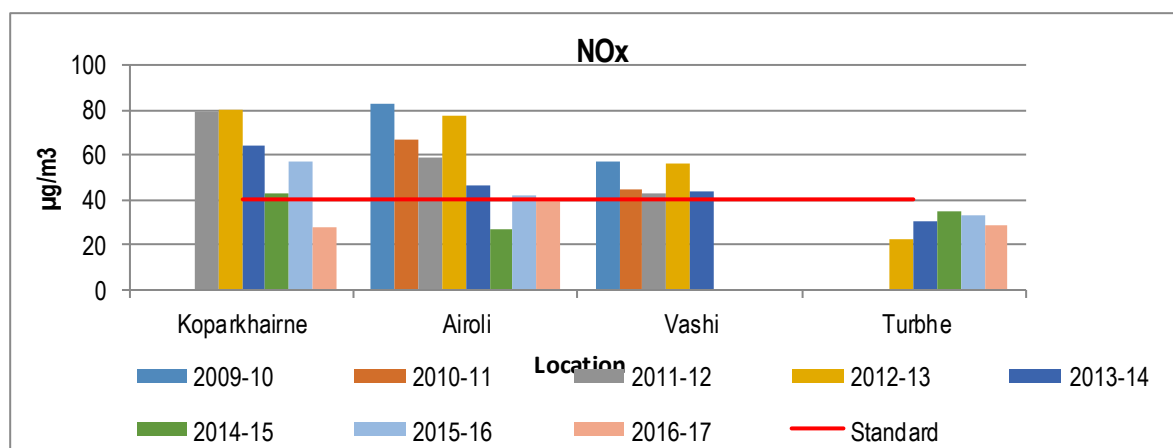


Figure No. 13: Yearly Trend in concentration of NO_x at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

Trend of PM₁₀ concentrations

Particulate matter, a complex mixture of extremely small particles and liquid droplets which are made up of a number of components, including acids (such as nitrates and sulfates), organic chemicals, metals, and soil or dust particles²¹. Particles that are 10 micrometers in diameter or smaller can pass through the throat and nose and enter the lungs and are

²⁰ <https://www3.epa.gov/ttn/catc1/dir1/fnoxdoc.pdf>

²¹ <https://www3.epa.gov/pm/>

commonly referred to as RSPM (Respirable Suspended Particulate Matter). Once inhaled, these particles can affect the heart and lungs and cause serious health effects.

It is observed that from Table No. 9 and

Figure No. 14 that levels of PM₁₀ exceeded the annual standard (60µg/m³) at Koparkhairne and Turbhe. Airoli showed PM₁₀ levels within the standard. The levels of PM₁₀ at Koparkhairne (99.44µg/m³) and Turbhe (97µg/m³) have decreased by 1.4 and 1.6 times respectively as compared to last year. The concentrations of PM₁₀ recorded at Airoli has decreased from 78.43 µg/m³ (2015-16) to 55.81 µg/m³ (2016-17). The decrease in concentration levels of PM₁₀ may be attributed to closure of quarries in Navi Mumbai region in 2016-17.

Table No. 9: Yearly trend in concentration of PM₁₀ at AAQMS in Navi Mumbai

| Year | Koparkhairne (µg/m ³) | Airoli (µg/m ³) | Vashi (µg/m ³) | Turbhe (µg/m ³) |
|-----------------|-----------------------------------|-----------------------------|--------------------------------|-----------------------------|
| Annual Standard | 60 | 60 | 60 | 60 |
| 2009-10 | | 154.26 | 96 | |
| 2010-11 | | 141.25 | 92 | |
| 2011-12 | 162.37 | 141.53 | 111 | |
| 2012-13 | 176.41 | 161.41 | 110 | 204.64 |
| 2013-14 | 135.53 | 74.60 | 108 | 151.2 |
| 2014-15 | 137.31 | 139.67 | Site shifting under process | 187.87 |
| 2015-16 | 138.62 | 78.43 | | 154.95 |
| 2016-17 | 99.44 | 55.81 | | 97.69 |

Source: Environmental Laboratory, NMMC

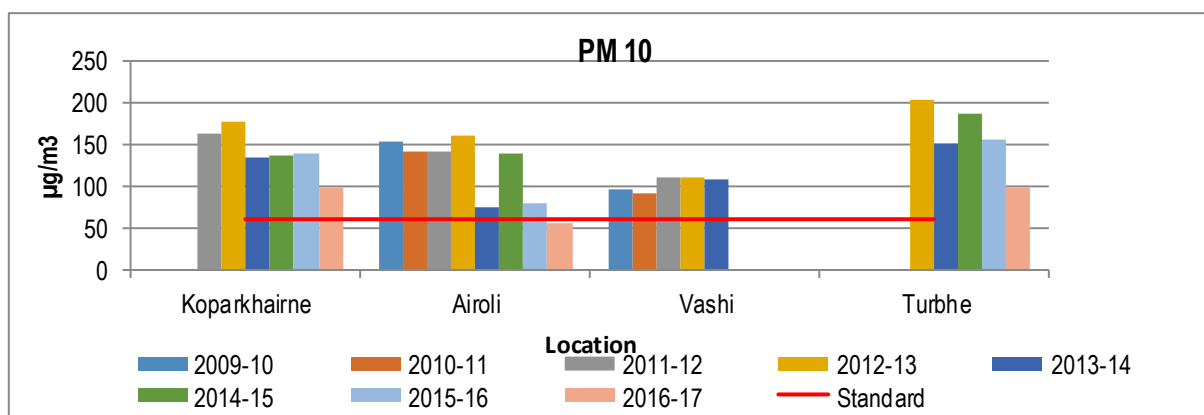


Figure No. 14: Yearly Trend in concentration of PM₁₀ at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

Trends in PM_{2.5} concentrations

PM_{2.5} is particulate matter of 2.5 micrometers in diameter, which is smaller - 1/30th the diameter of a human hair, which are emitted directly or formed secondarily in the atmosphere such as sulphates, nitrates and so on²².

From Table No. 10 and **Figure No. 15** PM_{2.5} levels in Navi Mumbai has violated the standards (40 µg/m³) at all regions except Airoli (24.03 µg/m³). The decreasing trend in PM_{2.5} levels is

²² <https://www3.epa.gov/pm/designations/basicinfo.htm>

observed over last 5 years. The concentrations of PM_{2.5} at Turbhe shows 1.3 times (49.79 µg/m³) decrease in concentration as compared to previous year (61.62 µg/m³). Similarly PM_{2.5} levels at Koparkhairne region have decreased from 61.62 µg/m³ (2015-16) to 40.92 µg/m³ (2016-17).

Table No. 10: Yearly trend in concentration of PM_{2.5} at AAQMS in Navi Mumbai

| Year | Koparkhairne (µg/m ³) | Airoli (µg/m ³) | Turbhe (µg/m ³) |
|-----------------|--------------------------------------|--------------------------------|-----------------------------|
| Annual Standard | 40 | 40 | 40 |
| 2009-10 | | 41.58 | |
| 2010-11 | | 39.38 | |
| 2011-12 | 78.40 | 33.11 | |
| 2012-13 | 74.89 | 50.46 | 71.16 |
| 2013-14 | 64.63 | 18.11 | 54.2 |
| 2014-15 | 63.98 | 42.82 | 71.57 |
| 2015-16 | 61.62 | 31.85 | 65.50 |
| 2016-17 | 40.92 | 24.03 | 49.79 |

Source: Environmental Laboratory, NMMC

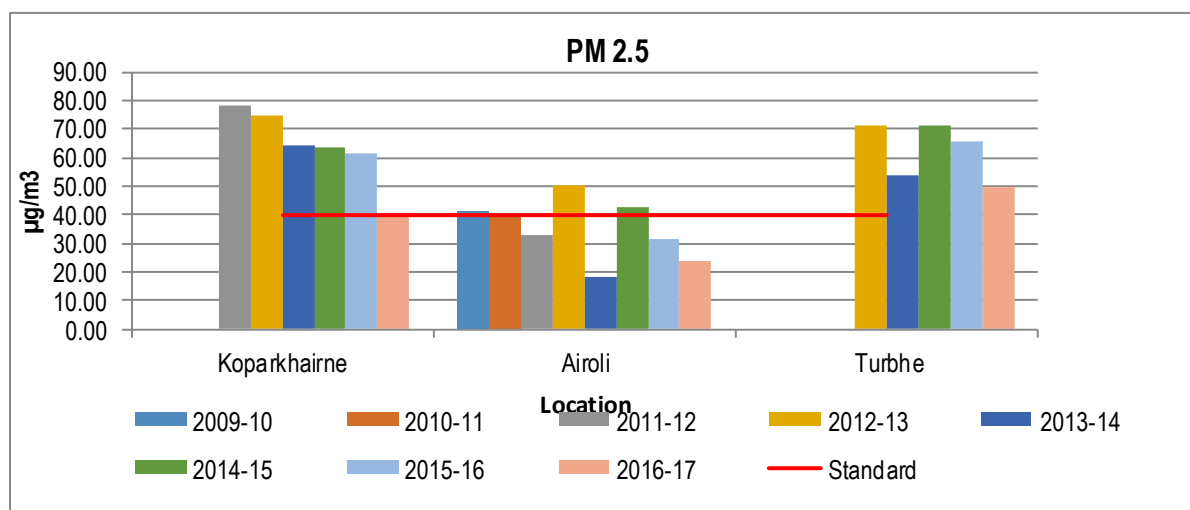


Figure No. 15: Yearly Trend in concentration of PM_{2.5} at AAQMS in Navi Mumbai

Source: Environment Laboratory, NMMC

Inter Station Analysis

SO₂

The interstation analysis for concentration of SO₂ presented in Figure No. 16 and

Table No. 11 indicates that the annual SO₂ concentrations at all the 3 stations are under the annual standards (50µg/m³). Even the 98th percentile values for daily concentrations were well below the daily standards (80µg/m³) at all 3 stations. Even though all the annual averages are well below the daily standards, the daily peak value at Turbhe is noted to be 80µg/m³ which is equal to annual standard.

Table No. 11: Concentration of SO₂ across NMMC region (2016-17)

| Row Labels | Max of SO ₂ | 98 Percentile | Average of SO ₂ | Min of SO ₂ | Daily Standard | Annual Standard |
|--------------|------------------------|---------------|----------------------------|------------------------|----------------|-----------------|
| Airoli | 43.03 | 41.54 | 25.50 | 7.8 | 80 | 50 |
| Koparkhairne | 68.24 | 58.26 | 28.84 | 0.46 | 80 | 50 |
| Turbhe | 80.60 | 73.12 | 36.24 | 0.8 | 80 | 50 |

Source: Environmental Laboratory, NMMC

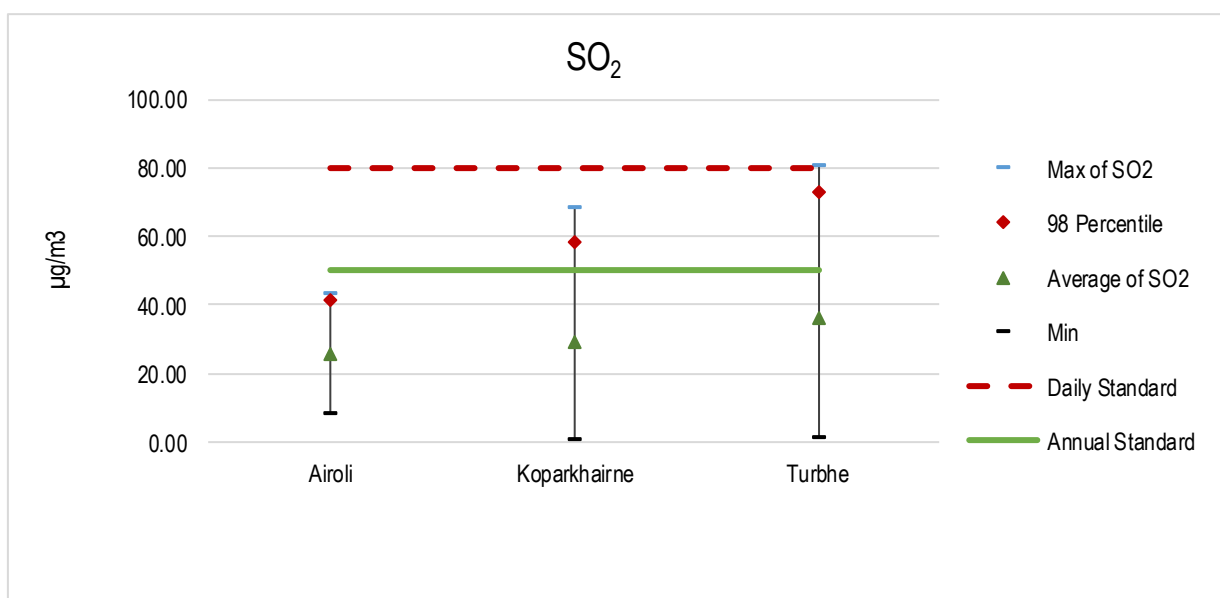


Figure No. 16: Concentration of SO₂ in NMMC region for the year 2016-17

Source: Environment Laboratory, NMMC

NO_x

The interstation analysis for concentration of NO_x displayed in **Table No. 12** and **Figure No. 17** indicate that all 3 stations are within the annual standard (40µg/m³). Even though the concentrations are within annual standard, the NO_x levels at Airoli lies on borderline (39.74 µg/m³) in 2016-17. Also the 98 percentile at Airoli violates the daily standard (80 µg/m³). The 98 percentile for Koparkhairne and Turbhe was recorded within the limit. Airoli station recorded the max of NO_x 93.05 µg/m³ which is 1.15 times the daily standard followed by Koparkhairne which recorded about 92.90 µg/m³. Turbhe was noted to be within the permissible limit in terms of daily and annual standard for NO_x levels.

Table No. 12: Concentration of NO_x across NMMC region (2016-17)

| Row Labels | Max of NO _x | 98 Percentile | Average of NO _x | Min | Daily Standard | Annual Standard |
|--------------|------------------------|---------------|----------------------------|------|----------------|-----------------|
| Airoli | 93.05 | 83.80 | 39.74 | 6.3 | 80 | 40 |
| Koparkhairne | 92.90 | 75.69 | 27.72 | 1.67 | 80 | 40 |
| Turbhe | 50.30 | 46.80 | 28.61 | 0.1 | 80 | 40 |

Source: Environment Laboratory, NMMC

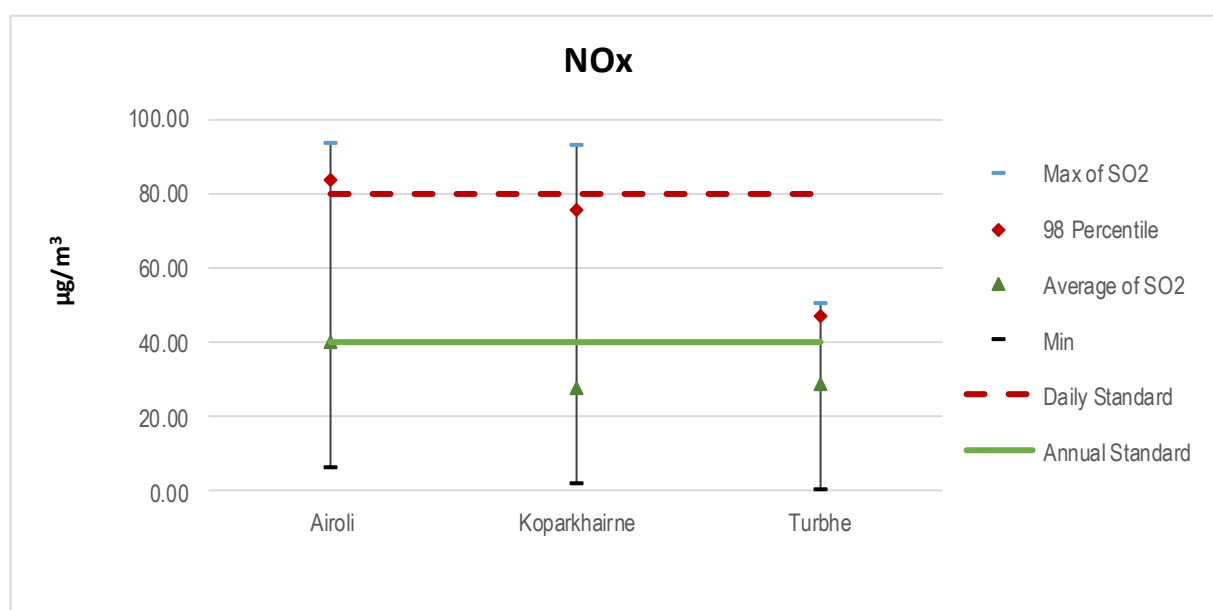


Figure No. 17: Concentration of NO_x in NMMC region for the year 2016-17

Source: Environment Laboratory, NMMC

PM_{2.5}

Table No. 13 and Figure No. 18 represents interstation analysis for concentration of PM_{2.5}. The analysis indicates that Turbhe (49.79 µg/m³) exceeds the annual standards of 40 µg/m³. Koparkhairane stations records 40.92 µg/m³ which slightly exceeds the annual limit. Airoli was noted to be in range in terms of annual standard. However the 98 percentile exceeded the daily standard 60 µg/m³ at all 3 locations. Turbhe recorded 129.61 µg/m³ which is almost double than the daily standard followed by 100.63 µg/m³ at Koparkhairane. Airoli recorded 69.42 µg/m³ slightly higher than daily standard.. This indicates rise in PM_{2.5} pollution due to traffic congestion within Navi Mumbai city.

Table No. 13: Concentration of PM_{2.5} across NMMC region (2015-16)

| Row Labels | Max of PM 2.5 | 98 Percentile | Avg of PM 2.5 | Min | Daily Standard | Annual Standard |
|--------------|---------------|---------------|---------------|------|----------------|-----------------|
| Airoli | 80.86 | 69.42 | 24.03 | 0.01 | 60 | 40 |
| Koparkhairne | 114.00 | 100.63 | 40.92 | 1.78 | 60 | 40 |
| Turbhe | 148.11 | 129.61 | 49.79 | 0.07 | 60 | 40 |

Source: Environment Laboratory, NMMC

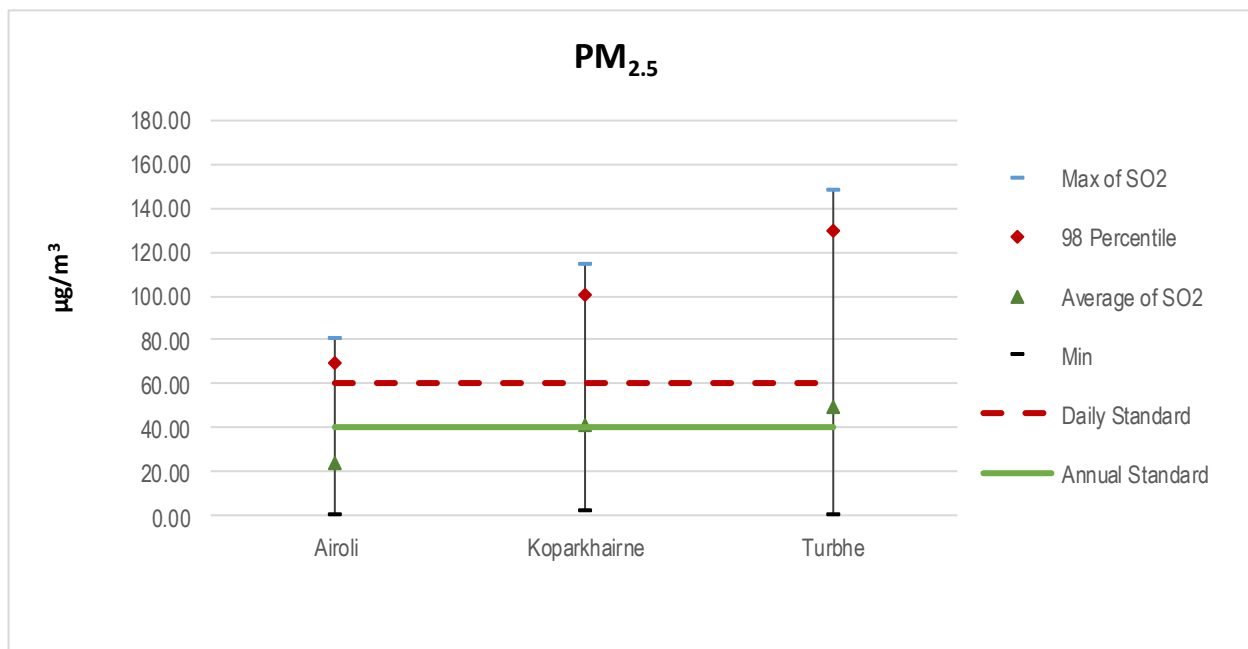


Figure No. 18: Concentration of PM_{2.5} in NMMC region for the year 2016-17

Source: Environment Laboratory, NMMC

PM₁₀

Table No. 14 and Figure No. 19 represents the interstation analysis for concentration of PM₁₀ in Navi Mumbai region. The annual average of PM₁₀ exceeds the annual standard limit (60 µg/m³) at all locations except at Airoli (55.81 µg/m³). The concentration of PM₁₀ was found to be highest at Koparkhairane (99.44 µg/m³) followed by Turbhe (97.69µg/m³). The 98percentile readings also exceeded the daily standards (100µg/m³) for all the stations except Airoli (96.58µg/m³). Koparkhairane stations recorded the 98th percentile value almost double (209.80µg/m³) the daily standard, followed by Turbhe which recorded daily maximum PM₁₀ concentrations of 198.16 µg/m³.

All the daily peak values for PM₁₀ were also highly exceeding the daily standards indicating serious threat of PM₁₀ pollution. The maximum reading was noted at Airoli (257.25 µg/m³) and Koparkhairne (257.25 µg/m³) which exceeded about 2.5 times the standard value followed by Turbhe (228.55 µg/m³) 2.3 times the daily standard.

Table No. 14: Concentration of PM₁₀ across NMMC region (2016-17)

| Row Labels | Max of PM 10 | 98 percentile | Avg of PM 10 | Min | Daily Standard | Annual Standard |
|--------------|--------------|---------------|--------------|-----|----------------|-----------------|
| Airoli | 257.25 | 96.58 | 55.81 | 1 | 100 | 60 |
| Koparkhairne | 257.25 | 209.80 | 99.44 | 11 | 100 | 60 |
| Turbhe | 228.55 | 198.16 | 97.69 | 8.8 | 100 | 60 |

Source: Environmental Laboratory, NMMC

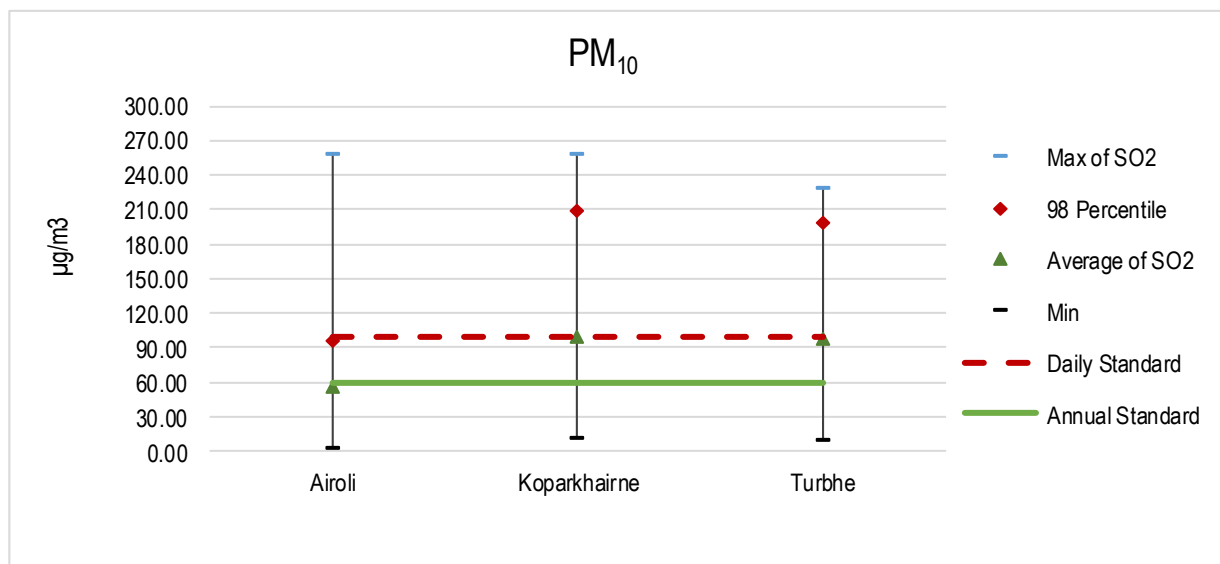


Figure No. 19: Concentration of PM₁₀ in NMMC region for the year 2016-17

Source: Environment Laboratory, NMMC

Carbon monoxide

It can be observed from **Figure No. 20** that Airoli and Koparkhairne violated the 8 hourly standards ($2\text{mg}/\text{m}^3$) of CO in certain months. The CO levels at Turbhe were seen within the standard limit. A seasonal pattern can be observed in the concentration of CO as recorded by all stations. The maximum 8 hourly CO concentration was recorded at Koparkhairne AAQMS followed by Airoli. Koparkhairne station has recorded the highest readings ($5.1\text{ mg}/\text{m}^3$ and $3.4\text{ mg}/\text{m}^3$) exceeding 2.5 times the standards in month of January. Airoli recorded highest reading in month of November ($3.18\text{ mg}/\text{m}^3$) which exceeds the standard. Turbhe recorded the CO levels in range of $0.2\text{ mg}/\text{m}^3$ to $2.0\text{ mg}/\text{m}^3$ throughout the year.

