Research

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India Urban Infrastructure Report 2020

Special Focus on Mumbai Transport Infrastructure with Key Impact Markets

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Mumbai HO
Knight Frank (India) Pvt. Ltd.
Paville House, Near Twin Towers
Off. Veer Savarkar Marg, Prabhadevi
Mumbai 400 025, India
Tel: +91 22 6745 0101 / 4928 0101

Bengaluru
Knight Frank (India) Pvt. Ltd.
204 & 205, 2nd Floor, Embassy Square
#148 Infantry Road
Bengaluru 560001, India
Tel: +91 80 4073 2600 / 2238 5515

Pune
Knight Frank (India) Pvt. Ltd.
Unit No.701, Level 7, Pentagon Towers P4
Magarpatta City, Hadapsar
Pune 411 013, India
Tel: +91 20 6749 1500 / 3018 8500

Chennai
Knight Frank (India) Pvt. Ltd.
1st Floor, Centre block, Sunny Side
8/17, Shafee Mohammed Road
Nungambakkam, Chennai 600 006, India
Tel: +91 44 4296 9000

Gurgaon
Knight Frank (India) Pvt. Ltd.
Office Address: 1505-1508, 15th Floor, Tower B
Signature Towers South City 1
Gurgaon 122 001, India
Tel: +91 124 4782 700

Hyderabad
Knight Frank (India) Pvt. Ltd.
SLN Terminus, Office No. 06-01, 5th Floor
Survey No. 133, Gachibowli
Hyderabad – 500032, India
Tel: +91 40 4455 4141

Kolkata
Knight Frank (India) Pvt. Ltd.
PS Srijan Corporate Park
Unit Number – 1202A, 12th Floor
Block – EP & GP, Plot Number - GP 2
Sector – V, Salt Lake, Kolkata 700 091, India
Tel: +91 33 6652 1000

Ahmedabad
Knight Frank (India) Pvt. Ltd.
Unit Nos. 407 & 408, Block 'C', The First
B/H Keshav Baugh Party Plot
Vastrapur, Ahmedabad – 380015
Tel: +91 79 4894 0259 / 4038 0259

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FOREWORD

Shishir Baijal
Chairman and Managing Director
Knight Frank India Pvt Ltd

A growing economy such as India requires substantial and focused investments in infrastructure that will enable businesses and attract further capital to sustain its economic momentum. India has long been counted amongst the fastest growing economies of its size, but the recent slowdown has cast a shadow on our GDP target of USD 5 tn by 2025. The Finance Ministry's Economic Survey of 2019 had concluded that India needs to spend 7%-8% of its GDP or USD 200 bn annually on infrastructure to meet its growth targets. The government's decision to invest nearly USD 1.5 tn in the next 5 years (or USD 300 bn annually), is a measure of its commitment to revive economic growth.

Urban centers form the engine that fuel economic growth across the world, and consequently contain the highest population concentrations that cause maximum conflicts with the environment. Proper planning and infrastructure development can mitigate and minimize these conflicts to a great extent and ensure that cities sustain their growing population without exacting too great a toll from the environment. The India Urban Infrastructure Report 2020 – Special Focus on Mumbai Transport Infrastructure with Key Impact Markets' discusses some of these major conflict areas and the role that regulatory interventions and systematic infrastructure development can play in mitigating them.

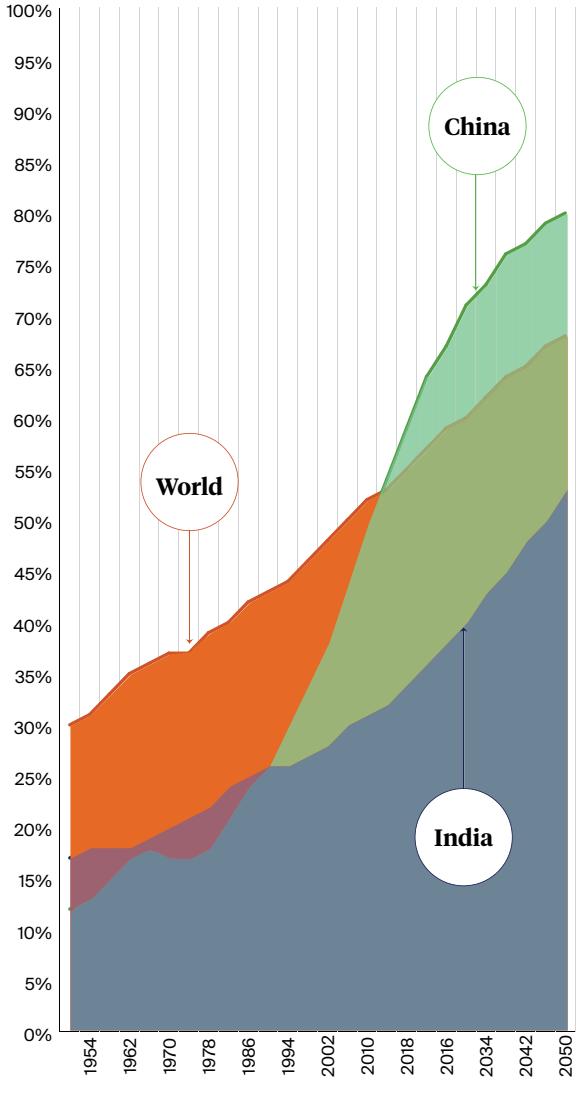
While the debate on urban infrastructure has moved beyond transport and on to other factors that affect the sustainability of the environment and our overall quality of life, transport infrastructure remains the most prominent factor that affects the real estate market. In this context, the Report considers the Mumbai Metropolitan Region (MMR) as a case study in how transport infrastructure projects have played a pivotal role in the growth of a city and the influence they have had on the population flows within. It focuses especially on the USD 26.7 bn of transport infrastructure projects currently underway in the MMR and analyses their impact on the real estate market in terms of locations that will see increased real estate traction due to mounting demand. We thank you for giving your time and consideration for this Report and hope you will find it an interesting read.

THE URBANISATION PHENOMENON

The global population has been growing rapidly in recent decades, especially in developing countries. This has caused a corresponding growth in Urbanisation as this population gravitates toward urban centers in search of employment opportunities and a better standard of living. Urban centers essentially concentrate economic activity and enable the resident population to participate in the country's growth story. Urbanisation is also widely recognized as the best solution to deal with the world's population growth as infrastructure can be focused and optimized to deal with the requirements of a dense population much more efficiently than to a dispersed population. Therefore an inevitable trend exists, following which the world will continue to become increasingly urbanised in future as well.

Chart 1.

GROWTH OF URBANISATION



Source: Department of Economic and Social Affairs, United Nations

The economic role of cities is substantial as they generate close to 80% of the global GDP and a massive 4.2 bn people or 55% of the human population lived in urban centres across the world at the end of 2018, according to the United Nations. Further, these urban centres are forecasted to house close to 68% or 6.5 bn people by 2050. While cities occupy just 3% of the Earth's land, is is estimated that they account for 60-80% of the global energy consumption and at least 70% of the carbon emissions. There were just 10 cities with 10 mn people or more in 1990, witch has grown to an estimated 33 such mega-cities across the globe.

Table 1.

URBANISATION IN INDIA

	Persons in million numbers		Decadal growth in population %	
	2001	**2011**	**1991-2001**	**2001-2011**
Total	1029	1210	21.5	17.6
Rural	743	833	18.1	12.2
Urban	286	377	31.5	31.8

Source: Census of India 2011

According to 1901 census, the population residing in urban areas in India was 11.4%. This count increased to 27.81% according to 2001 census, and crossing 31% as per 2011 census. The United Nations estimates India to be 34% urbanised in 2018 and forecasts that over 50% of India's population will live in cities by 2046.

CHALLENGES OF SUSTAINABILITY AND LIVEABILITY

◆◆

Urban planning has generally not kept pace with the rate at which today's urban centres have 'urbanised'. More reactive rather than proactive especially in the developing countries, poor urban planning has resulted in urban sprawl and low-density suburbanisation that substantially increases the cost of delivering infrastructure to a more dispersed population.

◆◆

Urban centres around the world form the bedrock of the economic engine that drives global growth. However, rapid population growth along with the fact that these cities operate in an economic, social and cultural environment that is vastly different from what existed 20 years ago, present enormous challenges to these growth centres. Especially since the turn of this century, urban centres have been persistently plagued with issues such as unplanned urban growth, changes in family patterns, growing incidence of slums and informal settlements, environmental pollution and the challenge of providing adequate urban services such as housing, efficient transport, water and power.

Although urbanisation is an important catalyst in making cities more prosperous and countries more developed, many cities all over the world are not geared for the myriad of challenges associated with it. Proper urban planning is the best way to mitigate the challenges associated with growing urban centers. However, while urban planning has evolved as a discipline globally, it has generally not kept pace with the rate at which today's urban centres have 'urbanised'. The current model of Urbanisation is more reactive rather than proactive, especially in the developing countries, and has resulted in urban sprawl and low-density subUrbanisation that substantially increases the cost of delivering infrastructure to a dispersed population. This has a negative impact on the environment as it is energy-intensive and consequently contributes dangerously to climate change. The model of Urbanisation creates social and spatial inequalities too which are characterized by extravagantly affluent communities and large slum areas, much like what Mumbai has become today. Cities perpetually face difficulties in managing the growing population in terms of ensuring equality in sharing the city's social and cultural assets.

From an economic perspective, this reactive model of Urbanisation is unsustainable as the costs incurred to fulfill capacities not added earlier in growing cities, far outweigh the perceived savings at the time of installing them in the first place. Other economic fallouts of Urbanisation also include widespread unemployment especially among the youth and the existence of unstable and low-paying jobs and informal income-generating activities, which create economic hardship, unequal access to urban services and amenities and poor quality of life for many.

Challenges and Shortcomings of Sustainable Urban Development

1.1

UNPLANNED DEVELOPMENT

Urbanisation entails the optimisation or intensification of infrastructure of an existing or upcoming urban area, and pushing the geographical boundaries of urban centers to accommodate its constantly increasing population. As the city expands its municipal boundaries, it must be in a position to provide basic physical facilities like electricity, transport infrastructure such as roads or rail, clean drinking water, communication infrastructure besides health and education infrastructure for its resident population. However, the infrastructure in most cities - particularly in developing countries, is stretched too thin currently, due to a limited view of the capacities required to factor in growth in the medium to long term. Often, investments in infrastructure occur once the population has already moved in and the authorities do not have the time to plan future capacity or execute projects to adequately address existing concerns.

Gurgaon is a prime example of a city where development started in the late 1990s in pockets of affluent areas and office complexes that had no civic infrastructure or planning other than that provided by the real estate developer within the boundaries of his project. This lack of planning and arbitrary development caused immense stress on the government to provide adequate infrastructure for the growing city. The Gurgaon district population grew over 2.5 times during 1991 – 2011 and exceeded 1.5 mn by 2011. Almost 71% of this growth took place in the 2001 – 2011 period. The city had to contend with unplanned streets, acute electricity shortage and dangerously high air pollution levels. The city tdid not have a municipal body responsible for urban planning till 2008, when it started to fill in the gaps in infrastructure and had to incur much

higher infrastructure development costs as it lagged the city's population influx by the better part of a decade.

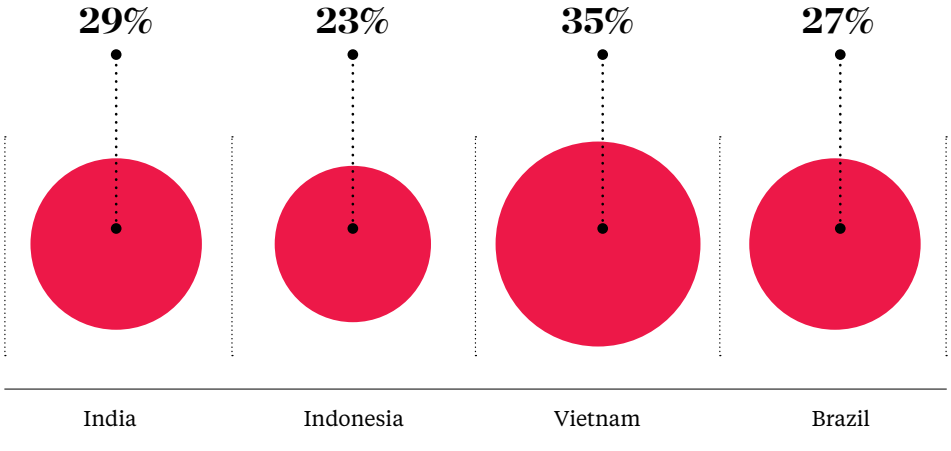
1.1.1 Growth of slums:

The United Nations define slums as heavily populated urban areas characterised by substandard housing and squalor. They are vast informal settlements that have become the most visible manifestation of urban poverty in developing world cities. Almost an exclusively urban phenomenon, slums proliferate in cities where the existing housing, transport, health and sanitation infrastructure is too costly and grossly inadequate for the growing population. The slum challenge continues to be one of the faces of poverty, inequality and deprivation in many cities in developing countries. While urban areas provide better access to employment and the promise of an improved lifestyle, growing cities such as Mumbai are hard pressed to accommodate the influx of prospective workers. Prohibitive housing costs in the city force most of this workforce, especially with mid to lower income levels to settle in far flung suburbs that are over 60 – 120 minutes away from workplaces or settle in slums such as Dharavi that are at least located closer to the city centre.

There were 0.9 million homeless people in urban India as per the Census data of 2011, in addition to a slum population of roughly 65 million (or 17% of urban India). People from rural India which is home to over 833 million people, have migrated to urban centres in large numbers and they make up a sizeable chunk of India's urban slum population. According to UN estimates, the proportion of urban population living in slums in India in 2009 was 29.4% (The UN definition of slum varies from that of the Census of India)

Chart 2.

URBAN POPULATION IN SLUMS



Source: State of the World Cities 2012/2013, United Nations

Slums are broadly characterized by certain distinct problems:

Poor living conditions

Crowding and lack of sanitation characterized by extremely small living quarters, common spaces and near absence or shortage of running water are some of the predominant problems. Urban resources such as water, power and open spaces are scarce and access to these is usually highly skewed toward the more privilileged. Slumdwellers rarely have access to running water or basic sanitation and health infrastructure such as toilets, hospitals and waste disposal. This frequently leads to an outbreak of diseases such as jaundice, cholera and malaria.

Unemployment

Despite the fact that urban areas are hotbeds of economic activity and provide prolific employment opportunities, the number of people competing for jobs is often more than the jobs available. Unemployment is thus an inevitable problem and globally, slums are home to the unemployed due to the marginal cost of living they afford. According to the National Sample Survey Office, the unemployment rate in urban India stood at a multi-decade high of 7.8% in FY 2018.

Crime

Slum conditions make maintenance of law and order difficult. Unemployment and poverty force people into anti-social activities and slums thus become a breeding ground for criminal activities.

1.2

CONFLICT WITH ENVIRONMENT

Humans are the dominant species on earth and we have thrived over the ages because of our unique ability to alter the environment to suit our needs. Urban areas represent the largest concentration of human societies and invariably have the greatest impact on the surrounding environment. Human activity that isn't directed and regulated through appropriate infrastructure can cause substantial damage to the natural environment and this damage increases with rising populations.

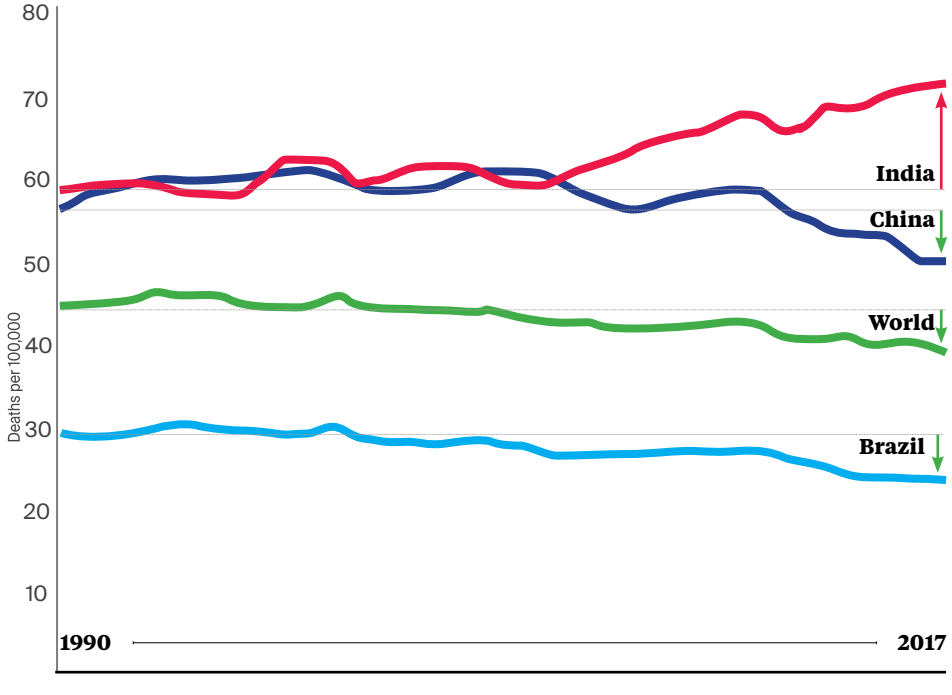
Some challages that uncontrolled urbanisation throws up include, inadequate sewage facilities leading to polluted water; unregulated growth leading to housing being built in environmentally sensitive areas and a lack of availability of gas or electricity leading to intensive cooking with wood fires, something that seriously compromises air quality. Following are some of the environmental phenomena that occur due to the proliferation of urban areas:

1.2.1 Air pollution

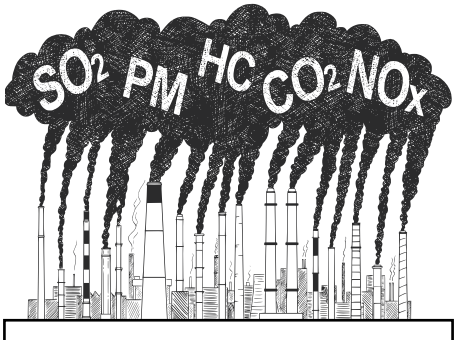
Air pollution occurs due to harmful emissions of gases and smoke from factories and vehicles. Current research shows that high amounts of suspended particulate matter in air, particularly in cities, contributes to health issues ranging from respiratory diseases such as Asthama and Chronic Obstructive Pulmonary Disease to neurobehavioral disorders and cancer. The World Health Organisation (WHO) highlights air pollution as the greatest environmental risk to human health. Further, it is estimated to be the cause of 7 million premature deaths every year (4.2 million from ambient outdoor pollution, and 2.6 million from household pollution). This mortality is primarily due to exposure to small particulate matter of 2.5 microns or less in diameter (PM2.5), which causes cardiovascular and respiratory disease, and cancer. A study conducted by the Lancet Journal concluded that over 1.2 mn Indians are estimated to have died prematurely in 2017 due to air pollution.

Chart 3.

DEATHS CAUSED BY AMBIENT PARTICULATE MATTER POLLUTION



Source: Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2017 (GBD 2017) Results, Institute of Health Metrics and Evaluation (IHME)



COMPONENTS OF AIR POLLUTION

Air pollution can be defined as the emission of harmful substances to the atmosphere. This broad definition includes a number of pollutants, some of which are:

- Sulphur Dioxide (SO2)
- Nitrogen Oxides (NOx)
- Ozone (O3)
- Particulate Matter (PM - small suspended particles of varying sizes)

Table 2.

WHO GUIDELINE LEVEL FOR EACH POLLUTANT (µg/m3*)

Parameter	Period	Reading
$PM_{2.5}$	1 year	**10**
	24 h	**25**
PM_{10}	1 year	**20**
	24 h	**50**
Ozone, O_2	8 h	**100**
Nitrogen dioxide, NO_2	1 year	**40**
	1 h	**200**
Sulphur dioxide, SO_2	24 h	**20**
	10 min	**500**

Source: World Health Organisation
* µg/m3 - microgram/ cubic meter

SO2 and NOx (generic term for nitrogen oxides in reference to air pollution, namely Nitric Oxide (NO) and Nitrogen Dioxide (NO2)) can react in the earth's atmosphere to form Particulate Matter (PM) compounds. The sources of each pollutant vary, however, most are generally linked to fuel combustion and industrial activities; pollutants are released as by-products of these processes. The effects of PM compounds on health manifest at levels of exposure currently being experienced by many people both in urban and rural areas, in developed and developing countries – although exposures in many developing cities today are often far higher than in developed cities of comparable size. The impact of PM compounds is more pronounced in the fast growing cities of developing countries.

A study conducted by the Lancet Journal concluded that over 1.2 mn Indians are estimated to have died prematurely in 2017 due to air pollution

There are serious risks to health not only from exposure to PM, but also from exposure to Ozone (O3), Nitrogen Dioxide (NO2) and Sulphur Dioxide (SO2). "WHO Air Quality Guidelines" estimate that reducing annual average fine Particulate Matter (PM2.5) concentrations from levels of 35 µg/m3, common in many developing cities, to the WHO guideline level of 10 µg/m3, could reduce air pollution-related deaths by around 15%. As with PM, concentrations are often highest in urban areas of low and middle-income countries. Ozone is a major factor in asthma morbidity and mortality, while Nitrogen Dioxide and Sulphur Dioxide can also play a role in asthma, bronchial symptoms, lung inflammation and reduced lung function.

Delhi

Delhi is the capital of India and has been bearing the brunt of air pollution over the past several decades. The 16.8 million population of the National Capital Territory of Delhi have been subject to average PM2.5 levels of 132 µg/m3 in 2014, 2015 and 2016 while the WHO annual standard for clean air is 10 µg/m3. The Air Quality Index for Delhi recorded the highest PM2.5 level (24 hrs) in November 2019 at 625 µg/m3, 25 times higher than the World Health Organization (WHO)-prescribed safe levels of 25 µg/m3 (24-hour average) and over ten times higher than the more relaxed Indian standard of 60 µg/m3.

Chart 4.

DELHI AIR QUALITY INDEX (12 MONTHS)

October 2018							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w40	130	151	156	125	167	174	148
w41	157	174	171	162	134	135	181
w42	160	177	180	172	167	182	202
w43	180	170	164	186	204	169	242
w44	248	263	312				

November 2018							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w44				249	257	241	203
w45	146	370	232	195	357	321	304
w46	276	287	279	210	172	209	188
w47	192	232	249	281	174	229	169
w48	174	222	199	209	224		

December 2018							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w48						232	208
w49	177	211	227	214	232	235	243
w50	240	288	298	255	156	173	185
w51	189	230	271	247	281	310	359
w52	394	355	350	277	286	297	270
w53	304						

January 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w1		360	319	328	375	292	282
w2	227	233	235	202	209	297	287
w3	301	158	181	158	181	283	280
w4	281	210	119	199	203	154	169
w5	200	175	194	250			

Febuary 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w5					267	226	246
w6	205	181	237	247	138	127	164
w7	222	-	-	-	-	-	-
w8	-	-	-	-	-	-	-
w9	-	-	-				

March 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w9					-	-	-
w10	-	-	-	-	-	-	-
w11	-	-	-	-	-	-	-
w12	-	124	161	146	184	99	123
w13	132	140	142	139	161	162	160

April 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w14	124	133	137	144	161	170	152
w15	199	149	155	158	148	137	122
w16	123	127	127	63	99	148	159
w17	147	169	163	158	167	161	160
w18	173	175					

May 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w18			167	174	161	178	161
w19	190	183	188	218	218	197	184
w20	276	268	125	147	138	145	108
w21	159	162	149	134	159	106	109
w22	124	124	129	136	146		

June 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w22						155	164
w23	154	143	130	151	145	126	132
w24	151	132	166	129	120	116	156
w25	117	104	91	163	102	150	148
w26	104	75	127	152	153	136	143

July 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w27	153	146	155	102	91	122	87
w28	98	133	123	147	157	153	141
w29	150	112	98	100	82	141	120
w30	116	135	150	136	66	90	74
w31	65	63	78				

August 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w31				79	88	94	101
w32	125	130	84	91	71	50	53
w33	75	67	70	86	90	58	36
w34	49	103	122	122	114	132	153
w35	-	65	97	106	93	95	

September 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w35							119
w36	89	116	154	158	89	85	83
w37	93	137	146	159	136	90	78
w38	102	139	140	98	68	89	100
w39	74	91	95	88	59	45	61
w40	50						

Source: World Meteorological Organization - surface synoptic observations (WMO-SYNOP) - U.S. Embassy and Consulates' Air Quality Monitor in India

Table 3.

AIR QUALITY INDEX SCALE AS DEFINED BY THE US-EPA 2016 STANDARD

	AQI	Air Pollution Level	Health Implications	Cautionary Statement (for PM2.5)
	0 – 50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk.	None
	51 -100	Moderate	Air quality is acceptable; however, with some pollutants, there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
	101-150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Active children, adults and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
	151-200	Unhealthy	All residents may begin to experience health effects; members of sensitive groups may experience more serious health effects.	Active children, adults and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children, should limit prolonged outdoor exertion.
	201-300	Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.	Active children, adults and people with respiratory disease, such as asthma should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.
	300+	Hazardous	Health alert: All residents may experience serious health effects.	Everyone should avoid all outdoor exertion.

The major factors causing air pollution in Delhi are listed below:

Vehicular emission is the biggest contributor to air pollution in Delhi, contributing 18-39% to the city's pollution, according to an April 2019 analysis by the Council on Energy, Environment and Water (CEEW). With almost 11 million vehicles as on March 2018 according to Delhi's Economic Survey 2018 – 2019 report and 598 vehicles per 1,000 population, the city highest in vehicular density in India. The government has imposed the odd-even rule intermittently that effectlively halves the number of privately owned cars plying on the road. It has also imposed more stringent measures such as declaring a public health emergency and ordering the temporary closure of schools in November 2019 to protect children from toxic air.

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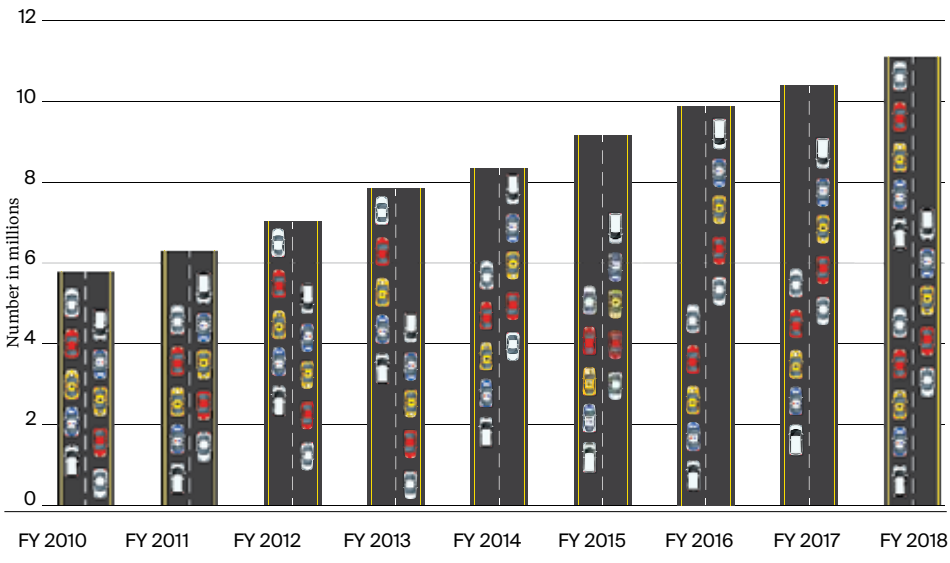
Chart 5.

TOTAL VEHICLES IN DELHI



Source: Delhi Economic Survey 2018-19

Every year after harvesting the rice crops, neighbouring states of Haryana and Uttar Pradesh burn the leftover stubble. The smoke from this burning is carried by the wind towards Delhi and the pollutants get locked in an atmosphere that is already polluted. The farmers burn the stubble immediately after harvest to save time and reduce cost, and to make the field ready for the next harvest. This is done routinely in the months of October and November and the pollutants get trapped in the wet, cold winter air causing a severe smog. This could account for upto 44% of Delhi's daily air pollution level as recorded on October 31st by the System of Air Quality and Weather Forecasting And Research (SAFAR). The agricultural department has laid a ban on this practice but the practice still continues.