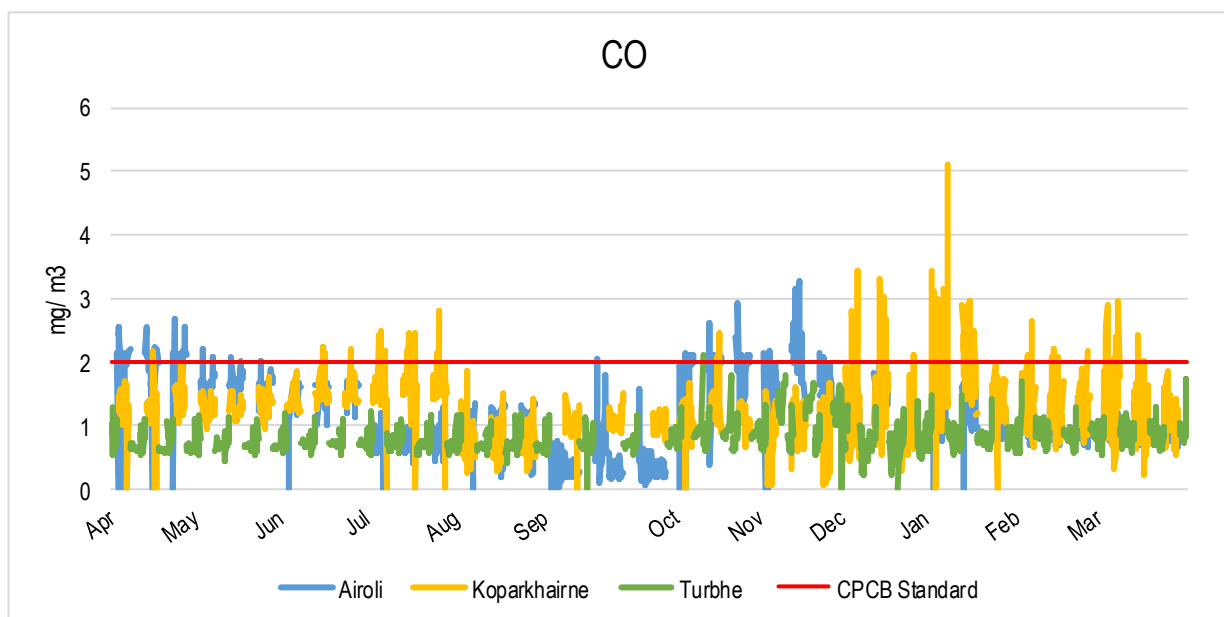


Figure No. 20: Concentration of CO in NMMC region for the year 2016-17

Source: Environment Laboratory, NMMC

Ozone

Navi Mumbai is non-polluted for ozone pollution as recorded by the station at Koparkhairane. It is clearly observed from Figure No. 21 that the ozone concentrations are well below the standards ($100\text{ }\mu\text{g}/\text{m}^3$) for all the months. Slight increase in the winter season (December to March) is observed in the concentrations of Ozone. The highest concentration of Ozone is observed in Month of February ($60.55\text{ }\mu\text{g}/\text{m}^3$).

Methane

The concentration of Methane recorded at 3 AAQMS namely Airoli, Koparkhairane and Turbhe are presented below in Figure No. 22. Turbhe has recorded highest methane concentration due to presence of landfill site as compared to Koparkhairane and Airoli. The average 8 hourly reading at Turbhe are recorded between 9- 10 ppm. The daily maximum value for Turbhe is recorded as 89 ppm.

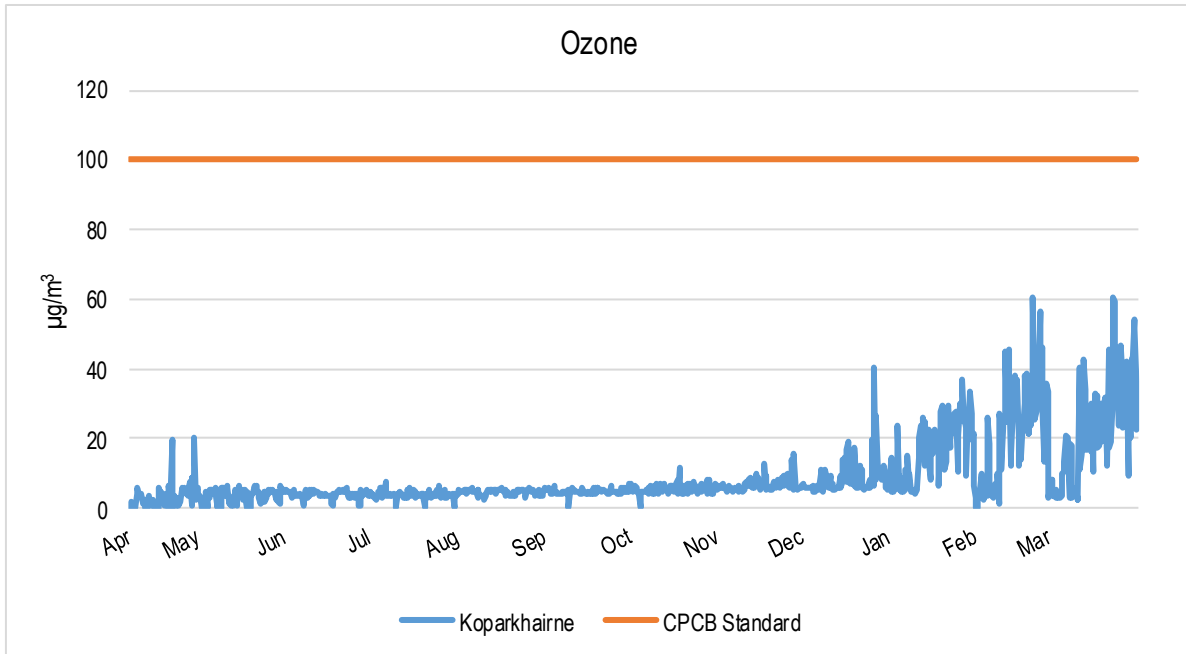


Figure No. 21: Concentration of Ozone in NMMC region for the year 2016-17

Source: Environment Laboratory, NMMC

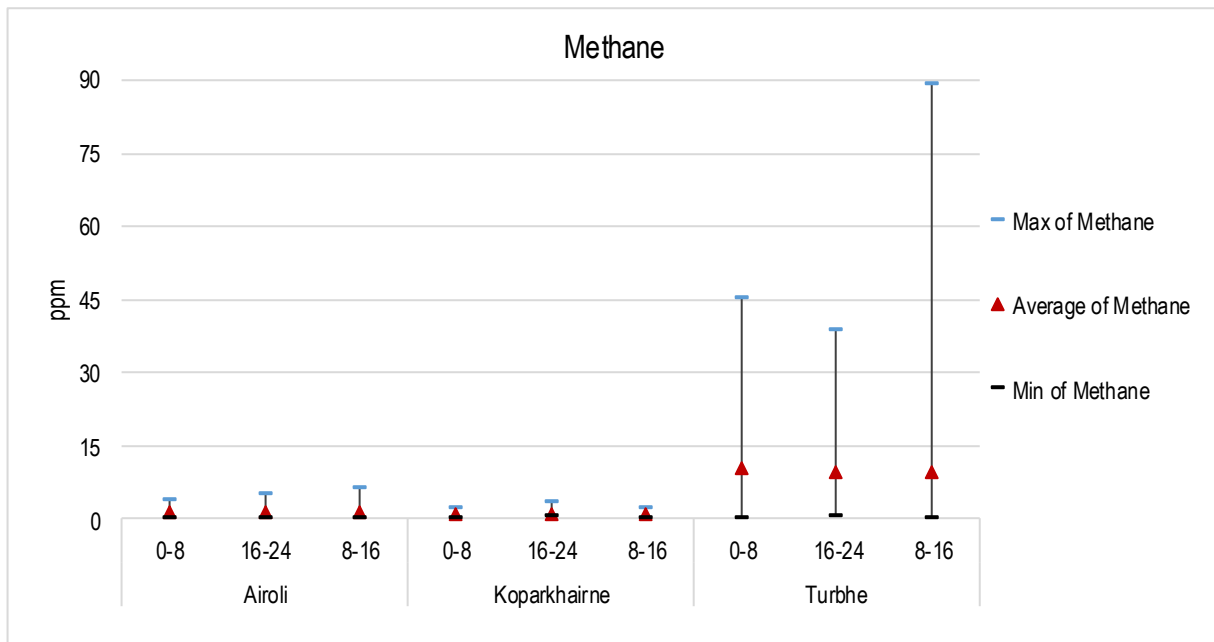


Figure No. 22: Concentration of Methane in NMMC region for the year 2016-17

Source: Environment Laboratory, NMMC

Air Quality Index

Air Quality Index (AQI) is the most convenient way to convey the information on outdoor air quality which could be easily understood by general public. AQI transforms complex air quality data of various pollutants into a single index value. Most of the AQI developed by various agencies are within a range of 0 to 500 and is categorized into Good, Satisfactory, Moderate, Poor, Very Poor or Severe based on the concentrations of various pollutants and their health impacts at various concentrations. Higher value of AQI indicates high level of pollution. The AQI for Navi Mumbai is based on calculation of AQI developed by CPCB²³.

From Figure No. 23, it is observed that Navi Mumbai is clean for NO_x, SO₂, CO and Ozone pollutants as all the observations are either in Good or Satisfactory category. Only 5-10% of observations were recorded under Moderate category. The regions of Turbhe and Koparkhairne were observed to be polluted under Moderate to Very poor category for particulate matter. 15% of observations were seen under Poor category followed by 3% under Severe category for PM_{2.5} (RSPM) more than 50% observation were noted under Moderate category for PM₁₀ (SPM). Airoli region was clean for all parameters throughout the year.

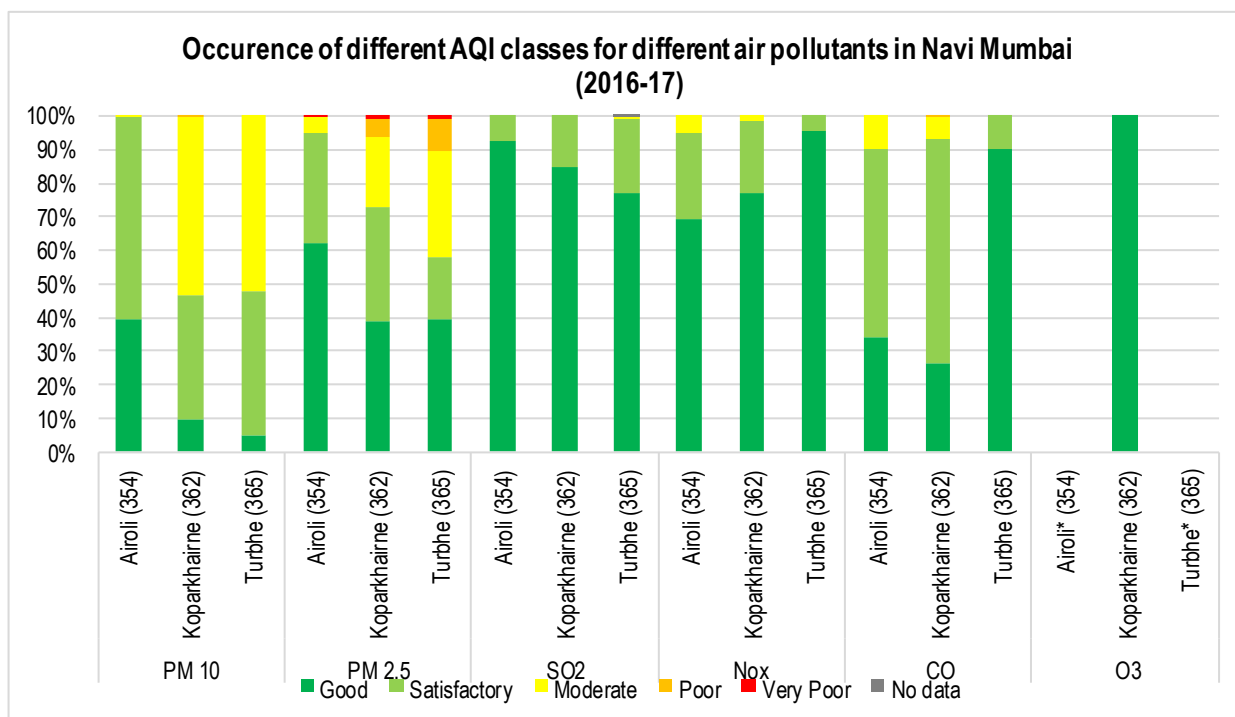


Figure No. 23: Occurrence of AQI classes for air pollutants in NMMC (2016-17)

Source: Environment Laboratory, NMMC

*Note: Ozone was not monitored at Airoli and Turbhe in 2016-17

²³ 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. 24, that almost all the readings from residential areas violated the day (55dB) time standards. The areas near Ghansoli ward office and Airoli ESR, Sector 18 & 19 recorded the highest average noise levels (63 db) followed by the area near Vashi Hospital, Sector 10 (61 db). The noise levels at Vashi Hospital, Sector 10 has increased by 6 % as compared to previous which recorded 58dB in 2015-16. The lowest reading was recorded in Agroli SCADA Control Panel, Belapur (57.5 dB).

All locations under commercial areas recorded within the day time standard (65 dB). The area near Juinagar ESR, Sector 11 recorded the highest average noise level (61 dB) followed by area near Turbhe MCH, Sector 22 (60 dB). The lowest average noise level was recorded at area near Nerul GSR Sector 21(57.60 dB).

The traffic zones recorded noise levels higher than the standard limits of residential area. The noise levels was recorded in range of 66-70 dB. The Digha Ward Office recorded the highest average noise level (70 dB) followed by Rabale Pump House and Belapur Fire Brigade (69 dB). The lowest noise level was recorded Vashi Ward Office, Juhugaon (66 dB)

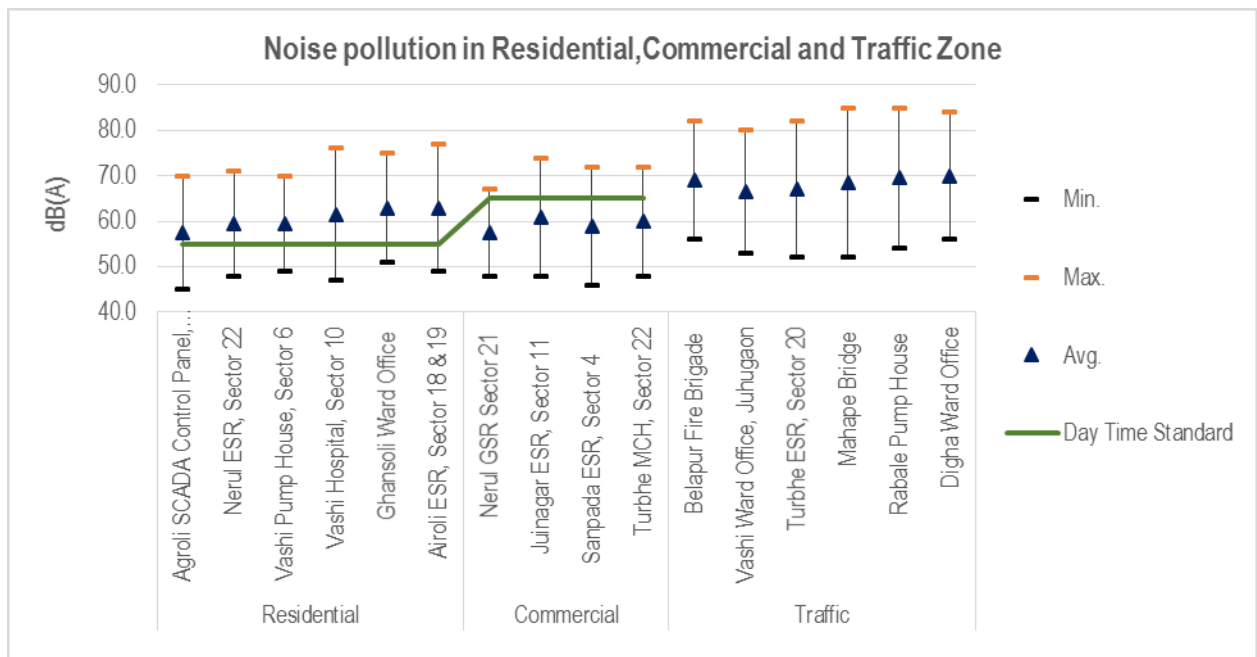


Figure No. 24: Level of noise pollution in various areas of Navi Mumbai

Source: Environment Laboratory, NMMC

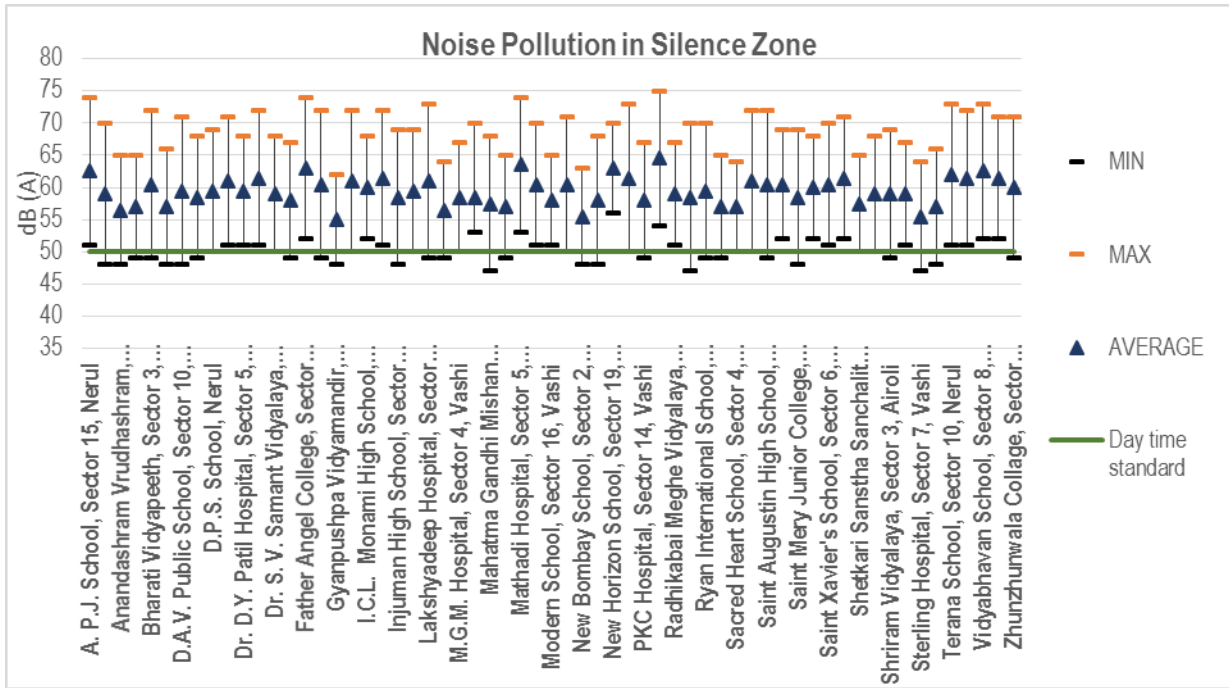


Figure No. 25: Level of noise pollution in silent areas NMMC area

Source: Environment Laboratory, NMMC

Figure No. 25 represents the silence zones in NMMC area. In the year 2016-17, all stations in silence zones under NMMC exceeded the average day standard limits of 50dB. R.F.Naik Vidyalaya, Sector 7, Koparkhairne recorded the highest average daily noise levels of 65dB. followed by Mathadi Hospital, Sector 5, Koparkhairne with average noise level of 64 dB. The lowest average noise level (55 dB.) was recorded at Gyanpushpa Vidyamandir, Sector 4, CBD Belapur.

Pressures

Vehicular Growth

As depicted in Figure No. 26 there has been a steady increase in number of registered vehicles. The overall vehicle population on road has increased by 41,387 (11%) as compared to previous year. The major growth (16%) is observed in number of Taxi/Auto rickshaws in the year 2016-17 .Decrease in number of Buses/Carriages (39%) 2 wheelers (7%) and 4 wheelers (3%) is noted in the current year 2016-17. The major decline in number of heavy vehicles is observed by 43% followed by number of buses (39%) as compared to previous year. The total number of vehicles registered in Navi Mumbai (Category wise) are presented in Annex -III

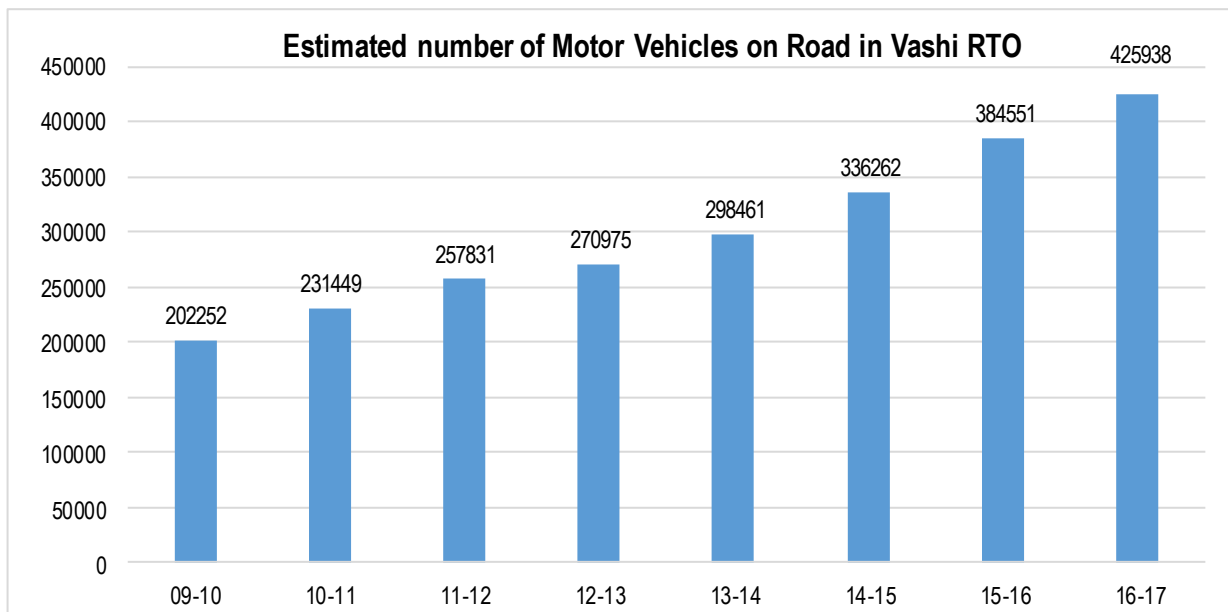


Figure No. 26: Estimated number of Motor Vehicles on Road in Vashi RTO

Source: RTO Publication 2016-17

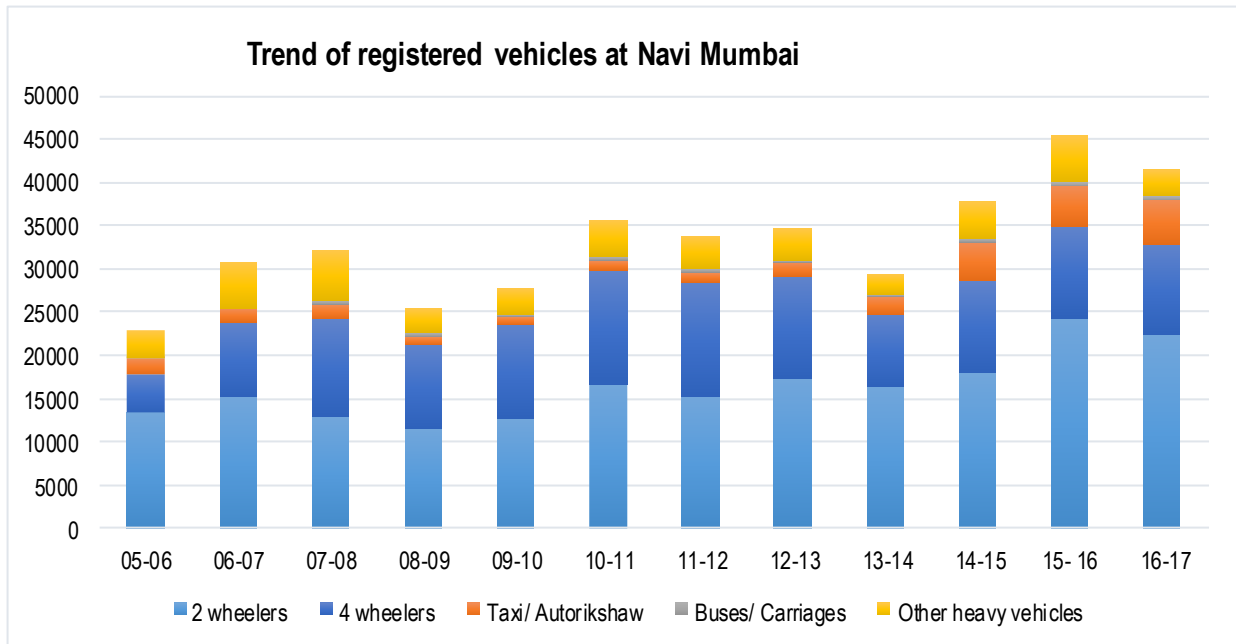


Figure No. 27: Decadal trend in annual vehicle registrations in Navi Mumbai

Source: RTO Publication 2016-17

Fuel consumption

Figure No. 28 represents the trend of fuel consumption within Navi Mumbai city. Motor Spirits (MS) commonly known as petrol, HSD are the commonly used fuels within the city. Due presence of TTC industrial belt within NMMC limits, there is huge demand for petroleum products like Furnace oil and HSD in industries too.

In 2016-17 the total petroleum sale within Navi Mumbai is noted to be around 78 thousand Kiloliters (KL). The sale in Navi Mumbai has grown by 37% as compared to previous year 2015-16. With only a slight dip in the year 2014-15, there has been an increasing trend in consumption of fuels in Navi Mumbai. In the year, the sale of HSD has increased by 57%, followed by MS and Furnace oil by 17% as compared to previous year. The decrease in LDO (Figure No. 29) is seen by 63% as compared to last year.