The coal-fired Badarpur Thermal Power Station located in the south-east corner of Delhi close to Faridabad, is another major source of air pollution in Delhi. Despite producing less than 8% of the city's electric power, it produced 80 to 90% of the Particulate Matter pollution in Delhi according to the Centre for Science and Environment. In view of the detrimental effect to the environment, the power plant has been permanently shut down since 15 October 2018.

> A study revealed that Delhi's toxic air is shrinking newborns; with the air not only adversely affecting the growth of the foetus, but also resulting in premature births

Effects of air pollution in Delhi

A large number of studies in Delhi have examined the effect of air pollution on respiratory functions and the associated morbidity. The most comprehensive study among them was the one conducted by the Central Pollution Control Board in 2008, which identified significant association of air pollution with adverse health outcomes. The findings were compared with a rural control population in West Bengal. It was found that Delhi had 1.7-times higher prevalence of respiratory symptoms (in a 3 months period) compared with rural controls ($P < 0.001$). Prevalence of asthma (in a 12 months period) and physician-diagnosed asthma among the participants of Delhi was significantly higher than in controls. Lung function was reduced in 40.3% individuals of Delhi compared with 20.1% in the control group. Another prominent study by IIT Kanpur in 2016, concluded that during the summer and winter months, the levels of PM10 and PM2.5 were 4-7 times higher than the national air quality standards.

A study conducted in association with Indian Meteorological Department, London School of Hygeine and the Public Health Foundation of India, to assess the link between air pollution and birth outcomes in the capital, revealed that Delhi's toxic air is shrinking newborns; with the air not only adversely affecting the growth of the foetus, but also resulting in premature births.

Particulate Matter (PM) is one of the deadliest components of air pollution which can settle deep in the lungs and get absorbed into the blood stream. The most visible effect is respiratory problems and cardiovascular diseases. However, the ill-effects of air pollution also affect the auto-immune system of the body. The rheumatology department at All India Institute of Medical Sciences (AIIMS), following a three-year investigation, concluded that rheumatoid arthritis flares up with increase in PM levels. This can have pathological effects like tissue damage, altered organ growth and altered organ functions.

1.2.2 Water pollution – Water supply and sanitation facilities are probably the most critical factors that sustain urban life, regardless of income status. Urban areas have the potential to waste and pollute water in many ways. According to the Water and Sanitation Programme administered by the World Bank, the amount of non-revenue water, which basically means water unaccounted for and wasted (i.e. leakages,

stealing, unauthorised connections, collection inefficiencies, etc was estimated to be as high as to 40% to 70% in Indian cities in 2009. Recent estimates by the Municipalities of Bengaluru and Mumbai peg this number between 20% and 25% while that of Hyderabad could still be as high as 40%.

Waste-water from streets carries oil, rubber, heavy metals and other contaminants from automobiles. Untreated or poorly treated sewage can be high in pollutants such as fecal coliform bacteria, nitrates, phosphorus, chemicals and other bacteria. Groundwater and surface water can be contaminated from many sources such as garbage dumps, toxic waste and chemical storage and use areas, leaking fuel storage tanks and intentional dumping of hazardous substances. Air pollution can lead to acid rain, nitrate deposition and ammonium deposition, which can alter the water chemistry of lakes. Due to dumping of sewage from factories in water bodies, water pollution occurs which can lead to the outbreak of epidemics.

Urban water pollution is a growing problem in developing countries of the world. Indian cities are among some of the most polluted urban centres around the globe.

Sewage: Densely populated areas require adequate sewage facilities as well. Due to the lack of municipal sewage treatment, human waste has become one of the largest contributors to the pollution of water bodies in urban areas. According to the Central Pollution Control Board, untreated waste is the largest source of water pollution in India. Canals, rivers and lakes in cities of developing countries often serve as dumping grounds for sewage, solid and liquid wastes as efficient garbage or effluent disposal infrastructure is not available.

In 2015, according to the Central Pollution Control Board, the estimated sewage generation in India was 61,948 MLD (million litres per day) against an available treatment capacity of 23,277 MLD. The large gap between generation and treatment of sewage is acute in developing urban areas as well. The problem is not only that cities are lacking in sufficient treatment capacity but also that the sewage treatment plants that exist are not maintained properly and hence operate well under capacity. Over 80% of the world's wastewater – and over 95% in some least developed countries – is released into the environment without treatment according to the United Nations.

Bengaluru water crisis: Bengaluru is an apt example of an Indian city exploiting its water resources till its survival itself came into question. It was one of the first Indian cities to market itself as a tech hub in the 1990s and experienced prolific economic growth, with global tech giants such as Google, Microsoft, IBM and Dell starting large scale IT/ITeS operations in the city. Its population grew by 47% since 2001 to about 9.6 million in 2011 and is forecasted to reach 20 million by 2031.

Not foreseeing the subsequent tech boom, the city authorities, did not adequately plan for Bengaluru's growing water needs. Years of rapid urbanisation, a swelling population and poor water management have led to falling groundwater levels and highly polluted lakes filled with flammable chemical waste. The Bangalore Water Supply and Sewerage Board (BWSSB) is the main agency that manages drinking water and is responsible for supplying the city's daily requirement of 2.2 bn litres - but it can provide it only about 60% of this requirement currently. The Cauvery river is currently the largest source of, water and droughts in recent years besides increasing demand from neighbouring states have made it difficult to rely on this source.

Wells form the other major source of water for the city, especially in outskirts such as Sarjapur and Whitefield that are beyond the reach of the city's water system. However, groundwater levels are falling so fast due to overuse and inadequate conservation measures that the State Government estimates that groundwater levels could run dry within the next five years. Already, wells are being dug to a depth of 2,000 feet.

Bengaluru was built around a number of lakes that acted as rainwater reservoirs and replenished natural aquifers that provided a renewable source of water for the city. However, rampant Urbanisation and concretization of the city allows only an estimated 4% - 9% of the rainwater to find its way into the lakes or the natural aquifers. Indiscriminate dumping of toxic effluents and sewage have also slowly made these lakes unusable. Bellandur lake, which is the city's largest lake often froths or bursts into flames while other lakes have been encroached upon and yet others have just dried up.

From over 260 lakes in 1960, Bengaluru has only about 80 now, though efforts are underway to restore some of them. Jakkur lake is a notable example of a concerted effort by the government and community to restore it, that has borne fruit after nearly a decade. Jakkur lake was cleansed by the Bengaluru Development Authority; however, littering and dumping of garbage had resumed and threatened to erase the efforts of the authority. Concerned citizens approached the authorities and a comprehensive plan was put together with the help of horticulture and plants experts to not just increase the green cover in the area but also to attract butterflies, migratory birds and bees. The balanced, socio-ecological model gave equal importance to conservation of flora and fauna. The lake has now transformed from a polluted and dying lake to an ecological hotspot and a sustainable and usable water resource for the city.

1.3

RISING TEMPERATURES

Built-up spaces have a significantly higher capacity to absorb and retain heat compared to non built-up areas. A drastic increase in built-up spaces in urban areas due to factors such as paving over formerly vegetated land, an increasing number of high-rise apartments and offices has caused temperatures to rise significantly.

A Study conducted by IIT Delhi found that there has been an increase of 3-5 degree celsius in land surface temperatures and 2-3 degree celsius in air temperatures in the 1972-2014 period in Delhi. This rise in temperature necessitates an increased demand for air conditioning and refrigeration which in turn results in increased energy costs and heat emissions from the air-conditioning and refrigeration systems. This also causes an increase in the emission of Ozone gases that further escalate a temperature rise and are extremely detrimental to human health. Rising temperatures are also a big factor in sustaining the spread of Malaria and other diseases.

REGULATING URBANISATION IN INDIA

The government of India has launched various programmes to address urban governance issues and gaps in infrastructure. Some of the key programmes include the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Heritage City Development and Augmentation Yojana (HRIDAY), Smart Cities Mission, Clean India Mission and R-Urban Mission.

Managing Urbanisation and planning for sustainable urban growth are among the most formidable challenges confronting India today. Accounting for nearly 11% of the world's urban population according to the United Nations, India's urban system comprising 7,932 cities and towns, with a population of 377.16 mn (Census 2011), is the second largest in the world. According to the UN, urban India accounted for close to 34% of its total population in 2018 and the number is forecasted to exceed 50% by 2046.

Recognising the vast impact that Urbanisation has on the environment, the Indian government committed its Intended Nationally Determined Contribution (INDC) to United Nation Framework Convention on Climate Change (UNFCCC) in 2015. The INDC centers around India's policies and programmes on promotion of clean energy, resilient urban centres, promotion of waste to wealth, safe, smart and sustainable green transportation network, abatement of pollution and efforts to fight the build-up of carbon by enhancing the carbon sink through creation of forest and tree cover.

The government of India has launched various programmes to address urban governance issues and gaps in infrastructure. Some of the key programmes include the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Heritage City Development and Augmentation Yojana (HRIDAY), Smart Cities Mission, Clean India Mission and R-Urban Mission.

The government's commitment to address pollution can also be seen in its increased budgetary allocation for Environment Ministry from last fiscal by 10.4 per cent to INR. 29.5 bn for FY 2020. There was also an allocation of INR.4.6 bn for pollution control schemes including National Clean Air Programme (NCAP).

Chart 6.

URBAN INITIATIVES SINCE 1992

1992

INITIATIVE

The 74th Constitutional Amendment Act

GOAL

Empowering municipalities functionally, financially and politically.

2002

INITIATIVE

Urban Reform Incentive Fund (URIF)

GOAL

Eliminating systemic weaknesses to strengthen municipal finance and functioning

2005

INITIATIVE

Jawaharlal Nehru National Urban Renewal Mission (JNNURM)

GOAL

Eliminate structural and systemic weaknesses to create an investment climate and to improve local governance and finance

2007

INITIATIVE

National Urban Housing and Habitat Policy (NUHHP)

GOAL

Affordable housing for all with emphasis on vulnerable sections of society

2011

INITIATIVE

Rajiv Awas Yojana (RAY)

GOAL

Working towards slum-free cities via property titling and tenure security

2013

INITIATIVE

National Urban Livelihoods Mission

GOAL

Reducing urban poverty by providing access to employment

2014

INITIATIVE

Swachh Bharat Abhiyaan (Clean India Mission)

GOAL

Providing access to scientific sanitation and management of solid waste

2015

INITIATIVE Development of 100 smart cities

GOAL Enhance the quality of urban life and provide a clean and suitable environment by employing smart solutions for the efficient use of available resources and infrastructure

INITIATIVE Atal Mission for Rejuvenation and Transformation of 500 cities with over 100,000 population (AMRUT)

GOAL Create infrastructure that has a direct link to the provision of better services to the people by applying reforms to improve service delivery and make municipal functioning transparent and accountable

INITIATIVE Pradhan Mantri Awas Yojana (Housing for All)

GOAL Address the housing requirements of the urban poor including slum dwellers by promoting slum rehabilitation and affordable housing in partnership with the private sector and providing subsidies such as the credit linked subsidy and subsidy for beneficiary-led housing construction or enhancement

INITIATIVE Heritage City Development and Augmentation Yojana (HRIDAY)

GOAL Supporting core infrastructure aimed at revitalization of areas close to heritage sites by focusing on water supply, sanitation, landscaping and tourist conveniences.

2016

INITIATIVE

RURBAN Mission

GOAL

Accelerating rural development and providing basic urban services

Source: Knight Frank India

The government of India has launched various programmes to address urban governance issues and gaps in infrastructure. Some of the key programmes include the Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Heritage City Development and Augmentation Yojana (HRIDAY), Smart Cities Mission, Clean India Mission and R-Urban Mission.

2.1

ENVIRONMENTAL CHALLENGES OF URBAN INDIA AND COUNTERMEASURES TAKEN

Urbanisation is a major driving force behind Indian economic growth and contributes close to 60% of its Gross Domestic Product. Recent studies attest to the increasing linkages between Urbanisation and per capita GDP; however, these are low compared to other large Asian economies. There exist large, untapped economies of scale which require effective interventions in the spheres of urban and spatial planning, urban land markets and governance.

Here are some of the major hurdles faced by Indian urban centers and measures taken by the government to address them:

2.1.1 Urban air and water pollution

Cognizant of the impact that Urbanisation has on the environment, the government has increasingly made efforts to integrate climate change in its urban development strategy. Striking a balance where the benefits of Urbanisation are maximized without compromising the environmental benchmarks is among the key environmental concerns that confronts India today. Studies on cities and their environment have established the significant economic cost that the country bears on account of poor air and water quality. Several steps have been taken to address environment-related issues, which mainly include a National Mission on Sustainable Habitat. The main objectives of the Mission are promotion of energy efficiency as a core component in urban planning, enforcement of fuel efficiencies, management of urban waste and promotion of public transport. Other linked incentives include reduction of subsidies on unclean fuels, promotion of Transit Oriented Development (TOD) and development of compact cities and mixed land-use Master Plans.

Measures to address air pollution

Factors such as Increase in ownership of private vehicles, growth in construction activities in urban areas without adequate arrangement for construction waste disposal, growing mobility demands, increasing demand for power and industrial production, unplanned development of industries and hazardous industrial wastes, inefficient use of energy in buildings, excessive use of biomass for cooking and heating are some of the reasons for the increase in air pollution in urban areas of India. The government has taken the following steps to combat air pollution in urban centres in recent years:

- National Air Quality Index (NAQI) was launched to evaluate the status of air pollution in cities.
- Continuous Emission Monitoring System (CEMS) mandates the highly polluting industries to install 24X7 real-time monitoring of emission and effluent discharge points. 17 categories of highly polluting industries are effectively monitored for common hazardous waste and emissions from their biomedical waste incinerators.
- Faster Adoption and Manufacturing of Hybrid and Electric Vehicles Scheme (FAME) offers incentives to the owners of electric/hybrid vehicles. The Union Cabinet cleared a INR 100 bn programme under the FAME-II scheme in February 2019. The scheme is being implemented over a period of three years with effect from April 1, 2019. It is the expanded version of the present scheme FAME India I (Faster Adoption and Manufacturing of (Hybrid) and Electric Vehicles (FAME) which was launched on April 1, 2015, with a total outlay of INR 8.9 bn.
- The Green Highways (Plantation and Maintenance) Policy was launched to develop a 140,000 km long ‘treeline’ alongside national highways. The National Highways Authority of India (NHAI) has already planted close to 10 million trees under this policy in the 2015-18 period.
- The Green India Mission (GIM) launched in 2015, aims to increase the forest/tree cover up to 5 million hectares (mha) and improve the quality of forest/tree cover on another 5 mha of forest/non-forest

lands. As per an early 2019 report by a parliamentary committee, the mission lacks the funding required to fulfill its ambitious goals and this shortfall is being addressed currently.

- India aims to improve fuel standards by switching from Bharat Stage 4 (BS 4) to Bharat Stage 6 (BS 6) norms across the country from April, 2020 onward. Similar to Euro 4 and Euro 6 norms in the west, BS6 compliant petrol vehicles are required to be 25 per cent cleaner by reducing NOx (Nitrogen Oxide) numbers from 80mg/km to 60mg/km. For diesels, the BS6 norms aim at reducing three pollutants - HC (Hydrocarbons), NOx and PM (Particulate Matter) by 43%, 68% and 82% respectively.
- The Fly Ash Utilization Policy makes it mandatory to use only fly ash or fly ash based products in construction of buildings, roads and reclamation/ compaction of land within a radius of 100 km from a coal-based thermal power plant, thus displacing the use of cement. It also mandates utilization of fly ash for backfilling or stowing of the mines.
- Currently, 586 ambient air quality monitoring stations are operational, covering 246 cities, towns and industrial areas. The Government of India has released a new four coloured classification scheme for industries, based on their pollution levels. India Green House Gas (GHG) Programme is another voluntary programme that builds comprehensive measurement and management strategies to reduce emissions in India.
- Auto LPG Dispensing Stations (ALDS) have been established in 232 cities/towns to increase the acceptability of lesser polluting LPG vehicles.

Measures to address water pollution

In India, it is estimated that about 62,000 million litres per day (mld) of wastewater is generated in the urban centres having a population of more than 50,000, accommodating 70 per cent of urban population. The untreated wastewater is a major source of pollution of surface water bodies and rivers, and there is an urgent need for augmenting the treatment capacity and promoting the recycling and reuse of treated water. There are approximately 816 sewage treatment plants (522 operational and rest at different stages of construction and planning) having a combined capacity of 23,277 million litres per day across 28 states and 9 union territories according to the Central Pollution Control Board. The government has taken the following steps to combat water pollution in urban centres in recent years:

- Preparation of action plan for sewage management, restoration of water quality and setting up of monitoring network for assessment of water quality by the state governments.
- Installation of Online Effluent Monitoring System to check the discharge of effluent into the water bodies complying with effluent standards by State Pollution Control Boards/Pollution Control Committees.
- The government has issued directions for the implementation of Zero Liquid Discharge (ZLD). This is a water treatment process focused on recovering 100% of the water from waste streams. While the process focuses on extracting the most water possible, ZLD is a highly energy intensive process that involves several steps to remove all solids from the wastewater and for this reason it has not been widely adopted.
- Common Effluent Treatment Plants (CETPs) are being set up to treat the effluent emanating from clusters of compatible small-scale industries. Individual Effluent Treatment Plants (ETPs) generally face problems from lack of space, resources, capital cost and specialized manpower for operation and maintenance, which are especially magnified in the case of small-scale industrial facilities. These problems are addressed by collective treatment of effluents from a large number of small-scale facilities at a single site where they undergo treatment similar to what it would be subjected to individually. This brings economies of scale, specialization, ease of operation and maintenance to an activity otherwise isolated to individual units. According to Central Pollution Control Board, 193 Common Effluent Treatment Plants (CETPs) were installed in the country as on 2016, with a combined capacity of 1,474 million litres per day (mld).
- The National Lake Conservation Plan (NLCP) and National Wetland Conservation Programme (NWCP) have been implemented and intregrated with a National Plan for Conservation of Aquatic Eco-systems (NPCA) to undertake various conservation activities including lake beautification, biodiversity conservation, awareness creation and community participation.

- Lake Development Authorities have been formed in States such as Karnataka, Manipur, Odisha and Rajasthan. Rajasthan has passed the Rajasthan Lakes (Protection and Development) Bill, 2015. Andhra Pradesh, Jammu & Kashmir and West Bengal have strengthened legislations governing wetlands. The Kerala Conservation of Paddy Land and Wetland Act, 2008 prohibits the transfer and reclamation of paddy/wetlands. However, these conservation attempts have also met with resistance from private interests in certain instances. One such instance is the Karnataka Lake Conservation and Development Authority that was installed in 2014 but repealed in 2016.
- The National Water Mission (NWM) has been formed to conserve water, minimize waste and ensure equitable distribution through development and management of integrated water resources. The key goals of the mission are as under:

  Enhancement of water use efficiency by 20 per cent.

  Creation of a comprehensive water database in public domain and assessment of climate change impact on water resources.

  Focused attention on vulnerable areas including over-exploited areas.

  Promotion of citizen and state actions for water conservation, augmentation and preservation

  Promotion of basin level integrated water resources management
- The Government of India, through its various urban development programmes, has been supporting the cities in the improvement of sewerage networks and sewage-treatment facilities. The Atal Mission for Rejuvenation and Urban Transformation (AMRUT) programme and Smart Cities Mission have a component on septage and sewerage management facilities.
- Rainwater harvesting, which replenishes and recharges the ground water, is a significant component of Watershed Development Programme, taken up under different schemes of the central and state governments. Several municipal authorities including Delhi have amended their existing building bye-laws, making it compulsory for every large house or hotel (170 square metres or more in area) to undertake rainwater harvesting. Neeranchal is a recent programme by the Government of India to give additional impetus to watershed development in the country.
- Namami Gange Mission is launched to clean and protect the National River Ganga and its tributaries in a comprehensive manner. Conservation of all other rivers is covered under the National River Conservation Programme (NRCP) implemented by the National River Conservation Directorate.

The cities of Belgaum, Gulbarga and Hubli-Dharwad in Karnataka are apt examples of cities that tackled inadequate water supply problem. The Government of Karnataka, with assistance from World Bank, launched Karnataka Urban Water Sector Improvement Project (KUWASIP) in five selected zones in the three cities to build and deliver an efficient and commercially viable 24X7 urban water supply system through Public Private Partnership (PPP).

- The project included investments to improve bulk water supply and commissioned a private operator to construct-operate-manage 24X7 urban water-supply systems for two years, after a preparatory phase of 18 months.
- The investment was made by Karnataka Urban Water Supply and Drainage Board (KUWSDB) and the private operator was responsible for the installation of meters, tariff collection, etc. The tariff structure was rationalized by introducing variable rates based on consumption. Significant reforms were carried out in public sector institutions such as KUWSDB and Karnataka Urban Infrastructure Development and Finance Corporation.
- Losses were reduced from 50 per cent to 7 per cent due to improvements in the transmission and distribution network, and improved metering. Over 25,000 households now receive 24X7 water supply.

2.1.2 Solid waste management

This is a critical area in urban management. As per estimates, 115,000 tons of municipal solid waste is generated per day in India. It is estimated that the solid waste generated in small, medium and large cities and towns in India per capita per day is about 0.1 kg, 0.3–0.4 kg and 0.5 kg respectively. The estimated annual increase in per capita waste quantity is about 1.33% per year (National Environmental Engineering Research Institute).

According to the Urban Development Ministry, just 4% of the solid waste generated in the country is treated and 10% is dumped in landfill sites, many of which are unscientifically built and do not do a good job of preventing ground water and soil contamination. The Ministry estimates that the volume of solid waste generated in cities will increase to 0.5 million tonnes per day by 2030 as people move from villages to cities.

Measures taken to manage solid waste

- Solid Waste Management (SWM) projects in the country have been provided significant budget outlays over the years. INR 25 bn (USD 397 mn) is allocated as grants-in-aid to States and urban local bodies, specifically for SWM through Public-Private Partnerships.
- The Union Ministry of Environment, Forests and Climate Change (MoEF&CC) has notified the Solid Waste Management Rules, 2016. This document provides a detailed framework (segregation, transportation, treatment and disposal) for waste management in every urban local body.
- The Bio-Medical Waste (Management and Handling) Rules and Plastic Waste Management Rules have been implemented since 2016, though implementation of the same continues to be a challenge. According to the CPCB Annual Report of 2016, the total quantity of Bio-Medical Waste generation in the country is approximately 517 tonnes per day (TPD). As per the joint Report by Associated Chambers of Commerce and Industry of India (Assocham) and Velocity in 2018, the total quantity of medical waste generated in India is 550 TPD, and these figures are likely to increase to nearly 775.5 TPD by 2022. To grapple with this manifold increase in the generation of Bio-Medical Waste (BMW), 199 Common Bio-Medical Waste Treatment Facilities (CBWTFs) are in operation and 23 are under construction (CPCB, 2017).
- The Environment Ministry has notified e-Waste Management Rules, 2016. The new rules have provisions for financial penalty for damage caused to ecology and any third party due to improper management of e-waste.
- The Swachh Bharat Mission (Clean India Mission) had an objective of making the country clean and litter free with scientific solid-waste management in about 4,041 towns covering a population of 306 million. It aimed to construct 10.4 million individual household toilets and 0.5 million community and public toilets - an aim it has achieved more than halfway through in the current financial year (2019-20) according to the Swachh Bharat Mission website. It also aimed to implement 100 per cent door-to-door waste collection and transportation of waste in all cities.

  Although the State governments have made significant progress in managing solid waste in the past five years under the Centre's Swachh Bharat Mission, the 2018 cleanliness survey found that only 10% of 471 cities segregated household waste. According to a study released by ICRIER in January, 2019, Delhi had the lowest (39%) overall collection of garbage from homes among the metros and Ahmedabad the highest (95%). Mumbai and Chennai, the two other big metros covered under the Study, had achieved 80% of door to door garbage collection.
- Niti Aayog has set a target of constructing 800 MW of waste- to- energy plants to deal with the growing urban waste problem. Under this programme, some cities have come up with innovations eg. Indore has successfully converted waste into Compressed Natural Gas (CNG), a model that 72 countries under the aegis of United Nations Environment Programme want to replicate. Dehradun is working on generating bio-oil from urban waste.

2.1.3 Urban transport

Urban transport infrastructure and services are grossly inadequate, both in quantity and quality. The number of private motor vehicles has multiplied over a hundred times in recent decades and more than tripled in the 10 years ending 2018 according to the Ministry of Road Transport and Highways (MORTH), leaving the road network and capacity severely stressed. Public bus services which are state-owned public entities are limited to large cities and are stretched beyond capacity on a daily basis. The use of modes such as walking, cycling, and other transport modes is on the decline—the overall result being increasing road congestion, falling road speed, increasing air pollution, and reduced road safety.

Measures to improve urban transport efficiency and minimise environment impact

The National Urban Transport Policy (2014) focusses on planning for people rather than vehicles, by providing sustainable mobility and accessibility to places of work, education, services and recreation at affordable costs. It has involved internalizing urban transport as a key variable in urban planning exercises. It calls for putting in place intelligent transport systems for traffic management and establishing institutional mechanisms and capacity building for better planning and management of transport systems. In recent years, recognising the challenges of climate

change, cities are moving towards adopting public transport systems and integrating land use and transport planning. Below are some of the measures taken up by the government to streamline the transport system:

- **Mass Rapid Transit Systems (MRTS):** There are more than 11 cities that have initiated Mass Rapid Transit Systems (MRTS). It is an integral component of India's urban transport infrastructure and its importance is growing. The Metro systems have an impact on the development and land use in cities but the fact that land-use planning had not been integrated with the Metro project plans is a missed opportunity for Transit Oriented Development (TOD). The Hyderabad Metro Rail Project (71 km), however, is implemented under Public-Private-Partnership, not as a simple mass transit system, but as an urban redesign concept with emphasis on last-mile connectivity and using an innovative financial design so as to require very little public funds.
- **Phasing out of old polluting vehicles:** The government's bid to phase out commercial vehicles older than 15 years is facing stiff resistance. However, in a bid to dis-incentivize ownership of older polluting vehicles, the Road Transport and Highway Ministry has proposed an increase in the cost of re-registration of 15 year old vehicles upto 25 times from July 2020.
- **Promoting Transit Oriented Development:** Transit Oriented Development (TOD) is being done with densification and re-densification of cities so that commute of distances can be reduced, thereby reducing vehicular pollution.
- **Dedicated Freight Corridors (DFC):** Two corridors viz. 1,520 km. Mumbai-Delhi (Western Dedicated Freight Corridor) and 1,856 km. Ludhiana-Dankuni (Eastern Dedicated Freight Corridor) are being constructed. These two phases of the DFC project are expected to reduce emissions by about 457 million ton CO2 over a 30 year period.
- **Coastal and water transport:** The government is promoting growth of Coastal Shipping and Inland Water Transport. To enhance inland waterways transport, the government has implemented the Jal Marg Vikas initiative for capacity augmentation of National Waterway. It is also in the process of establishing integrated waterways transportation grid with a view to provide all existing and proposed national waterways with road, rail and ports connectivity. Of the three multimodal terminals being built on the Ganga river under the Jal Marg Vikas initiative, the one at Varanasi on National Waterway I between Kolkata and Varanasi, is India's first such project that became operational in November, 2018.
- The government is factoring in non-motorised transport options such as cycling and walking tracks into the plans of the Smart Cities that are being conceived. Chennai is the first city to attempt a Non-Motorised Transport Policy.

2.1.4 Land acquisition for urban infrastructure development

Supply and usage of urban land are regulated across the globe and India is no exception. However, the processes of land acquisition for urban use is cumbersome and constrained primarily by factors such as the purpose of the underlying land acquisition, zoning restrictions, the amount of compensation, and the time taken in litigation. A recent Study conducted by the Centre for Policy Research concluded that the political and social contestation over land acquisition stems from the inherently coercive nature of the land acquisition process, which created a severe imbalance of power between the State and the land owners. The result is a situation of great inequity for land owners.

Measures taken to ease the land acquisition process

The amendments made in the Land Acquisition and Resettlement Act, 2013 are steps in the right direction to redress the imbalance of power that was built into the Land Acquisition Act, 1894, Initiating innovative practices such as land pooling and negotiated land purchases that improve price discovery and transparency and encourage the land owners to trust the acquisition process. Other important initiatives in this sphere relate to introducing online procedures for land registration, reduction of stamp duties and repeal of the Urban Land (Ceilings and Regulation) Act, 1976. Land reservations have also been mandated for the urban poor in townships and layouts, ensuring that the benefits of urban development accrue to the poor through increased access to urban spaces and enhanced employment opportunities. Reservations normally vary from 15–25 per cent of the total units.

AMARAVATI—LAND POOLING SCHEME

In 2014, the Indian State of Andhra Pradesh was bifurcated into two. One State continued to be called Andhra Pradesh, while the other was named Telangana. The existing State capital Hyderabad was to be shared for 10 years, before eventually coming under Telangana's jurisdiction after 2024. Under pressure to plan and build a capital city from scratch within this short timeframe, the new Andhra Pradesh government started securing land for its new capital of Amaravati via land pooling through which the State promises landowners a smaller but developed plot of land in the future, in exchange for current landholdings. These reconstituted plots would come with smart utilities and infrastructure such as citywide WiFi access, paved roads, sewage pipes and electricity lines. This model could encourage landowners' buy-in by giving them a stake in the future capital. Making land the primary mode of exchange instead of money would also reduce the pressure on the State's finances.

A cabinet subcommittee was tasked to devise a land pooling system. It created a policy detailing how landowners would be compensated under the land pooling scheme. The scheme started in January 2015 with the aim of obtaining 38,581 acres of land. The Andhra Pradesh Capital Region Development Authority (CRDA)—Amaravati's urban planning agency—recognised that the scheme's success would depend on whether it was inclusive and fair to those being asked to give up their land. A draft of the scheme was made widely available to the public, with 30 days given for public feedback and objections. Government officials visited various villages to consult residents on the design, size and location of their returnable plots. Landowners could see for themselves the plot subdivision plans for their villages and address their queries to the officials directly.

Out of the 24 villages approached to give up their land, 22 agreed within four months of the scheme's announcement. Following this, the returnable land plots were allocated through electronic lotteries for fairness. These lotteries were held at the villages, with landowners receiving confirmation of their plot allocation via mobile message. Their plot allotment letters were also printed and handed out to them immediately with soft copies made available online. Within 60 days of implementation, the government managed to persuade 25,000 farmers to give up 30,000 acres of land. Time will tell the success of Amaravati's development. However, the model of land pooling used to acquire land is a good example for other states to follow.

2.2

QUALITY OF LIFE IN URBAN INDIA

The importance of urban infrastructure is commonly highlighted as a major factor that impacts productivity and quality of life, and on grounds of the correlation between quality of infrastructure and GDP. Despite this, infrastructure deficits and deprivation persist across Indian cities. The government has been concerned with these deficits and has attempted to address them under the JNNURM and mounted a concerted effort via various missions. This also gives rise to the need of taking stock of infrastructure indicators across cities to gauge the extent of this deficit so that efforts can be more focused toward remedying them and successful efforts can be lauded.

2.2.1 Ease of Living Index

The Ministry of Housing & Urban Affairs, India launched the 'Ease of Living' Index for cities in June 2017. The first Index under this framework was released in 2018. The Index is in line with India's goal to promote evidence-based planning and action towards sustainable urbanisation. It covers 111 Indian cities which include those identified under the Smart Cities Mission with a total population of approximately 134 million. Further, this first of its kind exercise assesses the identified 111 cities across numerous indicators drawn from national as well as international benchmarks and are strongly linked to the Sustainable Development Goals (SDGs). Following are a few key findings of the 2018 Index with regards to the top 8 cities* covered by Knight Frank:

Table 4

QUALITY OF LIVING INDICATORS

City	Population (in millions)	Population Category	Overall Rank (out of 111)	Transportation & Mobility	Reduced Pollution	Assured Water Supply	Waste Water Mgmt.	Solid Waste Mgmt.	Power Supply
Pune	3,124,458	Population ≥ 1 million < 4 million	1	12	2	2	4	5	10
Navi Mumbai	1,120,547	Population ≥ 1 million < 4million	2	4	48	7	8	10	74
Greater Mumbai	12,442,373	Population ≥ 4million	3	8	54	3	7	17	16
Thane	1,841,488	Population ≥ 1 million < 4million	6	1	53	4	6	11	1
Chennai	4,646,732	Population ≥ 4million	14	3	26	11	12	52	103
Vasai Virar City	1,222,390	Population ≥ 1 million < 4million	20	14	5	31	21	48	61
Ahmedabad	5,633,927	Population ≥ 4million	23	5	49	40	48	41	62
Hyderabad	6,993,262	Population ≥ 4million	27	21	60	67	36	76	6
Ghaziabad	1,648,643	Population ≥ 1 million < 4million	46	59	20	45	43	66	84
Kalyan Dombivali	1,247,327	Population ≥ 1 million < 4million	50	22	83	68	72	45	9
Bengaluru	8,495,492	Population ≥ 4million	58	49	91	48	58	58	95
New Delhi	11,292,358	Population ≥ 4million	65	55	100	57	25	50	101
Pimpri Chinchwad	1,727,692	Population ≥ 1 million < 4million	69	9	66	15	32	59	70
Faridabad	1,414,050	Population ≥ 1 million < 4million	72	83	86	74	78	102	12
Gurugram	886,519	Population ≥ 0.5 million < 1million	88	69	7	94	75	70	97

Source: Ministry of Housing and Urban Affairs

* Ahmedabad, Bengaluru, Chennai, Hyderabad, Kolkata, Mumbai, National Capital Region (NCR), Pune

Table 4

SOCIAL INDICATORS

City	Population (in millions)	Population Category	Overall Rank (out of 111)	Education	Health	Economy & Employment	Housing & Inclusiveness
Pune	3,124,458	Population ≥ 1 million < 4 million	1	8	4	7	23
Navi Mumbai	1,120,547	Population ≥ 1 million < 4million	2	2	3	16	35
Greater Mumbai	12,442,373	Population ≥ 4million	3	36	23	63	6
Thane	1,841,488	Population ≥ 1 million < 4million	6	27	15	9	4
Chennai	4,646,732	Population ≥ 4million	14	24	25	70	70
Vasai Virar City	1,222,390	Population ≥ 1 million < 4million	20	3	16	21	52
Ahmedabad	5,633,927	Population ≥ 4million	23	60	73	45	19
Hyderabad	6,993,262	Population ≥ 4million	27	49	44	59	24
Ghaziabad	1,648,643	Population ≥ 1 million < 4million	46	106	75	20	1
Kalyan Dombivali	1,247,327	Population ≥ 1 million < 4million	50	31	13	81	67
Bengaluru	8,495,492	Population ≥ 4million	58	55	103	71	87
New Delhi	11,292,358	Population ≥ 4million	65	59	111	109	99
Pimpri Chinchwad	1,727,692	Population ≥ 1 million < 4million	69	71	60	80	92
Faridabad	1,414,050	Population ≥ 1 million < 4million	72	1	46	106	45
Gurugram	886,519	Population ≥ 0.5 million < 1million	88	81	100	65	13

Source: Ministry of Housing and Urban Affairs | *Ahmedabad, Bengaluru, Chennai, Hyderabad, Kolkata, Mumbai, National Capital Region (NCR), Pune

RANKING OF 8 CITIES OUT OF 111 CITIES ACROSS INDIA. AS PER THE EASE OF LIVING INDEX 2018 BY THE MINISTRY OF HOUSING AND URBAN AFFAIRS (MOHUA)

Pune	PUNE	1
	PIMPRI CHINCHWAD	69
Mumbai	NAVI MUMBAI	2
	GREATER MUMBAI	3
	THANE	6
	VASAI VIRAR CITY	20
	KALYAN DOMBIVALI	50
Chennai	CHENNAI	14
Ahmedabad	AHMEDABAD	23
Hyderabad	HYDERABAD	27
Bengaluru	BENGALURU	58
National Capital Region (NCR)	GHAZIABAD	46
	NEW DELHI	65
	FARIDABAD	72
	GURUGRAM	88
Kolkata	Does not feature in the 111 cities considered for this exercise)	

Source: Ministry of Housing and Urban Affairs

SINGAPORE CASE STUDY

The fact that Singapore upgraded its infrastructure while it was populated and economically active, makes it more relevant a case study for Indian cities. The biggest challenge faced by metros in India is to upgrade infrastructure without hampering the day-to-day activities.

The island city-state of Singapore is among the most advanced economies of the world today. Founded in 1965 as the Republic of Singapore, this *Alpha+ global* city is situated at the southern tip of the Malay peninsula, one degree north of the equator. The country's expanse stretches over one main island and 62 smaller islets and it is home to a population of 5.7 million (Source: singstat.gov.sg) as of 2019. Singapore has carved its place in the world as the most advanced Asian economy and is progressively working on being the world's first smart nation. Singapore ranks 9th on the United Nations Human Development Index 2018 edition and has the 3rd highest Gross Domestic Product (GDP) per capita (PPP terms) in the world as per 2018 numbers of the International Monetary Fund (IMF). The World Bank has ranked Singapore as the 'Easiest place to do business' in the world for nine years straight. The country is known for its quality infrastructure and technological advancement which is even more commendable when seen in the context of its topographical challenges. Singapore's geographical location brings with it some significant disadvantages; for instance - being situated in close proximity to the equator results in a consistently hot and humid weather, all year round; its scenic islandic geography comes with deprivation of basic resources like land, forests, farms and energy deposits. Notwithstanding such difficulties, the island nation has a prospering economy and remarkable success on indicators of national social progress and this was possible because of a clear vision of Singapore's founding leadership. Over the years, Singapore has raised the standards of national development and set a high benchmark the world over. With its singular focus and a distinct emphasis the use of technology, it presents a successful model of overall development that can be very well emulated and adapted by other countries.

For the purpose of this Infrastructure Report, we would be focusing on the infrastructural development in Singapore by studying select sectors and understanding its relevance for Indian metros. The fact that Singapore made this progress happen while it was populated and economically active makes it more relevant a case study for Indian cities as the biggest challenge faced by them is to develop adequate and quality infrastructure for people without significantly hampering the day-to-day activities. Most of the benchmarked international examples in infrastructure are either cases of creation of new cities from scratch or are of reviving of dead and deserted townships. In both cases the scope of disrupting routine economic activity and of delays caused due to population presence is minimal. This is not an option with Indian urban metros as they are very densely populated and have high economic activity but need substantial scaling up of infrastructure. Therefore, Singapore is an apt case study.

As mentioned earlier, Singapore is among the first few countries to embark on the journey of becoming a Smart Nation. While the emphasis on technological adoption for development purposes started in 1980s, the comprehensive Smart Nation Vision came in 2014. Singapore's first successful stint with development and implementation of smart services was in the transport and mobility sector with its Intelligent Transportation System (ITS). Next came the wide scale e-governance project. Both these technological experiments significantly heightened utility of the available infrastructure and helped in accurately addressing infrastructure inadequacy issues, if any, resulting in enhanced quality of living for citizens. Eventually technology became an integral part of all developmental policies of Singapore, specifically for its tremendous potential for execution. Today, Singapore offers a tried and tested method of infrastructure transformation that can certainly help align and structure India's pursuit of urban infrastructure.

3.1

ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

ICT has played a major role in Singapore's success story. The country's leadership laid special emphasis on harnessing the potential of technology for advancing their development goals and the result was accelerated and efficient implementation of their vision for the nation. Today, Singapore is the only country in the world walking on the path of a Smart Nation.

Technology plays a crucial role in furthering the cause of any development as huge amounts of real time data can be gathered, processed, analysed and disseminated/communicated in real time with the help of ICT. Such utility of data helps tackle a wide range of urban challenges as it aids governments in correctly identifying and addressing infrastructure gaps and inadequacies. For instance, a network of sensors, cameras and GPS devices embedded in taxi cabs and on roads helps track traffic, predict future congestion and inform drivers of alternative routes. Further, a strong e-governance foundation advances the cause of development as it makes the transition to technology fast and smooth. The role of ICT in planning and implementing development goals, therefore, cannot be ignored or underplayed. Such a technology-driven approach in achievement of development goals could be easily adapted in India as well, especially with the exponential growth in broadband connectivity and mobile penetration in the recent past. To understand how an ICT-based model works, we have focussed our area of study on two specific infrastructural sectors in Singapore – transport and mobility, and water management.

3.2

Transport and mobility sector

This is the most intelligent, technologically advanced and sophisticated sector in Singapore and the existing system is aptly known as Intelligent Transport System (ITS). Following are a few significant measures adopted by the Singapore government, along with ITS, to enhance transport and mobility:

3.2.1 Intelligent Transport System

The ITS was developed gradually over a period of 10 years and is at present the most advanced smart service available in the country. This sophisticated system helps organise traffic flow to avoid congestion and ensure safety of citizens on the road. The key feature of ITS, however, is its holistic approach towards traffic management. It operates in tandem with other transport initiatives of the government such as free public transportation in pre-morning peak hours.

3.2.2 Restriction on the number of vehicles

Owing to the limited geographical expanse and the high density of population, Singapore has stringent laws that restrict the number of vehicles on road in order to limit pollution and congestion. One such law is the requirement for vehicle owners to pay higher duties (one and a half times higher than the market value) for purchasing a car and to bid for the Certificate of Entitlement that permits vehicle movement on roads. Consequent to this, despite a population of 5.6 million as of 2019 (Source: singstat.gov.sg) only 0.65 million vehicles ply the roads of Singapore (2016 number, Source: International Case Studies of Smart Cities by Inter-American Development Bank). Citizens are encouraged to give preference to the well-functioning public transportation systems such as buses, taxis and trains – mass rapid transit as well as light rail transit. Attractive transport schemes such as free travel by public transport in the pre-morning peak hours is one such example of incentivising citizens.

3.2.3 Use of ICT

Internet access as well as mobile penetration are significantly high in Singapore. This makes integration of ICT easier. Higher the integration, faster the collection and dissemination of information with real time accuracy. Some of the most developed smart services in Singapore are in the transportation and urban mobility sector. Even the ITS was possible on account of the wide availability of internet and smart devices across the country. Quick and real time access to information benefits citizens and governments alike, making transport a hassle-free experience. Singapore's One. Motoring application is an example of the use of ICT to create easily accessible, mass base applications that enable real-time communication and analysis of data.

In conclusion, Singapore has successfully set up an efficient transport and mobility system in place that not only helps avoid traffic and congestion but also keeps pollution levels in check. Technology on the whole and ICT in particular have played a crucial role in the achievement of this goal.

3.2.4 Lessons for India

Indian metros have a very high density of population which inadvertently results in traffic woes and congestion issues. The heightened air pollution levels just adds on to the misery. Traveling within most metro cities i.e. the daily commute, is more cumbersome and gruelling than traveling between different cities. Inadequate and inefficient means of public transport coupled with high population numbers is the primary reason for the urban infrastructure woes. High density of population results in over-crowding of the available public transport means, and hampers their quality and efficiency further. Poor quality of public transport across most cities results in increased vehicular traffic and has eventually worsened road mobility.

According to a recently published traffic study by the global mapping company TomTom, Mumbai is the world's most traffic congested city with the highest extra travel time at 65% i.e. Mumbai commuters have to spend 65% more time in congested conditions/peak hours than the average travel time taken for the same route and distance in free-flow conditions. New Delhi also found a place in the same Study at number 4 position (amongst 403 global cities) with an extra travel time of 58%. Another Study inferred that the best time to travel on Mumbai city roads is between 2 am to 5 am! Bengaluru's road congestion is infamous enough to impact real estate decisions in the city. New Delhi's air pollution levels are becoming a serious health hazard for its residents.

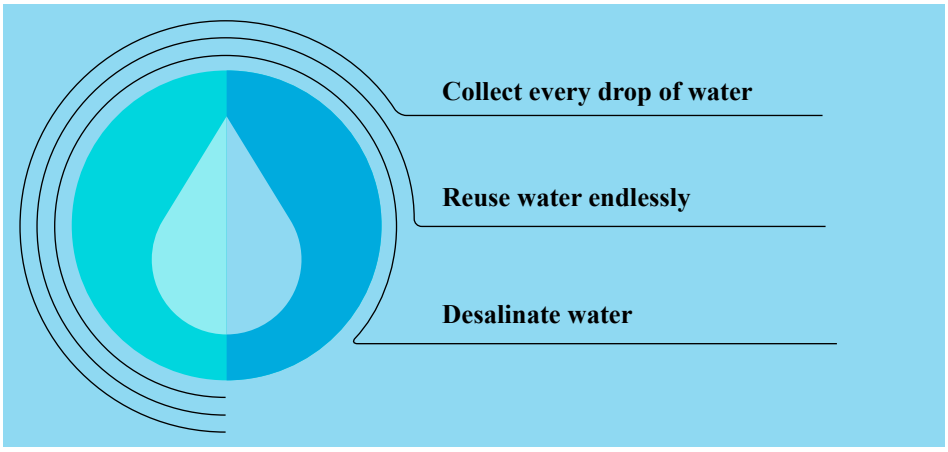
While the government is working on better and improved infrastructure facilities across the country, the under- construction projects are creating further discomfort in the already existing chaos. The simultaneous construction of all six inter-city Metro Links in Mumbai, for instance, has deteriorated the traffic condition beyond measure. Doom falls when externalities such as rains and floods hit the city. All these infrastructural woes have serious repercussions on the economy of the city as well as the health of citizens. Cumbersome daily commute along with frequent infrastructural disruptions bring down employee morale and hamper their economic potential, impacting business on the whole. Citizens also have a higher exposure to critical illnesses and disorders. It is therefore necessary to systematically address these infrastructure inadequacies and soon.

Singapore definitely has a lot to offer in terms of solution building. First and foremost is the extensive use of ICT in Singapore's transport and mobility sector for traffic management and ensuring road safety. On the lines of Singapore's ITS, the government can create a pan-India digital interface such as a mobile application which is easily available to all residents, where city-specific real time updates of traffic and information on possible alternative routes is available. This is possible with the help of a network of sensors, cameras and GPS devices embedded in taxi cabs/buses and on frequented roads/ junctions. Further, ICT can help evaluate the carrying capacity which will help address the most pressing issue in Indian cities at present i.e. infrastructure inadequacy. This will help define the gaps between available means of transport and the number of people using them with respect to quantity, quality and efficiency. Such a defined and accurate gap analysis will help the government channelise its efforts in the right direction. Thus the role of ICT in the development of transport and mobility sector in India cannot be undermined and can be executed basis Singapore's tried and tested method, at least in the beginning. The second thing to learn and adopt from Singapore's experience is their stringent vehicle quota system. The geographically constrained island nation has stringent laws that restrict the number of vehicles on road in order to limit pollution and congestion. One such law is the requirement for vehicle owners to pay higher duties (one and a half times higher than the market value) for purchasing a car and to bid for the Certificate of Entitlement that permits vehicle movement on roads. Owing to the ever growing number of vehicles on the roads of Indian metros that are aggravating congestion and high carbon emission issues, it has now become necessary to disincentivise vehicle ownership. At the same time, it is necessary to focus on providing quality and efficient public transport facilities, encouraging models like car pools and so on. Singapore's idea of incentivizing public transport by introducing schemes like free public transport in pre-morning peak hours can also be implemented in cities like Mumbai, Bengaluru and New Delhi where people in large numbers take the train or bus to commute to work. Undoubtedly, the quality of public transport needs to be scaled up to Singapore standards of efficiency and hygiene, and the high population density of Indian cities need to be specifically taken into consideration. On the whole, India can substantially emulate Singapore's transport and mobility sector initiatives and adapt them suitably to solve city-specific infrastructure woes.

3.3

WATER MANAGEMENT SECTOR

The island nation of Singapore is surrounded by saline water and has no natural aquifers or groundwater table. The only available source of fresh water is rains which is abundant thanks to its equatorial location. However, owing to its proximity to the equator, it is also prone to a high rate of evaporation. Conventionally, Singapore's two primary sources of water have been rainfall from its own catchment areas and raw water imported from the neighbouring Johor State (Malaysia). However, both these sources were subject to high vulnerabilities and therefore it was important that the country find a more definitive and permanent source for its water. Accordingly, Singapore adopted the following three principles -



Singapore's national water agency, Public Utilities Board (PUB), has successfully resolved Singapore's water challenge by a systematic and efficient execution of the above three tenets. It micro manages the entire water cycle of the country from rain water collection to purification to supply to recycling and reusing. At present, Singapore's water comes from four important sources, referred to as the four national taps: rain water, imported water, recycled water and desalinated water.

3.2.1 Collect every drop of water (water conservation)

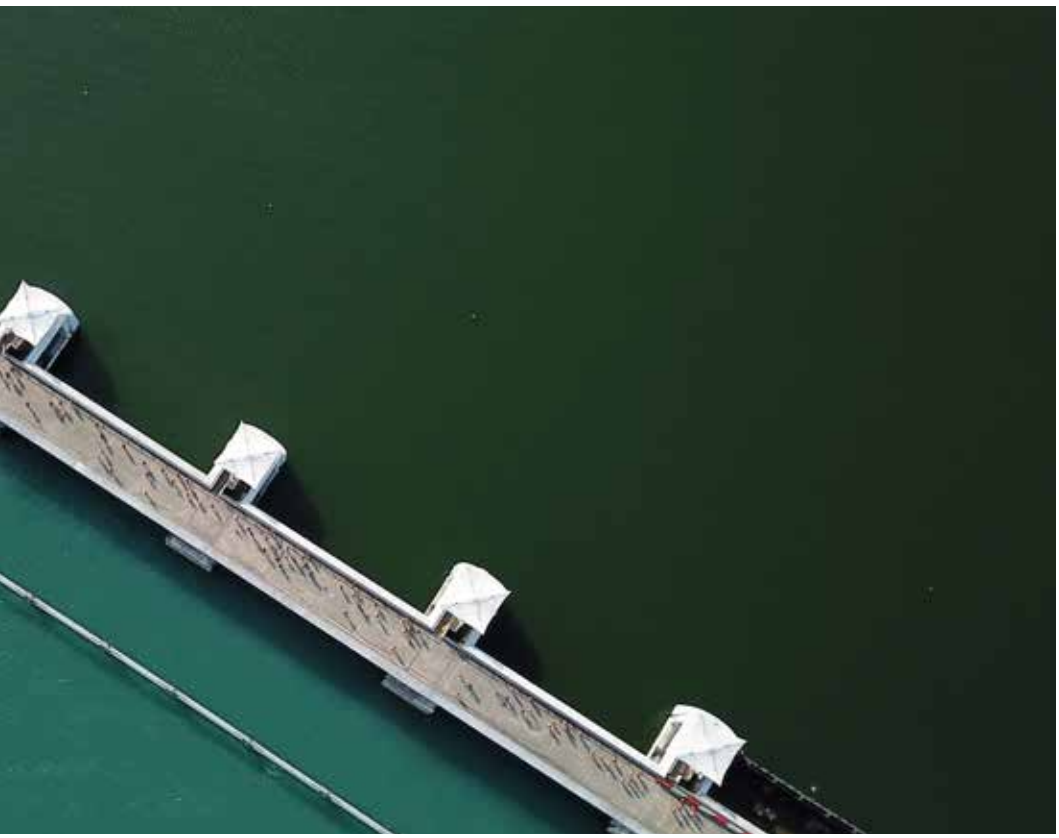
Two separate and well-planned networks for drainage and sewage along with a comprehensive network of drains, rivers, canals and reservoirs for storage ensure that the rain water from urban catchments is harnessed to its full potential. Further, a water demand management programme run by PUB ensures active citizen participation in conservation goals and minimizes losses. With the help of an ICT based application, every Singapore citizen is informed about his/her daily water consumption and is advised on the ways to conserve water. This has helped bring down the per capita consumption of water in households from 165 litres a day in 2003 to 143 litres a day in 2017. The aim is to reduce it to 130 litres a day by 2030 (Source: pub.gov.sg).

3.2.2 Reuse water endlessly

The most significant player in Singapore's water success story has been NEWater. Introduced in 2003, NEWater is high quality reclaimed water produced after used water is treated and then purified with advanced membrane technologies viz., microfiltration, reverse osmosis and ultraviolet disinfection. The resultant product, termed as NEWater, is ultra-clean water that has passed more than 30,000 scientific tests of safety and also surpasses World Health Organisation (WHO) requirements thus making it safe to drink. This water source mainly services the non-domestic sectors such as wafer fabrication parks, industrial estates and commercial buildings for industrial and air-cooling purposes. Of the total water consumption in Singapore at present, 55% comes from the non-domestic sector and this share is expected to grow to 70% by 2060 (Source: pub.gov.sg). NEWater helps cater to 40% of the total non-domestic sector demand in Singapore at present and its contribution is also slated to grow to 55% by 2060 to keep up with the rising demand (Source: pub.gov.sg). It is important to note here that a major role in NEWater's success in Singapore was played by its wide scale public acceptance which can be attributed to the government's efforts at public education and transparency.

3.2.3 Desalinate water

Being an island nation, Singapore is surrounded by water albeit saline.



Technological advancement has made it possible to desalinate water through a thorough process of treatment and purification and the end product is usable water. Singapore has learnt to reap benefits of its surrounding sea waters by setting up desalination plants. At present there are three such plants with a total capacity of 130 million gallons per day (mgd) that caters to 30% of the country's present water requirement, primarily of the non-domestic sector (Source: pub.gov.sg). Two more such plants are in the process of development, slated to be ready by 2020. It is expected that desalinated water will continue to contribute 30% water supply in the coming years even as the overall demand goes up (Source: pub.gov.sg).

In conclusion, Singapore has addressed its water challenges through a systematically planned and executed combination of harnessing the potential of all available natural water sources and recycling of its used water. Technology on the whole and ICT in particular have played a crucial role in the achievement of this goal.

3.2.4 Lessons for India

Important metro cities in India are today facing severe water crisis. Bengaluru and Chennai are the worst affected as most of their natural water resources have either dried up or are depleting at an increasing rate. Lack of a scientific approach in using natural sources of water, especially groundwater, and rampant construction activity without cognizance of environmental implications is the reason for the present doom. Although the water crisis in Indian cities is manmade, unlike Singapore, a lot can be learnt from Singapore's approach. Large scale use of ICT in planning and execution of water management programme is foremost. This could be a pan-India initiative where citizens can actively participate in water conservation efforts through a government interface like a mobile application. Second comes the need to build two distinct networks for drainage and sewage in every town or city, as is possible. Efficient execution and strict monitoring of this dense network for water management is possible, again, with the help of ICT. This will help channelise water flow and minimise losses of all kinds. Third is widening the scope and scale of desalination plants in India. Cities like Chennai can most certainly capitalise their vast coastlines by using desalinated water for non-domestic use thus reducing the dependency of non-domestic water needs on natural sources which can then be exclusively used for domestic consumption.

Another significant learning from Singapore's water success story is the idea of reclaimed or recycled water. Most countries are today facing water scarcity challenges which is making recycling of water inevitable. Lack of sufficient information and understanding on the subject and the fear arising out of this ignorance has made the wide acceptance of recycled water difficult. People are averse to the idea of reusing used water although it is treated and purified sufficiently before reusing. This issue was addressed by Singapore by undertaking public education on NEWater in various phases. This brought in transparency and helped build people's trust on the product. As a result, Singapore is able to source a significant portion of its water demand from NEWater and is also scaling it up to keep the share of supply substantial. India needs to use this idea of public education as well as the concept of recycle and reuse to be able to meet its ever-growing demand and address the ongoing supply crunch. Land-locked cities and metros as well as industrial towns can particularly benefit from this. Accordingly, a pilot can be set up in Bengaluru which is reeling under severe water pressures and its land-locked nature is not helping in finding sustainable solutions. On the whole, India can emulate substantially from Singapore's water success story and adapt them suitably to solve city-specific water challenges.