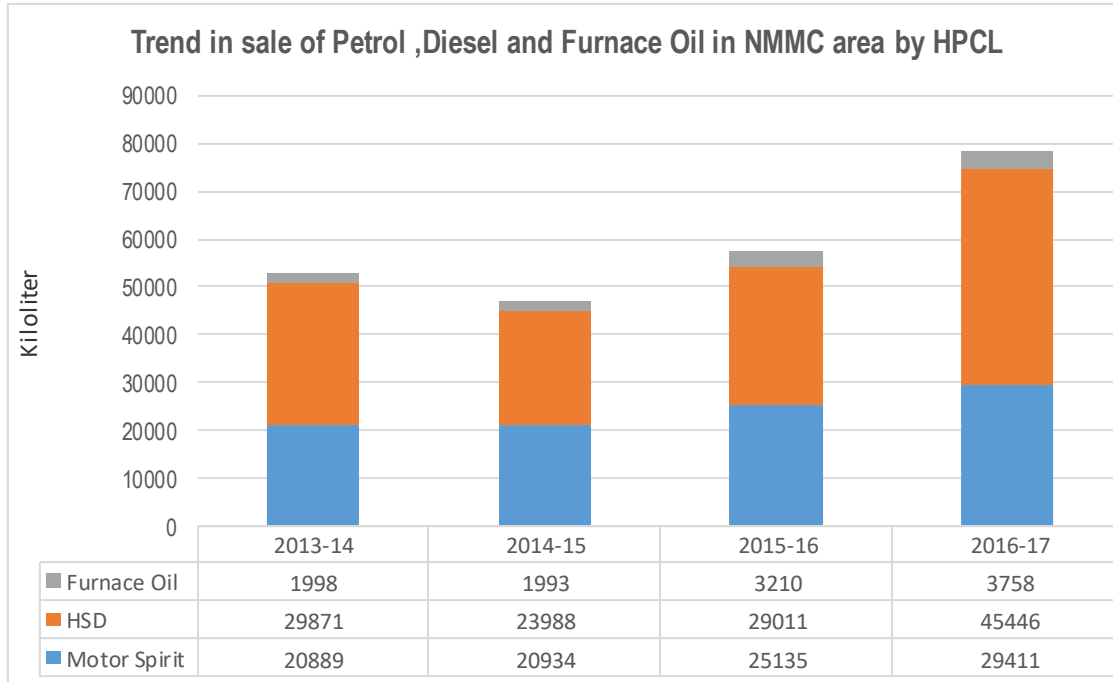


Figure No. 28: Trend in sale of Petrol, Diesel and Furnace Oil in NMMC area by HPCL

Source: HPCL

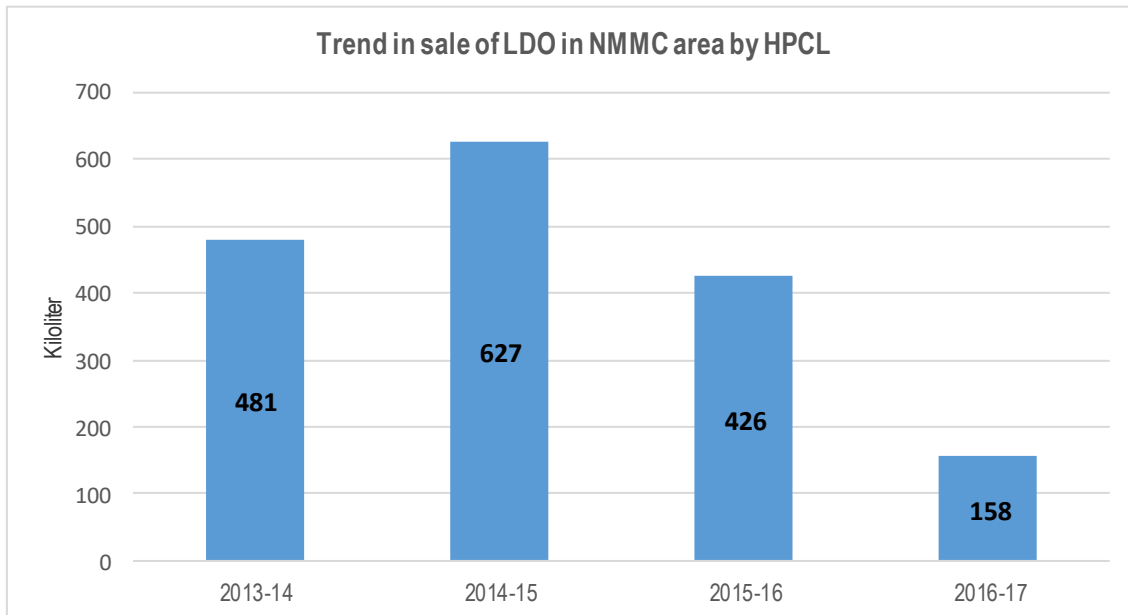


Figure No. 29 : Trend in sale of LDO in NMMC area in NMMC area by HPCL

Source: HPCL

Impact

Diseases caused by air pollution

Due to long term exposure to air pollution, 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 the Global Burden of Disease (GBD) that about 4.2 million deaths due to exposure of PM 2.5. About 17.1% of deaths are occurred from ischemic heart disease, 14.2% from stroke, 16.5% from lung cancer, 24.7% from LRIs, and 27.1% from Chronic Obstructive Pulmonary Disease (COPD) due to long exposure of Particulate Matter. Exposure to ambient ozone has also resulted in 254,000 deaths globally²⁴. As per WHO, India has about 15-20 million population suffering from asthma out of which 10% to 15% are noted in 5-11 year old children²⁵.

Hence monitoring of these diseases is an important to monitor the health status of the city. However data regarding the above mentioned diseases is unavailable. Thus 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.

Response and Initiatives

Measures taken by NMMC and MPCB to improve air quality within Navi Mumbai city are highlighted below:

Initiatives by NMMC

- NMMC has successfully completed the concretisation of the MIDC road has largely helped to reduce the issue of traffic congestion. The completion of work of Sion-Panvel highway has resulted in diverting a large amount of traffic from entering the city.
- Use of Sweeping machines for vacuum suction of dust/fine particles at Palm Beach road, Thane-Belapur and other major roads to reduce air pollutants.
- NMMC has installed timers at traffic signals which helps reduce idling period
- Number of quarries are closed which has resulted in decline of particulate matter within the Navi Mumbai municipal limits
- Online Display of Air quality index in public is installed by NMMC at four locations - Airoli (Fire Station), Turbhe (landfill Site), Koparkhairne (Teen Taki signal) & Nerul (Wonders park - managed by IITM).
- As response to MHA-USAID-UNIDO Partnership project on Developing Resilient Cities through Risk Reduction in context of Disaster and Climate change (2016-2020), Navi Mumbai in collaboration with IITM (SAFAR), Pune is implementing a pilot project on Strengthening early warning system for monitoring and disseminating air quality parameters and weather forecasts for stakeholders. This is first kind of initiative done by Government of India across the nation.
- As per the meeting held on 30th June 2017, the highlights of SAFAR project are listed below:

²⁴ [State of Global Air/2017](#), Institute for Health Metrics and Evaluation's Global Burden of Disease Project and the Health Effects Institute

²⁵ <http://www.who.int/mediacentre/factsheets/fs206/en/>

1. As per the project total 5-6 AAQMS are required to install in Navi Mumbai ,but in order to reduce the expenditure incurred in procuring Air Quality Monitoring Instruments existing 4 AAQMS are integrated into the SAFAR Project
2. New AQMS shall be installed in Belapur and two industrial areas.
3. At least one station for monitoring mercury shall be installed in Mahape, since it's an industrial belt.
4. Existing LED display boards over Railway Stations, NMMT Bus stands, for informing public about health status of the environment.

Initiatives by MPCB

Monitoring infrastructure

- Three AAQMS (Nerul, Rabale, Mahape) have been established by MPCB under NAMP (National Air Quality Monitoring Program). Installation of CAAQM station at Mahape is proposed by MPCB.
- Inventory of Hazardous air Pollutant emitting units along with LDAR (Leak detection & repair) system is maintained by MPCB. Total 16 industries identified as a Hazardous Air Pollutant emitting units out of which 10 industries have installed LDAR.
- MPCB has installed additional manual Ambient air monitoring station at MIDC Mahape for monitoring 12 parameters (Sulphur Dioxide, Nitrogen Dioxide, Particulate matter (PM₁₀), Particulate Matter (PM_{2.5}), Ozone, Lead, Carbon Monoxide, Ammonia, Benzene, Benzo(a)Pyrene(BaP), Arsenic and Nickel).
- All the bulk drug units in TTC MIDC have been directed to install VOC analyzer with alarm system by MPCB.
- Source emission monitoring from industries in CEPI (Comprehensive Environmental Pollution Index) Area is carried out by MPCB.

Air pollution control measures

- Stone quarries and crushing units were identified as one of main source for particulate matter as per a survey study was carried out by NEERI & IIT under MPCB²⁶. Post the survey action against 24 defaulting units, was taken out of which 19 stone crushers units have taken steps towards improvement of air pollution control system by installing dust suppression system, water sprinkling arrangement & metal road. All stone crusher units have installed water sprinkling system & cover the trucks during transportation of raw & finished material as recommended by MPCB.
- Around 69 industries in TTC industrial area have changed their fuel pattern to PNG (Piped Natural Gas) as fuel supplied by MGL (Mahanagar Gas Limited) and 22 more industries have already submitted their application for PNG connection.
- Proposal for installation of new CNG station is in consideration by the Mahanagar Gas in TTC MIDC Area to help promote usage of CNG fired vehicles
- Synchronize traffic line strategy for phase out old vehicles by RTO is recommended by MPCB.

²⁶ http://cpcb.nic.in/Progress_Report_Navi_Mumbai_Nov_2016.pdf

Water Resources

Earth is termed as 'Blue Planet' because 71% of the earth's surface is covered with water. The earth has an abundance of water yet majority of water (97.5%) is saline water. Out of remaining 2.5% of fresh water, around two thirds if it is in frozen form in ice caps and glaciers. Only about 0.3% of freshwater is available for human use majority of which comes from rivers²⁷. Water is one of the vital renewable resources on earth. Lakes, rivers, streams groundwater are important fresh water sources. The majority of freshwater is actually found underground as soil moisture and in aquifers. Water is required for our daily activities like drinking, cleaning, cooking and all industries require water for their operations. There are hydropower plants which utilize water for electricity generation. Water is having multiple benefits but due to ever increasing population and urbanization, pressure is increasing on this vital resource and problems like water shortage and water quality deterioration is arising. Hence, we must put more attention on saving and managing this source.

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)

NMMC area has 3 dams namely Hetawane, Barvi and Morbe in its vicinity. The NMMC gets its daily supply of water from Morbe dam, an earthen dam, on the Dhavri river (tributary of Patalganga river) near Khalapur, Raigad district. The height of the dam above lowest foundation is 194 ft. while the length is 11,220 ft. It covers the surface area of about 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. The salient features of Morbe dam is presented in Table No. 15.

Table No. 15: Specification 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 ⁴ m ³ |
| Surface area | 978 hectares |

Source: Central Water Commission²⁸

²⁷ <http://www.ngwa.org/Fundamentals/teachers/Pages/information-on-earth-water.aspx>

²⁸ <http://www.cwc.nic.in/main/downloads/National%20Register%20of%20Large%20Dams%202009.pdf>

NMMC daily monitors the water quality of the raw as well as treated water before it is supplied to the city. The raw water is initially pumped from the dam to the water treatment plant situated at Bhokarpada. 0.2mg/l chlorine is used as a disinfectant and added at source as well as at water treatment plant. 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 | |
|--------|------------------------|-------|------------------------|--------------------|---|--------------------|
| | | | | | Desirable Limits | Permissible Limits |
| 1 | Physical Appearance | | Clear | Clear | | |
| 2 | Odour | | Odourless | Odourless | Agreeable | Agreeable |
| 3 | Turbidity | N.T.U | 2.4 | 0.5 | 1 | 5 |
| 4 | pH Value | | 7.1 | 7.2 | 6.5 to 8.5 | No relaxation |
| 5 | Free Residual Chlorine | mg/l | nil | 0.8 | 0.2 | 1.0 |

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

Lakes and ponds

Lakes and ponds are of importance because of their extent of utilization. These can be used as a popular recreational spot or even as a source of fresh water. Lakes and ponds not only support biodiversity but also helps regulate the processes of soil formation, groundwater recharge and flood protection. Within NMMC, there are total 24 lakes with varying capacities and account to a total coverage area of 2.23 Lakh sq.m. The Belapur node has 5 lakes, maximum number amongst all nodes, and accounts around 28% of the lake area share in NMMC jurisdiction. This is followed by Ghansoli node with 25% of share area and has 4 lakes within the node. The Gothivali Lake in Ghansoli is the biggest lake and has a 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/Pond | 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 (Table No. 18 and Table No. 19). On analysing the samples it is observed that the pH levels for all the lakes are well within the limits. The concentrations of suspended solids at Vashigaon Lake (315mg/l) was found almost triple than the permissible limit (100 mg/l) while Shirvane lake (111mg/l) and Savalogaon lake (112mg/l) also recorded suspended solids concentrations higher than the permissible limit. The dissolved oxygen (DO) level was found to be slightly high (7.2 mg/l) in Diva Lake, Talvali Lake (7.2mg/l), Sanpada (7.5mg/l) and Koparkhairne (7.7mg/l) compared to the limits (4 - 7mg/l). Vashigaon (1198.97mg/l) showed higher Sulphate amount than the permissible limit (<1000mg/l). Total Dissolved Solids (TDS) level was found to be within the permissible limit in all lakes and none of the lakes exceeded the standard for B.O.D, C.O.D, Nitrate, Nitrite, Phosphate, Chloride, and Hardness. These tests indicates that the overall quality of the lakes are good in Navi Mumbai.

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

| Node | Name of Lake | PH | S.S (mg/l) | TDS (mg/l) | D.O (mg/l) | B.O.D (mg/l) | C.O.D (mg/l) |
|--------------|--------------------|---------|---------------|---------------|---------------|-----------------|-----------------|
| | | 5.5-9.0 | <100 | <2100 | 4.0-7.0 | <100 | <250 |
| Airoli | Airoli Naka | 7.3 | 62 | 591 | 5.1 | 11 | 67 |
| | Divra | 7.4 | 43 | 976 | 7.2 | 8 | 97 |
| Belapur | Belapur | 7.5 | 30 | 453 | 5.9 | 7 | 91 |
| | Darave | 7.3 | 76 | 884 | 5.3 | 6 | 78 |
| | Karave | 7.4 | 63 | 550 | 5.4 | 4 | 44 |
| | Killegaonthan | 7.6 | 38 | 460 | 5.6 | 3 | 32 |
| | Agroli | 7.5 | 51 | 837 | 5.6 | 3 | 43 |
| Digha | Khokad | 7.2 | 42 | 718 | 6.1 | 4 | 29 |
| Ghansoli | Rabada | 7.3 | 46 | 884 | 6.2 | 5 | 42 |
| | Gumali | 7.3 | 59 | 728 | 5.4 | 5 | 62 |
| | Talvali | 7.4 | 59 | 662 | 7.2 | 8 | 73 |
| | Gothivali | 7.4 | 36 | 356 | 4.5 | 8 | 77 |
| Nerul | Nerul Sector 20 | 7.3 | 55 | 814 | 5.4 | 6 | 70 |
| | Shirvane | 7.4 | 111 | 1227 | 4.7 | 4 | 60 |
| Turbhe | Turbhegaon | 7.3 | 93 | 868 | 5.5 | 4 | 55 |
| | Sanpada | 7.3 | 61 | 479 | 7.5 | 9 | 52 |
| Vashi | Vashigaon | 7.3 | 315 | 1743 | 5.6 | 8 | 67 |
| | Juhugaon | 7.3 | 53 | 603 | 3.3 | 13 | 58 |
| Koparkhairne | Koparkhairne | 7.5 | 71 | 317 | 6.9 | 6 | 97 |
| | Khairne | 7.5 | 79 | 328 | 6.5 | 6 | 50 |
| | Savaligaon(Kopari) | 7.5 | 112 | 1116 | 7.7 | 15 | 129 |
| | Bonkode | 7.3 | 67 | 953 | 3.8 | 4 | 56 |
| | Mahapegaon | 7.0 | 63 | 730 | 6.4 | 9 | 43 |

Source: Environmental Laboratory, NMMC

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

| Node | Name of Lake | Nitrate (mg/l) | Nitrite (mg/l) | Phosphate (mg/l) | Chloride (mg/l) | Hardness (mg/l) | Sulphate (mg/l) |
|--------------|--------------------|-------------------|-------------------|---------------------|--------------------|--------------------|--------------------|
| | | <45 | | <5 | <1000 | - | <1000 |
| Airoli | Airoli Naka | 3.127 | 3.450 | 0.414 | 54.93 | 380 | 227.24 |
| | Diva | 4.305 | 0.251 | 0.390 | 102.18 | 285 | 223.05 |
| Belapur | Belapur | 1.736 | 1.101 | 0.302 | 70.28 | 188 | 175.43 |
| | Darave | 3.006 | 1.740 | 0.335 | 72.74 | 445 | 441.28 |
| | Karave | 2.250 | 0.248 | 0.250 | 68.74 | 188 | 271.14 |
| | Killegaonthan | 1.222 | 0.024 | 0.437 | 40.38 | 155 | 109.19 |
| | Agroli | 2.764 | 0.546 | 0.209 | 35.53 | 343 | 407.19 |
| Digha | Khokad | 2.273 | 0.303 | 0.318 | 59.25 | 288 | 348.82 |
| Ghansoli | Rabada | 5.083 | 0.122 | 0.341 | 112.68 | 308 | 344.19 |
| | Gumali | 0.690 | 1.021 | 0.326 | 71.18 | 280 | 244.90 |
| | Talvali | 2.997 | 0.590 | 0.386 | 90.82 | 236 | 203.87 |
| | Gothivali | 1.864 | 0.322 | 0.595 | 59.26 | 153 | 131.90 |
| Nerul | Nerul Sector 20 | 2.872 | 0.030 | 0.292 | 51.71 | 414 | 344.90 |
| | Shirvane | 2.691 | 2.510 | 0.268 | 87.33 | 733 | 485.48 |
| Turbhe | Turbhegaon | 3.233 | 1.857 | 0.246 | 37.95 | 496 | 429.45 |
| | Sanpada | 2.900 | 1.269 | 0.218 | 33.98 | 210 | 357.43 |
| Vashi | Vashigaon | 2.665 | 0.079 | 0.162 | 43.66 | 816 | 1198.97 |
| | Juhugaon | 1.097 | 2.069 | 0.866 | 66.23 | 190 | 182.19 |
| Koparkhairne | Koparkhairne | 1.875 | 0.147 | 0.291 | 46.87 | 130 | 85.19 |
| | Khairne | 1.796 | 1.565 | 0.218 | 72.72 | 188 | 86.33 |
| | Savaligaon(Kopari) | 3.123 | 0.032 | 0.344 | 174.35 | 475 | 389.32 |
| | Bonkode | 3.436 | 4.666 | 0.170 | 53.81 | 350 | 235.81 |
| | Mahapegaon | 3.356 | 1.664 | 0.171 | 110.28 | 308 | 265.32 |

Source: Environmental Laboratory, NMMC

Creek

NMMC monitors creek water and has setup monitoring stations at 6 different locations (Map No. 3). The annual average water quality of creek in NMMC area is tabulated below in Table No. 20. From the annual average values for the water quality tests, it is found that the creek water from all 6 locations has very high levels of chlorides. All the readings from creek water samples have violated the limits for chloride (<600 mg/l) by more than 12 times. This has led to reduction in oxygen levels in the creek ecosystem which is clearly reflected from the low DO (Dissolved Oxygen) levels in the water samples at Nerul Palm beach road (0.4 mg/l), Sanpada (3.4 mg/l) and Koparkhairne (1.4 mg/l). Except Nerul Palm beach road location, all other locations shows BOD more than the permissible limit. Creek near Koparkhairne shows the highest reading for BOD (181 mg/l) than the permissible limit (<100 mg/l). Thus the creek water is in a polluted state in Navi Mumbai.

Ground Water

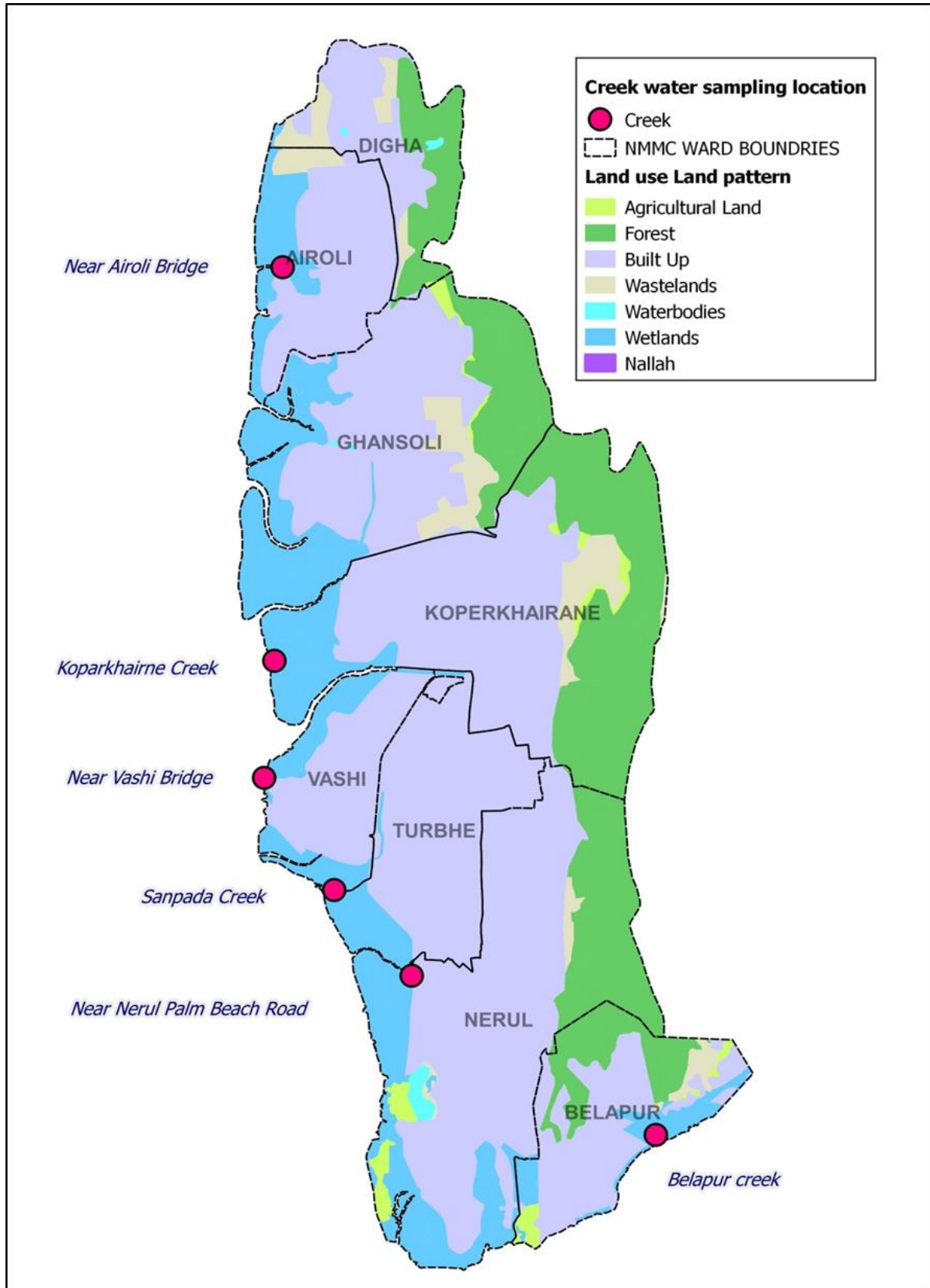
Due to well-planned and established chain of water supply, the dependence of the NMMC region on ground water table for its daily activities is low compared to other regions. NMMC performs regular analysis and monitors the quantity of various parameters like pH, DO, BOD, residual chlorine, hardness, sulphate and faecal coliform. In the year 2016-17, NMMC conducted water quality test for around 22 wells in NMMC area (Table No. 21). 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. Water quality was also identified for the borewell present at the Landfill site at Turbhe (Table No. 17). It readings indicate all the parameters are well between the limits but detects the presence of coliform.

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

| Location | Parameters | | | | | | | |
|----------------------------|------------|--------------|--------------|---------------|---------------|-------------------|---------------------|--------------------|
| | pH | SS (mg/l) | DO (mg/l) | BOD (mg/l) | TKN (mg/l) | Nitrate (mg/l) | Phosphate (mg/l) | Chloride (mg/l) |
| Limits | 5.5-9.0 | <100 | 4.0-7.0 | <100 | <5 | | <45 | <600 |
| Belapur | 7.0 | 552 | 4.3 | 107 | 15.978 | 3.051 | 2.497 | 7732.92 |
| Near Nerul Palm Beach Road | 7.0 | 716 | 0.4 | 94 | 16.521 | 3.142 | 1.672 | 7392.34 |
| Near Vashi Bridge | 6.7 | 1230 | 5.2 | 154 | 10.163 | 3.555 | 0.252 | 16524.05 |
| Sanpada | 6.8 | 1032 | 3.4 | 166 | 13.804 | 3.038 | 0.179 | 15076.60 |
| Koparkhairne | 7.0 | 517 | 1.4 | 181 | 9.828 | 3.647 | 1.407 | 7712.93 |
| Near Airoli Bridge | 6.8 | 802 | 4.5 | 107 | 11.012 | 4.765 | 2.271 | 10902.47 |

Source: Environmental Laboratory, NMMC

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



Source: Environment Laboratory, NMMC

Table No. 21: Well water quality recorded in NMMC area in 2016-17

| Sr. No. | Location | PARAMETERS | | | | | | | | | | | |
|---------|---|------------|-----------|-------------------|--------|--------|--------|----------|----------|----------|-------------------|--------|--------|
| | | pH | Turbidity | Residual Chlorine | DO | BOD | CO D | Chloride | Hardness | Sulphate | MPN Count /100 ml | E.Coli | F.Coli |
| | | | NTU | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | | | |
| 1 | Agroligaon, Sector 29 | 7.3 | 0.00 | Nil | 4.5 | 25 | 61 | 38.92 | 450 | 380.90 | 23 | +ve | +ve |
| 2 | Shahabazgaon, Sector 19 | 7.2 | 0.00 | Nil | 2.2 | 5 | 20 | 58.39 | 220 | 116.76 | 23 | +ve | +ve |
| 3 | Shiravane, Sector 1, Nerul | 7.5 | 0.00 | Nil | 3.5 | 5 | 20 | 25.95 | 80 | 48.95 | 23 | +ve | +ve |
| 4 | Sarsole, Sector 6, Nerul | 7.0 | 7.70 | Nil | 2.4 | 19 | 40 | 51.90 | 270 | 67.80 | 23 | +ve | +ve |
| 5 | Karavegaon, Near Lake, Nerul | 7.3 | 0.00 | Nil | 2.4 | 11 | 51 | 64.87 | 120 | 62.47 | 23 | +ve | +ve |
| 6 | Daravegaon, Sector 23, Nerul | 7.3 | 0.00 | Nil | 3.5 | 6.0 | 20 | 51.90 | 200 | 80.38 | 23 | +ve | +ve |
| 7 | Turbhegaon, Sector 21 | 6.7 | 0.00 | Nil | 4.7 | 28 | 71 | 194.62 | 750 | 476.19 | 23 | +ve | +ve |
| 8 | Ganpatipada, Turbhe | 7.2 | 0.00 | Nil | 3.2 | 24 | 40 | 71.36 | 200 | 37.90 | 23 | +ve | +ve |
| 9 | Tin Taki, Sector 18, Koparkhairne | 7.3 | 0.00 | Nil | 2.4 | 8 | 20 | 32.44 | 120 | 23.42 | 23 | +ve | +ve |
| 10 | Infront of P.C.Patil's House, Sector 19, Koparkhairne | 7.3 | 0.00 | Nil | 1.6 | 29 | 81 | 45.41 | 100 | 32.57 | 23 | +ve | +ve |
| 11 | Near Keshav Uncle's House, Sector 19, Koparkhairne | 7.1 | 0.00 | Nil | 3.7 | 15 | 30 | 64.87 | 250 | 84.95 | 23 | +ve | +ve |
| 12 | Anant Patil, Chinchali, Ghansoli | 7.0 | 0.00 | Nil | 3.1 | 13 | 30 | 110.28 | 430 | 158.85 | 23 | +ve | +ve |
| 13 | Old Video Center. Talvalinaka, Ghansoli | 7.1 | 0.00 | Nil | 4.6 | 16 | 51 | 77.85 | 80 | 57.33 | 23 | +ve | +ve |
| 14 | Rabadagaon behind GSR/ESR, Rabada | 7.2 | 0.00 | Nil | 2.5 | 15 | 51 | 45.41 | 80 | 36.76 | 23 | +ve | +ve |
| 15 | Near Vitthal Mandir, Divagaon, Airoli | 7.3 | 0.00 | Nil | 3.4 | 35 | 71 | 32.44 | 50 | 38.09 | 23 | +ve | +ve |
| 16 | Vitbhatti, Airoligaon, Airoli | 7.0 | 0.00 | Nil | 5.6 | 12 | 40 | 97.31 | 310 | 171.61 | 23 | +ve | +ve |
| 17 | Near Hanuman Mandir, Chinchpada, Airoli | 7.1 | 0.00 | Nil | 5.5 | 14 | 30 | 77.85 | 230 | 18.85 | 23 | +ve | +ve |
| 18 | Ilathanpada, Digha | 7.2 | 0.00 | Nil | 3.7 | 7.0 | 20 | 64.87 | 220 | 44.57 | 23 | +ve | +ve |
| 19 | Subhashnagar, Digha | 7.2 | 0.00 | Nil | 4.0 | 14 | 51 | 110.28 | 360 | 64.76 | 23 | +ve | +ve |
| 20 | Sanjay Gandhi Nagar, Digha | 7.2 | 19.40 | Nil | 5.2 | 14 | 30 | 77.85 | 260 | 62.23 | 23 | +ve | +ve |
| 21 | Juhugaon, Sector 11, Vashi | 7.0 | 37.90 | Nil | 1.4 | 20 | 40 | 77.85 | 260 | 82.09 | 23 | +ve | +ve |
| 22 | Vashigaon, Sector 6, Vashi | 6.7 | 51.10 | Nil | 1.5 | 15 | 51 | 38.92 | 790 | 176.76 | 23 | +ve | +ve |