3.4

Development challenges in Indian cities

A major concern in all Indian urban metros at present is reconciling liveability, environmental sustainability and economic growth, especially with increasing urban density resulting from high population numbers. Following are a few key challenges and infrastructure woes faced by most Indian urban metros:

- Lack of a modern and adaptable planning framework as most urban government bodies still follow conventional methods and techniques that have lost relevance in today's time and age. Integration of technology is one such example. As ICT is a relatively new development and was not a part of the traditional approach to planning, most urban development plans fail to harness its immense potential.
- Multiplicity of government bodies and agencies within a sector and at various levels, results in delays and inefficient implementation of proposed plans. Availability of funds and use of land are other areas that get impacted owing to the involvement of numerous parties which also creates loopholes in accountability and responsibility.
- There is a strong emphasis on adding physical infrastructure without thoroughly evaluating the present gap in carrying capacity and without accounting for forecasted rise in demand. Further, there is an essential disconnect of the present approach with environment-friendly and sustainable solutions making current projects unviable in the future.
- Urban transportation policies lack a holistic approach as they mostly cover road vehicles. Very little or no emphasis is laid on mass public transport modes such as local trains/metros and bicycle and walking tracks.
- There is a lack of regular, strong and transparent infrastructure audits.
- There is also a lack of sufficient involvement of private players, citizens, Non-Governmental Organisations (NGOs) and environmental bodies in planning as well as execution.

While providing housing for all remains an important agenda for the Indian government, improving the quality of living for all citizens is equally important and urgent. Clean and efficient public infrastructure, more greenery, open spaces and public parks are a must to enhance the quality of life of the people. The government needs to engage in a meticulously designed and implemented technology-based plan spanning across 15-20 years with designated periodic milestones. An umbrella vision such as 100 percent digitization of key infrastructure sectors within a long term time frame of about 20 years needs to be set, which can then be supplemented by more detailed plans within the framework, with a smaller time frame of about five years. For instance, smart utility infrastructure in select few urban metros can be planned by 2025.

3.5

Conclusion

Singapore presents an ideal case scenario for systematic and consistent development of the nation with the strong aid of technology. Possibly, India can adapt and adopt from this model to attain its developmental goals. However, it would not be fair to draw exact parallels between the two countries that have significantly different polity, geography, population and challenges. An apples to oranges comparison is not the right approach. Nevertheless, an elemental reference can definitely be drawn from Singapore's different models and adapted to suit India's diverse needs. The transport and mobility sector can be a good start for India's urban infrastructure goals.

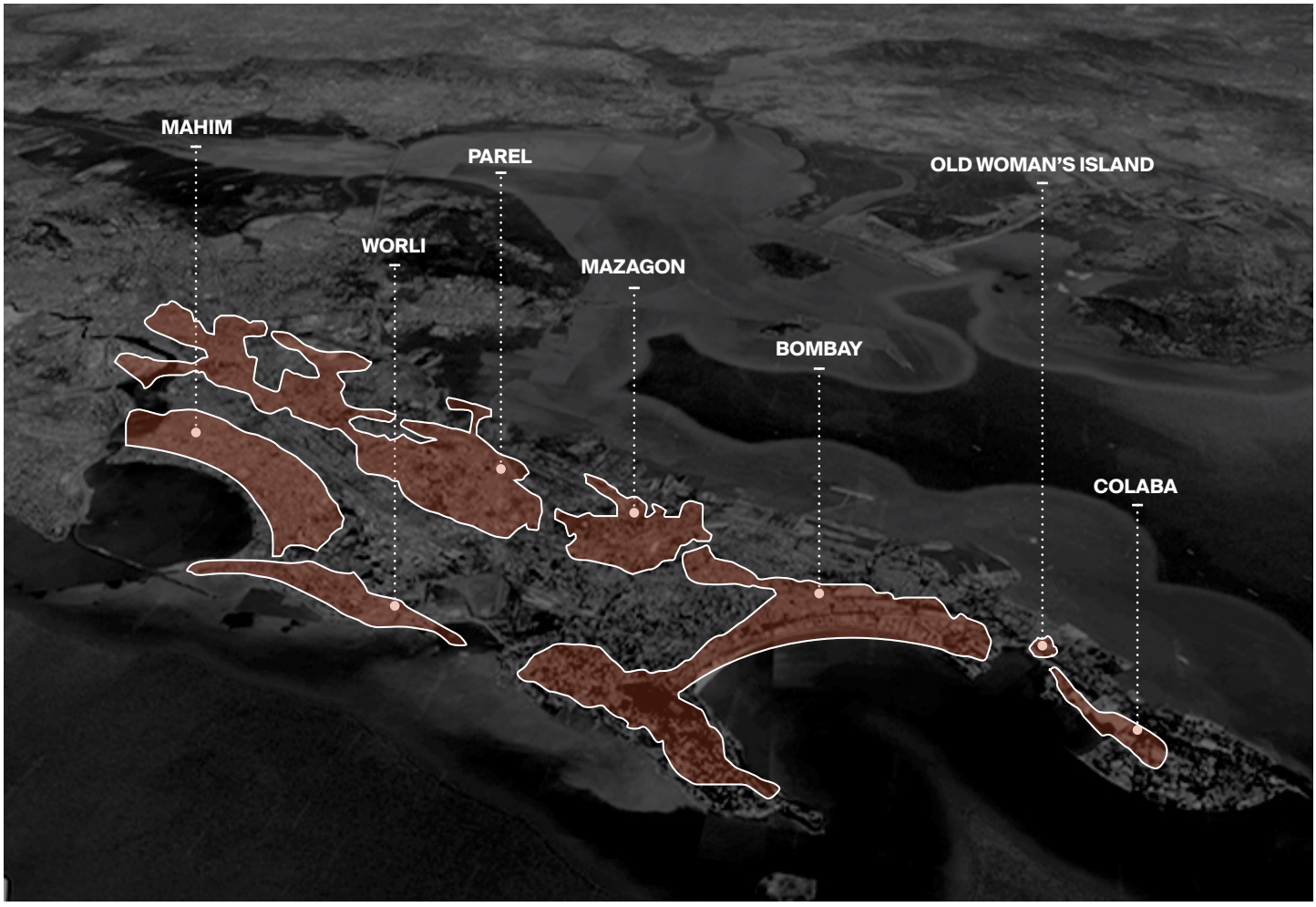
MUMBAI: THE MEGACITY

The Mumbai Metropolitan Region (MMR) which is referred to as the financial capital of India is spread over 4,000 sq. km. and includes the municipal corporations of Brihanmumbai Municipal Corporation (BMC), Navi Mumbai Municipal Corporation (NMMC), Mira-Bhayandar Municipal Corporation, and Thane Municipal Corporation (TMC). With the recent additions of Palghar, Vasai, Kalyan, Bhiwandi, Ambernath, Karjat, Khalapur, Pen and Alibaug to MMR, the expanse of MMR has now spread over 6,000 sq. km.

4.1

EVOLUTION OF MUMBAI

Mumbai city, as we know it today, initially comprised of only seven major islands. It took over 150 years to join the original seven islands of Mumbai. These islands were lush green, thickly wooded, and dotted with 22 hills, which had Arabian Sea flowing through at high tides. The original island of Bombay was only 24 km long and 4 km wide from Dongri to Malabar Hill (at its broadest point) and the other six were Colaba, Old Woman's island, Mahim, Parel, Worli and Mazagaon. The land between the islands was reclaimed from the sea in 1730 to create a major port city and several road projects commenced simultaneously. The port activity was the driver of the city's growth at that time.



The land reclamation was completed in the 19th century and the city became a hub for economic activities and several educational institutes were set up. Post-independence, the city started to grow and was competing with Kolkata to become the financial capital of India.

In the years before India's independence and in the first few decades after independence, Kolkata was the financial capital of India. Kolkata was ahead of Mumbai in terms of economic development and was the hotbed of real estate and economic activity. However, over the next few decades, the city of Kolkata, due to various reasons, started losing its hegemony to Mumbai. Mumbai started growing and gaining prominence as the financial capital of India and transformed into the current day mega city. Today, Mumbai is no longer a single city which was formed by reclaiming land from the sea, it is an agglomeration of several regions under MMR.

Infrastructure and regional development which aided the transformation

- The railway lines of the Western Railway (WR), as we know it today, were constructed during the land reclamation. The Western Railway was constructed from Churchgate station northwards and the Central and Harbour lines were started from the erstwhile Victoria Terminus or VT (now known as Chhatrapati Shivaji Maharaj Terminus or CSMT) northwards and to the north-east towards Navi Mumbai.
- Initially, due to comparatively better rail and road connectivity, the population of Mumbai started concentrating in the western part of the city (i.e. Bandra-Virar). Over the years, as the vehicle density increased, the Western Express Highway was widened, and a number of flyovers were constructed to cater to the growing vehicle population. The Versova-Andheri-Ghatkopar (VAG) metro led to significant development of office space along the Andheri-Kurla road. Today, this metro serves as a crucial interchange point for commuters travelling from WR to the Central Railway (CR). Previously, the rail commuters had to travel all the way till Dadar for the interchange.
- As the Central Railway services and road connectivity started improving in the Central Suburbs (i.e. Sion to Mulund), these catchments started witnessing an influx of population. Local railway trains on CR started operations till Thane, which was later extended to Kalyan and then to Badlapur. The Eastern Expressway which is a part of NH3 caters to the residential and office catchments of the Central Suburbs. The Eastern Freeway, which became operational a few years ago, gave a significant boost to connectivity between the Central Suburbs and South Mumbai.
- Earlier, Thane was a separate node away from the main island city. As the road and local railway infrastructure improved, and as Mumbai expanded from island city to suburbs, Thane got integrated into MMR.
- Vasai-Virar were earlier a part of Thane district but got integrated with the Western Suburbs as it had efficient connectivity to the city through the WR networks. As CR networks improved, regions beyond Thane such as Dombivli, Kalyan, Ambernath and Badlapur got integrated into MMR. Bhiwandi, which is near Thane, due to better road connectivity, low land prices and lack of appropriate railway connectivity evolved as a warehousing market to cater to the warehousing needs of Mumbai.
- Navi Mumbai was developed in the early 1970s as a twin city of Mumbai to decongest the island city by taking office occupiers and port activities outside of the main city. The Jawaharlal Nehru Port Trust (JNPT) was established to divert the cargo activities and traffic away from the Mumbai Port Trust (MbPT). The trans-harbour railway line was constructed to provide rail connectivity between Mumbai and Navi Mumbai. However, capacity constraints of the trans-harbour line hindered seamless flow of commuters via trains. As a result, only port activities could shift from Mumbai city to JNPT, and JNPT is now the largest container port in India. Several roads and bridges were constructed to boost connectivity between Mumbai and Navi Mumbai - the Vashi bridge, the Sion-Panvel Highway, the Mulund-Airoli Bridge and the Kalwa bridge on the Thane-Belapur Road. These road projects helped office spaces to develop in Navi Mumbai. However, the Navi Mumbai concept did not take-off as envisaged and did not bring about the desired result of taking office demand away from the main city. The emergence of new office districts in Lower Parel, Bandra Kurla Complex (BKC), Andheri East, Goregaon East and along LBS Road in the Central Suburbs hindered the movement of offices to Navi Mumbai.

Connectivity and infrastructure development play a major part in the development of any city; Cities are not created within a short span of time, it took over two centuries for Mumbai to evolve from seven islands to the present-day MMR. The primary reason why Mumbai could grow was the focus on improving connectivity which made travelling long distances within an hour possible. However, looking at what happened to Kolkata, this growth of Mumbai from 7 islands to a megacity of MMR should not be taken for granted.

4.2

DRAWING PARALLELS WITH KOLKATA

Similar to what Mumbai is today, Kolkata was a dominant economic force before independence and continued to flourish in the initial few decades after independence. The city was bustling with economic activity, had good quality transport infrastructure and offered a large number of employment opportunities. The transportation networks prevalent in Kolkata at that time, were one of the best in the country. Even the office buildings were considered to be 'modern' as per the existing standards of the time. The city boasted a strong entrepreneurial culture which complemented the economic activities. As a result, some of the biggest companies of that day and age, were based out of Kolkata. Being situated on the banks of Hoogly river, Kolkata was home to a major port and a natural center for trade and commerce, which attracted the trader communities.

However, as the years progressed after independence, due to constrained business environment, the collapse of British rule and the East India Company (EIC), bifurcation of West and East Bengal, and reduction in usage of inland waterways for cargo transport, the city lost its economic prosperity to Mumbai. The city of Mumbai gained prominence and started growing much faster than Kolkata in the 1970–2000 period, driven by port, manufacturing and BFSI activities. The entrepreneurial population started migrating to Mumbai as ecosystems to support businesses were better than those being offered in Kolkata. Subsequently, employment opportunities generated in Mumbai led to a greater influx of population into the city. This led to the demand for real estate and ancillary services growing substantially in the city.

Due to rising demand and the land locked nature of Mumbai city, real estate prices climbed exponentially compared to other radially aligned cities where land availability is not as constrained. Consequently, in the early 2000s, rapidly expanding information technology (IT) companies had to look out for other cities to set up their operations and a majority of the manufacturing activities moved out of MMR. Kolkata had another opportunity to regain its lost charm which was available during the IT boom. The city missed out on it due to apathy of key stakeholders and Bengaluru, Pune, Hyderabad, Chennai and the National Capital Region (NCR) emerged as key contenders as they latched on to this opportunity to be a part of the IT revolution. These cities have grown predominantly due to the IT revolution in India.

Despite the IT companies moving to other cities, Mumbai continued to grow. The city became the port of call for companies in BFSI, media, telecom, pharmaceutical, consulting, exports and services sectors. The real estate activity and prices grew much stronger from the 2000s to the present-day period. The city became one of the most expensive real estate markets of the country and some areas of Mumbai are ranked on the list of the most expensive locations globally.

From lagging behind Kolkata to the present day scenario- where the tables have turned and the city of Kolkata finds the gap between Mumbai and itself insurmountable- Mumbai has come a long way! This progress was achieved on the back of concerted efforts of policy makers, vision of leadership, strong entrepreneurial culture, BFSI growth, port activities, growth in trade, growth in services sector, improvement in quality of living and the most important factor being the development of the Mass Rapid Transport System (MRTS). The local trains were the lifeline of this infrastructure development which made it possible for the residents to travel a distance of over 60 km in approximately an hour. The railway networks were complemented with the growth of autorickshaw, taxi and bus services making commuting easier for the masses. This was further augmented with the rise in ownership of private vehicles and drastic improvement in road networks.

Mumbai could evolve from seven islands to the present-day MMR and a megacity only because of the thrust on improving the connectivity, be it rail, road or public transport networks. When Kolkata started to decline, Mumbai was well positioned to fill the gap. This was primarily because the

British government had done the necessary groundwork in terms of infrastructure development, which is indispensable for the growth and expansion of any city. However, the pace at which the other cities of India such as Bengaluru, Gurgaon, Noida, Pune, Ahmedabad and particularly Hyderabad have grown in the past two decades is commendable. Most of them have grown faster than Mumbai in that period, and Mumbai is now facing serious competition from these cities to stay relevant. If we refer to Table 4, we can see that the current office stock in some of these cities is larger than that of MMR. Further, a huge amount of office supply is slated to be delivered in these cities over the next 3 years which would make them much bigger office markets than MMR. As office spaces are occupied, employement is generated.

As a 'cause and effect' relationship of employment generation leading to increased housing demand and eventually the expansion of the city, the office space numbers tell a tale. Bengaluru is one of the best examples of this. The residential market in MMR and several other cities in the country have been suffering due to poor demand, but Bengaluru which has a thriving office market has witnessed a relatively stronger residential demand in the same period.

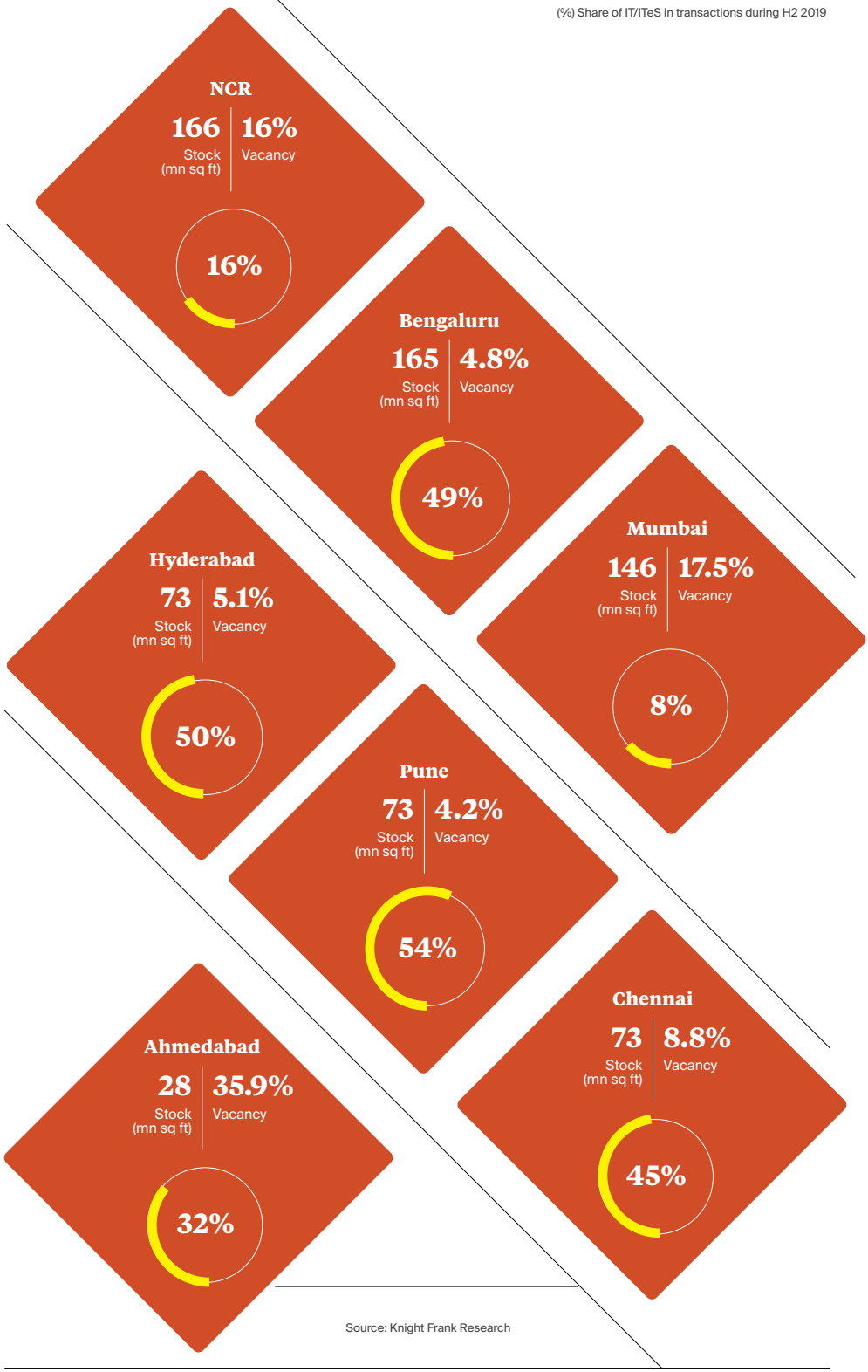
For IT companies, Bengaluru, Pune and Hyderabad offer an ecosystem which is far superior to MMR. This is substantiated by the share of IT/ITeS transactions of these cities as a percentage of total office transactions. If we refer to Table 4, the share of IT/ITeS transactions for most of these cities, than that of MMR.

The BFSI sector, which has been the major driver of office demand in MMR, is now moving towards digitisation and automation. This transformation requires huge emphasis on Information Technology (IT). Hence, companies in the BFSI industry are also slowly moving towards establishing their presence in cities that provide a good IT ecosystem. Further, the real estate cost and associated cost of living in some of these cities is much lower than Mumbai, which reduces the overall cost for an organisation

Table 4

OFFICE TRANSACTIONS AND SUPPLY ACROSS MAJOR CITIES IN 2019

(%) Share of IT/ITeS in transactions during H2 2019



Source: Knight Frank Research

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On a regular day, during peak hours it takes over 2.5 hours to reach from one end of the city to another by road. For the 8.5-11 hours of time spent at work, the total time could average up to 12 to 15 hours including travel time. Put aside 6-8 hours of time for sleep and the resident of MMR is left with no more than 2 to 4 hours of time for personal activities each day.

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as well as its employees. As a result, MMR is facing significant competition from these cities to attract companies.

Kolkata was the number one city of India until five decades ago and presently, it is Mumbai; but the biggest challenge for Mumbai is to maintain this position over the next five decades. Going by the way things stand today, there are significant challenges which would make it difficult for Mumbai to maintain its lead over other cities of India.

4.2.1 Will Mumbai go the Kolkata way?

The growth of Mumbai should not be taken for granted. At present, Mumbai may be a mega city which is competing with some of the global cities; however, Kolkata enjoyed a similar status five decades ago. Cities do not get crippled overnight, it is a slow process of decline and generally happens over several decades. The process is too silent to ring alarm bells amongst the leadership, but it gives ample time and several discernible signals to the stakeholders involved to take cognizance of the signs of decadence.

Mumbai, being a peninsular city has grown rapidly toward the north and north-east on the back of strong local railway network which was complemented with the development of road networks in the form of Western Express Highway and Eastern Express Highway. The development of the satellite city of Navi Mumbai on the eastern part of the city has also helped take some load off the city limits and the central and western lines. However, most of the arterial road networks of MMR are now utilized well beyond saturation. Thus, commuting which was the unique selling proposition (USP) of Mumbai, has now become the biggest bottleneck hindering the city's growth.

Due to rapid population growth, narrow roads, poorly planned infrastructure, emergence of larger buildings on narrow roads and high vehicle density, at several locations in MMR, the number of cars using a particular road has crossed its carrying capacity. As per a recent media study based on data from the transport department , Mumbai has 3.7 million (or 37 lakh vehicles) in the city as on November 2019 which includes – 2 wheelers, 4 wheelers, buses, trucks, LCVs, taxis and autos. Assuming 4 meter (m) to be the average length of vehicle, the total length of road required to accommodate these 3.7 million vehicles comes to 14,800 kilometer (km). Even if we assume all roads in Mumbai to be 3x3 lanes (6 lanes), then the total road length required to accomdate these many vehicles comes to 2467 km. However, the existing cumulative length of road network in Mumbai is just 2000 km. Thus, the existing vehicle population has far exceeded the carrying capacity of roads in Mumbai. Mumbai roads have reached the saturation point in terms of road widening and in most places of the city, there is little scope for adding lanes through this. Thus, the total road length in Mumbai is unlikely to increase unless we create new road networks through a coastal road or sealink, but the vehicle population would continue grow in the years ahead which would worsen the situation further.

Globally, most cities suffer from traffic and long commute times, but Mumbai figures at the bottom of the list. As per TomTom's 2018 traffic Index, Mumbai ranks lowest amongst 403 cities globally in terms of peak hour traffic congestion. On a regular day, during peak hours it takes over 2.5 hours to reach from one end of the city to another by road during peak hours. On weekdays, it takes over an hour just to get in and out of the major business districts. Lower Parel, Elphistone and BKC are apt examples of this. The road connectors between Mumbai and Navi Mumbai have also been seeing increasing traffic delays over recent years.

Further, during monsoons, the traffic delays are only exacerbated as the increased incidence of potholes and water-logging drastically slows down movement of vehicles.

[1] Worst car density in India worsens, city now has 530 per km

Churchgate
Virar

4 hr 9 min (82 km)

CST Rail Station
Kasarvadavli

2 hr 23 min (44 km)

Time taken to travel from one end of the city to another during peak hours (5-7pm)

Churchgate
Borivali

2 hr 53 min (40 km)

Source: As indicated by Google maps on 26th September 2019

For the 8.5-11 hours of time spent at work, the total time could average up to 12 to 15 hours including travel time. Put aside 6-8 hours of time for sleep and the resident of MMR is left with no more than 2 to 4 hours of time for personal activities each day.

The railway networks which are considered the lifeline of Mumbai - are over-saturated and inadequate to handle the existing population, let alone any new influx. Incidents of death due to over-crowding in trains are reported every day.

To sum it up, the population of the city grew beyond the most aggressive estimate of any town planner at that time. The resulting lack of infrastructure capacity is affecting quality of life now and is threatening to jeopardise the future of the city.

Despite Mumbai being one of the most vibrant cities of India in terms of culture, having a diverse set of employment opportunities and a vast talent ecosystem, several companies and employees located in other cities of India are not keen to shift to Mumbai. The traffic conditions, over-crowded local trains, poor quality of life compared to other cities, lack of open spaces, high cost of living and the largely unaffordable real estate prices are factors that charatcterize life in Mumbai today.

Unaffordable real estate prices have caused many companies across sectors to shift from Mumbai to other cities, a considerable percentage of them being IT companies. If the infrastructure scenario in the city is not improved significantly, it could cause overall demand for real estate, both commercial and residential, to shrink. Kolkata faced a similar situation a few decades ago, with existing companies moving out of the city and new occupiers reluctant to move in. Mumbai could be heading to a similar juncture.

As per the United Nations, by the year 2046, 50% of India's population would be living in urban areas which is significantly higher than 34% in 2018. With its infrastructure already stretched beyond its limit, it is hard to conceive of Mumbai being able to accommodate such an increase in residents without a massive overhaul and increase in its infrastructure carrying capacity.

4.3

MMR GIVING OUT SEVERAL SIGNS OF DISTRESS

4.3.1 Crumbling Infrastructure

Mumbai has already started giving out the early signs of distress with small failures in its infrastructure ecosystem every few months. These incidents are very small to ring alarm bells, but if you add them up then the picture that emerges is quite gloomy. Some recent incidents include the bridge collapse outside CST station, the stampede at Elphinstone railway station, the fire at Kamala mills rooftop restaurant, the collapse of pedestrian bridge at Andheri station, the wall collapse at Malad due to heavy rains, the death on local trains due to overcrowding almost every day and the abrupt closure of several pedestrian as well as road bridges and flyovers across the city on being declared unsafe.

These stray incidents are early signs that the city is deteriorating and will be crippled in a few decades if issues are not addressed on priority. Thousands of lives have been lost in these incidents. The deaths in such individual incidents may be an insignificant percentage compared to the population of Mumbai, but if we add up the numbers, then it is too large to ignore. If we refer to the Table 2, the number of lives lost due to crumbling infrastructure over the last 5 years is upwards of 3,500 and indicatively exceed the lives lost due to terrorist attacks in Mumbai.

Table 6

NUMBER OF DEATHS DUE TO CRUMBLING INFRASTRUCTURE

Bridge collapse outside CSMT

Year 2019 | 6 deaths

https://www.news18.com/news/india/mumbai-footover-bridge-collapse-live-at-least-4-dead-over-30-injured-in-accident-near-cst-railway-station-2066933.html

Malad wall collapse during rains

Year 2019 | 30 deaths

https://www.indiatoday.in/india/story/death-toll-in-july-2-malad-wall-collapse-reaches-30-1570205-2019-07-17

Fire at Kamala Mills rooftop restaurant

Year 2017 | 14 deaths

https://thewire.in/urban/kamala-mills-fire-mumbaia

Cities like Mumbai are resilient and can recover from such incidents, but for it to dominate in the global context and compete with other cities of India for corporate interests, an unprecedent thrust must be given to infrastructure and town planning. If these incidents are ignored, the cumulative number may someday become unpalatable.

4.3.2 Poor drainage networks

The water logging issues that the city experiences every year indicate that the city drainage networks are incapable of handling heavy rains. The residents of the city are also guilty of irresponsibly throwing waste and plastic bags in drains which clog them. However, even if the drainage lines are clear, the existing drainage networks are old, designed for the population of several decades ago and inadequate to handle the higher rainfall volume as latest estimates suggest.