Source: Environmental Laboratory, NMMC

Table No. 22: Water Quality of Turbhe bore well

| Location of Well (Turbhe) | pH | Turbidity | Residual Chlorine | DO | BOD | COD | Chloride | Hardness | Sulphate | MPN Count/100 ml | E.Coli | F.Coli |
|---------------------------------|------------|------------|-------------------|------------|------------|-------------|--------------|--------------|--------------|------------------|------------|------------|
| | | NTU | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | | |
| Turbhe Land fill site Bore well | 7.5 | 2.7 | Nil | 5.5 | 2 | 50 | 214.08 | 340 | 210 | 23 | +ve | +ve |
| | 6.9 | 1.07 | Nil | 5.9 | 2 | 70 | 159.95 | 350 | 206 | 23 | +ve | -ve |
| | 7.3 | 0.9 | Nil | 6.0 | 2 | 30 | 166.62 | 330 | 160.76 | 23 | +ve | +ve |
| | 7.3 | 2.5 | Nil | 5.2 | 4 | 38 | 90.823 | 30 | 144.95 | 23 | +ve | +ve |
| | 7 | 0.3 | Nil | 5.3 | 4 | 19 | 58.39 | 110 | 118.29 | 23 | +ve | +ve |
| | 7.8 | 0.3 | Nil | 6.1 | 8 | 80 | 82.95 | 300 | 162.29 | 23 | +ve | +ve |
| | 7.7 | 0.7 | Nil | 6.3 | 2 | 30 | 129.75 | 280 | 156.38 | 23 | +ve | +ve |
| | 6.6 | 0.7 | Nil | 4.5 | 1 | 19 | 123.26 | 420 | 108.19 | 23 | +ve | +ve |
| | 6.7 | 0.0 | Nil | 6.6 | 2 | 20 | 175.16 | 450 | 61.71 | 23 | +ve | +ve |
| Average | 7.2 | 1.0 | | 5.7 | 3.0 | 39.6 | 133.4 | 290.0 | 147.6 | 23 | +ve | +ve |

Source: Environmental Laboratory, NMMC

Water Resource Management

Water supply (Network)

This year on an average (average supply across all months), NMMC supplied around 392 MLD of treated water to Navi Mumbai city from the Bhokarpada treatment plant. Upon deducing the water losses, which account to about 18% of the water supply, it is estimated that around 321.4 MLD (Table No. 23) water was supplied by NMMC out of which 290.4 MLD was supplied to domestic sector, 25 MLD to the commercial sector and around 6 MLD to gaonthan and slums. The supply of water to about 1,25,732 connections was through the well-developed distribution network of 972 km long facilitated by 132 booster pumps. The NMMC provides max. 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: Highlights of the water supply network at a glance

| Head | Details |
|---|--|
| Total Average water supply in 16-17 | 392 MLD |
| Processing and Distribution losses | ~18% |
| Net Water Supply to Navi Mumbai (NMMC limits) | 321.44 MLD |
| Length of distribution network | 1130 Km |
| Number of booster pumps | 162 |
| Water supply breakup | Metered: 321.4 MLD Unmetered: 70.6 MLD |
| Water supply sectoral break up | Domestic: 290.4 MLD Commercial: 25 MLD Gaonthan & Slums: 6 MLD |

Source: Environmental Laboratory, NMMC

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 India²⁹, the benchmark water supply is 135 LPCD including losses. It is estimated that net water supply in NMMC area is about 200 LPCD this year which is higher than the designated benchmark. The NMMC supplies the highest LPCD water supply as against the other ULB's in MMR (Figure No. 30).

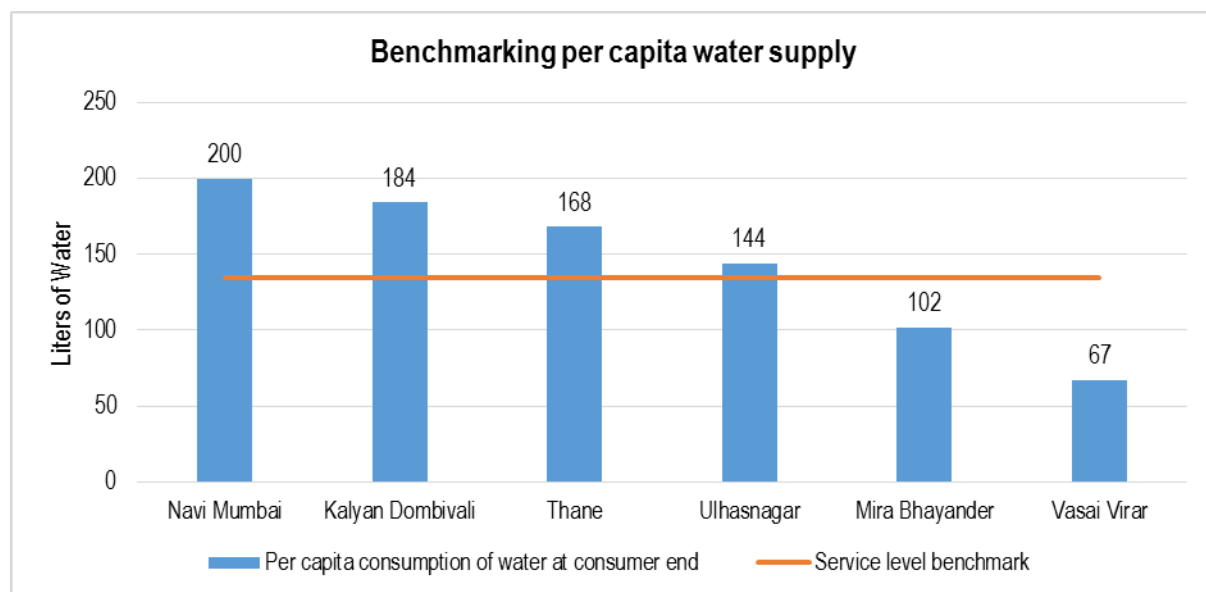


Figure No. 30: Benchmarking for per capita water supply for major ULBs in MMR

Source: Performance assessment system ³⁰

Drinking water quality at tap end

NMMC regularly monitors drinking water samples at various points across the city to check the quality of water 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 2016-17, total 19,875 samples were analysed out of which 4.72% (984) samples were detected to be non-potable (Figure No. 31).

From Figure No. 32, it is observed that Nerul zone registered non potability samples for Co-Op. Housing Societies as well as commercial water samples for 9–10% of the samples. Similarly, Koparkhairne node recorded non potability for about 6% for both Co-op. Housing societies and Domestic samples. Compared to 12% non potability of domestic samples in year 2015-16, Belapur node recorded all the domestic samples as potable in 2016-17. Airoli (4.7%), Ghansoli (4.8%) and Vashi (4.6%) recorded more than 4% of water samples as non-potable from commercial sector. Belapur node recorded 4.9% of the samples from public tap

²⁹http://saiindia.gov.in/english/home/Public_Folder/Professional_Practices_Group/State_Local_Manual/PU_DUCHERRY_MANUAL/Wad%20Manual/Water%20Supply.pdf

³⁰<http://www.pas.org.in/>

water as non-potable which was found to be highest compared to all nodes. Other nodes recorded non-potable sample for less than 4% of the observations.

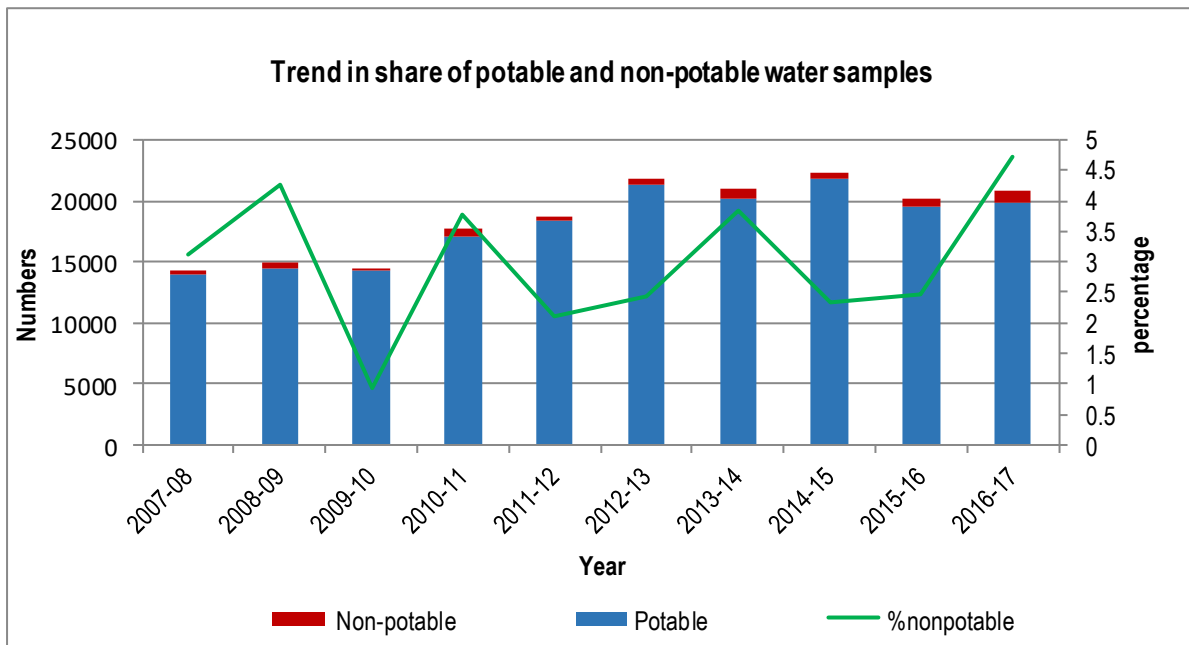


Figure No. 31: Trend in share of potable and non-potable water samples in NMMC area

Source: Environmental Laboratory, NMMC

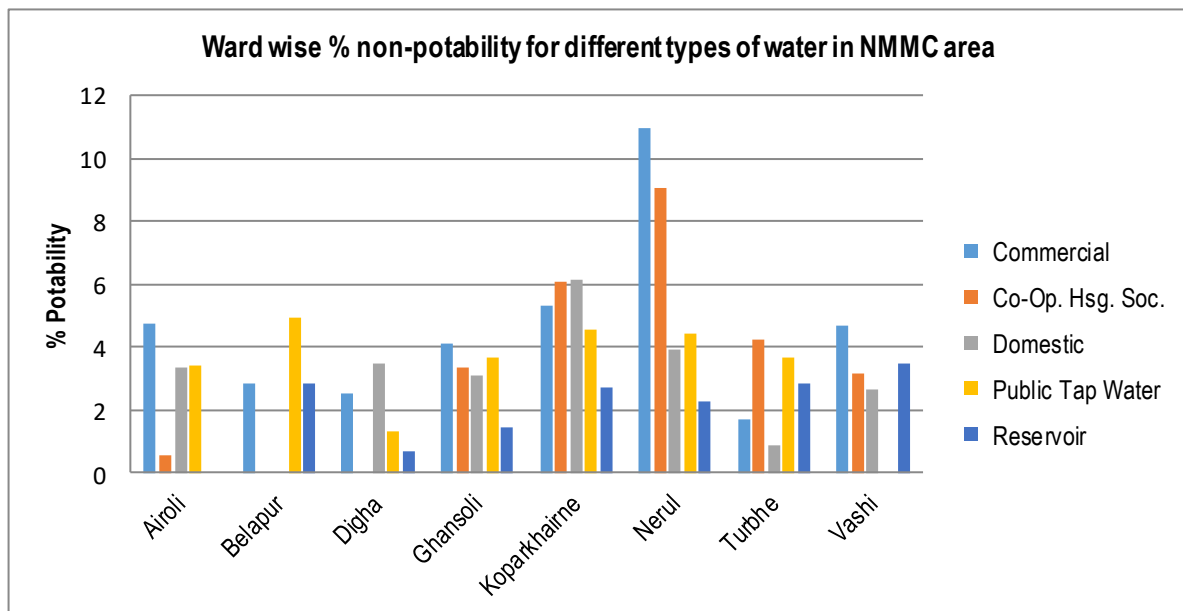


Figure No. 32: Ward wise % non-potability for different types of water in NMMC area

Source: Environmental Laboratory, NMMC

Sewage treatment and public toilets

NMMC has a well-planned underground sewage network which has coverage of about 99% in NMMC area and caters to about 2,44,345 connections. The total length of sewer lines is 448.37 km which caters 100% of the population. Also, there are about 506 public toilets (5567 seating capacity) with equal distribution for men and women.

Sewage Treatment Facilities

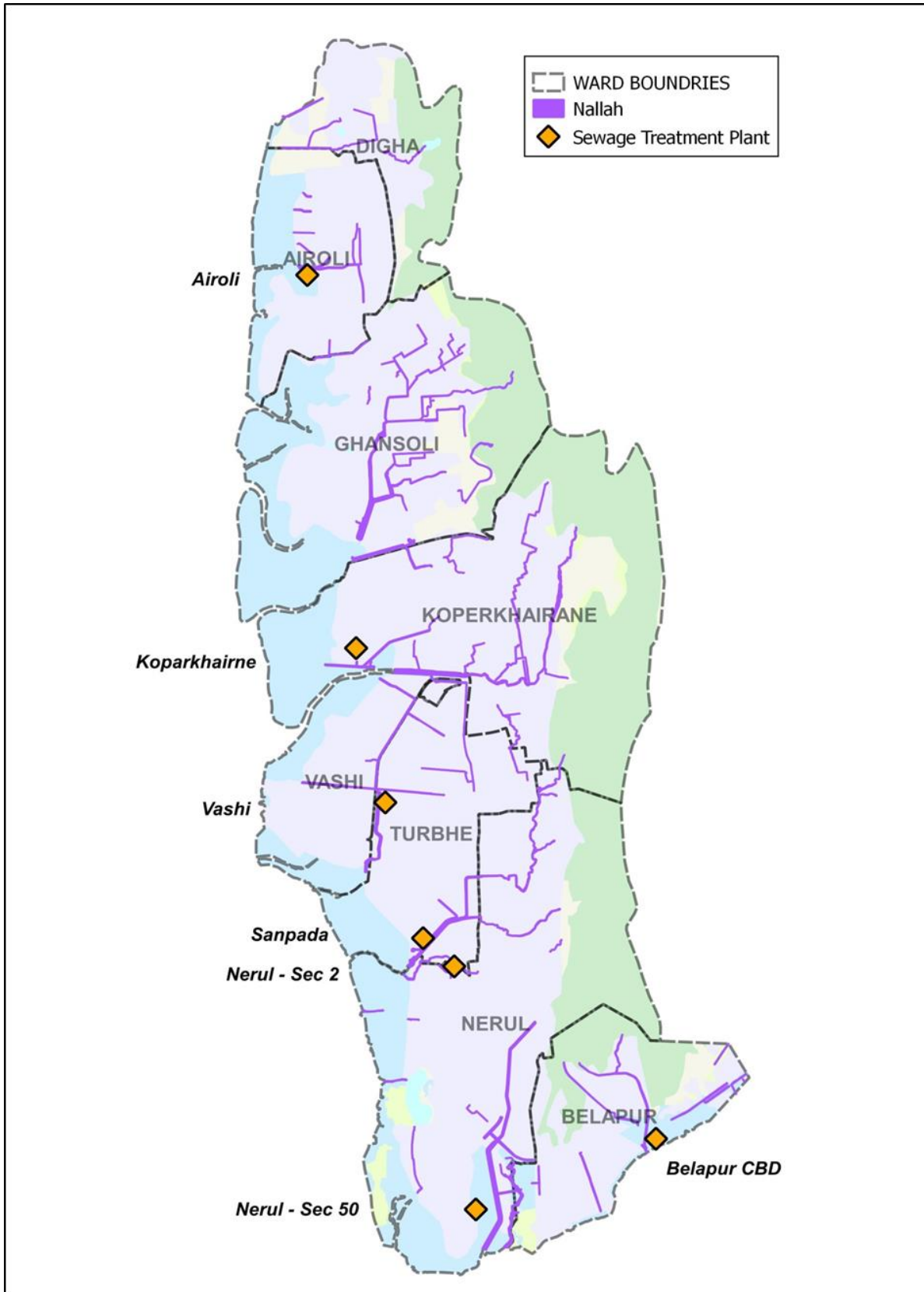
NMMC has 7 sewage treatment plants and one aerated lagoon connected to Sanpada STP (Map No. 4) for treatment of sewage generated in NMMC jurisdiction area. The total capacity of STPs accounts for 424 MLD. Daily around 205 MLD sewage gets generated and 100% of the sewage gets treated in STPs. The STPs possess Primary as well as Secondary treatment system which works on the of Cyclic Activated Sludge Treatment technology 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. Water quality tests are conducted daily during secondary treatment at an ISO certified laboratory.

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 STPs in Navi Mumbai under NMMC is provided in Table No. 24.

Table No. 24: List of functional Sewage Treatment Plants in NMMC area (2016-17)

| Sr. No. | Node & Sector | Design Capacity (MLD) | Treatment technology |
|--------------|-------------------|-----------------------|--|
| 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 | Ghansoli - 15 | 30 | |
| 7 | Airoli - 18 | 80 | |
| Total | | 454 | |

Source: Environmental Laboratory, NMMC



Map No. 4 Location of STPs in NMMC area

Performance of Sewage Treatment plant

Before discharge water from STPs into the creek, NMMC performs monitoring of water quality regularly. This helps in checking levels of various parameters which affects water quality and also to check efficiency of treatment plants. The data for the inlet and outlet is presented in Table No. 25. All parameters are well within the standard limit from all 7 STPs.

Table No. 25: Average performance and efficiency of STPs in NMMC area

| STP | PH | | B.O.D(mg/l) | | C.O.D(mg/l) | | S.S(mg/l) | |
|-------------------|-------|-----|-------------|-----|-------------|-----|-----------|-----|
| | 6.5-9 | | <10 | | <50 | | <20 | |
| | In | Eff | In | Eff | In | Eff | In | Eff |
| CBD Belapur - 12 | 7.1 | 7.5 | 105 | 4 | 255 | 49 | 162 | 8 |
| Nerul - 50 | 6.9 | 7.1 | 146 | 4 | 235 | 35 | 133 | 8 |
| Sanpada - 21 | 6.9 | 7.4 | 140 | 3 | 294 | 32 | 128 | 7 |
| Vashi - 18 | 6.8 | 7.0 | 140 | 4 | 256 | 48 | 174 | 9 |
| Koparkhairne - 14 | 6.9 | 7.2 | 116 | 4 | 324 | 28 | 131 | 6 |
| Ghansoli - 15 | 6.8 | 7.2 | 124 | 4 | 252 | 44 | 112 | 6 |
| Airoli - 18 | 6.7 | 7 | 156 | 4 | 306 | 44 | 152 | 8 |

Source: Respective STPs Laboratory, NMMC

Standards as per BIS Notification dated 21st April 2015

Storm water Management

NMMC area has storm water drain networks of total 550km (Table No. 26) 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%

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.

Table No. 26: 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

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 carry industrial effluent to the creek. They carry mixed wastewater during dry season. The list of nallahs is tabulated in Table No. 27 and the water quality of the samples collected from nallahs is presented in Table No. 28.

Compared to last year (2015-16), the suspended solid levels in the year 2016-17 are found to be within the permissible limit (<600 mg/l) prescribed by CPCB in all water samples of nallahs (Table No. 28). Except for Pavane MIDC and Turbhe sector 24, all remaining nallahs shows high amount of chloride than the permissible limit. Belapur sector 12 shows highest level of chloride (7966.47mg/l) which is almost 8 times higher than the prescribed standard of 1000mg/l followed by Junagar Herdillia nallah (5944.04mg/l) and Airoli Bharat Bijali Nallah (4074.08mg/l).

Table No. 27: Details of open Nallahs in NMMC area

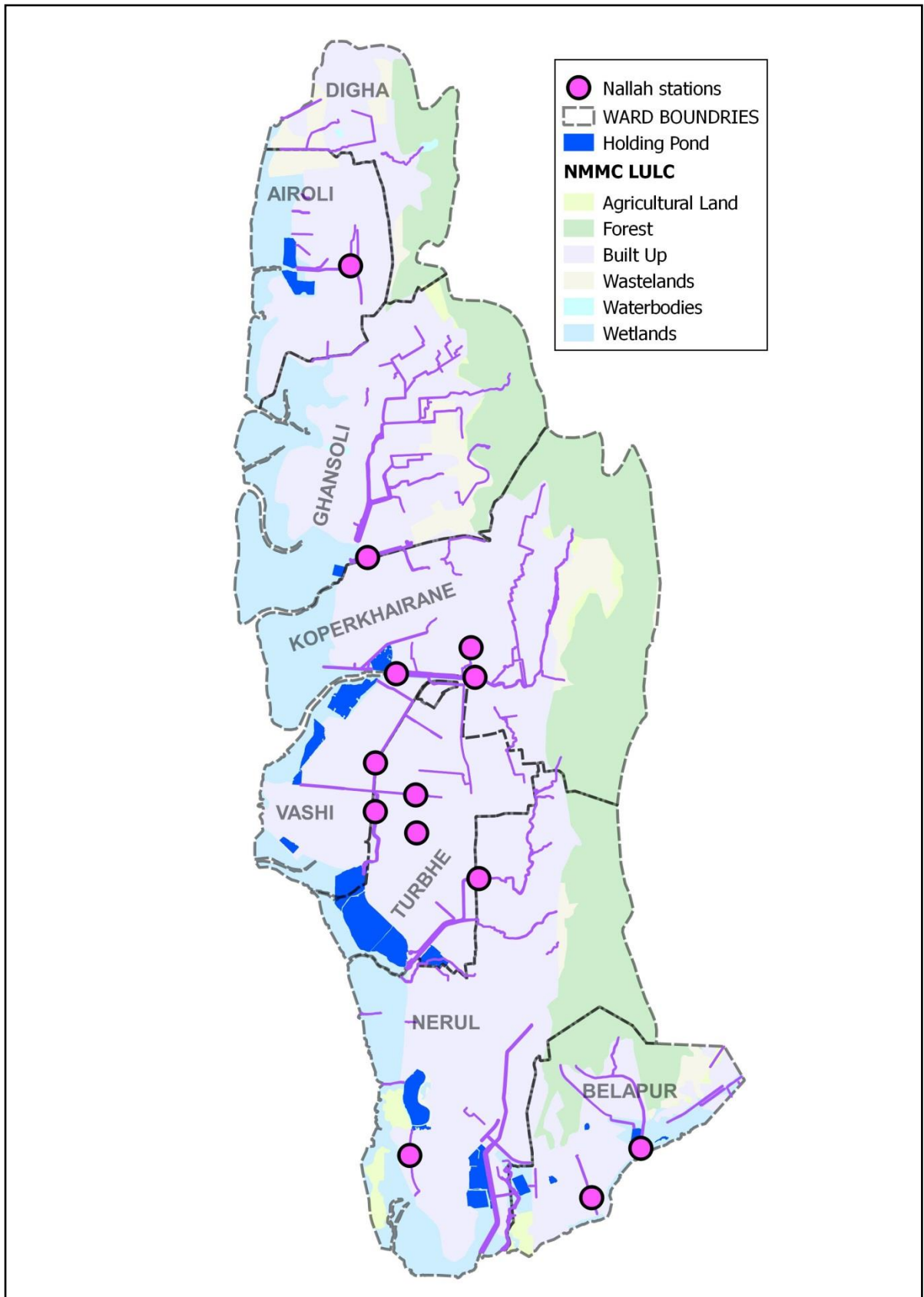
| Sr. No | Nallah | Node | From | To | Length (meters) |
|--------|-------------|---------------|---------------------------|-------------------|-----------------|
| 1 | Nalla No-1 | Belapur | Sector-1 | Sector-12 | 2418 |
| | | | Artist Village Branch | | 726 |
| | | | Sector-1a Nalla | | 430 |
| | 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. 28: Annual Average water quality of water samples collected from nallahs

| Zone | Name Of Nallah | Parameters | | | | | | | | |
|--------------|-----------------------------------|------------|--------|--------|--------|--------|---------|---------|----------|----------|
| | | pH | D.O | B.O.D | C.O.D | S.S. | Nitrate | Nitrite | Sulphide | Chloride |
| | | | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) |
| | Limits | 5.5-9.0 | - | <350 | - | <600 | <45 | - | - | <1000 |
| Belapur | Belapur Sector 12 | 7.3 | 3.1 | 23 | 397 | 523 | 1.532 | 0.149 | 18.80 | 7966.47 |
| | Belapur Sector 15A | 7.6 | 1.3 | 24 | 235 | 49 | 2.040 | 0.151 | 21.20 | 170.29 |
| Vashi | Vashi Sector 18 (Khairme Nallah) | 7.0 | 1.6 | 60 | 353 | 117 | 2.942 | 0.065 | 31.04 | 3035.66 |
| Turbhe | Turbhe Mafco Nallah sector 17,18 | 7.0 | 1.7 | 11 | 94 | 273 | 2.602 | 0.070 | 30.48 | 1186.61 |
| | Pavane MIDC Nallah | 7.2 | 1.6 | 45 | 240 | 161 | 4.157 | 0.144 | 31.36 | 396.33 |
| | Turbhe Sector 19 | 6.9 | 0.8 | 27 | 128 | 376 | 1.551 | 0.062 | 32.64 | 2677.66 |
| | Turbhe Sector 24 | 7.3 | 0.9 | 12 | 133 | 169 | 0.647 | 0.067 | 15.84 | 418.46 |
| | Juinagar Herdillia Nallah | 7.1 | 3.0 | 59 | 570 | 260 | 1.701 | 0.144 | 32.00 | 5944.04 |
| Koparkhairne | Koparkhairne Sector 11 | 7.1 | 0.9 | 20 | 279 | 150 | 4.199 | 0.069 | 13.36 | 3220.10 |
| | Mahape Bridge Nallah | 7.0 | 1.5 | 84 | 448 | 258 | 3.275 | 0.126 | 13.12 | 3344.25 |
| Airoli | Airoli Bharat Bijali Nallah | 7.0 | 1.2 | 63 | 348 | 218 | 3.017 | 0.230 | 9.76 | 4074.08 |
| Ghansoli | Nocil Nallah | 6.9 | 1.8 | 82 | 417 | 102 | 4.828 | 0.249 | 18.32 | 1493.34 |
| Nerul | Nerul Palm Beach Road | 7.5 | 0.6 | 19 | 193 | 213 | 2.880 | 0.034 | 23.92 | 1907.28 |

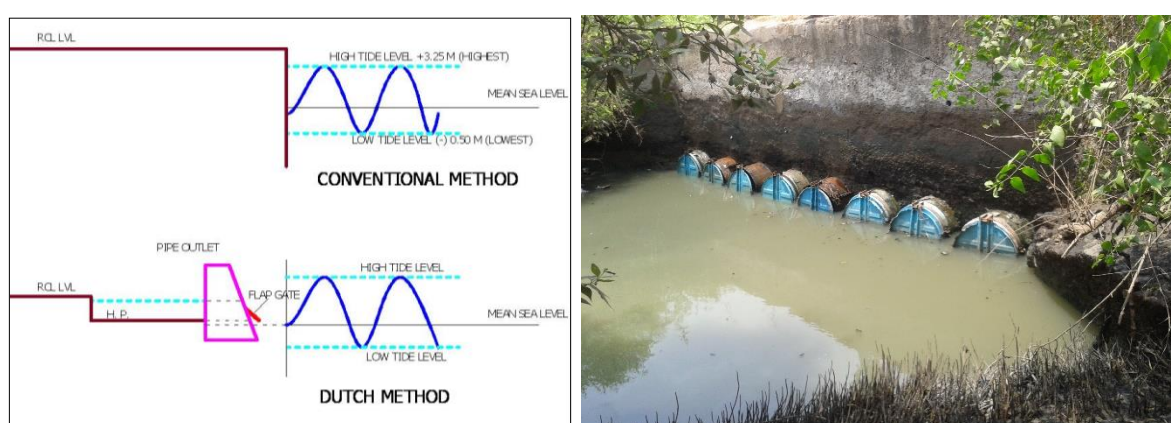
Source: Environmental Laboratory, NMMC



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

Holding Ponds

CIDCO used the Dutch technology for flood control to optimise the reclamation levels of the city, as certain areas of Navi Mumbai are located below the High Tide Level. This method is used for control of ingress of seawater during high tide and allowing excess water to flow in to the sea during low tide naturally or by pumping with the help of high capacity pumps during high tide. For disposal of rainwater, holding ponds have been constructed in different nodes. Bunds have been constructed around these ponds and control mechanism for release of water during low tides has been installed (Picture No. 7). 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 (Table No. 29).