The havoc that waterlogging incidents create during monsoon bring the city to a standstill year after year. Various studies on global warming indicate that due to changing weather patterns, the intensity of rainfall in Mumbai would increase every year. The studies indicate that Mumbai is likely to witness greater rainfall over short spells each year. Higher intensity implies more incidents of waterlogging, unless the capacity of drainage networks is improved. The monsoon of Mumbai in 2019 is a good example, where it rained for a lesser number of days during the monsoon season, but the rainfall intensity in those days was higher. In 2019, Mumbai received almost the entire season's rainfall in the month of July. Earlier the rainfall was evenly spread over four months, from June to September. The graphs below graphs indicate how rainfall was spread during the monsoon season in 2014 vs in 2017 vs in 2019. The graph for 2019 is more erratic and deviates from the normal which indicates the high intensity days.

Stampede outside Elphinstone Road Station

Year 2017 | 23 deaths

https://m.economictimes.com/news/politics-and-nation/death-toll-in-elphinstone-stampede-in-mumbai-rises-to-23/articleshow/60892935.cms

Overcrowding in trains

Year 2014 | 797 deaths

Year 2015 | 807 deaths

Year 2016 | 657 deaths

Year 2017 | 654 deaths

year 2018 | 650 deaths

https://timesofindia.indiatimes.com/city/mumbai/suburban-railway-deaths-drop-by-10/articleshow/67374028.cms

Total lives lost due to crumbling infrastructure in the last 6 years

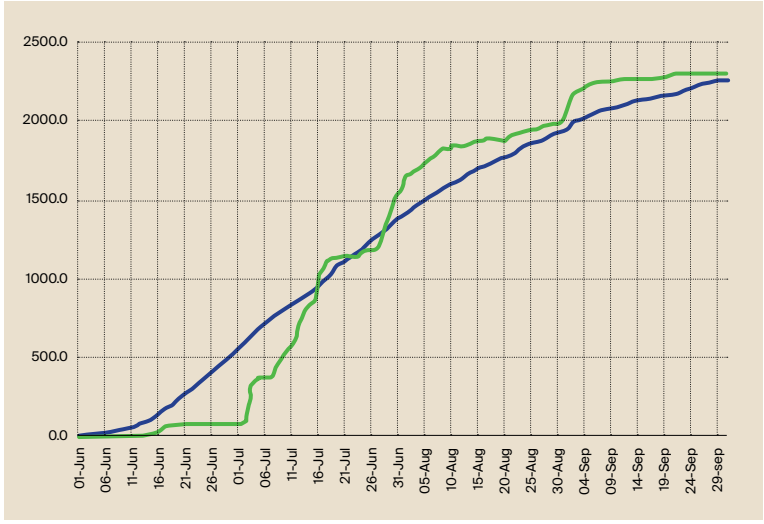
Total

3,638

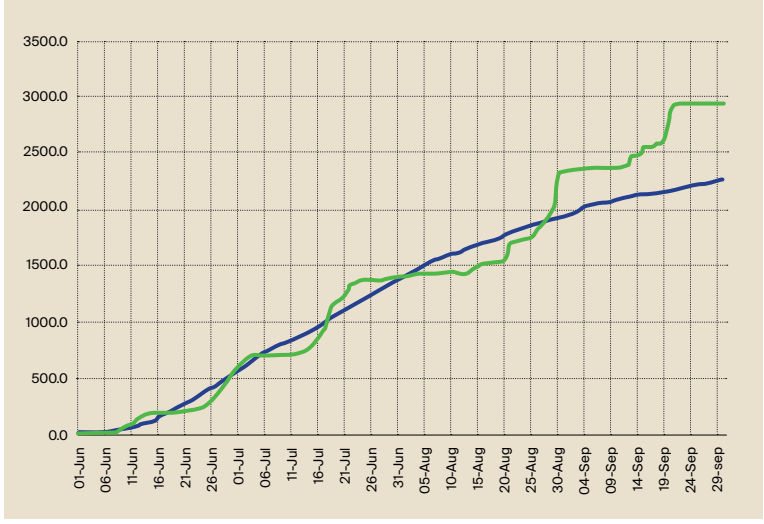
deaths

Source: Media reports

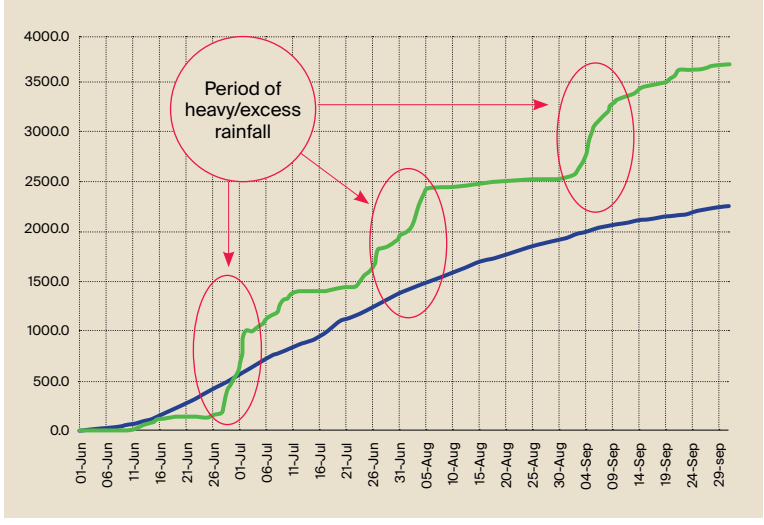
CUMULATIVE RAINFALL OVER SANTACRUZ IN 2014



CUMULATIVE RAINFALL OVER SANTACRUZ IN 2017



CUMULATIVE RAINFALL OVER SANTACRUZ IN 2019



Santacruz Rainfall Santacruz Normal Rainfall

Source: IMD Mumbai

Heavy rains and waterlogging disrupt life in Mumbai as people are either not able to report to office or return home from office. The work/productivity is impacted for at least two consecutive days. Increased frequency of such incidents impacts the city's competitiveness, as several workdays are lost. In 2019 alone, MMR witnessed at least four such days when the entire MMR was affected due to heavy rainfall. During some of the heavy rainfall days, all three railway lines had stopped functioning and some stretches of the highway and many roads were not accessible due to waterlogging.

Going forward, due to increased intensity of rainfall, companies will have to brace themselves for disruption of work and loss of productivity and workdays during the monsoon season. However, for a mega city like Mumbai, which is the financial capital of India, such disruption of work every year is unacceptable. If the drainage networks are incapable of handling the current rainfall intensity, then they are not likely to be capable of handling the increased rainfall intensity forecasted in the years ahead.

The financial impact due to waterlogging is often neglected. It is an expensive affair and it burns a huge hole in the pocket of residents. Residents have to spend money for repairing their vehicles and property every year, sometimes multiple times in the same season. Even insurance companies are facing losses due to large payout as compensation every year and they have increased the premiums, which is again borne by residents. Potholes crop up on the surface roads and the roads needs to be re-laid. In many cases, the governments also compensate the flood victims, which is an additional loss to the strained finances of the exchequer.

According to a recent report by the United States Trade and Development Agency (USTDA) and KPMG, Mumbai alone lost INR 140 bn or INR 14,000 crore to flood related damages in 10 years from 2005 to 2015. Add to it the losses incurred from 2015 till date, the financial loss figures would be appalling. The cost of laying an effective drainage network is a one-time affair and would turn out to be less expensive than the cost

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residents and companies have been bearing each year due to damage to property and loss of productivity.

Developers pay a huge amount of construction charges as area improvement charges which are collected by the administration to develop the utility infrastructure of the area. The same is then added to the cost of the flat and passed on to homebuyers. However, despite the construction boom in MMR over the last 2 decades and such vast sums being collected as area improvement charges, the utility infrastructure in most areas of Mumbai has not been upgraded. If this problem is not addressed immediately, eventually MMR would lose out to the other better planned cities of the country.

4.3.3 Water scarcity

Several cities in India are water stressed and staring at a Cape Town like scenario. Chennai came very close to 'Day Zero' in the summer of 2019. The northern belt of Bengaluru is facing acute water scarcity as ground water reserves in this region have almost dried up. Despite having good quality infrastructure in those regions of Bengaluru, the water crisis is affecting the real estate demand.

Due to global warming, the weather patterns are becoming increasingly unpredictable and the number of extreme weather incidents are on the rise. Cape Town is a glaring example of

a coastal city facing an unprecedented water crisis. The city was dependent on rainfall to meet its water requirements but shifting rainfall patterns and three years of severe drought has got the city close to 'Day Zero'.

MMR has a huge population which gets its water from lakes located in and around the city. As the lakes supplying water to Mumbai rely on rain-fed sources, climate change will play a significant role in water availability in the future. There is a great deal of uncertainty about how exactly rainfall patterns will change due to global warming. India being a rainfall dependent country, has witnessed back-to-back years of drought in several states due to insufficient or no rainfall in the past few years. If MMR were to face a drought like scenario even for a year, it is unlikely that the city would be able to cope with it. Due to the delayed onset of insert in 2019 after monsoon, the municipal corporation, had to dip into the reserve stock of water to supply water to the city. Had it not rained heavily in July 2019, the city would have faced severe water cuts, which would have thrown life out of gear for its residents.

Some regions of MMR have already been at the receiving end of insufficient rainfall. A few years ago, in May 2017, the High Court (HC) had put a temporary ban on new construction in the Thane Municipal Corporation (TMC) region and restrained the authority from issuing a Commencement Certificate (CC) to any real estate project in Thane, as the municipal corporation lacked the capacity to supply water to these news buildings. The ban was lifted later. However, in future, if the rainfall is deficient, it is likely that such an event may be repeated across MMR.

In a case of extremes, Mumbai suffers water logging and floods during monsoons and is under threat from water cuts during summer. During monsoon, huge quantities of potable water flow into the drains and into the sea. This indicates that the city lacks adequate planning in terms of effectively managing the water resources and a large amount of fresh water is wasted.

As per a report submitted by the committee of experts appointed by BMC, the water requirement of Mumbai is estimated to increase by 71% from the present 3,800 MLD (million litres per day) to 6,424 MLD by 2041. This increase in demand expected to primarily be driven by old buildings, redevelopment of slums, improvement in quality of living, higher incomes, beside an increase in population. The municipal corporation is undertaking few more reservoir projects to cater to the same. However, it is unlikely that these sources will be sufficient to meet the demand in a rainfall deficient year.

If the annual rainfall is below normal in any given year, the current demand of 3,800 MLD is not met. During the monsoon of 2018, the rainfall was below normal and consequently, the administration supplied 10% less water to the city each day from November 2018 until June 2019. Unless we are able to set up mechanisms as other global cities have done to recycle and reuse wastewater, actively adopt rain water harvesting, store excess rainwater in tunnels or reservoirs and use desalination methods to make sea water potable; the estimated future demand of 6,424 MLD is unlikely to be met.

The BMC has taken a step in the right direction and proposed a 5% rebate in property tax to societies who reuse and recycle waste water. However, for existing housing societies, the process of redesigning drainage networks of the building in order to recycle waste water is a highly complex and expensive affair. Even the installation of a filtration/recycling plant or making space for the same in an existing building is difficult. Hence, the setting up of treatment plants and the drainage networks for recycling of waste water must be incorporated as a part of building code for buildings over a particular size. Developers would then make it a part of their project during the construction stage itself which is easier instead of the same being constructed/incorporated at a later date by the society members.

Water availability and water management needs to be given utmost importance as it is one of the biggest challenges that face the cities of India and will impact real estate demand in future. MMR, due to its massive population and dependence on rainfall for its requirements, is more vulnerable than other cities.

4.3.4 Solid waste management

Mumbai generates over 7,000 tonnes of waste every day. This waste is dumped on open grounds in the form of landfill. Most dumping grounds of Mumbai are already filled to the brim and do not have the capacity to accommodate such huge quantities of waste generated every day. Hence, this waste needs to be processed and recycled in order to reduce the area required for landfill. The waste which has built up in the dumping grounds of Mumbai over the years is largely untreated and as a result, may have turned toxic. This untreated waste pollutes the air and ground water severely in areas in and around the dumping ground.

For the BMC region, the scenario of waste disposal is precarious. The dumping ground at Mulund has been shut, the one at Deonar which is currently handling 20% of the city's waste is expected to shut by December 2019 and the city will than be left with only one dumping ground at Kanjurmarg. [2]

Due to a spate of fires in dumping grounds in 2016, which had engulfed the entire city in smoke for several days, the High Court (HC) had come down heavily on the BMC and enforced a ban on any new construction within BMC limits. A similar ban on new constructions was also enforced by the court in the Kalyan-Dombivli Municipal Corporation (KDMC). The court had cited lack of dumping grounds, poor waste disposal techniques and lack of measures to recycle and reprocess, for enforcing the ban. The HC had asked the municipal corporations to come up with credible solutions for lifting the ban. These were lifted after several months of impasse. In the case of BMC, it extended to almost two years after which the Supreme Court had to intervene and provide a temporary reprieve.

The BMC did try to find solutions to reduce the amount of waste generated in the city, but better alternatives need to be explored. a segregation of dry and wet waste is one

[1]'Mounds of mixed waste give the lie to Kanjurmarg dump segregation claim'

such initiative which has helped reduce the quantum of waste generated in the BMC region. However, at present, it is restricted only to larger residential societies under BMC. The same must be extended to all buildings under BMC and across municipal corporations in MMR. One other solution is recycling and treatment of waste to minimize the land required for dumping. In the Kanjurmarg dumping ground, BMC has setup a bioreactor and Material Receiving and Segregating Facility (MRF) to treat waste. This has helped reduce the land required to dump waste. Other municipal corporations in the MMR should also adopt similar scientific methods of treating and disposing of waste.

The population and the waste generated by it in MMR will only grow with time. With awareness levels about the harmful effects of dumping ground on the rise, municipal corporations will find it difficult to acquire land for dumping ground in the future. Hence, credible solutions for treatment and minimization of land required for waste disposal must be explored and implemented.

4.3.5 Deteriorating air quality

In 2016, there were several fire incidents in the dumping grounds of Mumbai during which the visibility and air quality of the city was impacted. Pilots were finding it difficult to land at the Mumbai airport due to low visibility; patients with respiratory ailments complained of breathing problems; there was a foul odour in the air and all of this was affecting the health of residents and children alike. It took several days to douse the fire, as the dumping grounds had significant presence of highly inflammable waste which was dumped unscientifically and irresponsibly. The air quality of Mumbai during that period had become as bad as that which NCR experiences during winters. The quality of air in NCR during winter is estimated to be as harmful as smoking 20 cigarettes a day. There were reports which indicated that a large number of expats are not willing to shift to NCR due to this reason.

Mumbai being a coastal city enjoys the sea breeze, which blows the polluted air from the city to the hinterlands. Despite the sea breeze, air quality in most areas of Mumbai is in the danger zone and not suitable for breathing. Unlike NCR, which suffers from poor air quality due to burning of crop stubble in Punjab, the air quality of MMR is poor due to construction dust, emissions from poorly maintained vehicles, exhaust from cars, unscientific burning of waste, small illegal industries operating in slums and congestion on the roads. With rising affluence and growth, the vehicle population and construction activity in the city is expected to increase which will only add to this burden.

The WHO global air pollution database in 2018 ranked Mumbai as the fourth most polluted megacity in the world. The chart and table below highlight the fact that the particulate matter of 2.5 microns (PM2.5) has been in the 'Unhealthy' to 'Very Unhealthy' category in Mumbai for most days from October 2018 to February 2019. It is only during monsoon that the air quality is good.

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Despite the sea breeze, air quality in most areas of Mumbai is in the danger zone and not suitable for breathing. The WHO global air pollution database in 2018 ranked Mumbai as the fourth most polluted megacity in the world.

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Chart 5.

$PM_{2.5}$ MATTER IN MUMBAI

October 2018							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w40	-	-	-	-	-	-	-
w41	-	-	-	-	106	147	172
w42	170	164	161	150	120	131	157
w43	172	173	149	153	157	141	164
w44	143	114	147	-	-	-	-

November 2018							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w44	-	-	-	150	147	145	126
w45	114	105	167	148	253	200	233
w46	169	166	166	154	153	162	165
w47	176	183	183	208	165	166	166
w48	170	175	171	165	166	-	-

December 2018							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w48	-	-	-	-	-	166	171
w49	179	178	173	175	163	162	174
w50	173	162	149	136	145	140	156
w51	160	163	164	-	-	133	161
w52	168	180	197	157	145	167	157
w53	161	-	-	-	-	-	-

January 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w1		174	196	204	229	207	192
w2	211	169	175	195	216	225	223
w3	222	188	183	184	200	208	205
w4	255	-	115	134	157	153	146
w5	151	138	136	155	-	-	-

Febuary 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w5	-	-	-	-	150	159	174
w6	180	166	174	158	109	148	152
w7	168	190	175	151	110	140	141
w8	157	150	145	164	108	121	174
w9	154	136	122	114	-	-	-

March 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w9	-	-	-	-	122	155	161
w10	80	87	120	108	121	136	147
w11	137	118	106	121	102	118	152
w12	148	155	138	121	95	86	130
w13	161	164	157	145	141	130	114

April 2019							
-	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w14	86	84	89	100	89	74	72
w15	77	76	71	72	76	92	115
w16	98	90	98	59	79	91	83
w17	82	87	72	72	66	70	-
w18	112	91	-	-	-	-	-

May 2019							
-	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w18	-	-	96	90	106	93	94
w19	79	75	73	64	51	44	51
w20	58	70	65	72	69	69	72
w21	61	55	58	51	56	78	69
w22	76	83	75	61	56	-	-

June 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w22	-	-	-	-	-	57	50
w23	51	52	44	51	46	43	48
w24	55	58	69	56	85	72	62
w25	60	61	67	52	-	-	-
w26	-	85	66	52	41	31	50

July 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w27	58	32	48	62	75	65	46
w28	59	48	83	85	73	43	44
w29	36	52	48	56	59	75	70
w30	74	37	26	30	55	52	51
w31	59	54	42	-	-	-	-

August 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w31	-	-	-	38	47	31	27
w32	39	49	47	53	79	75	71
w33	62	55	55	65	53	48	55
w34	49	53	53	44	52	53	48
w35	47	64	56	56	53	44	

September 2019							
	Mon	Tue	Wed	Thu	Fri	Sat	Sun
w35	-	-	-	-	-	-	45
w36	37	49	19	18	13	22	30
w37	30	54	55	66	42	44	48
w38	34	45	44	59	70	50	53
w39	64	65	56	57	53	33	39
w40	31	-	-	-	-	-	-

Source: World Meteorological Organisation, Mumbai US Consulate air pollution

Table 7.

AIR QUALITY INDEX SCALE AS DEFINED BY THE US-EPA 2016 STANDARD

	AQI	Air Pollution Level	Health Implications	Cautionary Statement (for PM2.5)
	0 – 50	Good	Air quality is considered satisfactory, and air pollution poses little or no risk.	None
	51 -100	Moderate	Air quality is acceptable; however, for some pollutants there may be a moderate health concern for a very small number of people who are unusually sensitive to air pollution.	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
	101-150	Unhealthy for Sensitive Groups	Members of sensitive groups may experience health effects. The general public is not likely to be affected.	Active children and adults, and people with respiratory disease, such as asthma, should limit prolonged outdoor exertion.
	151-200	Unhealthy	Everyone may begin to experience health effects; members of sensitive groups may experience serious health effects.	Active children and adults, and people with respiratory disease, such as asthma, should avoid prolonged outdoor exertion; everyone else, especially children, should limit prolonged outdoor exertion
	201-300	Very Unhealthy	Health warnings of emergency conditions. The entire population is more likely to be affected.	Active children and adults, and people with respiratory disease, such as asthma, should avoid all outdoor exertion; everyone else, especially children, should limit outdoor exertion.
	300+	Hazardous	Health alert: everyone may experience more serious health effects.	Everyone should avoid all outdoor exertion

As per a recent report titled 'BMC Environment Status Report 2018-19', Mumbai's annual average concentration of the hazardous PM 2.5 (particles less than 2.5 microns in size) was at 60 (measured as micrograms per cubic metre), 50% above the Central Pollution Control Board's permissible limit of 40. PM 2.5 is amongst the most hazardous pollutants, as it is small and can get deep into lungs and may even enter the bloodstream. Several studies have linked particle pollution exposure to a variety of problems including premature death in people with heart or lung disease, nonfatal heart attacks, irregular heartbeat, aggravated asthma, decreased lung function and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing.

A series of measures needs to be undertaken in Mumbai to improve the quality of air such as migration to electric cars, planting of trees, making it expensive to use private vehicles, completion of MRTS projects, promote carpooling, strict enforcement of construction norms, etc. Air pollution is a silent killer, people do not die overnight but the lifespan of the person is reduced, and the health issues increase, which takes a huge toll on the residents. Children are the most susceptible to air pollution and if the menace is not curtailed, children growing up today and all the future generations would suffer from respiratory problems for their entire life.

If people and expats are not keen to shift to NCR due to poor air quality of the city, MMR would also suffer the same fate. A decade ago, air pollution was not as debated as it is today, there were bigger challenges such as water and transport which were more important. But as awareness levels increase and the country develops, air pollution would be an important topic of discussion and would drive the flow of population.

4.4

COURTS CLAMP DOWN ON ADMINISTRATIVE AUTHORITIES DUE TO INFRASTRUCTURE BREAKDOWNS

The problems that the infrastructure logjams are creating in MMR is impacting real estate and other allied industries adversely. Creating new infrastructure to augment current capacity invariably involves acquiring land for development, which creates further conflicts with the environment. However, as the benefits far outweigh the effects on environment, it is permitted.

In the recent past, due to various environmental issues, the real estate industry of MMR was at the receiving end of the clamp down by courts. While the industry is partly responsible, the accountability should rest with the planning authorities as it is their reponsibilty to create an environment for sustainable development and not the other way around.

Environment issues, be it quality of air, water, health, ease of living, waste management, etc. are gaining prominence with time. These issues were too inconsequential or intangible to be discussed a few decades ago, but are the focus of a global debate on sustainability of human progress and urbanisation today. As the effects of climate change and global warming become more apparent, these environment issues will be taken more seriously and may become the deciding factor for any project as these factors affect the quality of life and sustainability of a city.

MMR is found lacking in several aspects of infrastructure and in quality of life offered to its residents. The courts have started taking cognizance of the problems that infrastructure logjams have created and have come down heavily on the administration. Some of the recent actions include-

- HC ban on granting Commencement Certificates (CC) to new projects in TMC region due to inadequate water availability in May 2017
- HC ban on all new constructions in BMC due to the dumping ground issue in March 2016
- HC ban on new construction in Kalyan Dombivali Municipal Corporation (KDMC) due to the dumping ground issue in April 2015

The court actions were taken against the slackness of the administration, so that they are forced to come up with effective sustainable solutions. But they affected the real estate industry adversely and also pushed several developers under severe financial stress. While the ban on new construction activity was subsequently lifted after an impasse, such sudden interim barriers during regular course of business are not sustainable for a mega city like Mumbai. For MMR to stay relevant and maintain its status as the economic capital of India, serious emphasis must be given to tackle the challenges that the city faces regarding sustainable to development and to creating a benign environment for business.

4.5

GOVERNMENT EFFORTS TO TACKLE MMR'S CHALLENGES

MMR is facing several challenges which are capable of dethroning it from the position of being the crown jewel of India. While air, water, drainage and waste management are important parameters affecting the livability of a city, it is the physical infrastructure elements such as transportation and connectivity that decide the future of a high growth city like Mumbai in a developing economy.

The government, the administration and the stakeholders have started acknowledging these challenges and have undertaken several measures to tackle the problems faced by MMR. As indicated above, some of the efforts are meaningful, but others are not having the desired impact.

On the aspect of infrastructure development and improving connectivity, the government has been responsive, and we are witnessing unprecedented action on ground. There are several large infrastructure projects currently underway at various stages of construction in MMR. Most of the projects are expected to be operational in the next 8-10 years and will transform MMR.

All transportation and infrastructure projects have a material impact on real estate. Considering the scale of projects underway in MMR, it becomes essential to study and analyse the impact of these projects on real estate.

4.6

THE BIG INFRASTRUCTURE PUSH

The transportation challenge of the MMR, which is traveling long distances in a reasonable time through affordable MRTS should get a significant boost in the next decade. The government has acknowledged the fact that the travel time from places of employment to residential markets has gone up over the years and become impractical. It is threatening to hinder the growth of the city and forcing companies to move out of MMR.
To mitigate this problem, an unprecedented amount has been invested over the past 5 years to create new MRTS infrastructure in MMR. MRTS projects worth over INR 1.87 tn (or INR 1.87 lakh crore) are currently underworks. This is the highest that has been invested in MMR over a 5-year period since independence. Some of the noteworthy projects are indicated in Table 3.

Table:8

MAJOR INFRASTRUCTURE PROJECTS UNDER-CONSTRUCTION IN THE MUMBAI METROPOLITAN REGION (MMR)

Project	Approximate cost (INR bn)	Approximate length of the project (km)		Completion by (official deadline)	Ridership by 2031
Mumbai Metro Line 2 A – Dahisar to DN Nagar	64	18.589	246 km of metro networks	Second half of 2020	609,000
Mumbai Metro Line 2 B – DN Nagar to Mandale	110	23.643		Dec 2021	1,049,000
Mumbai Metro Line 3 – Colaba – Bandra – SEEPZ	230	33.5		Phase 1 by 2021	1,600,000
Mumbai Metro Line 4 – Kasarvadavali (Thane) to Wadala	145	32.32		2022	1,231,000
Mumbai Metro Line 4 A – Kasarvadavali to Gaimukh	9	2.7		2022	
Mumbai Metro Line 5 – Thane – Bhiwandi – Kalyan	84	24.9		2022	302,500
Mumbai Metro Line 6 – Lokhandwala to Vikhroli (EEH)	67	14.477		NA	400,000
Mumbai Metro Line 7 – Dahisar East to Andheri East	62	16.475		Second half of 2020	668,000
Mumbai Metro Line 9 – Dahisar East to Mira Bhayandar and Andheri East to CSIA	65	13.581		NA	1,112,000
Mumbai Metro Line 10 – Gaimukh-Shivaji Chowk	44	9.2		March 2022	NA
Mumbai Metro Line 11 – Wadala and CSMT	87	12.8		March 2026	NA
Mumbai Metro Line 12 – Kalyan to Taloja	41	20.7		NA	192,420
Navi Mumbai Metro Line Phase I, II and III	40	23.4		Phase 1 - 2020	-
Coastal Road – Marine Lines to Kandivali West	400	29.2	68 km of road networks	2021 for Phase 1	68,000 cars by 2023
Mumbai Trans-harbour Link (MTHL)	142	21.8		2022	100,000 vehicles by 2032
Bandra-Versova Sea Link	70	17.17		2024	NA
Navi Mumbai International Airport	210	Not applicable	Not applicable	2020	Not applicable
TOTAL	**1,870**	**314**			

Source: Knight Frank Research, MMRDA | *Note – NA-Not available

Many projects mentioned in table 6 were expected to be operational 15 years ago. Had that been the case, MMR would not have faced some of the challenges it is facing now. Due to apathy on policy implementation these projects did not see the light of the day for long. However, learning from the past mistakes emphasis is now on the execution and completion of these projects. Once operational they would transform the way residents in MMR travel. Connectivity across MMR would be seamless as most regions of MMR would come inside a ring based closed structure as indicated in the map.

Focus must be on improving connectivity and not just creating infrastructure

The projects indicated in Table 8 will create massive infrastructure networks in MMR. Such large infrastructure projects are built with the hope of guiding real estate development and population to that area. However, things do not always pan out as envisaged. There are many instances where infrastructure was created in the hope of guiding real estate development and population to a particular region, but the desired movement of population in that direction did not happen. The major reason for such failure is the lack of focus on connectivity.

Connectivity and proximity to places of employment (office districts) is an important driver for driving demand for real estate and population to that location. In many instances the connectivity factor scores over social and utility infrastructure. Development of Vasai-Virar region and Navi Mumbai during the initial years is a case in point.

Navi Mumbai was conceptualized as a planned city in 1970 designed to take population and office space away from Mumbai and Vasai-Virar region was to be preserved in its natural state to accommodate the excess sea water, the flow of which was hindered due to reclamation of land in Mumbai. It was also meant to serve as a source of farming to provide supplies to Mumbai.

In the initial three decades, Navi Mumbai, despite having good quality infrastructure like utility, roads, town-planning, sewage, social infrastructure, water supply and electricity, lost out to Vasai-Virar, as Navi Mumbai lacked connectivity to the office and residential markets of Mumbai. In those days, the population and office spaces were concentrated in the western and southern part of the city, and as cars were a luxury there were not many effective modes of commute or MRTS networks to reach the office hubs from Navi Mumbai and vice versa. On the contrary, growth in Vasai-Virar took off with barely any of the superior local infrastructure compared to that available at Navi Mumbai. The primary reason for growth of Vasai-Virar was the efficient connectivity to the office markets in western and southern parts of Mumbai through the Western Railway netwok. However, over the years, due to the completion of various infrastructure projects which improved connectivity between Mumbai and Navi Mumbai, the latter gained acceptance and started witnessing influx of population. The presence of good quality infrastructure helped propel Navi Mumbai much ahead of Vasai-Virar today.

Connectivity to office hubs can change the fortunes of a real estate catchment. Many of the upcoming infrastructure projects will connect newer markets or improve connectivity of existing markets with office hubs. This will lead to significant real estate traction along the project corridor in the influence area.

In the next section, we will evaluate the impact of select projects which are likely to be completed in the next decade and also prognosticate the key markets that are likely to witness the highest amount of real estate traction.

4.7

INFRASTRUCTURE PROJECTS AND KEY IMPACT MARKETS

Around 250 km of metro and 70 km of road projects are in various stages of construction in MMR. These projects should transform the way citizens of MMR travel and will influence real estate in the project corridor.

Work on all the under-construction Metro Lines in MMR have been taking place at a greater pace compared to the pace at which Mumbai Metro of Mumbai Metro Line 1 (Versova-Andheri-Ghatkopar) constructed. There were several mistakes in terms of planning and execution during it construction which delayed the project by several years. Since Line 1 was the first metro project in the city, some hiccups were expected as authorities lacked experience of executing a project of this scale. The administrative authorities have learnt from their mistakes and taken necessary precautions to avoid them.

As the population using these projects daily is expected to be high, it will drive real estate development along the project corridor. Hence, it is important to assess their impact on real estate development in future. Currently, the real estate market in MMR is subdued and not many developers are keen or have the ability take new positions and we may not witness action immediately. But as the market revives, we will witness significant real estate traction along the project corridors.

OBJECTIVE OF THIS STUDY-

To identify the key impact markets which are likely to witness greater real estate traction.

Methodology for identifying key impact markets along the project corridor

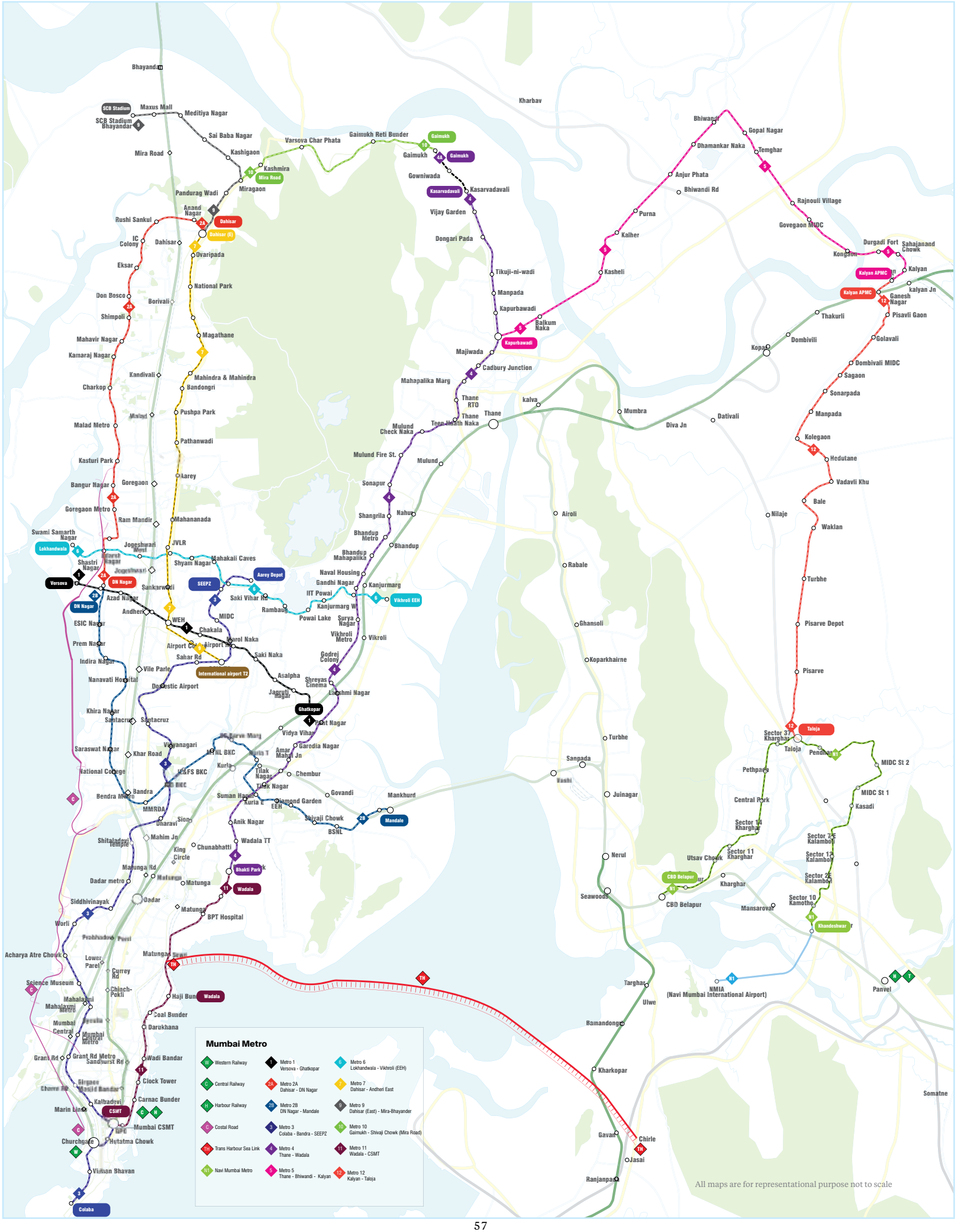
i. Evaluate the catchments along the MRTS corridor

ii. Identify catchments which are currently lacking connectivity

iii Assess the connectivity scenario of those catchments after the MRTS project is operational

iv Evaluate the scope for real estate traction in that catchment based on
   a. Availability of land for greenfield development
   b. Scope for greater real estate traction via redevelopment

Note: The objective of the study is to identify key impact markets from the perspective of potential for heightened real estate traction (i.e. demand and supply). The objective and methodology are not intended to gauge the scope for price appreciation in our earmarked key impacts markets as it is based on a different set of parameters which is not covered as part of this report.


Mumbai Metro
Western Railway
Central Railway
Harbour Railway
Costal Road
Trans Harbour Sea Link
Navi Mumbai Metro
Metro 1
Versova - Ghatkopar
Metro 2A
Dahisar - DN Nagar
Metro 2B
DN Nagar - Mandale
Metro 3
Colaba - Bandra - SEEPZ
Metro 4
Thane - Wadala
Metro 5
Thane - Bhiwandi - Kalyan
Metro 6
Lokhandwala - Vikhroli (EEH)
Metro 7
Dahisar - Andheri East
Metro 9
Dahisar (East) - Mira-Bhayander
Metro 10
Gaimukh - Shivaji Chowk (Mira Road)
Metro 11
Wadala - CSMT
Metro 12
Kalyan - Taloja
All maps are for representational purpose not to scale

4.7.1 Projects most likely to commence operations by 2022

Metro Line

2A

DAHISAR ⟷ **D N NAGAR**

Completion by –
Second half of 2020

Length
18.589 km (Elevated)

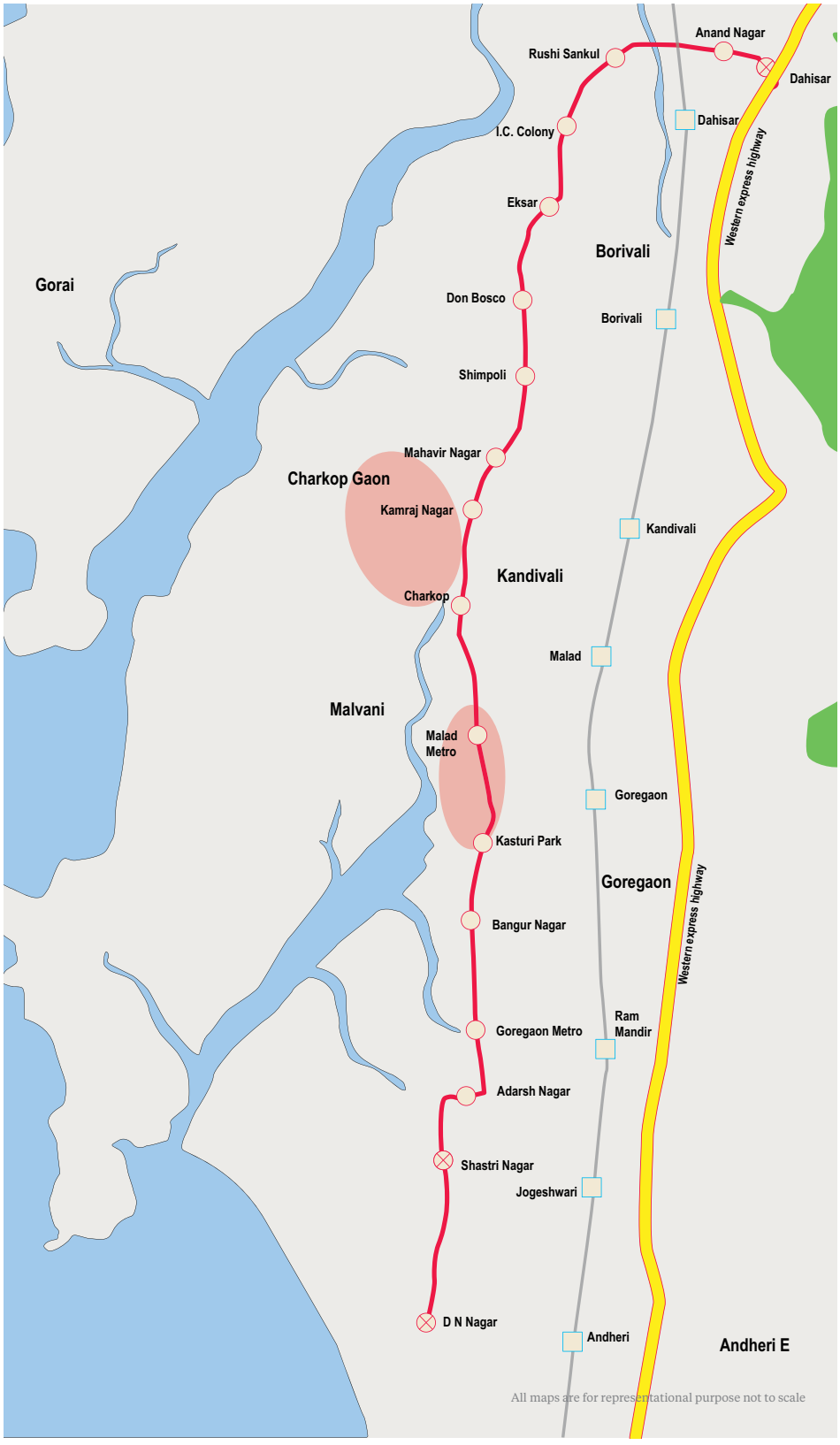
Stations
17 Nos. (All Elevated)

Dahisar	Charkop
Anand Nagar	Malad Metro
Rushi Sankul	Kasturi Park
I C Colony	Bangur Nagar
Eksar	Goregaon Metro
Don Bosco	Adarsh Nagar
Shimpoli	Shastri Nagar
Mahavir Nagar	D N Nagar
Kamraj Nagar	

Interchange stations for Metro at

1. D N Nagar (with Line 1: VAG metro)
2. Shastri Nagar (with Line 6: Lokhandwala - Vikroli)
3. Dahisar (with Line 7: Dahisar (E) - Andheri (E))
4. Dahisar (with Line 9: Dahisar (E) - Mira Bhayandar)

Source: MMRDA, Knight Frank Research



The Metro Line 2 is 42.23 km long divided into 2 phases – Line 2 A and Line 2 B. Line 2 A is 18.589 km long with 17 stations between DN Nagar and Dahisar. Line 2 B is 23.643 km long from DN Nagar to Mandale. Once the entire Line 2 is ready, it would become the longest Metro Line in MMR.

The initial deadline for completion of the line 2A was second half of 2019, however, it has been revised to second half 2020. At current pace of work the deadline of second half of 2020 is achievable, if required priority is given to execution.

The Metro Line 2 A corridor passes through the dense catchments along Link Road in Western suburbs from Dahisar to Andheri West. Apart from commercial office spaces in the Goregaon-Malad region, this metro majorly caters to residential catchments. It will be a boon for residents living along the Metro Line. Presently, it takes over 1.5 to 2 hours during peak hours to travel along Link road from Andheri West to Dahisar as the road has several traffic signals at almost every junction, high vehicle density and the width of the road is not uniform throughout as getting narrower at a few critical junctions.

This Metro Line would also help people living in Central Suburbs and working in the office hubs of Goregaon-Malad. Commuters can use the Metro Line 1 interchange at DN Nagar and reach their offices. Currently, one has to either travel by private car, bus, taxis or rickshaw from their homes to their workplaces in Goregaon-Malad or interchange from Metro Line 1 to WR at Andheri Station and take a train to Goregaon station, or alternatively go to Dadar to change from CR to WR and then take a train to Goregaon station and from Goregaon station again go by road to reach their office. During peak hours it takes 30-45 minutes just to reach from Goregaon station to office hubs of Goregaon-Malad.

The Metro Line 2 A will reduce the hassle of this segment of daily commuters. The same is true for those residing in Western Suburbs and travelling to Andheri East, Central suburbs or Goregaon-Malad for work. This line will also increase footfalls at the malls along the corridor. Students will also benefit as there are several educational institutes along this corridor.

The Metro Line 2 A connects with 4 Metro Lines. It connects with Metro Line 1 (Versova-Andheri-Ghatkopar) via interchange at DN Nagar, with Metro Line 6 (Lokhandwala to Vikhroli) via interchange at Shastri Nagar (Infiniti mall Andheri), with Metro Line 7 (Dahisar East to Andheri East) via interchange at Dahisar and Metro Line 9 (Dahisar East to Mira-Bhayandar) via interchange at Dahisar.

The real benefit of this Metro Line would actually accrue once the phase 2 or Line 2 B is ready. The Metro Line 2 B extends to Mandale and passes through the important office markets of BKC. The Metro Line 2 B also provides connectivity to office markets in South and Central Mumbai through Metro Line 3 via interchange at BKC and to Central Suburbs through Metro Line 4 via interchange at Eastern Express Highway.

It is proposed that this line would be extended to Navi Mumbai in the future and connected with Navi Mumbai Metro which would further increase footfalls on this line. However, this is still in proposal stage.

Key impact markets:

As per MMRDA, this Metro Line is expected to have a daily ridership of 407,000 by 2021 and 609,000 by 2031. Owing to such high ridership and daily movement of population, many markets along this corridor would witness traction. However, the markets along this corridor which have the potential to witness high real estate traction are likely to be-

A. The belt between Malad metro station and Kasturi Park Metro Station

This belt has large vacant land parcels. Currently, office occupiers are finding it difficult to travel there due to poor connectivity and isolation of the region. The only access to this place is by road and it is around 30 to 45 minutes from the nearest railway station. Once this project is operational, we many see several office projects and a few residential projects coming up in this belt. This region would also benefit from the upcoming Coastal Road. Once the Coastal Road is operational, it will get connected to most markets of Western Suburbs and South Mumbai. Given the development oppurtunities in this belt, around 11 million square feet of office supply can be expected.

B. Charkop and Ekta Nagar

Charkop and Ekta Nagar are located at a significant distance from major MRTS corridors. The Metro Line 2 A will pass right besides these clusters. Currently, the real estate market is subdued, and we may not witness traction immediately; however, as the market revives and with Metro Line 2 A becoming operational, the attractiveness of this location will improve. Even as there is scarcity of land in this catchment, the opportunities arising out of slum redevelopment will ensure higher real estate traction in these catchments and some portion of these clusters are likely to witness transformation. There are several industrial clusters in Charkop which have the ability to transform into residential.

Metro Line

7

DAHISAR ⟷ **ANDHERI (E)**

Completion by –
Second half of 2020

Length
16.475 km (Elevated)

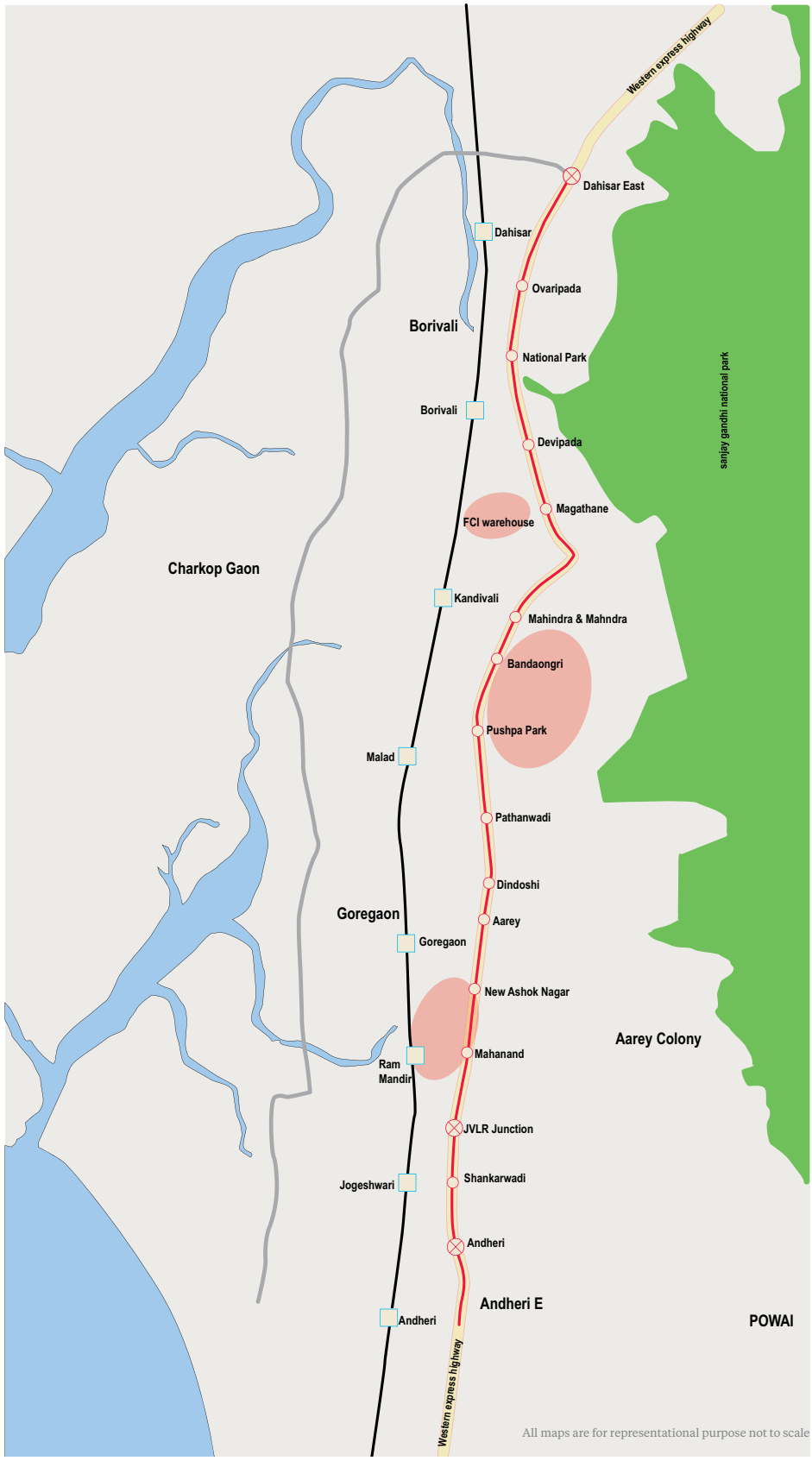
Stations
14 Nos. (All Elevated)

Dahisar	Pushpa Park
Ovripada	Pathan Wadi
National Park	Aarey
Devipada	Mahanand
Magathane	JVLR Junction
Mahindra & Mahindra	Shankarwadi
Bandongri	Andheri Metro (E)

Interchange stations for Metro at

1. Airport (with Line 3: Colaba - Bandra - SEEPZ) extended
2. Andheri Metro (with Line 1: WEH Station of VAG Metro)
3. JVLR Jn (with Line 6: Lokhandwala - Vikhroli)
4. Dahisar (with Line 9: (Dahisar (E) - Mira Bhayandar)
5. Dahisar (with Line 2A: Dahisar - D N Nagar)

Source: MMRDA, Knight Frank Research



Mumbai Metro Line 7 is 16.475 km long, connecting Dahisar East to Andheri East. This Metro Line will have 13 stations. The initial deadline for completion of this line was second half of 2019, however, it has been revised to second half of 2020 which is achievable if required priority is given to execution.

This Metro corridor passes through dense residential catchments and a major office catchment at Goregaon East. Once ready, the Metro Line will make commute for employees working at offices in Goregaon East easier. Residents living in Central Suburbs can use the VAG Metro Line 1 interchange at Western Express Highway junction to change to Metro Line 7 and reach their respective offices at Goregaon East. It will also help residents living along the Western Express Highway to reach their homes faster. Presently, travelling through Western Express Highway from Andheri East to Dahisar East takes a minimum of 2 hours during peak traffic time on most days. As per MMRDA, the time required by Metro to travel the same distance will reduce by 50% to 75%. This will be a significant boon for residents in this catchment.

Metro Line 2A and Metro Line 7 run parallel to each other from Dahisar and parallel to the railway line as well. Metro Line 7 runs along the eastern side and Metro Line 2 A runs along the western side. However, if we consider the characteristics of western suburbs, these two Metro Lines pass through completely different residential and office catchments. The catchments along both these routes are densely populated, and it takes almost 45 minutes during peak hours to go from west of these catchments to east and vice versa. Hence, both these projects are mutually exclusive.

The Metro Line 7 provides connectivity to various parts of the city through interchanges with 5 other Metro Lines. It connects with the Metro Line 1 (VAG) at Western Express Highway (WEH), with Metro Line 6 (Lokhandwala to Vikhroli (EEH)) at JVLR Junction, with Metro Line 2 (Dahisar to Mandale) at Dahisar and with Metro Line 9 (Dahisar East to Mira-Bhayandar) at Dahisar. This Metro Line would also be extended to the international airport where it will connect with Metro Line 3 (Colaba to Bandra to SEEPZ).

Key impact markets

As per MMRDA, this Metro Line is expected to have a daily ridership of 528,000 by 2021 and 668,000 by 2031. Owing to such high ridership and daily movement of population, many of the markets along this corridor will witness traction. The markets which have the potential to witness high real estate traction are likely to be-

a. The vacant land parcels and industrial sheds near Mahanand Metro Station

There are vacant land parcels and industrial sheds near Mahanand metro station, some of which are being used to host exhibitions. Located in close proximity of an established office location of NIRLON Knowledge Park, NESCO and having several office buildings within the vicinity, this location is likely to witness substantial commercial real estate traction. Given the development oppurtunities, office supply upwards of 10 million square feet can be expected in this region.

b. Slum clusters in Malad East to Kandivali East belt

There are several slum clusters on the Malad - Kandivali belt along the Western Express highway. Currently, the real estate market is subdued, and we may not witness traction immediately. However, once the market revives, there are several slum clusters in these regions which are likely to witness transformation through redevelopment. The ones closest to the highway would be the first to transform.

c. Food Corporation of India (FCI) warehouses in Borivali

The warehouses are inside city limits and a majority of food storage and distribution activities take place in Vashi APMC. If sufficient policy level changes are made, then these warehouses are likely to witness real estate traction. Real estate supply upwards of 18 million square feet can be expected in this region.

Metro Line

3

COLABA ⇔ **BANDRA** ⇔ **SEEPZ**

Completion by –
Phase 1 (i.e. SEEPZ to Bandra route) to start operations by 2021

Length
33.5 km (Underground)

Stations
26 Nos. (All Underground)

Cuffe Parade	Dadar
Vidhan Bhavan	Shitaladevi
Churchgate	Dharavi
Hutatma Chowk	BKC
CSMT Metro	Vidyanagri
Kalbadevi	Santacruz
Girgaon	Domestic Airport
Grant Road	Sahar Road
Mumbai Central Metro	International Airport
Mahalaxmi	Marol Naka
Science Museum	MIDC
Acharya Atre Chowk	SEEPZ
Worli	
Siddhivinayak	

Interchange stations for Metro at

1. SEEPZ (with Line 6: Lokhandwala - Vikhroli)
2. Marol Naka (with Line 1: VAG Metro)
3. Airport (with Line 7 extended: Dahisar (E) - Andheri (E))
4. BKC (with Line 2: Dahisar - Mandale)
5. CSMT (with Line 11: Wadala - CSMT)

Source: MMRDA, Knight Frank Research

The Mumbai Metro Line 3 is the city's first underground metro project connecting Colaba to Bandra (BKC) to SEEPZ. The Metro Line is 33.5 km long with 26 stations connecting 6 business districts, 30 educational institutions and 2 airports (domestic and international). The official completion date for Phase 1 of the project from SEEPZ to Bandra is 2021. While the project has been progressing at a good pace, it is currently facing several litigations particularly with respect to the location of the proposed car shed. If the litigation and impasse continue, it would be difficult for the project to meet the official deadlines.

The Metro Line passes through some of the most congested markets of South Mumbai, where the road capacity is limited and scope for expansion of roads (road widening) is very low. This Metro Line would be a boon to residents living in those areas and having offices in Lower Parel, BKC, Andheri East and SEEPZ. It would also aid those travelling to the airport. People living in suburbs and travelling to these business districts would use the Metro Line 3 more compared to those living in South Mumbai as they can travel to the business districts of Lower Parel, BKC and South Mumbai once the Metro Lines at interchange points are ready.

The Metro Line 3 has several interchange points along the corridor. It has interchange points with the two-railway lines of WR and CR and with 5 Metro Lines. The Metro Line 3 connects with VAG Metro Line 1 through interchange at Marol Naka station, with Metro Line 2B (Dahisar to Mandale) through interchange at BKC, with Metro Line 6 (Lokhandwala to Vikhroli (EEH)) through interchange at SEEPZ, with extended Metro Line 7 (Dahisar to Airport) through interchange at CSIA and with Metro Line 11 (Wadala to CSMT) through interchange at CSMT. It connects with railway lines at - Churchgate, Grant Road, Mumbai Central, Mahalaxmi and CSMT.