Picture No. 7: Schematic of the Dutch dyke (Left) and its actual photograph with flap gates (right)

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

| Holding Ponds | PARAMETERS | | | | | | |
|-------------------------|------------|--------|--------|--------|---------|---------|-----------|
| | pH | S.S | D.O | B.O.D | Nitrate | Nitrite | Phosphate |
| | 5.5-9.0 | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) | (mg/l) |
| Belapur Sector 12 | 6.9 | 475 | 3.4 | 56 | 2.926 | 0.059 | 0.204 |
| Belapur Sector 15A | 7.1 | 1072 | 10.3 | 70 | 2.948 | 0.111 | 0.212 |
| Vashi Sector 8 | 6.8 | 631 | 2.5 | 40 | 3.641 | 0.904 | 0.358 |
| Vashi Sector 10A | 6.7 | 1000 | 6.9 | 103 | 4.131 | 0.781 | 0.248 |
| Vashi Sector 11 & 12 | 7.0 | 393 | 2.0 | 25 | 5.397 | 0.385 | 1.668 |
| Vashi Sector 30 | 6.8 | 807 | 3.0 | 121 | 3.400 | 1.076 | 0.536 |
| Koparkhairne Sector 14 | 6.9 | 790 | 4.8 | 41 | 0.886 | 0.105 | 0.284 |
| Airoli Sector 18 | 6.6 | 717 | 4.4 | 81 | 4.945 | 0.414 | 2.354 |
| Airoli Sector 19 | 6.7 | 1043 | 6.3 | 60 | 5.317 | 0.319 | 0.695 |
| Sanpada Sector 18 to 20 | 6.8 | 1003 | 3.4 | 157 | 3.161 | 0.045 | 0.358 |

Source: Environmental Laboratory, NMMC

Table No. 30 depicts the water quality monitored at the holding ponds in the year 2016- 17. The pond at Vashi sector 30 violated BOD level (121 mg/l). Rest all locations have BOD within permissible limit. Higher DO levels (10.3mg/l) were found only at Belapur Sector 15A while Vashi sector 11 & 12 (2.0mg/l) and Vashi sector 30 (3.0mg/l) showed less DO levels. Rest all the parameters like pH, nitrite, nitrate and phosphates were well in the limits.

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 has increased from 336 MLD (2010-11) to 392 MLD (2016-17). The Figure No. 33 shows trend of water demand in NMMC jurisdiction area. It is estimated that the water requirement for NMMC would increase to about 500MLD by the year 2042.

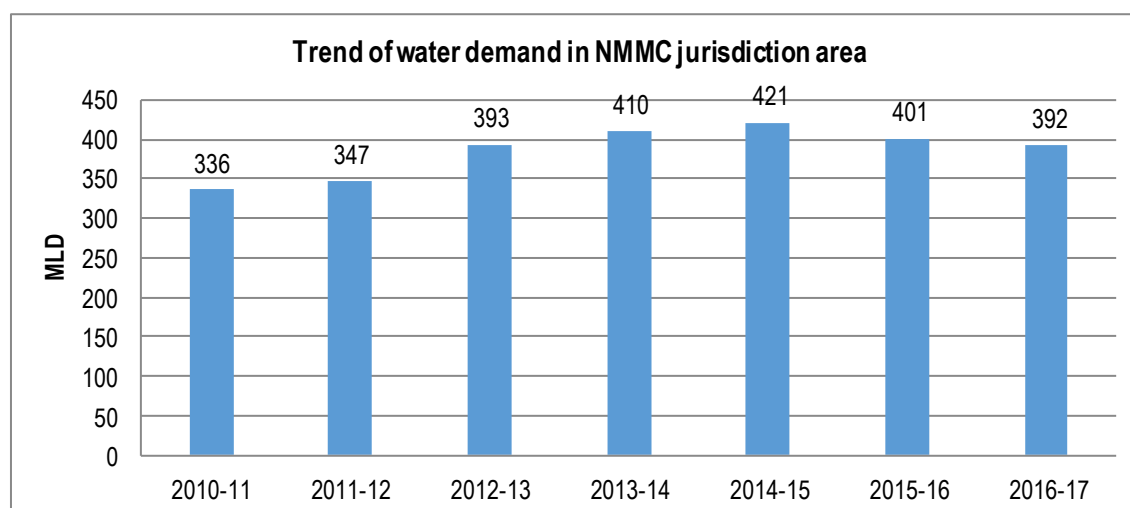


Figure No. 33: Trend of water demand in NMMC
Source: Water supply and sewerage department, NMMC

Electricity consumption of STPs in NMMC

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 and financial losses but also losses in terms of energy requirements at the pumping stations, booster pumps treatment consumables and so on. The electricity consumed by the STPs is provided below in Table No. 31.

Table No. 31: Consumption of electricity by the STPs in NMMC

| Sr. No | Parameters | Units | STPs | | | | | |
|--------|-------------------------|-------|---------|-----------|-----------|-------------------|------------|--------------|
| | | | CBD- 12 | Nerul- 50 | Vashi- 18 | Koparkh airne- 14 | Airoli- 18 | Sanpada - 20 |
| 1 | Total Capacity | MLD | 19 | 100 | 100 | 87.5 | 80 | 37.5 |
| 2 | Total Load | MLD | 8-10 | 35- 40 | 35- 40 | 32- 35 | 35- 40 | 10- 12 |
| 3 | Total Pumps | Nos. | 0 | 8 | 8 | 7 | 6 | 6 |
| 4 | Total capacity of pumps | HP | 0 | 1400 | 1400 | 1225 | 1050 | 480 |
| 5 | Total units consumed | Kwh | 433544 | 3229440 | 3295556 | 3596040 | 2825920 | 153672 |

Source: Water supply and sewerage department, NMMC

Distribution losses and Leakages

From Figure No. 34, it is noted that the losses have decreased by almost 2% i.e. from 20% to 18.05% compared to the previous year. The supply of water this year has also been reduced to 392 MLD with almost 9 MLD depreciation compared to last year. Decreasing trend in water losses is observed in 2016-17 compared to previous years where there was increasing trend in water losses.

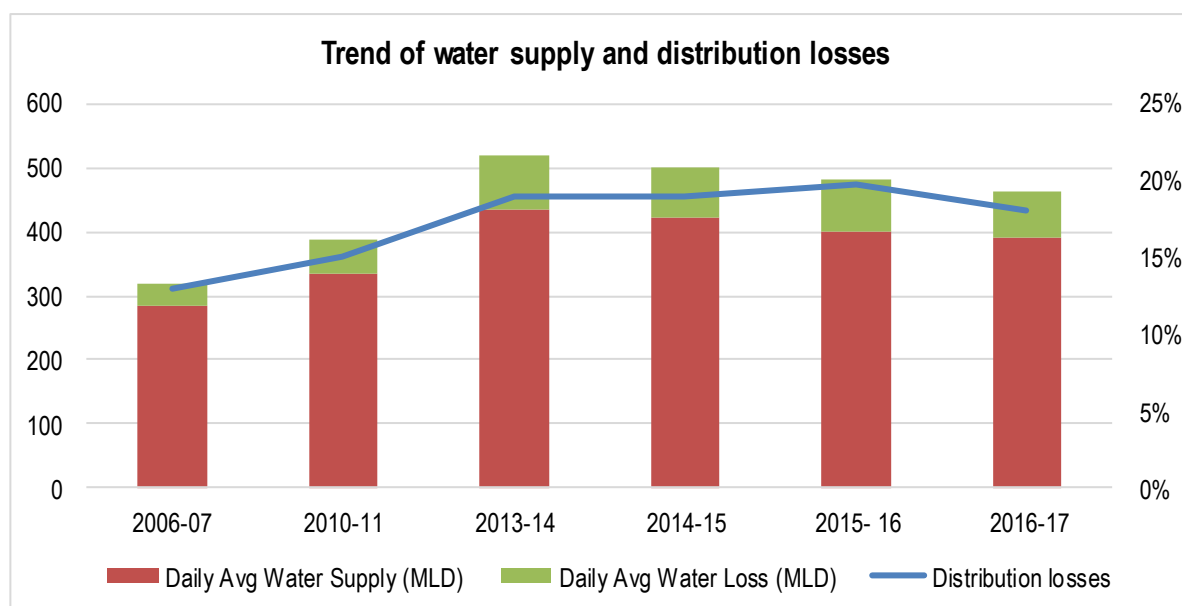


Figure No. 34: Trend of water supply and distribution losses in NMMC

Source: Water Supply Department, NMMC

Response

Installation of AMR's

In order to maintain a tally of water consumption and increase the share of metered water supply, NMMC initiated a drive for installing node wise AMR's (Automatic Meter Reader) system. For piped water supply with connection of 20 mm and above NMMC has made it compulsory to install AMR's. Around 3272 active consumers from residential, 720 from commercial and 176 institutional consumers have installed AMR till March, 2017.

Water supply Disconnections

The consumers which didn't oblige to the installation of AMRs NMMC took strict action against the consumers and upon issuing warnings disconnected the water connections if they failed to install AMRs. Water supply of around 218 active consumers of residential, 51 commercial and 5 institutional consumers have been disconnected. Further, around 11056 illegal water connections were disconnected and around 192 booster pumps are removed.

Release of Sewage and industrial effluents

As per CPHEEO, about 70-80% of total water supplied for domestic use gets generated as wastewater³¹. 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 marine and coastal 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. It is observed that the sewage generated this year has been increased slightly by 5 MLD compared to last year. The water supplied for the year 2016-17 is 392 MLD which is cut off by 9 MLD as compared to 2015-16 (401 MLD). The total sewage generated for the year 2016-17 accounts for 205 MLD.

Response – Nallah quality testing drive

On receiving complaints and grievances from citizens on release of polluted water/effluents from the nallahs and streams in Navi Mumbai, NMMC has carried out survey of chemical industries around Khairme nallah (Koparkhairme) to check pollution level.

Effluent samples were collected on 10th January, 2017 (Picture No. 8) and analysed for various parameters to estimate the level of pollutants in the samples. Samples were tested in triplicate by three agencies namely – NMMC environmental Laboratory, A third Party certified laboratory and the in-house laboratories of the chemical industries and reports were submitted and presented to MPCB.

Similar nallah water quality analysis drives for industrial effluents quality are proposed along all the nallahs. The Sanpada-Juinagar nallah has been shortlisted as the next nallah under the drive.

³¹R Kaur, SP Wani, AK Singh and K La, [Wastewater production, treatment and use in India](#),



Picture No. 8: MIDC effluent sample collection from industries near Khairne nallah

Response - Sewage network in slum pockets

1. NMMC has proposed to provide proper sewerage system for slum pockets and connects the sewage to STPs. NMMC has assured the drainage network in slum pocket area will be complete in one and half years year after taking possession of land for pumping station from MIDC authority.
2. NMMC has carried out survey of Ghansoli & Airoli node and prepared plan for collection of sewage & connect to nearest STP. Also, completed survey of Digha, Tubhe and Nerul area and preparation of plan is under process. After completion of individual plan, combine DPR will be prepared and on the basis of DPR work will be carried out.

Comprehensive Environmental Pollution Index (CEPI) Action Plan for Navi Mumbai

CPCB had carried out Comprehensive Environmental Assessment of 88 industrial clusters in country in December 2009 based on CEPI. For calculating CEPI, Navi Mumbai region was divided into 3 sectors namely Residential cluster (NMMC area), Residential-Industrial cluster (mixed) and Industrial cluster (TTC MIDC area of Turbhe, Rabale, Koparkhairne and Mahape) for consideration of CEPI. MPCB and NMMC have taken various short and long term measures with the help of stakeholders for improving CEPI. The list of measures undertaken (status as on December 2016) has been enlisted below.

Initiatives by MPCB/TBIA

1. Airoli and Digha Industrial area (K block) has been connected to CETP-TBIA Navi Mumbai through underground effluent collection system.
2. MPCB regularly monitors performance of ETPs (Effluent Treatment Plants). There are total 48 large and medium scale industries generating trade effluent and have

installed necessary ETPs. These ETPs perform satisfactorily and meet all consented standards. MPCB is taking further action on industries which fail to meet all consented standards. All major industries have improved their ETPs in order to reduce pollution load by atleast 10%.

3. Under NMMC area, MIDC authority has initiated steps towards replacement of existing old pipeline by HDPE pipeline in TTC MIDC area. For this work, Tender process is also floated. As per details received from MIDC authority during meeting held on 04/1/2017, the total length of pipeline is 130KM. Remoulding of 39.53KM HDPE pipeline is proposed and tender for replacement of 6.30KM pipeline is under process.
4. Monitoring of ground water quality at Turbhe landfill site for checking any contamination in ground water. Recent report on checking of ground water between 21/07/2016 to 26/07/2016 shows no abnormality in ground water quality.
5. The recent improvements/ upgradation undertaken by TBIA for improving the CETP for enhancing its overall performance are as follows
 - Installation of specially designed slow speed agitators
 - Construction of new equalization tank
 - Installation of RO system having capacity of 100 CMD
6. Installation of Supervisory control and data acquisition (SCADA) as a mitigative measure towards leakage of effluent carrying pipeline is under process. Till now, total 12 industries installed SCADA system.
7. Awareness programs are conducted regularly in coordination with TBIA, TTCWMA, CETP & other industries.

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. 9)



Picture No. 9: Water body at Nerul after its renovation and beautification

Silting of holding ponds

Holding ponds lie 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 (.Picture No. 10) 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. 10: Growth of mangroves at holding pond in Koparkhairne

Initiatives for Conservation and reuse of water

Reuse of water at WTP

Realizing the current need to conserve water, NMMC has adopted a method of “Back flushing” of water at the Bhokarpada water treatment plant (Picture No. 11). Around 10- 12 MLD of water is back treated and the water is used for various purposes. Initially the treated water was released in the natural stream but now the water is stored in a newly developed water storage tank. The work of installing of the water storage tank and other equipment was completed by April 2015. The stored water can now fulfill the need of around 50,000 people in the city. This initiative has also resulted into a saving of INR 1,08,000 per day which shall help compensate the cost of installation of tank and other equipment in the next 2 years.

Supply side management

Realizing the importance of conservation and preservation of water resources in the city, NMMC has taken several initiatives which not only help in reducing the pressure on water resources in the city but also help in conservation of energy.

- NMMC has planned 24x7 water supply in the city while also keeping up to the standard of 150 LPCD as prescribed by Ministry of Urban Development Government of India.

- 24x7 water supply with the help of gravity helps save a lot of electrical energy as all the Elevated Service Reservoirs (ESRs) & Ground Service Reservoir (GSRs) could be bypassed.



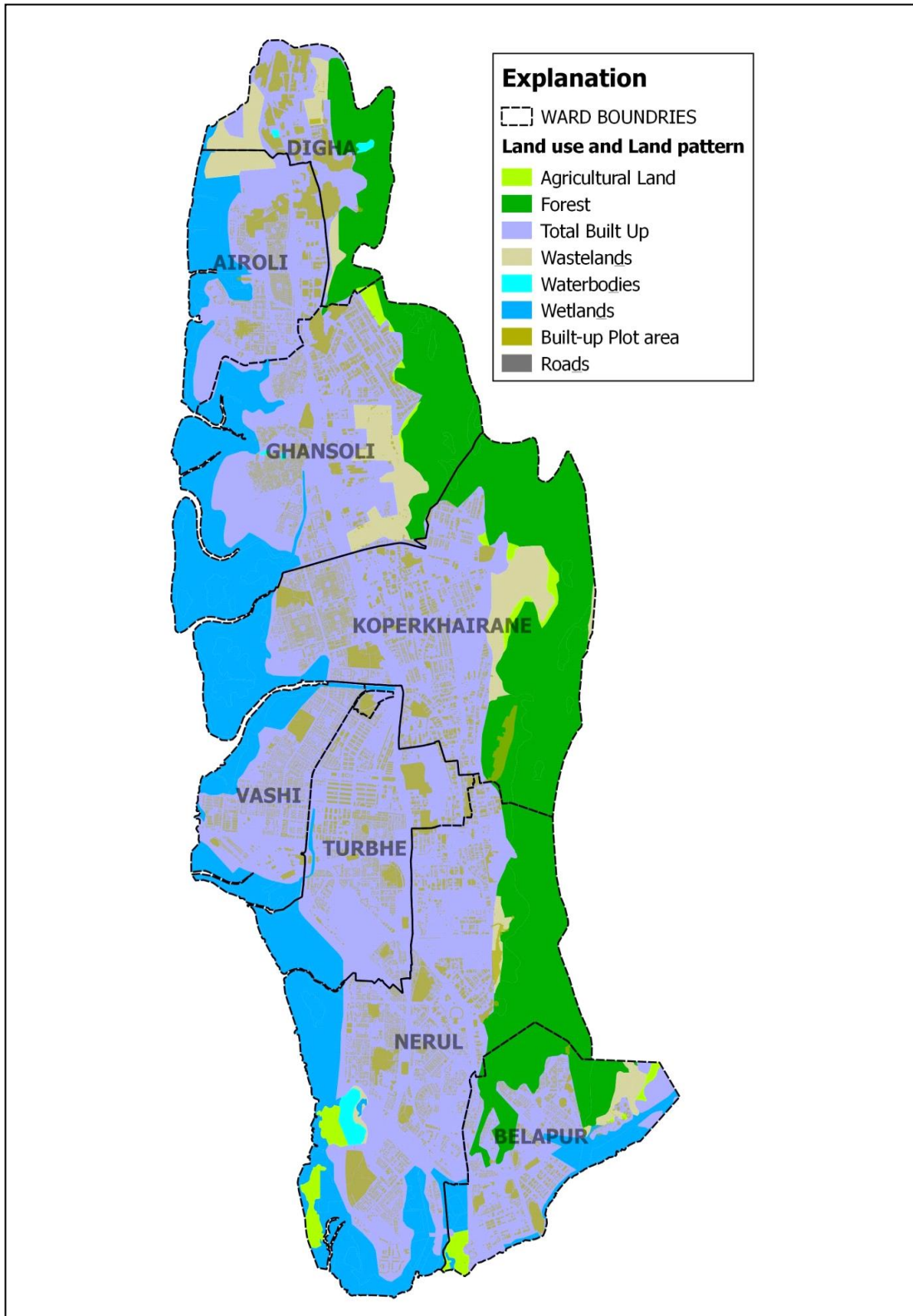
Picture No. 11: Back flushing of water at Bhokarpada water treatment plant

Source: City Engineering department, NMMC

Reuse of Treated Water

- NMMC has made it mandatory for industries to use treated wastewater which can be supplied to meet demand of water for various secondary applications in the city.
- A direct pipeline is proposed to be commissioned from the Sewage Treatment Plant (STP) to the industries to directly transfer the treated sewage water thus reducing the cost of transportation. This pipeline would be installed under the AMRUT scheme.
- Further two ESR's (Elevated Storage Reserves) are proposed for storage of this treated water. This would help in supply water through an effective channels.
- Total sewage generation from NMMC area is 205 MLD and same is treated in 08 STPs located at different locations.
- Treated Sewage water of STPs is currently used for the following
 - Supplied to CIDCO for watering plantations along road dividers
 - Supplied to NRI complex at Seawoods for gardening purpose
 - Supplied to construction sites for construction activity
 - Used for watering of lawns in NMMC gardens

Land Resource



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

Land is a basic natural resource and is important for overall sustainability of all terrestrial ecosystems. In industries like agriculture, forestry, mining, fishing, this resource plays a reproductive economic factor. Over centuries, people have been exploiting land resource and its allied products for their ever growing needs but these resources are finite and their over exploitation exerts more pressure on such resources. Increased demand or pressure results in range of problems like degradation of land, decreased crop productions due to wrong agricultural practices, soil pollution due to uncontrolled use of chemical fertilizers, competition for various development activities.

CIDCO (City and Industrial Development Corporation of Maharashtra), a public sector undertaking developed by the Government of Maharashtra has already put a lot of planning in development of Navi Mumbai. Appropriate plans were executed for building residential, commercial, industrial zones while maintaining green cover or spaces in and around the city. This section highlights the current situation of land resources in NMMC and also discusses the effects of various developmental activities on them.

Status

Change in Earth's surface is the combination of variety of geological and physical processes like soil erosion, plate tectonics, weathering of rocks, earthquakes, volcanoes and flood. Similarly, Humans also shape the land through activities like Deforestation, agricultural practices, mining, increasing construction activities. Land Use is the concept which explains the utilization and management of land and its resources by humans while Land Cover comprises of physical and biological components which exists on land surface in the form of forest cover and manmade structures³².

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. 32) of which built up area constitutes major portion (56.16%) and accounts to about 61.01 sq.km. This comprises residential, commercial, industrial, administrative constructions and infrastructure such as crematoriums, water supply, sewage disposal, roads, and railways. Forest cover is around (24.44%) which covers around 26.55 sq.km of area. 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. 32: Break up of Land Use Land Cover pattern in NMMC

| Sr. No | Land Use Land Cover | %Share of land cover | Area in km ² |
|--------------------|---------------------|----------------------|-------------------------|
| 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

³² <https://enviroliteracy.org/land-use/>

It can be observed from Figure No. 35 that more than 75% 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

The term built up area is an important land use for any city and is used primarily in urban planning, real estate development and construction industry. The increase in built up areas shows impact on the environment due to soil sealing and disturbance due to increase in transportation, noise levels, resources utilization, increased waste generation and ultimately pollution³³. More than 60% of the area in Navi Mumbai is under built up area for construction of residential, commercial, and industrial complexes 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.

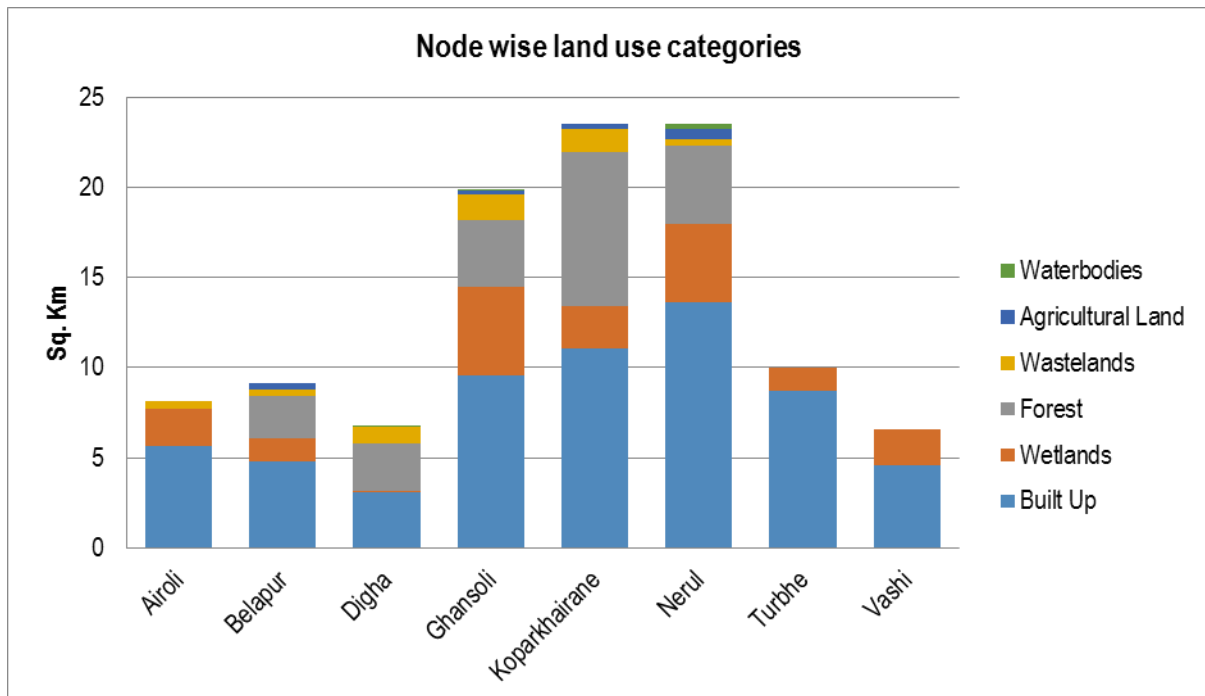


Figure No. 35: Ward wise land use categories in NMMC

Source: MRSAC

³³ <http://www.vliz.be/projects/deduce/IFS/IFS02.pdf>

Wetlands

Wetlands are those areas which are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support prevalence of vegetation typically adapted for life in saturated soil conditions³⁴. Wetlands usually consist of water structures like lakes, rivers, mangroves, coral reefs and so on. Artificial man-made wetlands consist of paddy fields, dams, salt pans and so on. Wetlands play a number of roles in the environment, mainly in water purification, flood control, carbon sink and shoreline stability. 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, creek, ponds, wells & so on. The water bodies are used for various domestic and industrial purposes in the city. These water bodies have been further discussed and their quality status been presented in the Water resources section of the report.