Key impact markets

As per Mumbai Metro Rail Corporation Limited (MMRCL), 1,600,000 people would be using this metro daily. As this Metro Line passes through already established saturated markets, not many vacant land parcels are available for new development. However, some established markets are likely to witness further demand and they are-

a. BKC

BKC is one of the most important business districts of the country, but it lacks connectivity through an MRTS projects. It takes atleast half an hour to get in and out of BKC during peak hours and reach the two highways (western and eastern) or nearest railway stations. With the BKC-Chunnabati connector now ready, the time required to reach Eastern Express Highway would reduce. Metro Line 2 B and Metro Line 3 are the first of the projects which would bring in MRTS right inside BKC. It would make commute easier for people working in BKC. BKC is already the most sought-after market of the city with low single digit vacancy levels. These projects would further augment demand. If the FSI in BKC would be 4 as it is now, office supply upwards of 8 million square feet can be expected in this market.

b. Undeveloped mill lands in Lower Parel

Lower Parel is an established office district in MMR which witnesses strong demand from occupiers and has low vacancy levels. There are a few mill land parcels in Lower Parel which have not yet been developed. These land parcels are likely to witness traction and develop into office spaces. The railway station of Lower Parel and the road networks leading to this market are largely saturated. The Metro Line 3 will help ease some load off these saturated networks, thereby aiding real estate traction.

c. Marol-MIDC belt

There are several old buildings and industrial units in this belt. There is an existing Metro Line catering to these markets. The Metro Line 3 would boost the connectivity of these regions to several parts of Mumbai and also to the important office markets of the city like BKC and Lower Parel. Combined together these projects can increase the potential of the belt to witness greater real estate traction through redevelopment.

d. Dharavi redevelopment

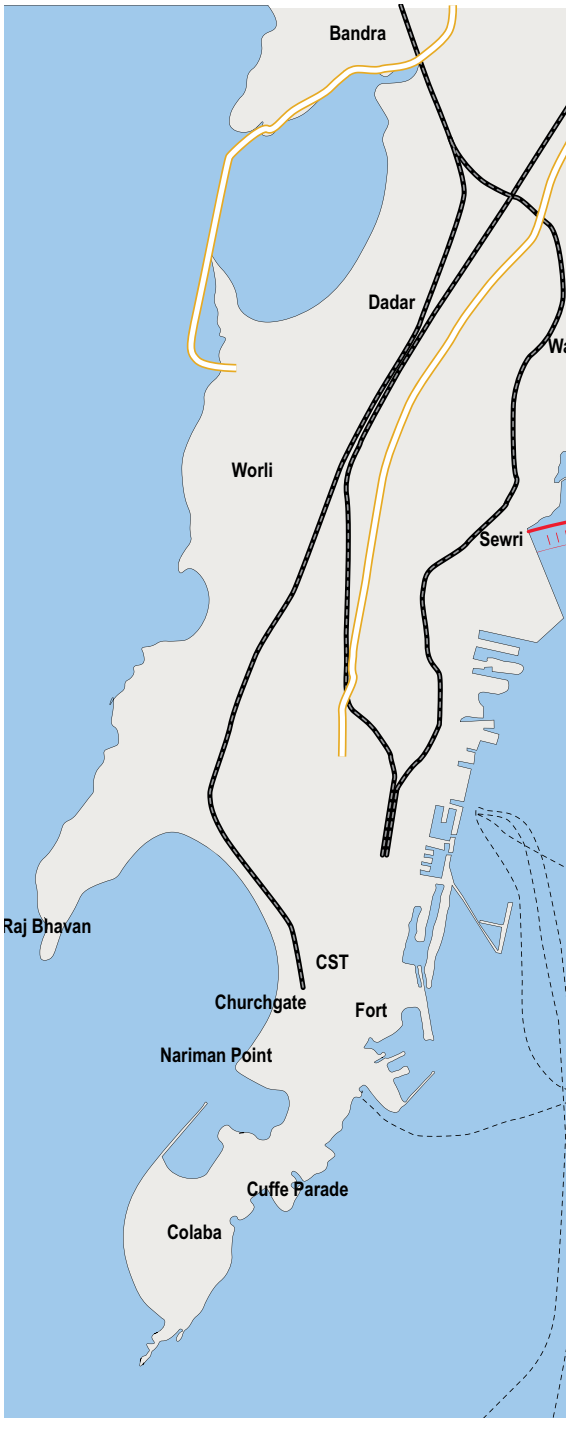
While redevelopment of Dharavi has been in the works for several decades now, in the latest efforts, the Government wants to establish a commercial business district and a township in this region. If Dharavi redevelops, the metro project has the ability to aid its transformation into a business district.

Trans Harbour Link

Completion by - **2022**

The Mumbai Trans Harbour Link was envisaged 35 years ago to facilitate decongestion between the island city and Navi Mumbai but failed to see the light of the day for almost three decades. Things have started moving now as it is crucial for the operations of the upcoming airport of Mumbai - Navi Mumbai International Airport (NMIA). The Mumbai Metropolitan Region Development Authority (MMRDA) has undertaken the implementation of the Mumbai Trans-Harbour Link Project, connecting Sewri on Mumbai side to Chirle on Navi Mumbai side. Work has already commenced on both sides.

This 21.8 km bridge is expected to help commuters traveling from Mumbai towards Navi Mumbai, Navi Mumbai International Airport, Jawaharlal Nehru Port, Panvel, Alibaug, Pune and Goa.



Key impact markets

As per MMRDA, 39,300 vehicles are expected to use this bridge everyday by 2022 which will increase to 100,000 vehicles by 2032 and 150,000 by 2042. Several markets in Navi Mumbai will benefit from this bridge as they would get access to office markets of South and Central Mumbai.

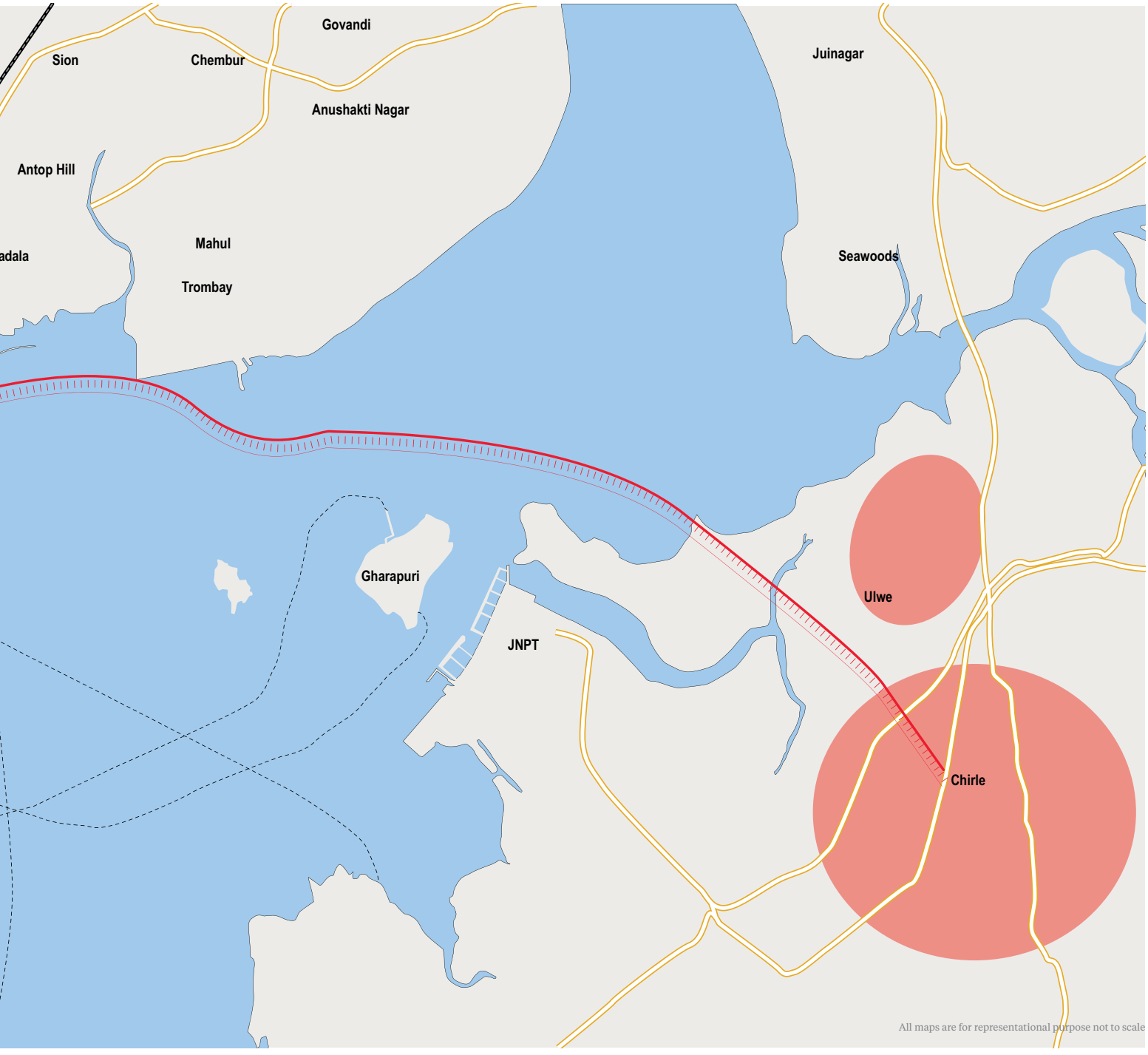
a. Chirle

MTHL lands at Chirle, from where various roads branching outwards are planned to disperse traffic towards JNPT, Navi Mumbai International Airport and Mumbai-Goa Highway. The Nerul-Uran railway line which is currently under construction would have a station at Ranjanpada, which will aid rail connectivity in Chirle. Thus, the regions around Chirle and the belt along the road connecting Chirle to Panvel will witness greater real estate traction.

b. Ulwe

Given the scope for greenfield development, once the link is complete, this region will witness further real estate traction. The region will also benefit from the railway stations which have been completed recently under the Mumbai Urban Transport Project (MUTP 3) and from the upcoming Navi Mumbai International Airport (NMIA).

[3] https://www.metrorailnews.in/mumbai-metro-line-2a-and-7-to-be-operational-by-2020/


Govandi
Sion
Chembur
Anushakti Nagar
Juinagar
Antop Hill
Mahul
adala
Trombay
Seawoods
Gharapuri
Ulwe
JNPT
Chirle
All maps are for representational purpose not to scale

4.7.2 Projects estimated to be operational between 2023-2030

In the previous section, we have analysed the projects that are likely to be operational by 2022. In this section, we look at the projects that are estimated to be operational in the 2023-2030 period based on their current on-ground progress, however official deadlines may precede our estimates.

Metro Line

2B

D N NAGAR ⟷ **MANDALE**

Completion by –
Official deadline 2022

Length
23.643 km (Elevated)

Stations
22 Nos. (All Elevated)

D N Nagar	MTNL, BKC
ESIC Nagar	S G Barve Marg
Prem Nagar	Kurla Terminus
Indira Nagar	Kurla (East)
Nanavati Hospital	Eastern Express Highway
Khira Nagar	Chembur
Saraswat Nagar	Diamond Garden
National College	Shivaji Chowk
Bandra Metro	BSNL
MMRDA	Mankhurd
ITO, BKC	Mandale
IL&FS, BKC	

Interchange stations for Metro at

1. D N Nagar (with Line 2A: Dahisar - D N Nagar)
2. BKC (with Line 3: Colaba - Bandra - SEEPZ)
3. Kurla (with Line 4: Thane - Wadala)

Source: MMRDA, Knight Frank Research

The Metro Line 2 is 42.23 km long divided into 2 phases – Line 2 A and Line 2 B. Line 2 A is 18.589 km long with 17 stations between DN Nagar and Dahisar. Line 2 B is 23.643 km long with 22 stations between DN Nagar and Mandale. However, there are a number of challenges the project may encounter on this corridor, from narrow roads from narrow roads, illegal structures and land acquisition to height restrictions. Hence, it would be difficult to meet the indicated deadline.

The Metro Line 2 B will be passing through dense residential catchments of western suburbs right from DN Nagar to Bandra, passing over the Link Road, Linking Road and a small stretch over SV Road. The line crosses BKC and connects to the railway line at Kurla Terminus which is an important railway station for outstation trains. Beyond that, the Metro Line extends to Eastern Express Highway and terminates at Mandale.

It is proposed that this line be extended to Navi Mumbai in the future and connect with Navi Mumbai Metro to further increase footfalls on this line. However, the proposal is still in the evaluation stage.

The Metro Line 2 will be beneficial for people working at BKC and residing in western suburbs, and for people residing in the Kurla-Mandale belt travelling to western suburbs. Currently, the primary roads connecting this office market to the dense residential catchments of western suburbs are Link Road and SV road. This route has multiple signals and limited capacity, which slows down the flow of traffic. People travelling on this route by car would benefit from this project. Also, there are many educational institutions along the corridor and the project would help the students studying there. As per MMRDA, this Metro Line is expected to reduce travelling time by 50% to 75%. The access to malls and other retail destinations along the corridor will improve once this Metro Line is operational.

This Metro Line connects with 6 other Metro Lines and the monorail line. It has interchange points with Metro Line 7 (Dahisar to Andheri East) and Metro Line 9 (Dahisar East to Mira-Bhayandar) at Dahisar, with the Metro Line 6 (Lokhandwala to Vikhroli (EEH)) at Shashtri Nagar (Infiniti Mall), with Metro Line 1 (Versova-Andheri-Ghatkopar) at D N Nagar, with Metro Line 3 (Colaba-Bandra-Seepz) at BKC, with Metro Line 4 (Thane to Wadala) at Kurla and with Monorail (Chembur to Jacob Circle) at Chembur.

Key impact markets

As per MMRDA, Metro Line 2B is expected to have a daily ridership of 890,000 by 2021 and 1,049,000 by 2031. Once complete, Metro Line 2 would be the longest Metro Line in MMR providing connectivity to several markets in a single corridor. Considering the length of the corridor and the high ridership, several markets along this corridor would witness real estate traction. However, many markets along this corridor are already developed and do not have much scope for expansion or fresh development. The few markets that have the potential to witness high real estate traction are likely to be-

a. BKC

BKC is the most sought-after business district of the city with low single digit vacancy levels but it lacks connectivity through MRTS projects. It takes at least half an hour to get in and out of BKC during peak hours and reach reach either of the two highways (western or eastern) or the nearest railway stations. With the BKC-Chunabati connector now ready, the time required to reach Eastern Express Highway will reduce. Metro Line 2 B and Metro Line 3 are the first of the projects which will bring in MRTS right inside BKC. It will make commute easier for people working in BKC. Metro Line 2 will connect BKC to the dense residential catchment of western suburbs. This project would further augment BKC's stature as one of the important office markets of the city. If the FSI in BKC remains be 4 as it is now, office supply upwards of 8 million square feet can be expected in this market.

Metro Line

4

KASARVADAVALI ⟷ WADALA

Completion by –

Official deadline - 2022[3]

Length

32.32 km (Elevated)

Stations

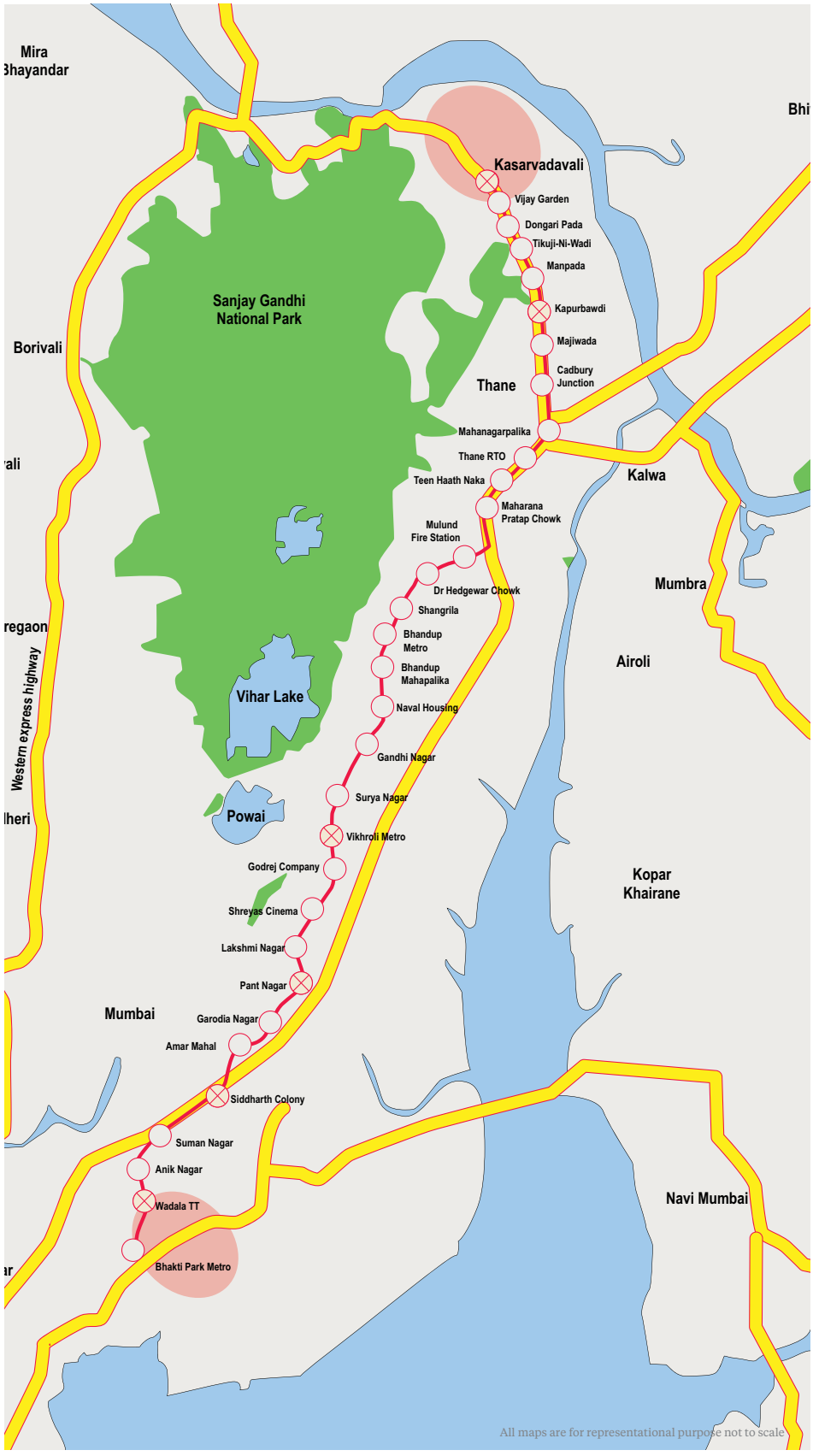
32 Nos. (All Elevated)

Kasarvadavali	Bhandup Mahapalika
Vijay Garden	Naval Housing
Dongari Pada	Gandhi Nagar
Tikuji-Ni-Wadi	Surya Nagar
Manpada	Vikhroli Metro
Kapurbawdi	Godrej Company
Majiwada	Shreyas Cinema
Cadbury Junction	Lakshmi Nagar
Mahapalika Marg	Pant Nagar
RTO Thane	Garodia Nagar
Thane Teen Haath Naka	Amar Mahal Jn.
Maharana Pratap Chowk	Siddharth Colony
Mulund Fire Station	Suman Nagar
Dr Hedgewar Chowk	Anik Nagar Bus Dep.
Shangrila	Wadala TT
Bhandup Metro	Bhakti Park Metro

Interchange stations for Metro at

1. Wadala (with Line 11: Wadala - CSMT)
2. Siddharth Colony (with Line 2: Dahisar - Mandale)
3. Pant Nagar (with Line 1: VAG Metro)
4. Vikhroli (with Line 6: Lokhandwala - Vikhroli)
5. Kapurbawdi (with Line 5: Thane - Bhiwandi - Kalyan)
6. Gaimukh (with Line 10: Gaimukh - Shivaji Chowk)

Source: MMRDA, Knight Frank Research



This Metro Line is also referred as Thane-Wadala Metro Line. The Metro Line 4 - Kasarvadavali to Wadala, is 32.32 km long with 32 stations between Kasarvadavali and Wadala. This line will be extended from Kasarvadavali to Gaimukh in the north which would be a 2.7 km extension with 2 stations. The project is expected to be completed by 2022. Considering the size of the project, unless the pace of construction is accelerated, it is difficult to meet the indicated deadline.

The Metro Line 4 will pass through certain established catchments as well as a few upcoming catchments. A considerable section of this project passes through LBS Road from Ghatkopar to Mulund which are densely populated. The Metro Line will connect many residential catchments to the office markets along the LBS Road. People working in offices located along the LBS Road and staying in the central suburbs will benefit from the resultant reduction in travel time. They will also be able to travel to the western part of MMR through interchange points with various Metro Lines. The Metro Line will also be extended to meet the Metro Line 2 and 7 at Dahisar via Metro Line 9 (Dahisar to Mira Road) and Metro Line 10 (Gaimukh to Shivaji Chowk). On the southern side, the Metro Line 4 would be extended till CSMT as Metro Line 11 Wadala to CSMT route, thus helping the commuters reach South Mumbai and their workplaces at Fort, faster.

It will be immensely beneficial to residents living along the Thane-Gaimukh belt as this area lacks MRTS. Currently, residents along this belt have to travel for close to an hour by road to reach the nearest railway station of Thane, from where they can commute to various parts of MMR. The Metro will provide the residents in this area with the much needed MRTS connectivity.

This Metro Line connects with 6 other Metro Lines and the monorail line. It has interchange points with Metro Line 10 (Gaimukh to Shivaji Chowk/Mira Road) at Gaimukh, with Metro Line 6 (Lokhandwala to Vikhroli (EEH)) at Vikhroli, with Metro Line 1 (Versova-Andheri-Ghatkopar) at Pant Nagar (Ghatkopar), with Metro Line 11 (Wadala to CSMT) at Wadala, with Metro Line 5 (Thane-Bhiwandi-Kalyan) at Kapurbawdi, with Metro Line 2 (Dahisar to Mandale) at Siddharth Colony and with Monorail (Chembur to Jacob Circle).

Key impact markets

As per MMRDA, Metro Line 4 is expected to have a daily ridership of 870,000 by 2021 and 1,231,000 by 2031. Metro Line 4 and 4A when complete will become the second longest Metro Line in MMR. The markets which are likely to see the highest real estate traction are-

a. Wadala Truck Terminus

As per the recent notification of the Urban Development Department (UDD), the truck terminus will be developed as a commercial centre on the lines of BKC. It will fall under the jurisdiction of MMRDA, which will be the Special Planning Authority (SPA) for that area. The truck terminus is spread over 115 hectares (288 acres) while BKC is spread over 300 hectares. The Metro Line 4 will boost connectivity of this region with the central suburbs and the Metro Line 11 (Wadala to CSMT) will augment connectivity of this market with South Mumbai. The truck terminus already enjoys good road connectivity to Central Suburbs and South Mumbai via the Eastern Express Highway and Eastern Freeway respectively. It also has access to Chembur and Parel through the Monorail network. Combined together, all these factors can propel the development of this region on the lines of BKC. If this area is permitted the same FSI of 4 as BKC, real estate supply of around 50 million square feet can be expected in this region.

b. Kasarvadavali to Gaimukh belt

There are large undeveloped land parcels in this belt. However, the only access to those land parcels is by Ghodbunder Road. Further, Gaimukh is located at an isolated part of MMR, far-off from any MRTS projects, which has curtailed its growth. The Metro Line 4 and 4 A will establish connectivity of this region with central and southern parts of Mumbai and the Metro Line 10 (Gaimukh to Shivaji Chowk) will bring it closer to the western suburbs. Thus, this belt will immensely benefit from the improved connectivity and should witness greater real estate traction.

[3] https://www.metrorailnews.in/mumbai-metro-line-2a-and-7-to-be-operational-by-2020/

Metro Line

5

THANE ↔ BHIWANDI ↔ KALYAN

Completion by –
Official deadline - 2022[4]

Length
24.9 km (Elevated)

Stations
17 Nos. (All Elevated)

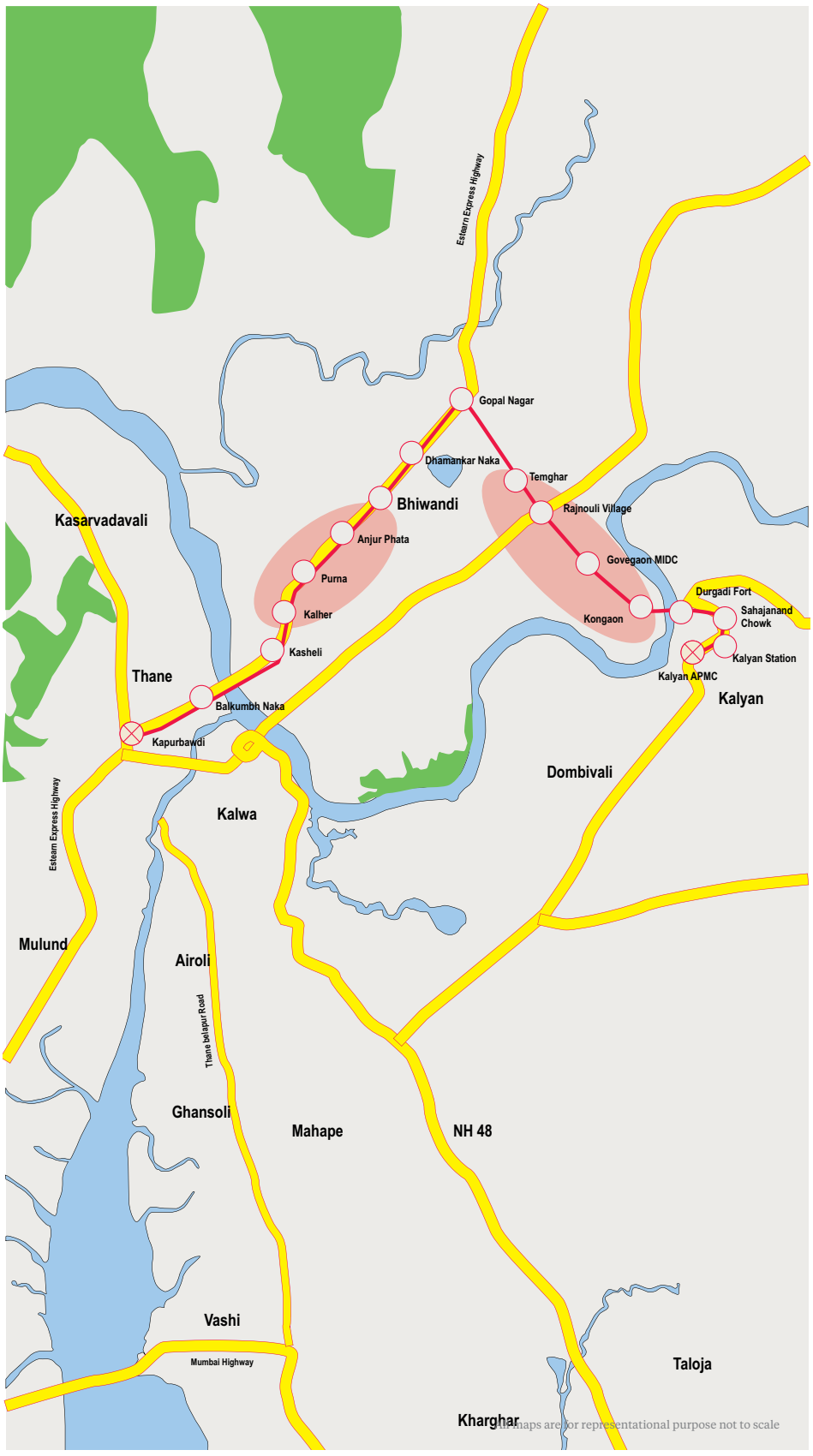
Kapurbawdi	Temghar
Balkum Naka	Rajnouli Village
Kasheli	Govegaon MIDC
Kalher	Kongaon
Purna	Durgadi Fort
Anjur Phata	Sahajanand Chowk
Dhamankar Naka	Kalyan Railway stn.
Bhiwandi	Kalyan APMC
Gopal Nagar	

Interchange stations for Metro at

1. Kapurbawdi (with Line 5: Thane - Bhiwandi - Kalyan)

2. Kalyan (with Line 12: Kalyan - Taloja)

Source: MMRDA, Knight Frank Research



The Thane-Bhiwandi-Kalyan Metro is the first MRTS project for Bhiwandi. The Metro Line is 24.9 km long with 17 stations between Thane and Kalyan.