Mangroves

Mangroves are salt tolerant plants found in tropical and sub-tropical intertidal regions of the world which collectively is termed as 'Mangrove Ecosystem'. Mangrove ecosystems are highly productive yet sensitive and fragile ecosystem which shelters many plants and animal species³⁵. They are distributed in the inter-tidal region between the sea and land (Picture No. 12)³⁶. Mangrove wetlands are ecologically important since they support breeding 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 decades³⁷ but only few areas are under the jurisdiction of Municipal Corporation. The dominant mangrove species recorded in the area included *Avicennia marina* and a mangrove weed, *Acanthus ilicifolius* and *Sonnertia alba*. 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 recorded³⁸. Mangroves act as a buffer zone between land and sea and protects the land from erosion and play an important role as a protective shield against cyclones, ecological disasters and protects shoreline. This is particularly significant for Navi Mumbai due to its geographical location. They are also important for maintaining biodiversity as mangroves acts as breeding and nursery grounds for variety of life forms including invertebrates, fishes, amphibians, reptiles and birds species.

³⁴ <http://www.wetland.org/downloads/Wetlands101ppt.pdf>

³⁵ http://agritech.tnau.ac.in/forestry/forest_mangrove_index.html

³⁶ http://www.marineclimatechange.com/marineclimatechange/bluecarbon_2_files/Girieta2011.pdf

³⁷ http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue40/news/toi_mangroves_cidco.pdf

³⁸ 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. 12: Dense mangroves cover along Thane creek

Carbon sequestration by mangroves in NMMC

Carbon sequestration is the term used to describe acquisition and storage of Carbon. It is the process of capturing and storing Carbon that would otherwise be emitted or remained in the atmosphere or to prevent carbon emissions produced by human activities in the atmosphere by capturing and diverting them to secure storage. Mangrove forests are one of the most promising means of carbon sequestration, having the highest net primary 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 gases³⁹. Studies have found that mangroves have the potential to store more carbon in their biomass compared to tropical and temperate forests⁴⁰. It is found that the global carbon burials (Carbon sequestration) of mangroves are approximately 18.4 Tera grams of carbon per year (Tg C/year)⁴¹.

As the Carbon footprint of Navi Mumbai is estimated to be about 2.8 million 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.

³⁹ <http://www.mangrovesforfiji.com/mangroves/carbon-sequestration>

⁴⁰ <http://www.wetlands.org/News/tabid/66/ID/3503/Not-all-mangroves-are-identical-new-study-reveals-hotspots-for-mangrove-biomass.aspx>

⁴¹ Patil V., Singh A., Carbon Sequestration in Mangroves Ecosystems, Vol. 7 No. 1A,2012,Pg No.577

Habitats in the city

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 significance & 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 CO₂ each person generates. Thus trees play a vital role in regulating the city's environment and helps maintain 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 provisional figures, the total tree count of the city is around 8.5 Lakhs

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. As the World's cities continue to grow, continuing to value green spaces is important but it is also a challenge, particularly in developing nations where there is a pressure for space, resources and development. A network of gardens and open spaces are critical for providing healthy habitats and preserving regional ecosystems amid growing cities. Urban Heat Island Effect can be reduced or virtually eliminated by increased numbers of green spaces in cities. Gardens and parks 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 and 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.

Other than garden NMMC is also undertaking initiative such as tree plantations on the other open spaces/areas present in the city such as the circles, Road dividers and T belts (Table No. 33).

Table No. 33: Ward wise open spaces along with their area in NMMC

| Sr. No | Area | Garden | | Open spaces | | Circle | | T belt | |
|--------------|--------------------|---------------|---------------|--------------------|---------------|----------|--------------|----------|--------------|
| | | No. of Garden | Area (sq. m) | No. of Open spaces | Area (sq. m) | Circle | Area (sq. m) | T belt | Area (sq. m) |
| 1 | CBD Belapur | 38 | 260028 | 22 | 47428 | 3 | 3436 | 1 | 7027 |
| 2 | Nerul | 33 | 145582 | 7 | 6196 | 1 | 780 | 2 | 7473 |
| 3 | Sanpada and Turbhe | 13 | 70705 | 1 | 500 | - | - | - | - |
| 4 | Vashi | 33 | 166023 | 11 | 26126 | - | - | 2 | 9778 |
| 5 | Koparkhairane | 15 | 50108 | 11 | 26858 | 1 | 437 | - | - |
| 6 | Ghansoli | 5 | 9872 | 7 | 18243 | - | - | - | - |
| 7 | Airoli | 25 | 109549 | 9 | 14178 | 1 | 110 | 3 | 5578 |
| 8 | Digha | 1 | 5100 | - | - | - | - | - | - |
| 9 | Palm beach road | - | - | 10 | 84976 | - | - | - | - |
| 10 | Thane Belapur Road | - | - | 2 | 60412 | 1 | 267 | - | - |
| Total | | 163 | 816967 | 80 | 284917 | 7 | 5030 | 8 | 29856 |

Source: Garden Department, NMMC

Biodiversity of NMMC

Biodiversity is the shortened form of 2 words 'Biological' and 'Diversity'. It refers to all variety of life form that can be found on earth as well as to the communities that they form and the habitats in which they live. 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 boosts ecosystem productivity where each species have an important role to play. Greater species diversity ensures natural sustainability for all forms of life. 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 has an abundant green cover ranging from Forest patch to mudflats and mangroves in coastal region which makes it an ideal spot for bird watching. Different species of water birds, local migrants, 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. 13).



Picture No. 13: 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 Chondrichthyes (Cartilaginous fish) representing 2 genera and 2 families and 28 species of Osteichthyes (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 Quarrying extract a wide range of useful materials from the ground such as Coal, metals and stones which are used widely in building and manufacturing industries. But at the same time, it can be very destructive to the environment. Land Degradation is one

of the significant impact arising from these activities which are mainly in form of land alteration due to excavation, soil pollution due to dumping of mine waste. Stone quarrying causes degradation of forest land, adverse effect on local biodiversity including human health. It is the main reason for degradation of many natural areas of India. Navi Mumbai also faces pressures from mining and quarrying activities. A total of 80 leases have been provided in 5 different regions of the city which account to a total area of 823988 sq. m (0.82 sqkm)⁴². The operators were permitted to carry out mining activities in the area till the year 2016 (September 2016). An approved period of lease for existing sites for stone mining and quarrying has been over. Air pollution with high RSPM level can be observed in the area near the mining sites as explained in Air section.

Dumping of Debris

Illegal dumping is the improper disposal of waste at any location other than a permitted landfill or treatment facility. It is not only against the law, but also poses a threat to human health and the environment. The common locations used for dumping often includes abandoned industrial sites, vacant public or private properties or even in mangrove areas. Dumping 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. Majority of the dumping is carried out in mangrove areas and holding ponds creating a pressure on these areas. Illegal dumping can impact proper drainage making areas more susceptible to flooding when debris blocks creeks and drainage basins. Mangrove area proves to be a critical 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

Human population is continuously increasing specially near coastal areas which puts significant pressure on natural resources. Mangroves are also facing significant pressure of destruction due to population growth, dumping of construction and other debris, clearing mangrove patches for reclamation. Overexploitation and unsustainable demand has resulted in considerable degradation of mangrove areas. Sometimes mangroves also face the threats from oil spills due to accidents. Illegal deforestation and burning of mangroves is also observed in some areas.

Poaching of Flamingos

Flamingos congregate each winter on mudflats of Navi Mumbai, on their migratory route. Since Greater and Lesser flamingos are threatened species, they fall under the protection of the Indian Wildlife (Protection) Act of 1972. Killing them could incur a penalty of up to 7 years in prison⁴³. Still there have been reports of Flamingo poaching reported in some parts of Navi Mumbai for consumption. In June 2016, there were reports of selling flamingo meat in local markets of Airoli. Poachers trapped these birds using synthetic threads tied on sticks buried in the mudflats where these birds comes to feed. Synthetic thread cause injuries on their legs which renders their ability to fly, thus gets trapped in those threads⁴⁴.

⁴² http://www.thane.nic.in/pdf/sand_mining/khanipatta_list.pdf

⁴³ <http://www.sanctuaryasia.com/conservation/news/9704-mumbais-famed-flamingos-fall-victim-to-poachers>.

⁴⁴ <http://www.freepressjournal.in/mumbai/flamingo-birds-are-poached-and-their-meat-sold-at-nearby-markets-in-airoli/878770>

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 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

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. This year NMMC is all set to inaugurate the Amusement park at Kopri village in Vashi, on the lines of the Old Woman's Shoehouse in Malabar Hill. The construction work is almost completed. The actual picture of the amusement park is presented in



Picture No. 14: Giant tortoise installation at Amusement park at Kopri village-Vashi

Raising awareness about Bio wealth of City

Biodiversity billboards

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. Similarly boards have been commissioned at Airoli



Picture No. 15: Biodiversity lecterns at Airoli

Developing a Coastal and Marine Biodiversity Centre

To improve knowledge of citizens about local coastal and marine habitat, its inhabitants and characteristics, Mangrove cell, Forest Department- Government of Maharashtra has developed a Coastal and Marine Biodiversity Centre (CMCB) at Airoli node in Navi Mumbai. The centre was built in collaboration with the Indo-German (GIZ) Project on Conservation and Sustainable Management of Marine Protected Areas. It is third marine interpretation centre of its kind only next to Mahatma Gandhi Marine National Park at Port Blair in Andaman, and Gulf of Mannar Marine Interpretation Centre near Rameswaram in Tamil Nadu⁴⁵.

Over 600 marine species are displayed in CMCB. The aim of this concept is to create a state of the art infrastructure wherein visitors can get information about the beauty of coastal and marine biodiversity of Maharashtra along with important roles plays by coastal area and threats to such ecosystem through series of visual, audible and tactile elements⁴⁶. The centre also have indoor features like Coastal and Marine Interpretation centre, souvenir shop, interactive displays. Outdoor attractions includes mangrove nursery, board walk, creek view and crab pond. The second phase of the project includes creation of marine museum dedicated solely for skeletal remains of marine mammals while third phase will include Garden Glow Park project on 5 acres of land which will be have glowing installations inspired by Dubai Garden Glow, a night time family attraction and is expected to be ready by December 2018⁴⁷.

⁴⁵ <http://indianexpress.com/article/cities/mumbai/airoli-marine-interpretation-centre-opens-for-tourists-today-4634786/>

⁴⁶ <http://www.travelandtourtworld.com/news/article/coastal-marine-biodiversity-centre-launched-airoli-mumbai/>

⁴⁷ <https://blooloop.com/link/garden-glow-park-airoli-mumbai/>



Picture No. 16: Coastal and Marine Biodiversity Centre (CMBC) at Airoli

Afforestation and tree plantation drives

- NMMC has carried out tree plantations in every block. In the current year (2016-17), NMMC planted about 25,000 trees across various nodes within the city.

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.

Protection of Mangrove-Wetland ecosystem

High Court gave orders to NMMC for protecting mangroves (Kandalvan) under NMMC jurisdiction area from destruction caused by illegal dumping in mangrove area. Various steps were taken by NMMC during 2016-17 for protecting mangroves. They are as follows

- Appointing all Section Officer as Nodal Officer by NMMC for preventing illegal dumping and to take necessary action in case of any illegal dumping.
- Toll free hotline numbers for all wards for grievances against mangrove destruction has been commissioned. Also responsible citizens can click photos of such illegal activities and send it on WhatsApp number availed by NMMC. Citizens can also register complaint or upload photos on nmmconline.com (egrievance).
- As per High court's order, putting any sign boards/posters, banners in or near mangrove area (ecologically sensitive places) is punishable under Environment Protection Act, 1986.
- Construction of curb stones for preventing entry of any vehicle for illegal dumping.
- Mangroves from Vashi, Ghansoli and Airoli nodes were protected by removing encroachments and by putting fencing.
- Created 2 Anti-debris mobile squad (Turbhe-Nerul-Vashi-CBD Belapur) and (Ghansoli-Koparkhairne-Airoli-Digha) for monitoring of illegal activities in mangroves region.
- Several Police cases against mangrove destruction were registered
- All this efforts for mangrove protection were appreciated in a meeting chaired by Regional/Divisional Commissioner, Konkan division.

Proposed Activities

- Increase Mangrove cover by undertaking mangrove plantation drives
- Installation of CCTV's in mangrove area to have surveillance check on trespassers and illegal activities
- NMMC is planning to conduct many Mangrove Plantation Drive and construction of Mangrove Park in Airoli.
- Informative sign boards and signage's to be put up in mangrove forest indicating the punishment for trespassers
- 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. This initiative will also allow citizens to connect with nature.

Solid Waste Management

Solid Waste Management, especially in urban areas, is one of the most critical issues these days. Solid Waste refers to trash or garbage discarded as unwanted or refuse arising from residential, institutional, commercial, industrial activities. SWM (Solid Waste Management) is a discipline which is associated with control of generation, storage, collection, transport, processing and disposal of solid waste materials while considering public health, economics and environmental aspects. Apart from residential and commercial areas Navi Mumbai has a strong presence of industrial area and a strong network of hospitals and medical facilities which generate diverse categories of waste. The following section discusses the various categories of waste generated and their disposal technique in Navi Mumbai.

Municipal Solid Waste

Consumption of resources leaves behind waste in various forms and consumerism, urbanization, penetration of use-and-throw concepts, irresponsible disposal of plastic (polyethylene), excessive use of packaging materials, plastic, styro-foam and so on has increased waste generation manifolds. Our changing lifestyle has further added to a diversity in waste generation ranging from food to clothes, plastics to E-waste. If non-disposed responsibly this waste accumulation may lead to various environmental as well as health issues.

NMMC is responsible for Municipal Solid Waste Management in NMMC area and it has appointed private contractors in 91 zones (including Thane Belapur Industrial Area) on day for collection, transportation and disposal of waste on day to day basis. NMMC collects and disposes the solid waste at the Turbhe scientific landfill site after appropriate segregation and processing of the waste as well as the leachate collected.

Source and Composition

In the year 2016-17, it is estimated that on an average around 726 Metric Tonnes (MT) of solid waste/day was generated in NMMC area which is almost 30 tons more as compared to the last year. As seen in Figure No. 36, 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. The main source of solid waste is from the residential areas comprising of household waste, accounting to more than 92% (672 MT) of the total waste. Also considering the breakup of the waste generated from the residential sector (Table No. 33) highest quantity (108.58 MT/day) of waste was generated and collected from Turbhe node, while lowest (32.50 MT/day) quantity of waste was generated from Digha node. The presence of APMC (Agriculture Produce Marketing Committee) right within the city is also a major source of solid waste, and accounts to about 7.1% (51.69 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.

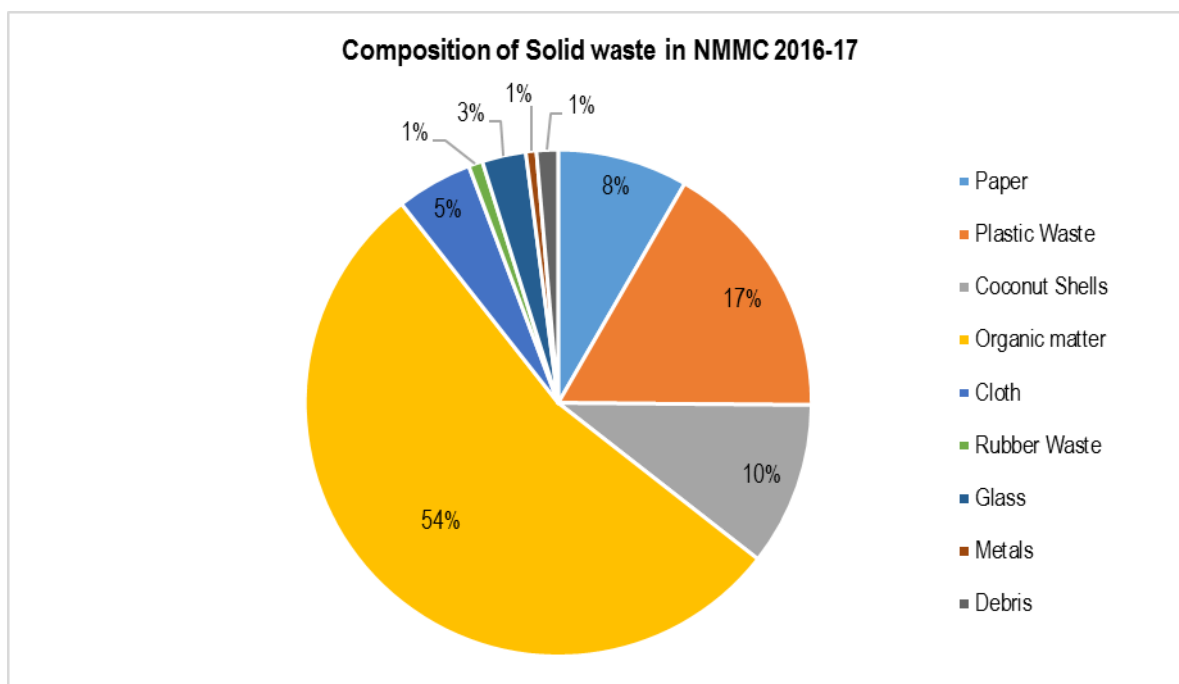


Figure No. 36: Composition of solid waste in NMMC

Source: Environment Laboratory, NMMC

Collection

The services offered by the department of Solid Waste Management department in Navi Mumbai can be broadly classified into two categories which are majorly operated through private contractors.

1. Daily road sweeping and cleaning of storm water drains prior to monsoon and
2. Solid Waste collection and Transport.

Solid Waste Collection is carried out for the entire city (108.63 sq.km) covering about 6343 units of housing societies, around 3977 units of Industries and 800 units of commercial establishments. The total number of household covered is estimated to be around 2.99 Lakhs through door to door collection (bell ringing) on daily basis thus ensures almost 100% coverage for solid waste collection. A significant numbers of dustbins are provided in each node of NMMC and at market places. There are total 14,660 bins (80L- 238, 120L-6300, 240L-7525 and 1.1m³ – 598) across various nodes of the city. The node wise distribution of green and blue dustbins, 120 Liters and 240 liters has been presented in Table No. 33. The green bins are used to collect the wet waste while the blue for dry waste.

Domestic solid waste from houses is mechanically collected and loaded in refuse transportation vehicles by transportation contractors. Around 483 persons are employed for waste collection and disposal at dumping site. The transportation vehicles used for the collection and transportation of solid waste is provided below in Table No. 35.

Table No. 34: Node wise quantity of daily MSW generated and number of dustbins in NMMC (2016-17)

| Sr. No | Node | Ward | Average daily MSW generation (Metric tons) | Number of Dustbins | | |
|-----------------|---------------|------|--|-----------------------------|-----------------------------|---------------|
| | | | | 120 Liters (green and blue) | 240 liters (green and blue) | Total |
| 1 | Belapur | A | 99.89 | 1987 | 1504 | 3491 |
| 2 | Nerul | B | 101.11 | 968 | 1277 | 2245 |
| 3 | Vashi | C | 85.25 | 939 | 815 | 1754 |
| 4 | Turbhe | D | 108.58 | 439 | 958 | 1397 |
| 5 | Koparkhairane | E | 106.10 | 1110 | 915 | 2025 |
| 6 | Ghansoli | F | 63.29 | 111 | 643 | 754 |
| 7 | Airoli | G | 74.44 | 716 | 1309 | 2025 |
| 8 | Digha | H | 32.50 | 30 | 104 | 134 |
| Subtotal | | | 671.16 | | | |
| 9 | APMC | | 51.69 | | | |
| 10 | Others | | 2.5 | | | |
| Total | | | 725.35 (approx 725) | 6,300 | 7,525 | 13,825 |

Source: Department of Solid Waste Management, NMMC

Sweeping

Daily sweeping in NMMC area is undertaken through private contractors. The city has been divided into 8 administrative divisions which are divided into 91 sub-divisions for monitoring purpose. A total of 1317 km length of road is swept everyday an average one sweeper sweeps 700 running meters of road length. The total number of sweepers employed for this purpose is 2646 and sweeping is conducted daily for about 8 hours starting in the morning.

NMMC has 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. A list of equipment owned by the contractor are Fibre bins (1856), Hand Containers (148), Grass cutting Machines (89) and Flippers (408).

Table No. 35: List of vehicles used for collection and transportation of solid waste

| Sr. No | Type of vehicle | Total no. of vehicles |
|--------|---------------------------------|-----------------------|
| 1. | 16 TGVW Compactor | 45 |
| 2. | 10- 11 TGVW Compactor | 24 |
| 3. | 15 GVW Mini Truck | 50 |
| 4. | Green waste vehicle | 8 |
| 5. | Inspection vehicle | 5 |
| 6. | Washing Jet hyper spray vehicle | 2 |

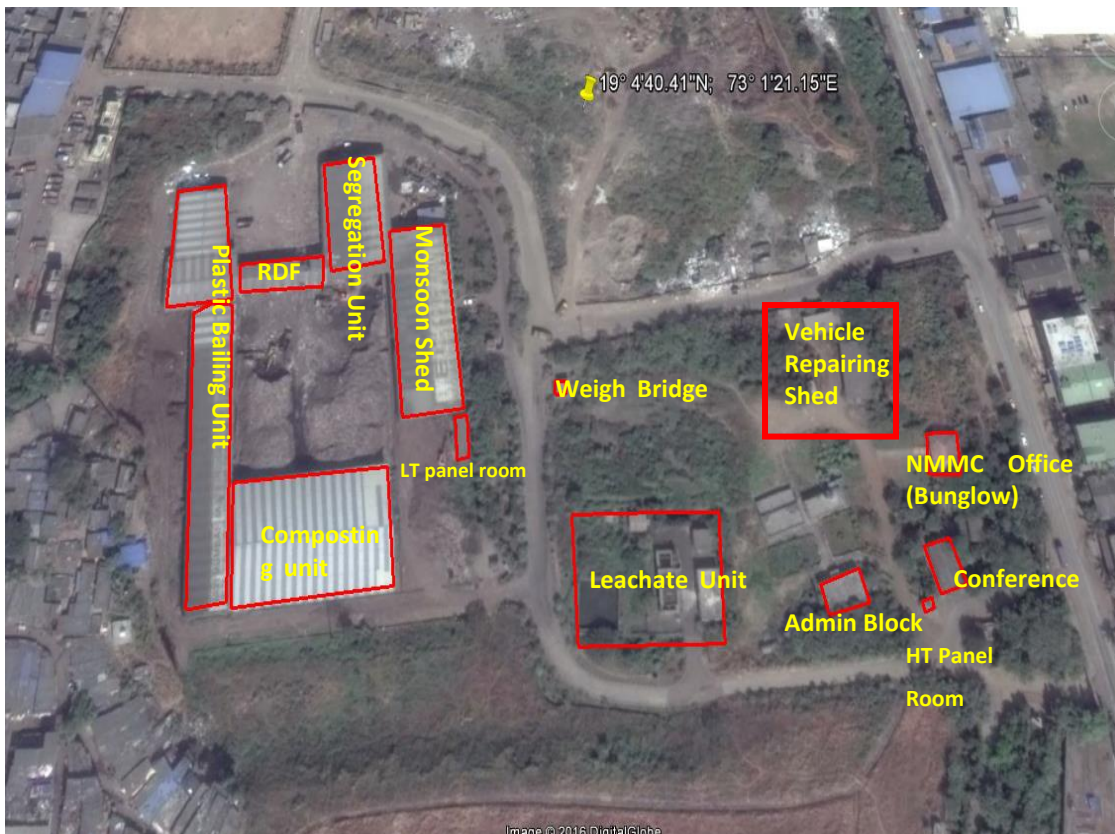
Source: Solid Waste Department, NMMC

Segregation, Processing & Scientific Disposal

Landfill Site – Basic Details

NMMC has its own sanitary landfill site at Turbhe, spread over 65 acres, which receives municipal solid waste daily for segregation, processing and scientific disposal. It is estimated that in the year 2016-17 the Turbhe landfill site received around 726 MT waste per day. The sanitary landfill has been protected, from stray dogs and trespassers, by constructing a compound wall along the periphery. Trees of various species are planted around the periphery of landfill site. Completed phases of sanitary landfill are covered with grass and reduce the direct emissions of 'Greenhouse gas', the landfill gas (majorly methane) is flared. Air Quality Monitoring Station present at this site helps to monitor air pollution from this integrated solid waste disposal facility at Turbhe.

Landfill site produces sizable amount of leachate which needs to be treated to prevent contamination of ground water table. For this purpose, LTP (Leachate Treatment Plant) was commissioned in 2011-12 where leachate gets recycled through Sequencing Batch Reactor (SBR) technology. The LTP has a design capacity of 60 KLD and on an average has a load of 25 KLD during non-monsoon months while during monsoon months the load reaches to about 50 KLD. The treated leachate is sprayed on the windrow composting pile-stocks to help maintain temperature of the windrows. The leachate water is regularly sampled and the quality of water is tested each year



Picture No. 17: Satellite picture and schematic layout depicting sections at Turbhe landfill site

Picture source: Google Maps

Quantification, Segregation and Disposal

At the land fill site in the waste processing plant, the waste is segregated into three sections namely dry, wet and mixed waste. From the dry and mixed waste, plastic is segregated and transferred to baling unit which converts plastic pieces into small beads (LDPE granules). These are then used for construction of roads and other industrial applications. The dry combustible waste like paper, cardboard, plastic and other corrugated materials are used to produce a homogenous material known as RDF (Refuse Derived Fuel) which can be used as a substitute for cement, lime plants or can be used to produce electricity. Other dry waste like glass, metal goes for recycling while wet waste converted to compost via windrows technology. A schematic of the processing and the overview of the segregation and disposal process is elaborated in Figure No. 37. While disposing the solid waste, de-odorant is sprayed to minimize the stench and nuisance which may be caused by flies and pests

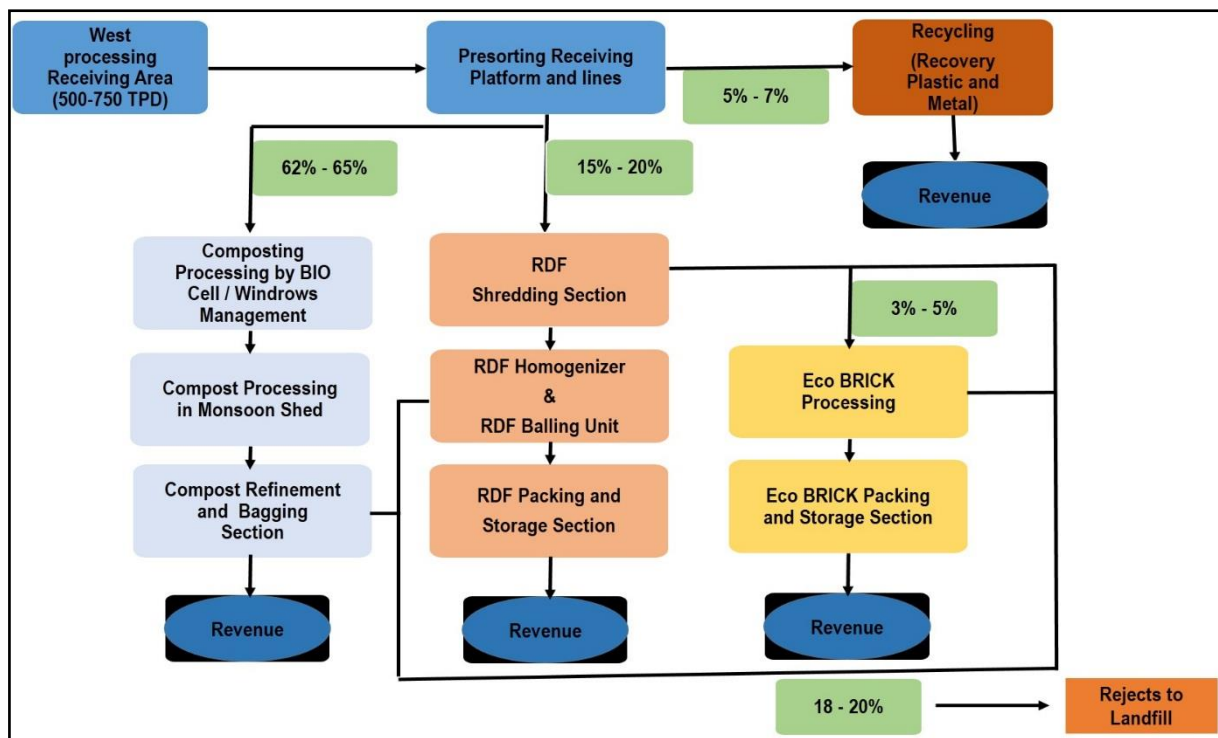


Figure No. 37: The process flow diagram of the Municipal solid waste

Source: Solid Waste Department, NMMC

Table No. 36: Leachate analysis report at Turbhe site in NMMC

| | Parameters | | | | | | |
|----------|------------|-----|-------|-------|----------|----------|----------|
| | pH | D.O | B.O.D | C.O.D | Chloride | Sulphate | Hardness |
| Influent | 7.4 | 1.1 | 577 | 2524 | 1799.33 | 345.70 | 653 |
| Effluent | 7.4 | 5.9 | 51 | 385 | 807.17 | 245.20 | 351 |

Note: All Values are in mg/l except pH

Source: Environment Laboratory, NMMC



Picture No. 18: Plastic Baling machine (Left) and Plastic agglomerate (right) at Turbhe landfill site

Response Initiatives

Segregation at Source

NMMC has initiated segregation of solid waste at the source for effective management and disposal of solid waste. The domestic waste which comprises of the dry and wet waste is collected differently at the door which further helps reducing the extra work of segregating the waste at the landfill site. In the year 2016-17, around 2,99,363 houses were covered on door to door basis and around 422 MTs of segregated waste at source was collected on daily basis. At city level, NMMC has kept dustbins of various sizes (80,120,240 litres) and colours like **green** (wet waste) and **blue** (dry waste) for segregation at each node. These dustbins are kept outside hotels, schools, colleges, malls, stations and other public places. Also, NMMC has started disseminating **red** bins for e-waste collection. The initiative is currently on demo phase which soon is going to implement on pilot stage throughout NMMC jurisdiction area.

Construction of Road from Solid Waste

NNMC has started using dumped plastic in making roads. Turbhe Landfill site which comes under NNMC, where plastic waste is recycled and made in into granules. This granules which are been made are mixed in tar (1% concentration) and used in making roads. NNMC has already started working with this plastic granules. Currently NNMC has started working with plastic granules, only on 100 meters roads. NNMC has undertaken construction of 10 such roads like the ones at Ghansoli underpass, MIDC Turbhe road and near Mahape Lake. For making plastic roads, plastic granules is mixed with tar and small stones (ashpalt), then they are mixed together on very high temperature, this ready mixture is used as wearing cot, on roads⁴⁸.

⁴⁸ <http://www.freepressjournal.in/mumbai/navi-mumbai-municipal-repairing-roads-with-granules-made-out-of-waste-plastic/994341>



Picture No. 19: Road construction using Plastic waste at Turbhe MIDC

Anti-Plastic Drive (January 8th)

It is very important to control use of plastic considering harmful effects of plastic on the environment and human life. Towards this, an 'Anti-Plastic Drive' was organized at Jewel of Navi Mumbai (Nerul) on 8th January, 2017 in collaboration with Sakal Group. Under this initiative, around 3885 large sack (24100 kg) of plastic was collected from 322 places in NMMC jurisdiction area. Three vehicles were provided to each node to transfer all plastic waste to Turbhe Solid Waste Management site for scientific processing. The plastic waste was processed and converted into small plastic beads. NMMC is utilizing these plastic beads for constructing new concrete roads through modern technique.

Table No. 37: Node wise waste collection places and quantity of waste collected

| Node | Places | Total plastic waste collected (in kg) |
|--------------|------------|---------------------------------------|
| CBD Belapur | 45 | 2035 |
| Nerul | 75 | 3410 |
| Vashi | 36 | 1045 |
| Turbhe | 28 | 1490 |
| Koparkhairne | 96 | 9180 |
| Ghansoli | 21 | 2446 |
| Airoli | 15 | 2320 |
| Digha | 6 | 2174 |
| Total | 322 | 24100 |

Source: Public Relations Office, NMMC

Red bin Initiative

NMMC has started E-waste collection as per Solid waste Management Rules, 2016. NMMC planned to place red bins for collection of domestic E-waste and hazardous waste like deodorant sprays, room fresheners, and dead batteries.

Eco Friend Industries has been appointed by NMMC to collect e waste as sample on demo stage from red bins placed at NMMC headquarters at CBD Belapur, Wonders Park at Nerul and at Inorbit mall, Vashi. The waste will be collected every fortnight by the appointed firm⁴⁹. Same work is going to be conducted on pilot scale through Eco Friend Industries and NMMC for which NMMC has displayed banners regarding this initiative.

Brand Ambassador for Swachha Navi Mumbai Mission Mr. Shankar Mahadevan, *Singer and Musician*, motivated people about scientific disposal of E-waste. The segregation will start soon all over the NMMC jurisdiction area by providing red bins in residential societies, railway stations, public places, malls, colleges and hospitals.

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 Koparkhairne 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

- Decentralized biogas plants of 10-30 MT capacity to be installed at the ward level in order to generate energy which could be used for area lighting at the ward level.
- Initiative to achieve 100% segregation of Municipal solid waste at source from all nodes under NMMC jurisdiction.
- Under the banner of Swacch Bharat Mission, NMMC has planned to install a Waste to Energy plant in the module of 600 TPD which shall help convert the Refuse derived fuel (RDF) to Energy.
- NMMC is planning to set up a construction and demolition waste debris recycling plant realizing the need for conservation of environment.
- 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 25kWe is proposed at the Turbhe land fill site and the power thus generated would be used for area lighting.

⁴⁹ <http://www.thehindu.com/news/cities/mumbai/nmmc-comes-up-with-red-bins-for-e-waste-hazardous-waste/article18725901.ece>

Biomedical Waste

Medical care is crucial for human health but the waste associated with medical facilities causes a direct impact on community, workers associated with healthcare industries and on overall environment as it may be infectious, toxic, pointed, sharp, un-hygienic and so on. Hence it is crucial to scientifically manage and dispose biomedical waste to reduce its direct impact on the environment as well as humans⁵⁰.

According to Biomedical Waste Management Rules, 2016, it is mandatory to follow notified rules for all persons who generate, collect, receive, store, transport, treat, dispose or handle biomedical waste in any form including hospitals, nursing homes, clinics, dispensaries, veterinary institutions, animal houses, pathological labs, blood banks, research and educational institutions, health camps, vaccination camps, forensic labs, blood donation camps, first aid rooms of schools⁵¹.

Generation and Collection

The Navi Mumbai city generates sizable amount of biomedical waste due to presence of various and advanced healthcare facilities like hospitals, blood banks, dispensaries, research laboratories and so on in Navi Mumbai city limits. MWML (Mumbai Waste Management Limited) is the sole agency responsible for collection, Transportation & Disposal of Bio Medical Waste generated within the city. MWML has the consent issued by MPCB (Maharashtra Pollution Control Board) and an agreement with Navi Mumbai Municipal Corporation for the same. As of 2016-17, around 2033 establishments in NMMC area have been registered with MWML for disposing their biomedical waste. MWML has commissioned barcoding system to maintain the record of bags sale with barcode stickers, Waste receipt health care establishment wise and Waste disposal batch wise. The average biomedical waste generated by the government run hospitals in NMMC, this year was around 13859.9 Kg (**Error! Reference source not found.**). Biomedical waste generated is collected from various government and private facilities by private contractor (MWML).



Picture No. 20: Vehicle (Left) and collection container deputed by MWML for collection of BMW
Source: Mumbai Waste Management Limited⁵²

⁵⁰ <http://www.cwejournal.org/pdf/vol7no1/CWEVO7NO1P117-124.pdf>

⁵¹ http://cpcb.nic.in/Bio_medical.php

⁵² <http://www.mumbaiwastemanagement.com/bio-medical-divison.htm>

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

| Categories (% evaluation) | Disposal Method | Vashi Hospital, Vashi | Mata Bal Hospital, Nerul | Mata Bal Hospital, Airoli | Total |
|---|----------------------------|-----------------------------|--------------------------------|---------------------------------|----------------|
| Needle, Lancet, Scalpel Veinflow, Discarded Glass wares- Tube, Pipettes, Syringes, Slides, Coverslips, Disposal Waste- IV Sets, Disposal syringes, Injection Vials, Amp. Glass, Bio Catheters, Plastic Bottles | Autoclaving & Shredding | 8825.67 | 247.96 | 189.25 | 9262.89 |
| Microbial Waste, Highly Infectious Waste, Isolate, Discarded Medicines, Solid Waste, Liquid Waste | Incineration | 4294.06 | 193.92 | 109.06 | 4597.05 |
| Total | | 13119.73 | 441.88 | 298.31 | 13859.9 |

Source: Health Department, NMMC

*Mata Bal Hospital from Turbhe and Koparkhairne were closed due for maintenance. Staff from these facilities were transferred to Nerul and Airoli.

Treatment & Disposal

Given the diverse nature of biomedical waste ranging from cotton swabs to plastic bottles and from blood samples to surgical blades, various treatment processes have been proposed before the same is disposed further. Autoclaving, chemical treatment and microwave treatment are some of the methods used for disinfecting the waste and help prevent infection.

MWML's facility is equipped with Incineration Systems with equipment like Primary Combustion Chamber with temperature range of 800°C to 850°C, Secondary Combustion Chamber with temperature range of 1050°C to 1100°C, Ventury Scrubber, Spray Quencher, ID Fan & 30 mtrs. Chimney, Autoclave, Shredder, Gas Monitoring Device, Effluent Treatment Plant and Computerisation. In the year 2016-17 around 13,200kgs (13.2 tons) of biomedical waste was generated.

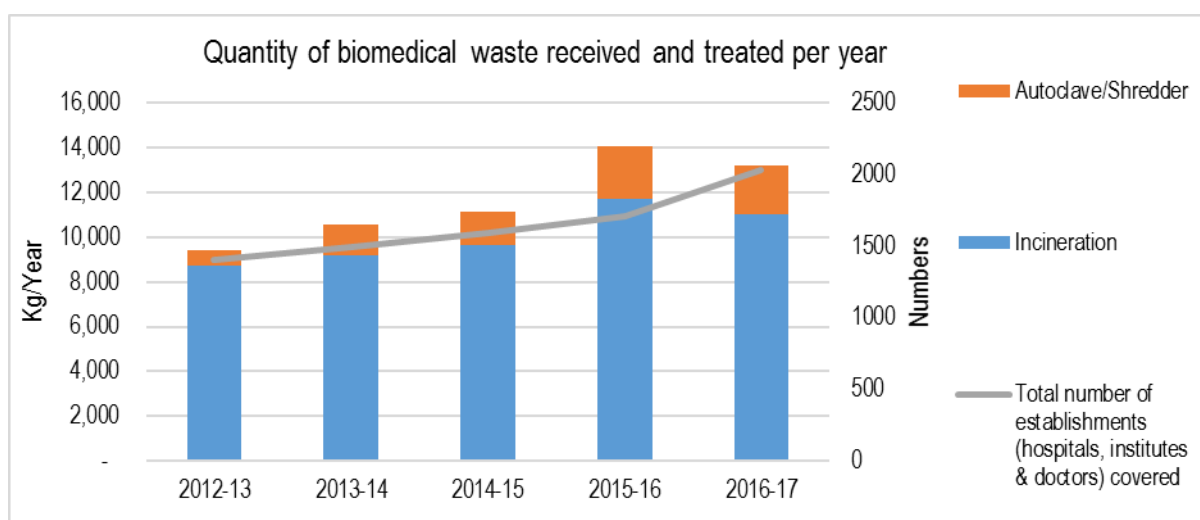


Figure No. 38: Quantity of biomedical waste received and treated per year
Source: Mumbai Waste Management Limited

Construction and Demolition Waste

C&D (Construction and Demolition) waste is generated whenever any construction/demolition activity takes place, such as, building roads, bridges, fly over, subway, remodelling etc. It consists mostly of inert and non-biodegradable material such as concrete, plaster, metal, wood, plastics etc. These wastes are heavy, having high density, often bulky and occupy considerable storage space either on the road or communal waste bin/container. Majority of this waste gets dumped along the roadside, wetlands, waterbodies, nallahs and storm water drains, thus choking them. Waste from small generators like individual house construction or demolition, find its way into the nearby municipal bin/vat/waste storage depots, making the municipal waste heavy and degrading its quality for further treatment like composting or energy recovery.

It is estimated that the construction industry in India generates about 10-12 million tons of waste annually. Projections for building material requirement of the housing sector indicate a shortage of aggregates to the extent of about 55,000 million cu.m. An additional 750 million cu.m. aggregates would be required for achieving the targets of the road sector. Recycling of aggregate material from construction and demolition waste may reduce the demand-supply gap in both these sectors.

Under Swachh Bharat Abhiyaan, NMMC is in the process of establishing a 300 tons/day capacity C&D recycling plant at its Turbhe Landfill facility. Around 5 acres of areas has been reserved to construct the facility on a PPP (Public Private Partnership) basis. An operator is being identified who shall be lend his lift-on-call service to collect C&D waste and NMMC also plans to install dedicated dustbins across the city for disposal of such waste. The plant shall segregate the waste into sand, metals and stone dust and also use part of it to manufacture paver blocks/tiles. Policy level modifications/interventions are under discussion to decide (i) arrangement on levying of charges for collection of C&D waste and (ii) strategizing mainstreaming of usage of the products for usage in the construction sector.

Hazardous Waste

Hazardous waste is a waste with properties that make it dangerous or capable of having a harmful effect on human health or the environment. Hazardous waste is generated from many sources, ranging from industrial manufacturing process wastes to batteries and may come in many forms, including liquids, solids, gases, and sludges. They can be by-products of manufacturing processes or simply discarded commercial products, like cleaning fluids or pesticides.

Navi Mumbai area comprises of a TTC (Trans Thane Creek) industrial area with diverse profiles like Chemical, Petro-chemical, Engineering, R&D laboratories, Pharma chemical industries which generate hazardous waste. Towards this the TTCWMA (Trans Thane Creek Waste Management Association) provides support for disposal of hazardous waste through secured landfill.

Generation, Collection and Disposal

- Industries register their membership with TTCWMA upon which the member industry sends their waste representative sample of waste for analysis to identify "Disposal Pathway".

- As of now there are 1942 members which supply their hazardous waste for treatment and disposal and the major category of hazardous waste treated by facility is ETP Sludge/ Sludge from Waste Water Treatment Plant which has a Solid texture.
- In the year 2016-17 about 7216 MT of hazardous waste was collected and treated by this facility, out of which around 6945 MT was disposed at the secured landfill site at this facility while the incinerable waste send to MWML, Taloja for incineration
- TTCWMA has a NABL accredited laboratory for characterization of waste, effluent and other environmental parameters.
- After analyzing it, TTCWMA send MPCB authorized Hazardous Waste Transport Trucks to the company.
- Company fills Form No. 10 (Manifest form) [as per Hazardous Waste Management Rule 2016] and send the consignment to TTCWMA.
- When these consignment comes to TTCWMA site, TTCWMA representative draw samples from truck and again do the analysis to cross check the parameters and concentration.
- Treatment of waste is done by addition of Lime, Cement and Fly ash.
- TTCWMA has facility for secured landfilling. These waste is disposed in scientifically prepared secured landfill cells.
- The total area allotted by MIDC to TTCWMA is 83,000 Sqr. Mtr and about 50% of the area is utilized for landfill cells currently is about 45,000 Sqr. Mtr. The expected lifespan of landfill cell is about 5-7 Years (depending on incoming Quantum of waste)

Health

Environment and Health

The relationship between environment and its impact on human health is highly complex and the status of our surrounding environment immensely influences our health. Various environmental factors plays a significant role in cases of health hazards, in humans as well as animals, globally and in developing countries in particular. These sources includes poor access and quality of potable water, unplanned urban settlements, air pollution, rapid industrialization, improper waste management, lack of hygienic practices⁵³. According to WHO (World Health Organization), an estimated 12.6 million (1.26 crores) people died due to unhealthy working and living environment in 2012 which accounted nearly 1 in 4 of total global deaths⁵⁴. It has been observed that rate of contracting NCDs such as chronic respiratory diseases, cardio-vascular disease increases in unhealthy environment.

Cities must have good healthcare facilities along with better environmental conditions to take care of its citizens especially during an epidemic outbreak or any medical emergencies. There are many private and government hospitals in Navi Mumbai that are equipped with latest technologies and specialist doctors, experienced staff which can handle any emergency cases. Day and night chemists are also available in the city. The following section presents list of healthcare facilities (Table No. 39), status of various diseases, actions taken to overcome or minimize such problems for the year 2016-17. The global standard for density of hospital beds the same is 3.5 beds per 1000 population⁵⁵ and Navi Mumbai (2.2)⁵⁶ has better density of hospital beds as compared to national (0.7) but it falls short in terms of global average (2.7) per 1000 population.

Table No. 39: Health care facilities in NMMC

| | 2012-2013 | 2013-2014 | 2014-15 | 2015-16 | 2016-17 |
|----------------------------|-----------|-----------|---------|---------|---------|
| No. of Private Hospitals | 184 | 184 | 188 | 197 | 198 |
| Registered With NMMC | 180 | 181 | 186 | 197 | 194 |
| Dispensaries | 158 | 184 | 191 | 184 | 135 |
| Ayurvedic Clinics | 351 | 377 | 386 | 377 | 315 |
| Homeopathy Clinics | 144 | 152 | 158 | 152 | 191 |
| Bachelor of Dental Surgery | 54 | 80 | 85 | 80 | 73 |
| Pediatricians | 75 | 75 | 75 | 75 | 75 |
| Gynecologists | 83 | 83 | 83 | 83 | 83 |
| NMMC Hospitals | 5 | 5 | 5 | 6 | 6 |
| NMMC Dispensaries | 20 | 21 | 21 | 21 | 22 |
| NMMC Mobile Dispensaries | 2 | 2 | 2 | 2 | 1 |
| Private Dispensaries | 797 | 865 | 920 | 920 | 849 |
| Private Nursing Homes | 76 | 81 | 81 | 81 | 81 |

Source: Health Department, NMMC

⁵³ <http://www.who.int/heli/publications/helirevbrochure.pdf?ua=1>

⁵⁴ <http://www.who.int/mediacentre/news/releases/2016/deaths-attributable-to-unhealthy-environments/en/>

⁵⁵ WHO Guidelines

⁵⁶ This involves private as well as government beds

Water Borne Diseases

Water borne diseases are any illness caused by intake of water contaminated with animal and human faeces which contains harmful or pathogenic microorganisms. Over the last decade, water related health issues have become more and more complex with emergence of new water related diseases and re-emergence of already existed ones. Gastroenteritis, dysentery, Hepatitis-B, Typhoid are commonly observed water borne diseases in Navi Mumbai. The total number of persons affected by water borne diseases are given below in Table No. 40. The number of affected persons reduced drastically this year compared to last 5 years.

Table No. 40: Persons affected by Water borne diseases in NMMC

| Area | Patients Per node | | | | | | | |
|--------------|-------------------|------------|------------|------------|------------|------------|------------|-----------|
| | 2009-10 | 2010-11 | 2011-12 | 2012-13 | 2013-14 | 2014-15 | 2015-16 | 2016-17 |
| CBD Belapur | 14 | 21 | 10 | 8 | 5 | 8 | 12 | 2 |
| Karave | 21 | 27 | 7 | 6 | 1 | 4 | 8 | 12 |
| Nerul | 23 | 20 | 4 | 8 | 6 | 5 | 12 | 1 |
| Nerul II | 21 | 32 | 15 | 5 | 7 | 4 | 16 | 0 |
| Shiravane | 23 | 29 | 17 | 5 | 51 | 42 | 33 | 2 |
| Sanpada | 8 | 24 | 15 | 7 | 6 | 10 | 21 | 1 |
| Indranagar | 48 | 37 | 35 | 26 | 29 | 32 | 36 | 5 |
| Turbhe | 81 | 40 | 63 | 6 | 25 | 30 | 55 | 8 |
| Vashi | 22 | 19 | 16 | 22 | 18 | 12 | 14 | 3 |
| Juhugaon | 20 | 12 | 28 | 33 | 1 | 1 | 26 | 7 |
| Khairne | 81 | 38 | 23 | 28 | 52 | 48 | 41 | 11 |
| Mahape | 56 | 16 | 63 | 37 | 24 | 26 | 28 | 1 |
| Pawane | 8 | 15 | 7 | 28 | 18 | 12 | 18 | 4 |
| Ghansoli | 18 | 32 | 38 | 21 | 18 | 16 | 34 | 4 |
| Rabade | 3 | 4 | 6 | 8 | 13 | 11 | 12 | 1 |
| Katkaripada | 21 | 20 | 2 | 2 | 0 | 5 | 19 | 2 |
| Airoli | 29 | 22 | 86 | 40 | 25 | 25 | 34 | 1 |
| Chichpada | 50 | 11 | 8 | 3 | 3 | 2 | 12 | 0 |
| Digha | 11 | 14 | 13 | 9 | 10 | 8 | 21 | 1 |
| Nagaon | 0 | - | - | - | 2 | 0 | 0 | 0 |
| Ilthanpada | 0 | 16 | 16 | 5 | 4 | 1 | 16 | 1 |
| NOCIL Naka | 0 | 0 | 0 | 0 | 4 | 0 | 8 | 0 |
| Total | 558 | 449 | 472 | 307 | 318 | 302 | 476 | 67 |

Data source: Health Department, NMMC

As seen in **Figure No. 39**, the number of cases for gastro intestine diseases have decreased drastically as compared to the past 2 years. There is almost 90% decrease (35 cases) in the number of cases if compared with the cases recorded last year (351 cases). *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. A drastic decrease could also be recorded by almost 98% in the cases of dysentery. The number of cases have decreased from 65 cases in 2015-16 to only 1 case in 2016-17. Hepatitis-B cases increased by double from 6 cases in 2015-16 to 12 cases in 2016-17 while Typhoid also showed decreasing trend from 54 cases last year to 19 cases in 2016-17.

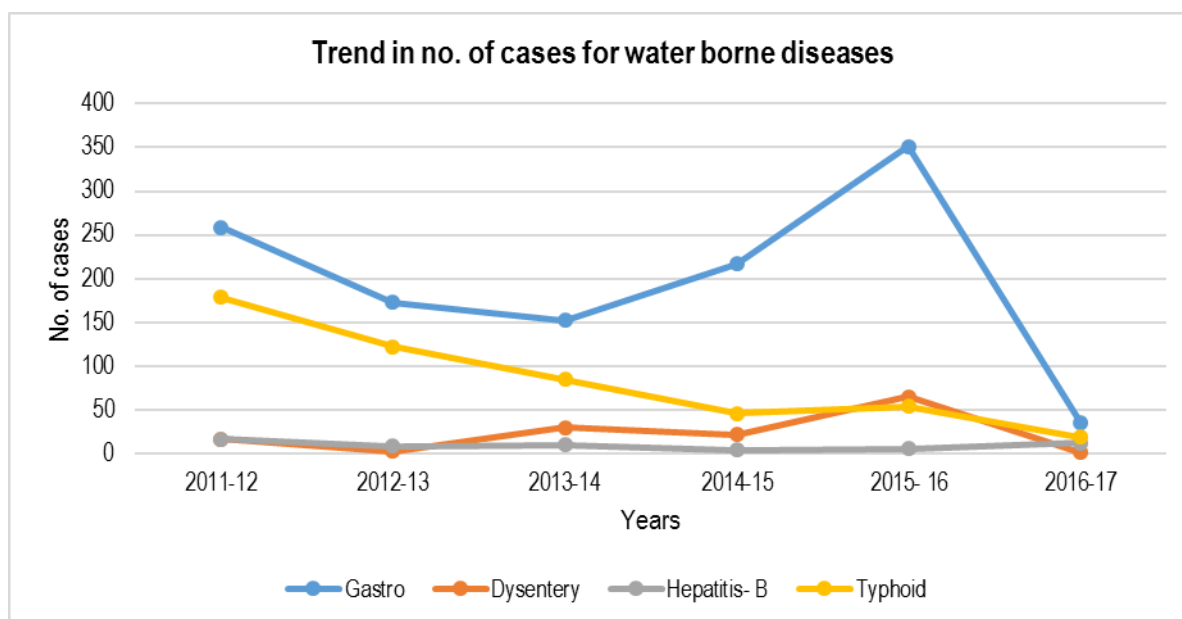


Figure No. 39: Trend in cases of water borne diseases reported in NMMC area

Source: Health Department, NMMC

Vector Borne Diseases

Vector borne diseases are transmitted by vectors like mosquitoes, ticks and fleas. These vectors can carry infective pathogens such as bacteria, viruses and protozoa which can be transferred from one host to another. The Occurrence and distribution of vector borne diseases is greatly influenced by climatic conditions. These diseases are commonly found in tropical and sub-tropical regions where many people do not get access to safe drinking water and hygienic conditions. These diseases contributes for around 17% of total global burden of infectious diseases where Malaria is most common and Dengue is one of the fastest growing vector borne disease in the world⁵⁷.

Malaria

Plasmodium parasite is responsible for causing Malaria. The spread of parasites in humans occurs through the bites of female Anopheles mosquitoes. There are five such parasitic species that cause Malaria in humans out of which *P. falciparum* and *P. vivax* pose the greatest threats. The intensity of transmission of Malaria greatly depends on climatic conditions. Malaria is more common in Tropical and subtropical climates. 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, a decreasing trend is been observed for the reported malaria cases from the past 2 years. The number of cases have decreased from 396 in 2013-14 to 242 in 2016-17.

⁵⁷ <http://www.who.int/campaigns/world-health-day/2014/vector-borne-diseases/en/>

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

| Nodes/Year | 2012-13 | 2013-14 | 2014-15 | 2015- 16 | 2016-17 |
|--------------|------------|------------|------------|------------|------------|
| CBD Belapur | 14 | 18 | 20 | 30 | 13 |
| Karave | 14 | 33 | 34 | 31 | 24 |
| Nerul | 13 | 19 | 18 | 12 | 11 |
| Nerul II | 17 | 39 | 27 | 19 | 5 |
| Shiravane | 12 | 23 | 26 | 17 | 8 |
| Sanpada | 13 | 24 | 20 | 14 | 11 |
| Turbhe | 16 | 13 | 26 | 20 | 24 |
| Pawane | 7 | 27 | 24 | 24 | 23 |
| Indiranagar | 22 | 54 | 39 | 27 | 41 |
| Juhugaon | 0 | 2 | 3 | 3 | 1 |
| Vashigaon | 2 | 5 | 5 | 4 | 2 |
| KoperKhairne | 17 | 21 | 20 | 19 | 15 |
| Mahape | 6 | 8 | 6 | 6 | 6 |
| Ghansoli | 10 | 21 | 16 | 17 | 13 |
| Rabade | 5 | 8 | 6 | 5 | 6 |
| Katkaripada | 9 | 12 | 14 | 9 | 7 |
| Airoli | 4 | 10 | 8 | 10 | 6 |
| Chinchpada | 4 | 10 | 9 | 7 | 3 |
| Digha | 14 | 20 | 16 | 7 | 7 |
| Ilthanpada | 8 | 12 | 13 | 11 | 8 |
| NOCIL naka | 0 | 0 | 6 | 9 | 8 |
| Total | 207 | 396 | 356 | 301 | 242 |

Source: Health Department, NMMC

Dengue

Dengue or Dengue Fever is a tropical mosquito borne viral disease transmitted by female mosquitoes mainly of the species *Aedes aegypti*. Dengue is spread throughout tropics and its intensity of occurrence is influenced by rainfall, lack of hygiene and sanitation, unplanned urban growth. Dengue fever is severe with symptoms like severe headache, nausea, vomiting, muscle joints and skin rashes. In absence of effective medical treatment, it may cause death of an individual. The disease could be prevented by following good practices like covering, cleaning domestic water storage tanks periodically, preventing mosquito breeding sites through proper environmental management. As shown in the Figure No. 40, the number of cases for Dengue fever have reduced (54) this year registering a decrease of almost 29% than the cases recorded last year.

Response

NMMC's health department is vigilant enough to check and initiate effective measures for the control and eradication of 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.

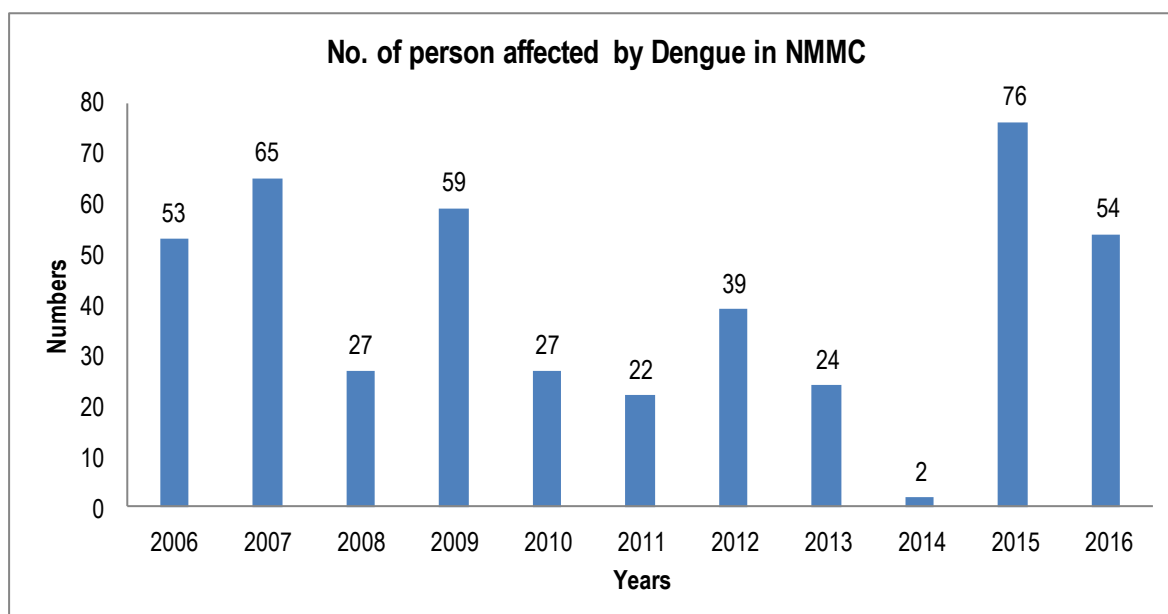


Figure No. 40: Total number of Dengue cases reported in Navi Mumbai

Source: Health Department, NMMC

Regular Preventive measures

- Weekly anti-larval spraying and fogging through private contractors divided into 20 groups with 261 contract workers and 44 workers for fogging activity is undertaken throughout area under NMMC jurisdiction. The program is implemented effectively due to detailed data availability regarding usage and frequency of anti-larval spraying and fogging (Picture No. 21).
- Guppy fish (*Poecilia reticulata*) is known to consume mosquito larvae and has been also documented largely through research activities⁵⁸. NMMC also undertakes various activities to cultivate as well as introduce guppy fishes at potential breeding sites. A detailed inventory (Picture No. 21) of such breeding sites is conducted before and after monsoon and currently, there are 11,372 guppy fish locations in NMMC. Every worker possesses information regarding Mosquito breeding sites, map locations, breeding site and these guppy fishes are introduced periodically to control the growth of mosquito larvae.
- NMMC also undertakes action for appropriate treatment of the affected patients as well as patients in the window period through a dual pronged approach. Direct and Indirect. The Direct survey is conducted through Household visits and giving treatment to the patient after blood test. In construction and sensitive sites, weekly visits are made and in other areas visits are made once every fortnight. In the indirect survey, proper treatment is provided to patients after taking blood samples through Government hospitals, 4 Mata Bal hospitals and 21 Civilian medical centres. Mass survey and medical camps are organised if deemed necessary.
- Mosquito survey- The survey is done to check status of mosquitoes in particular area to prevent or control any occurrence or spread of mosquito borne diseases. This is done by conducting a survey of mosquito infected areas for 15 minutes/site and taking immediate measures if the mosquito density is high.

⁵⁸ <https://www.ncbi.nlm.nih.gov/pubmed/8815867>



Picture No. 21: Anti-Larval Spraying activity (Left) Inventory of Guppy Fish Breeding sites (right)

Initiatives taken to control Vector borne diseases in 2016-17

Campaign for awareness against Dengue and Malaria

- Campaign was organized in April-May 2016 wherein 308244 houses were visited and 657309 breeding sites were surveyed, out of which 1401 were found to be active breeding sites. From these sites, 499 breeding sites were destroyed and 902 sites were treated.
- June, 2016 was declared as **Malaria Prevention Month** and under this initiative, around 160 Malaria camp, 72 medical education in schools, 16 student's march against malaria, 63 society meetings, and 17 private medical workshops were conducted.
- July, 2016 was declared as **Dengue Prevention month** and workshops were arranged in 69 places. Total 2443 blood samples were collected and 2507 patients were treated. Around 11205 brochures regarding malaria and dengue prevention were distributed.
- Special Indoor Checking Campaign was undertaken during August, 2016 under which 179747 houses were checked. Out of 339512 possible breeding sites, 1246 were found active which contained 300 *Anopheles*, 907 *Aedes*, and 39 *culex* sites which were destroyed and others were treated.
- During Ganesh-Utsav festival in September, 2016, awareness was done through camps, banners, hoardings. Similar activities were performed in other months.
- Guppy fish campaign was carried out in May, 2016 as a biological treatment for mosquito problems. After brief survey, guppy fishes were released in 11372 sites in which 6251 sites are permanent while 5121 are temporary Breeding spots. While anti-Mosquito powder was sprayed in Government, private schools and colleges.
- 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 systems⁵⁹. 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.

⁵⁹ <http://mpcb.gov.in/CEPI/pdf/Action%20Plan%20CEPI-Navimumbai.pdf>



Picture No. 22: Students and staff members of NMMC schools taking Pledge during Anti Dengue Month(left) and An awareness campaign during Ganapati utsav (right)

Preparedness for Swine Flu outbreak

1. Screening centres – NMMC is has 26 Screening centres for detection and diagnosis of swine flu which are used in case of swine flu outbreak. 21 in civilian medical centres, 3 in Mata Bal hospitals and 1 each in NMMC public hospital (Vashi) and in D.Y.Patil hospital (Nerul).
2. NMMC has 2 Isolation wards 1 in Vashi Public Hospital (8 beds) and other in D.Y.Patil hospital (10 beds).
3. Vaccination of Isolation ward staffs for prevention against swine flu.
4. Medicines and other important equipment in case of swine flu outbreak have been provided in stock with the screening centres and hospital authorities.
5. Training to people from various sectors has been given through workshops and posters few of them are listed in Table No. 42.

Table No. 42: List of places and number of trainees trained against swine flu

| Sr No | Venue | Participants |
|-------|---------------------------------------|-----------------------------|
| 1 | Arvato India Limited | 500 workers |
| 2 | Sai Snehdeep hospital in Koparkhairne | 45 staff members |
| 3 | Schools | 146 Principals and students |
| 4 | Civil medical centre, CBD belapur | 250 women |
| 5 | Private hospitals | 207 Private hospitals |

Recent Achievements

- Improvement in Animal Parasite Index (API) value from 18 in 1997 to 0.21 in 2016 due to effective prevention and control measures. According to State Government circular, API value less than 2 indicates effective implementation of National Vector Borne Disease Control Programme.
- Success in controlling Dengue spread during September to November 2016 by Health department.
- National Vector Borne Disease Control Programme, Indian Government, New Delhi and Respected Joint Director of Disease control Programme praised the work done by NMMC for controlling spread of such diseases and designated it as a Role Model for other Municipal corporations.

Air Borne Disease - Tuberculosis

Airborne diseases are caused by pathogenic microbes that transmit through air as a medium. These microscopic pathogens get discharged from an infected person via coughing, sneezing, laughing or close personal contact. The discharged microbes remain in air on dust particles and water droplets. Infection occurs once these microbes get inhaled or come in contact through touch. Tuberculosis is an Airborne disease caused by one species of Mycobacteria, called *Mycobacterium tuberculosis*. TB is a major cause of human deaths in India which kills more than 3,00,000 persons every year⁶⁰. This bacteria can attack any part of the body but particularly it attacks on Lungs, condition called as Pulmonary TB. The common symptoms of Pulmonary TB include fever, chest pain, Loss of appetite, cough, and weight loss. When an infection occurs in other parts of the body, outside lungs then the condition is called as extra pulmonary TB.

NMMC is continuously implementing a TB eradication program in the region. It could be observed from that the number of cases recorded for tuberculosis are showing an increasing trend for the past 5 years. The total no. new and re treatment cases have increased by 6.3% from the year 2015 (1795) to 2016 (1909). 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.

⁶⁰ <http://www.tbcindia.nic.in/index4.php?lang=1&level=0&linkid=382&lid=2748>

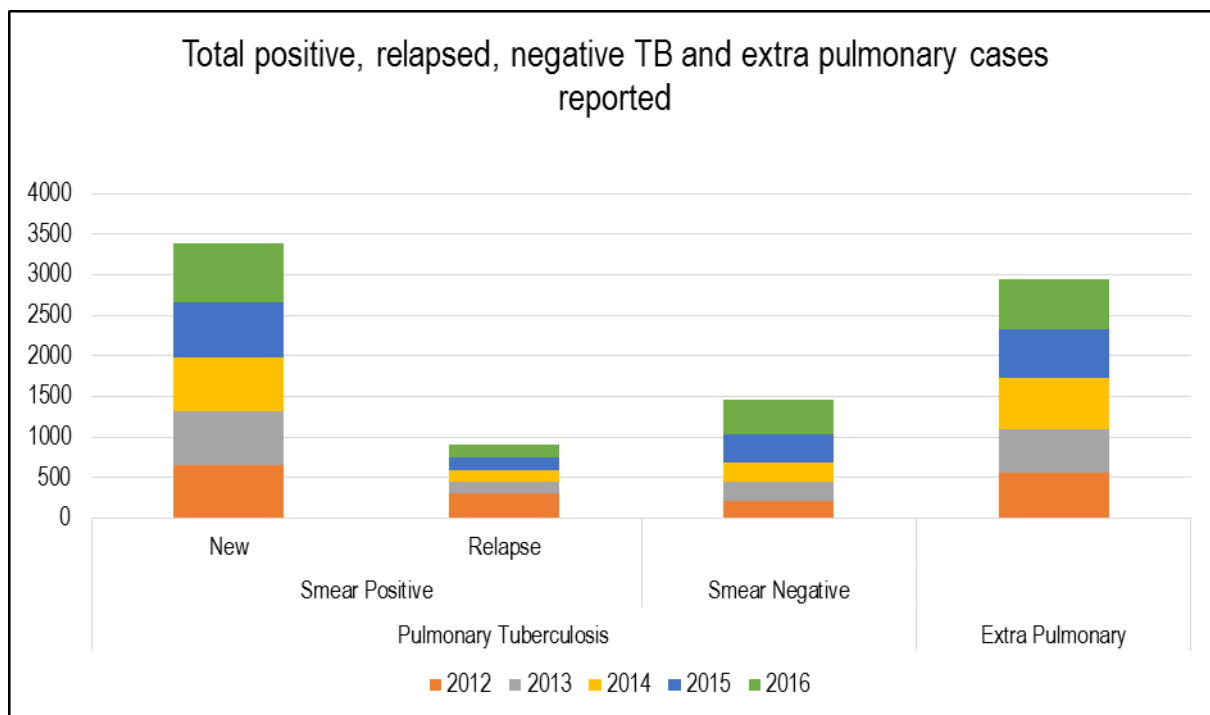


Figure No. 41: Total number of cases and deaths reported due to TB in the past five years
Source: Health Department, NMMC

Response

NMMC's Health department is regularly monitoring spread of air borne disease like Tuberculosis (TB). The department has taken various initiatives and providing facilities like free medical checkup for TB detection and free medicines from NMMC affiliated hospitals, health posts, NGOs. The NMMC has undertaken preventive as well as therapeutic measures to eradicate TB.

- Provision of Providing DOTS (Directly observed treatment, short course), also known as TB-DOTS everyday instead of 3 days in a week from current year. These DOTS are available in NMMC affiliated hospitals, NGOs, health posts.
- Conducting Cartridge Based Nucleic Acid amplification Test (CB-NAAT) on MDR (Multi-Drug Resistance) and XDR (Extensively Drug-Resistant) TB patients and providing medicines free of cost.
- Periodic training to hospital staffs and conducting TB eradication program.

Annex–I: Calculation of indices

Approach

The information on environmental parameters is often too complex and non-comprehensible 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 73.66%. The detailed parameters for EQI is tabulated in Table No. 44.

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. 1

It has been found out that present UII in NMMC area is 81.76 %.

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 77.71%.

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 | 100 | 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, % | | | | Remarks |
|---------|--|--------------------------------|-----------------|-----------------|-----------|--|
| | | Max | Average 2015-16 | Average 2016-17 | Variation | |
| A. | Ambient Air Quality | | | | | |
| A.1 | Air Quality Index-Residential Area (RSPM) | 10 | 7.11 | 7.11 | 0.00 | - |
| A.2 | Air Quality Index-Traffic Junctions (RSPM) | 5 | 2.95 | 3.00 | +0.05 | Due to completion of construction of roads in MIDC area. |
| B. | Ambient Noise Levels | | | | | |
| B.1 | Noise Level: Residential Area | 10 | 4.18 | 3.93 | -0.25 | Increase in vehicular population of the city and increase in honking & driving practices attributed to increase in noise levels. |
| B.2 | Noise Level: Traffic Junctions | 5 | 1.59 | 1.58 | -0.01 | Due to rapid increase in vehicular population in the city and construction of ROB in Thane Belapur Road by MMRDA |
| C. | Ambient (Surface/Ground) Water Quality | | | | | |
| C.1 | Surface (Drains) Water Quality, BOD mg/l | 3 | 2.20 | 2.32 | +0.12 | Decrease in BOD level of some Nallahs since NMMC conducted survey in Chemical industries along khairne Nallah. |
| C.2 | Surface (Lake) Water Quality, BOD mg/l | 3 | 2.21 | 1.84 | -0.37 | Due to lack of proper security system for preventing contamination of lake water by washing of clothes |
| C.3 | Ground (Well) Water Quality, BOD mg/l | 3 | 2.55 | 2.75 | +0.20 | Due to periodical cleaning & disinfection of wells. |
| C.4 | Efficiency of Sewage Treatment Plants | 6 | 5.85 | 5.85 | 0.00 | - |
| D. | Solid Waste Management | | | | | |
| D.1 | Solid Waste Collected, percentage | 3 | 2.85 | 2.94 | +0.09 | Micro planning in door to door garbage collection and change of compactor capacity to 5T, 8 T & 10 T. |
| D.2 | Solid Waste Segregation at Household Level, percentage | 2 | 0.20 | 1.20 | +1.00 | Due to proper awareness and monitoring of segregation of wet & dry garbage at household level. . |
| D.3 | Solid Waste Segregation at Disposal Site, percentage | 2 | 1.70 | 1.90 | +0.20 | Due to proper segregation of wet & dry garbage at source and due to increase in operational efficiency of processing plant |

| Sr. | Parameter | Environmental Quality Index, % | | | | |
|-----|--|--------------------------------|--------------|--------------|--------------|---|
| D.4 | Solid Waste Recycle at Household Level, percentage | 2 | 1.60 | 1.60 | 0.00 | - |
| D.5 | Solid Waste Recycle at Disposal Site, percentage | 2 | 1.90 | 1.90 | 0.00 | - |
| D.6 | Biomedical Waste Collected, percentage | 2 | 2.00 | 2.00 | 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 | 8.50 | +0.50 | Due to appointment of Nodal Mangroves Protection Committee by State Govt. |
| 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 | 4.86 | 4.76 | -0.10 | In rainy season increase in non-potability of some village & slum area. |
| F.2 | No. of cases of water borne diseases in node(cholera, Jaundice, Hepatitis) | 5 | 4.04 | 4.81 | +0.77 | Due to proper awareness and organization of health campaigns |
| F.3 | No of cases of malaria in node | 5 | 4.29 | 4.55 | +0.26 | Due to proper monitoring and control of breeding places of mosquitoes in NMMC area. |
| F.4 | Cases of TB, percentage population affected | 3 | 2.52 | 2.52 | 0.00 | - |
| F.5 | Control of Street Dogs | 2 | 1.20 | 0.80 | -0.40 | Due to increase in no. of dog bites |
| | Total | 100 | 71.59 | 73.66 | +2.07 | |

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 entered. | MPCB Regional Offices | 51.84 | 4 |
| | Spatial growth (Decadal) | Population density | Persons/sq Km | | Census | 10472 | 2 |
| | | % of slum area to city area | % | | Census | 21 | 2 |
| | | | | | | | |

| Thematic Indicators | Primary indicators | Data variables | Unit | Instructions | Source | Value | Score |
|----------------------------|--------------------|--|-----------|--|---------------------------------------|-------|-------|
| 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 rate | % | | Census | 4.32 | 8 |
| | | Infant mortality rate | % | | Census | 11.10 | 10 |
| | | | | | | | |
| Urban services | Water Supply | Net LPCD supplied | lpcd | | Water supply department | 293 | 10 |
| | | % of households connected by | % | | | 100 | 10 |

| Thematic Indicators | Primary indicators | Data variables | Unit | Instructions | Source | Value | Score |
|---------------------|---------------------|---|---------|--------------|-----------------------------------|-------|-------|
| | | service connection | | | | | |
| | | 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 | % | | | 85.00 | 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 to total BM waste | % | | | 100 | 10 |
| | Transport | Road area as % of city area | % | | Town Planning Department | 13.6 | 8 |
| | | % of population travelling by | % | | Regional Transport Authority | 60.0 | 4 |

| Thematic Indicators | Primary indicators | Data variables | Unit | Instructions | Source | Value | Score |
|--|---------------------------------------|---|-------|---|--------|-------|-------|
| | | public transport | | | | | |
| 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 Moderate L for Low A for Absent | | H | 6 |
| | | To what extent are awareness programs on environment launched during festivals or other times of the year? | | | | M | 4 |
| | | To what extent exhibitions / street plays etc organized to spread environmental awareness? | | | | H | 6 |
| | | To what extent does the city/town have any local Television channel running programs, advertisements related to environment | | | | M | 4 |

| Thematic Indicators | Primary indicators | Data variables | Unit | Instructions | Source | Value | Score |
|---------------------|--------------------|---|------|--------------|--------|-------|-------|
| | | sponsored by the respective ULB? | | | | | |
| | | 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? | | | | M | 4 |
| | | 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 | | | | M | 4 |
| | | | | | | | |

| Thematic Indicators | Primary indicators | Data variables | Unit | Instructions | Source | Value | Score |
|---------------------|--------------------|---|------|--------------|--------|-------|-------|
| | | the policy and regulations of the ULB? | | | | | |
| | | 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 centres and regular health checkups? | | | | VH | 8 |
| | | 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 | | | | VH | 8 |

| Thematic Indicators | Primary indicators | Data variables | Unit | Instructions | Source | Value | Score |
|---------------------|--------------------|---|------|--------------|--------|-------|-------|
| | | managed by the ULB? | | | | | |
| | | 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 |
| | 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 |

| Thematic Indicators | Primary indicators | Data variables | Unit | Instructions | Source | Value | Score |
|---------------------|--------------------|---|------|--------------|--------|-------|-------|
| | | 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

| SN | Category | Type of Vehicle | Financial Year | | | | | | | | | | | |
|----------------------------------|-------------------|--------------------------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | | 05-06 | 06-07 | 07-08 | 08-09 | 09-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 |
| Newly Registered during the year | | | | | | | | | | | | | | |
| 1 | 2-Wheelers | Motor Cycles | 11201 | 14262 | 12716 | 11345 | 5235 | 16361 | 15188 | 17395 | 16525 | 17953 | 24354 | 22535 |
| 2 | | Scooters | 2144 | 930 | 163 | 177 | 7547 | 271 | 81 | - | 0 | 0 | 0 | 0 |
| 3 | | Mopeds | 5 | 0 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 |
| 4 | 4-Wheelers | Cars | 4455 | 8082 | 11165 | 9586 | 10665 | 13042 | 13184 | 11808 | 8298 | 10841 | 10709 | 10345 |
| 5 | | Jeeps | 25 | 342 | 217 | 162 | 160 | 222 | 104 | - | 0 | 0 | 0 | 0 |
| 6 | | Station Wagons | 0 | 196 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 |
| 7(A) | Taxi/Autorickshaw | Taxi meter fitted | 0 | 0 | 0 | 0 | 0 | 0 | 187 | - | - | 0 | 0 | 3155 |
| 7(B) | | Taxi Tourist Cabs | 885 | 1010 | 1261 | 731 | 283 | 630 | 548 | 851 | 439 | 917 | 1966 | |
| 8 | | Auto-Rickshaws | 892 | 516 | 457 | 227 | 606 | 444 | 493 | 628 | 1663 | 3487 | 2445 | 1993 |
| 9 | Buses | Stage carriages | 0 | 0 | 31 | 33 | 49 | 116 | 11 | 4 | 1 | 43 | 44 | 109 |
| 10 | | Contract carriages | 94 | 131 | 346 | 337 | 209 | 314 | 251 | - | 35 | 248 | 334 | 164 |
| 11 | | School Buses | 0 | 0 | 14 | 30 | 23 | 35 | 136 | 180 | 99 | 96 | 143 | 32 |
| 12 | | Private Service Vehicles | 46 | 6 | 32 | 39 | 21 | 43 | 32 | 171 | 5 | 14 | 11 | 10 |

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| SN | Category | Type of Vehicle | Financial Year | | | | | | | | | | | |
|----------------------------------|----------------------|---------------------------|----------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| | | | 05-06 | 06-07 | 07-08 | 08-09 | 09-10 | 10-11 | 11-12 | 12-13 | 13-14 | 14-15 | 15-16 | 16-17 |
| Newly Registered during the year | | | | | | | | | | | | | | |
| 13 | | Ambulances | 6 | 4 | 41 | 24 | 35 | 39 | 28 | 10 | 16 | 37 | 18 | 18 |
| 14 | | Arti.& Muli. Vehicles. | 10 | 43 | 0 | 0 | 0 | 2 | 0 | 30 | - | 0 | 0 | |
| 15 | Other Heavy Vehicles | Trucks & Lorries | 1094 | 1316 | 2297 | 939 | 934 | 1717 | 1067 | 901 | 725 | 1655 | 2609 | 1057 |
| 16 | | Tankers | 210 | 204 | 445 | 186 | 257 | 168 | 220 | 249 | 155 | 226 | 267 | 283 |
| 17 | | Delivery Van (4 wheelers) | 864 | 1144 | 667 | 147 | 256 | 309 | 643 | 512 | 213 | 302 | 284 | 197 |
| 18 | | Delivery Van (3 wheelers) | 966 | 2167 | 1501 | 978 | 1095 | 1237 | 1462 | 1565 | 1019 | 1602 | 1866 | 1129 |
| 19 | | Tractors | 20 | 11 | 0 | 0 | 0 | 0 | 0 | - | 0 | 0 | 0 | 0 |
| 20 | | Trailers | 0 | 347 | 778 | 428 | 460 | 694 | 381 | 438 | 230 | 351 | 364 | 344 |
| 21 | | Others | 0 | 19 | 12 | 11 | 10 | 20 | 57 | 7 | 15 | 25 | 9 | 46 |