Bhiwandi is strategically located in MMR and enjoys good connectivity to most parts of MMR through roads. Until a few years back, the low land rates and the absence of any MRTS project in the catchment helped Bhiwandi emerge as a warehousing location to serve the MMR market. However, the rapid growth and expansion of Thane and MMR over the past few years has led to residential projects coming up in this catchment.

The higher realisations from residential projects has put upward pressure on the land prices in Bhiwandi and made it unviable for warehousing. Bhiwandi is now slowly transforming into an affordable housing destination. While land title issues persist, the Metro Line 5 will accentuate the transformation of Bhiwandi from a warehousing hub into a residential destination. The warehouses are now shifting further ahead on the Mumba - Nashik Highway.

For people residing in Bhiwandi, this Metro project will connect them with Thane, Kalyan and the Central Railway network which is only possible by road at present. The Metro Line 5 has interchange with 2 other Metro Lines and a railway line. It connects with the Metro Line 4 (Wadala to Gaimukh) at Kapurbawdi, with Metro Line 12 (Kalyan to Taloja) at Kalyan and with the Central Railway network at Kalyan station.

Key impact markets

As per MMRDA, Metro Line 5 is expected to have a daily ridership of 223,900 by 2021 and 302,500 by 2031. The markets along this corridor which are likely to witness the highest real estate traction are-

a. Temghar to Kongaon belt

The Temghar to Kongaon belt is located at the outskirts of Bhiwandi and has large vacant land parcels. The locations around metro stations of Temghar, Rajnouli Village, Gove Gaon MIDC and Kon Gaon would benefit the most from this Metro project and would be the first to transform.

Temghar to Kongaon belt also enjoys good road connectivity to Mumbai through the Mumbai-Nashik Highway and to Kalyan via Bhiwandi-Murbad Road. The Metro Line 5 will increase real estate traction in these markets.

b. Kalher-Anjurphata-Bhiwandi belt

Albeit the land title and strata sale of warehouses remain a challenge, once Metro Line 5 is operational, the warehouses located in this belt will witness real estate traction and can transform into residential market catchments. The lack of MRTS projects and narrow roads have hindered the growth of residential market in this belt. The Metro Line 5 would connect these regions to Thane as well as the Central Railway network at Kalyan. This belt has the potential to emerge as an affordable housing destination.

[4] https://www.metrorailnews.in/mumbai-metro-line-2a-and-7-to-be-operational-by-2020/

Metro Line

6

LOKHANDWALA ⟷ **VIKHROLI**

Completion by –
Official deadline - 2022[5]

Length
14.477 km (Elevated)

Stations
13 Nos. (All Elevated)

- Swami Samarth Nagar
- Adarsh Nagar
- Jogeshwari (West)
- Jogeshwari-Vikhroli Link Road (JVLR)
- Shyam Nagar
- Mahakali Caves
- SEEPZ Village
- Saki Vihar Road
- Rambaug
- Powai Lake
- IIT Powai
- Kanjurmarg (West)
- Vikhroli (EEH)

Interchange stations for Metro at

1. Shastri Nagar (with Line 2: Dahisar to Mandale)
2. JVLR Jn (with Line 7: Dahisar (E) - Andheri (E))
3. SEEPZ (with Line 3: Colaba - Bandra - SEEPZ)
4. Kanjurmarg (with Line 4: Thane - Wadala)

Source: MMRDA, Knight Frank Research

The Metro Line 6 is 14.477 km long with 13 stations between Lokhandwala and Vikhroli. The corridor starts at Swami Samarth Nagar passes along the Jogeshwari Vikhroli Link Road (JVLR) to Kanjurmarg and ends at Vikhroli on the Eastern Express Highway.

The Metro Line 6 will pass through dense residential catchments and a major office district of Powai. This metro project will help save considerable amount of time for people using JVLR daily to reach their destinations on either side of JVLR. At present, it takes over 2 hours by road to travel from Lokhandwala to Vikhroli during peak hours. As the Jogeshwari end of the JVLR gets narrower as one moves from Vikhroli to Jogeshwari, during peak hours, it takes 45 minutes from Maha Kali caves to reach Western Express Highway which is just over 2 km.

The JVLR is a high traffic route as it is one of the important road connectors for vehicles moving from western side of the city to the central and eastern side. There are large business districts on both ends of JVLR and midway in the SEEPZ-Powai belt which makes JVLR a crucial arterial road. The Metro Line 6 would be immensely beneficial for these commuters and the ones working in Powai. Further, most residential and office markets along JVLR lack MRTS connectivity and they are far-off from any railway stations on the WR or CR network and also from the Metro Line 1. Hence, Metro Line 6 will bring MRTS connectivity right besides these markets.

The Metro Line 6 is also crucial as it connects to 4 upcoming Metro Lines and 2 major railway lines of WR and CR. The Metro Line 6 has interchange with Metro Line 2 (Dahisar to Mandale) at Shastri Nagar (Infinti mall Andheri), with Metro Line 7 (Dahisar to Andheri East) at JVLR, with Metro Line 3 (Colaba-Bandra-SEEPZ) at SEEPZ, with Metro Line 4 (Thane to Wadala) at Kanjurmarg and with WR at Jogeshwari and with CR at Kanjurmarg.

Key impact markets

As per MMRDA, Metro Line 6 would have a daily ridership of over 400,000 by 2031. The metro corridor passes through dense developed catchments. However, there are some locations along this corridor which are likely to witness real estate traction and they are-

a. Vacant land parcels near Mahakali Caves Metro Station

The vacant land parcels in the vicinity of this metro station and its proximity to established office districts create a strong potential for large scale office and residential development. The buildings coming up here will offer breathtaking views of the lush green areas of Aarey Colony. Real estate supply upwards of 7 million square feet can be expected in this region.

b. Industrial units in SEEPZ-Powai belt:

Some of the erstwhile industrial units in this belt have already transformed into swanky office and residential complexes. The remaining industrial units should also witness greater real estate traction and transform. Based on development opportunities, real estate supply north of 15 million square feet can be expected in this belt.

c. Vacant land parcel in Kanjurmarg

There are large undeveloped land parcels in Kanjurmarg at the Vikhroli end of JVLR. These are located close to established office and residential catchments. The land parcels in those areas are likely to witness real estate traction. Real estate supply upwards of 10 million square feet can be expected in this region.

[5] https://www.metrorailnews.in/mumbai-metro-line-2a-and-7-to-be-operational-by-2020/

Metro Line

9

DAHISAR (E) ⟷ **Mira Bhayandar**

Completion by –
Official deadline - NA

Length
11.386 km (Elevated)

Stations
8 Nos. (All Elevated)

- Dahisar (E)
- Pandurang Wadi
- Miragaon
- Kashigaon
- Sai Baba Nagar
- Meditiya Nagar
- Bhagat Singh Garden (Maxus Mall)
- Subhash Chandra Bose Stadium

Interchange stations for Metro at

1. Shivaji Chowk (with Line 10: Gaimukh - Shivaji Chowk)
2. Dahisar (E) (with Line 7: Dahisar (E) - Andheri (E))
3. Dahisar (E) (with Line 2: Dahisar to Mandale)

Source: MMRDA, Knight Frank Research

Metro Line 9 is extension of Line 7 on either end from Andheri to CSIA and Dahisar to Mira Bhayandar. The Metro Line is 13.581 km long (11.386 km elevated and 2.195km underground) with 11 stations. The Andheri East to CSIA stretch of this metro is also referred to as Metro Line 7A.

The Metro Line 9 is an extension of Metro Line 7 (Dahisar to Andheri East) on either end. The Dahisar end would be extended to Mira-Bhayandar and the Andheri East end would be extended to the Chhatrapati Shivaji International Airport (CSIA) airport Metro. Residents living in Mira-Bhayandar would be integrated to the city through this Metro Line. They can travel along Western Express Highway till the International Airport using this metro. From there, they can interchange to Metro Line 3 (Colaba-Bandra-SEEPZ) at CSIA and travel all the way to Colaba passing through key business districts of BKC, Lower Parel and other important office markets of South Mumbai. On the northern end it would connect to Metro Line 10 (Gaimukh to Shivaji Chowk). Residents living in this area can use this metro to travel to Thane and use Metro Line 4 (Thane to Wadala) to travel to Central Suburbs.

The Metro Line 9 connects with 3 other Metro Lines through line 7 as indicated above. Metro Line 9 connects with Metro Line 10 (Gaimukh to Shivaji Chowk) via interchange at Shivaji Chowk, wtih Metro Line 2 (Dahisar to Mandale) at Dahisar and with Metro Line 3 (Colaba-Bandra-SEEPZ) via interchange at CSIA.

As per MMRDA, Metro Line 9 would have a daily ridership of over 1,112,000 by 2031. Most markets in the project corridor have already developed and are dense residential catchments with little scope for new development.

Metro Line

11

Wadala ⟷ **CSMT**

Completion by –

Official deadline - March 2026[8]

Length

9.209 km (Elevated + Underground)

Stations

11 Nos. (1 Elevated+10 Underground)

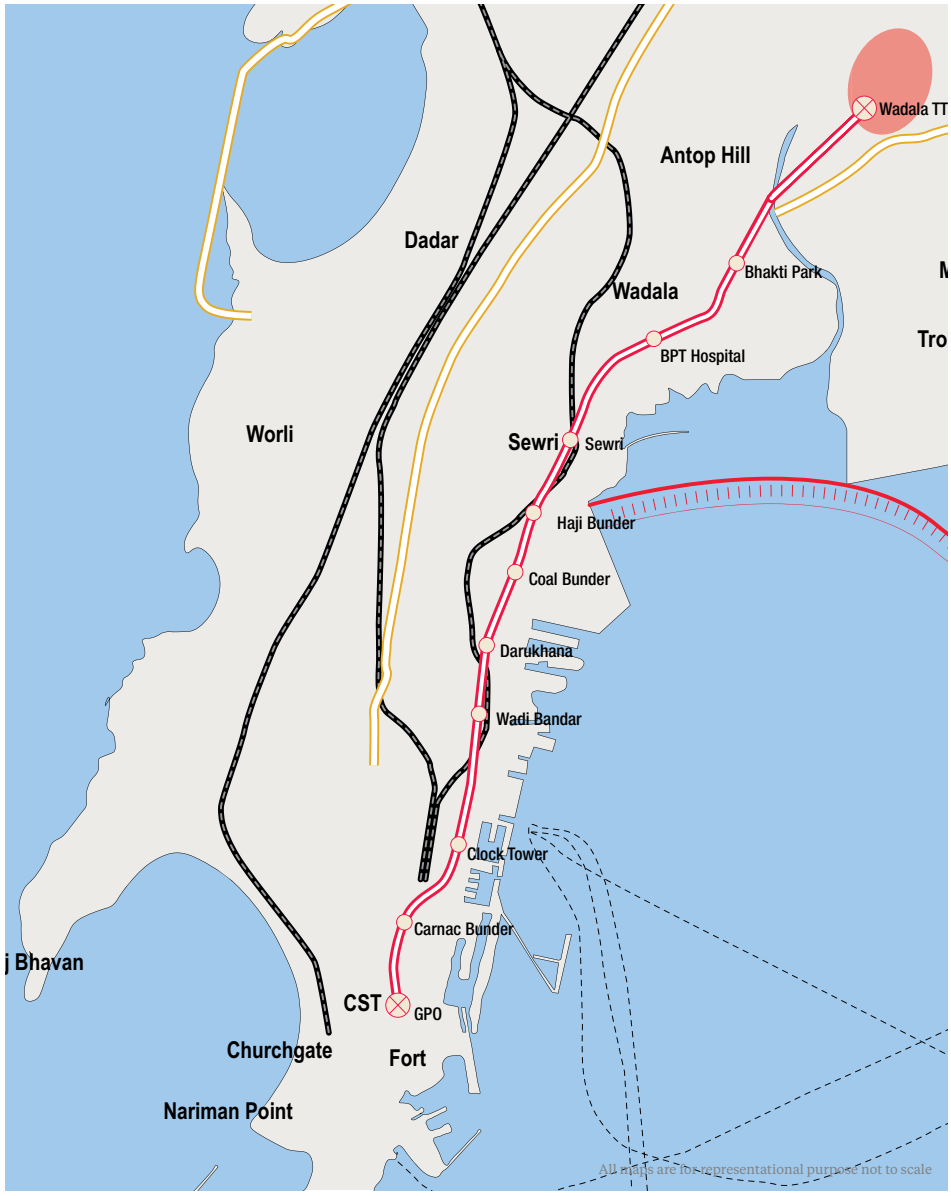
- Chhatrapati Shivaji Maharaj Terminus
- Carnac Bunder
- Clock Tower
- Wadi Bunder
- Darukhana
- Coal Bunder
- Hay Bunder
- Sewri Metro
- BPT Hospital
- Ganesh Nagar
- Wadala

Interchanage stations for Metro at

1. Wadala (with Line 4: Thane - Wadala)

2. CSMT (with Line 3: Colaba - Bandra - SEEPZ)

Source: MMRDA, Knight Frank Research



The Metro Line 11 is an extension of Metro Line 4 (Thane to Wadala). The Prime Minister had laid the foundation stone for this Metro Line in September 2019.

The Line is around 12 km long and is likely to have 11 stations, of which 3 would be elevated and 8 underground. The elevated stations are likely to include Wadala RTO, Ganesh Nagar and BPT Hospital, whereas the underground stations are likely to be Sewri, Hay Bunder, Coal Bunder, Darukhana, Wadi Bunder, Clock Tower, Carnac Bunder and CSMT. [9]

This Metro Line passes through dense, developed catchments with very little scope for new development except for Mumbai Port Trust. There have been multiple discussions on redeveloping the land under the ambit of Mumbai Port Trust (MbPT). If the plan fructifies, then the Metro Line 11 will aid in augmenting the real estate traction in that area.

[8] https://www.thehindu.com/news/states/state-clears-three-metro-projects/article28693524.ece

[9] https://www.news18.com/news/india/bringing-thane-dombivali-closer-to-mumbai-heres-how-mmr-residents-can-benefit-from-3-new-metro-lines-2300413.html

Metro Line

10

Gaimukh ⟷ **Shivaji Chowk**

Completion by –
Official deadline - March 2022[6]

Length
9.209 km (Elevated)

Stations
5 Nos. (All Elevated)

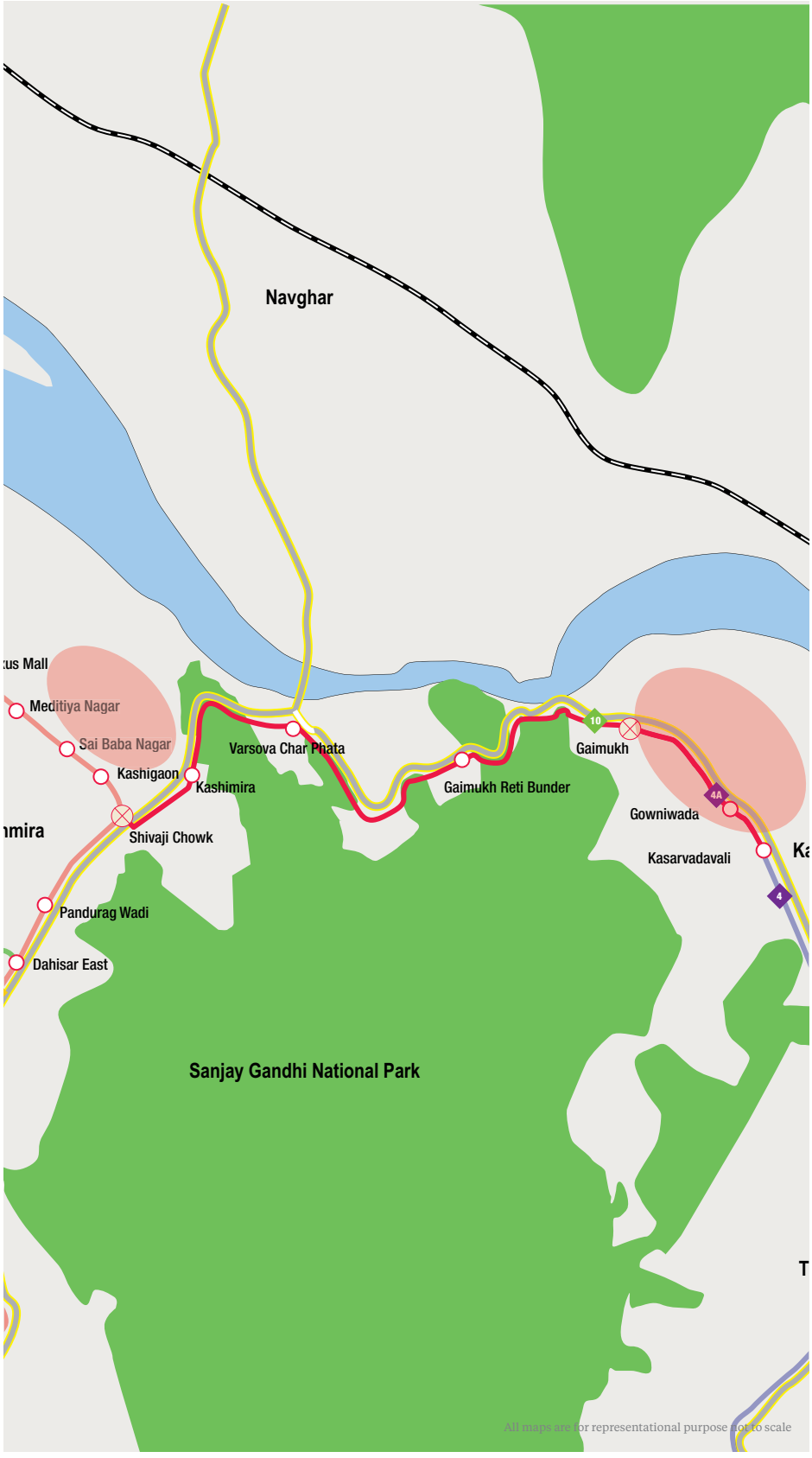
- Gaimukh
- Gaimukh Reti Bunder
- Varsova Char Phata
- Kashimira
- Shivaji Chowk (Mira Road)

Interchange stations for Metro at

1. Gaimukh (with Line 4 and 4A: Gaimukh - Wadala)

2. Shivaji Chowk (with Line 9: Dahisar (E) - Mira Bhayandar)

Source: MMRDA, Knight Frank Research



The Metro Line 10 is around 9 km long connecting Gaimukh in Thane to Shivaji Chowk in Mira Road. Currently road is the only means of transport for people travelling from Gaimukh to Shivaji Chowk.

This Line would also be a crucial MRTS connector connecting Thane and western suburbs and would also be used by commuters travelling from northern regions of Mumbai (Borivali East to Virar) to Thane and central suburbs (Mulund to Sion) and vice-versa.

The Metro Line 10 connects with Metro Line 4 and 4A via interchange at Gaimukh and with Metro Line 9 (Dahisar to Mira-Bhayandar) via interchange at Shivaji Chowk.

Key impact markets

a. Kasarvadavali to Gaimukh belt

There are large undeveloped land parcels in this belt. However, the only access to those land parcels is by road. Further, Gaimukh is located at an isolated part of MMR, far-off from any MRTS projects, which has curtailed its growth. The Metro Line 10 (Gaimukh to Shivaji Chowk) would connect it with the western suburbs and the Metro Line 4 and 4 A will establish connectivity of this region with central and southern parts of Mumbai. Thus, this belt will immensely benefit from this improved connectivity to both parts of the city - western suburbs and central suburbs and thus witness greater real estate traction.

b. Kashimira

On account of available land parcels, there are development opportunities in the region of Kashimira. This region is located away from existing MRTS projects and rail networks. Hence, this location is likely to witness real estate traction due to Metro Line 9 (Dahisar East to Mira-Bhayandar) and Metro Line 10 (Gaimukh to Shivaji Chowk).

[7]https://www.news18.com/news/india/mumbai-to-get-three-new-metro-lines-by-2026-maharashtra-cabinet-gives-go-to-the-project-2243053.html

Metro Line

12

Kalyan ⟷ **Taloja**

Completion by –
Official deadline - March 2024[7]

Length
20.7 km (Elevated)

Stations
17 Nos. (All Elevated)

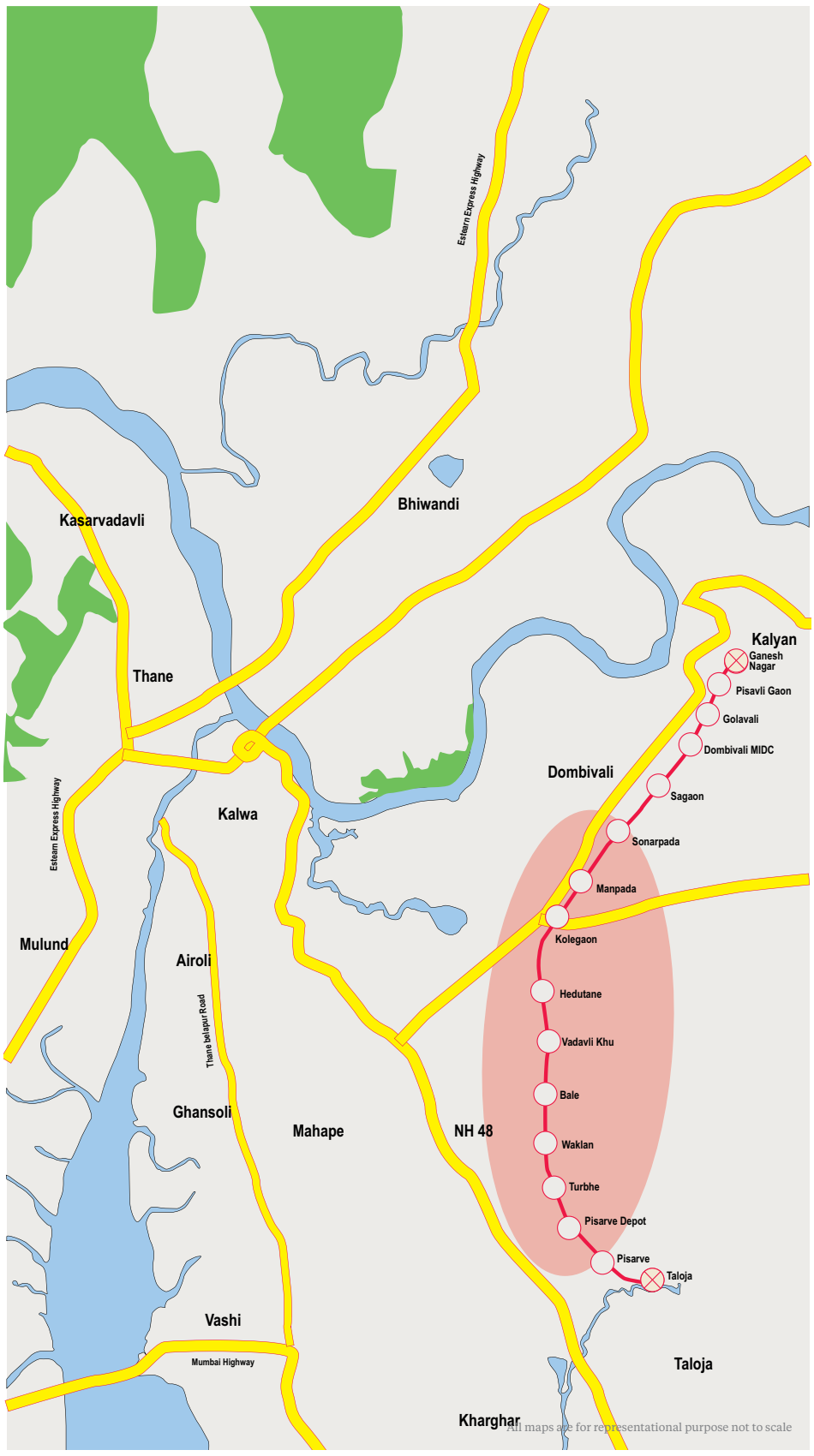
Kalyan APMC	Vadavali
Ganesh Nagar	Bale
Pisvali Gaon	Waklan
Golavali	Turbhe
Dombivali MIDC	Pisarve Depot
Sagaon	Pisarve
Sonarpada	Taloja
Manpada	
Hedutane	
Kolegaon	

Interchange stations for Metro at

1. Kalyan (with Line 5: Thane - Bhiwandi-Kalyan)

2. Taloja (with Navi Mumbai Metro Line 1: Belapur-Kharghar-Taloja-Pendhar)

Source: MMRDA, Knight Frank Research



The Metro Line 12 is estimated to be around 20.7 km long connecting Kalyan to Taloja. It will have 17 stations between Kalyan and Taloja.

Most of the Metro Lines in MMR are passing through developed or existing catchments with very little scope for new development. These projects are catching up with development rather than it being the other way.

The Kalyan-Taloja Metro Line will be the amongst the first Metro Line of MMR, a major portion of which passes through catchments which are undeveloped or under developed. The Metro Line 12 will precede development in many areas along the route.

MMRDA wants to develop these clusters under Transit-Oriented Development (TOD) model. A section of this corridor also falls under the Navi Mumbai Airport Influence Area (NAINA) zone of the City Industrial Development Corporation (CIDCO). CIDCO will be planning authority for that section. There is tremendous scope for planned development along the corridor on the likes of Navi Mumbai or create something even better.

The Metro Line 12 provides connectivity to Thane, Bhiwandi, Kalyan and Navi Mumbai through 2 Metro Lines. It connects with Metro Line 5 (Thane – Bhiwandi – Kalyan) through interchange at Kalyan and with Navi Mumbai Metro Line 1 (Belapur-Kharghar-Taloja-Pendhar) through interchange at Taloja.

Key impact markets

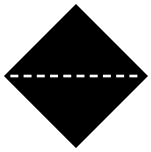
The Metro Line 12 is the first major project providing connectivity to several unconnected or isolated markets along the route. It is expected to have a daily ridership of over 192,420 by 2031. The markets that are likely to witness high real estate traction and development are-

a. Sagaon to Pisarve belt

There are large undeveloped land parcels in this belt. Many lack effectivity connectivity either by road or by any MRTS projects. The Metro Line 5 would lead to increased real estate traction in this belt. The regions around the below mentioned metro stations should witness the highest real estate traction-

i. Sonarpada
ii. Manpada
iii. Hedutane
iv. Kolegaon
v. Vadavli khu
vi. Bale
vii. Waklan
viii. Turbhe
ix. Pisarve

[7] https://www.thehindu.com/news/states/state-clears-three-metro-projects/article28693524.ece
[8] https://www.news18.com/news/india/bringing-thane-dombivali-closer-to-mumbai-heres-how-mmr-residents-can-benefit-from-3-new-metro-lines-2300413.html



Coastal Road

Official deadline for completion - 2022 for Phase 1

The Coastal Road is a 29.2 km long road network starting at Nariman Point in the south and culminating at Kandivali Junction of Link Road in the north. The project is expected to reduce travel time in this stretch from over 2 hours to 40 minutes. The project is divided in multiple phases; Phase 1 from Princess Street flyover to Worli end of Bandra-Worli Sea Link is expected to be completed by 2022. The stretch from Worli to Versova would be via sea Link which includes the existing Bandra-Worli Sealink. The Bandra-Versova Sea Link is currently being undertaken by Maharashtra State Road Development Corporation (MSRDC). As per the current alignment, as we move northwards after varsoa, the Coastal Road comes on land, merges with existing roads and later goes on stilts.

This is a crucial project which would improve access to South Mumbai from Western Suburbs. The existing road networks connecting these markets are saturated. Further, the scope for widening of roads or constructing any new road in South Mumbai is limited, and the possible solution is to construct underground roads which is expensive or reclaim land from sea for Coastal Road or construct a sea Link.

The Coastal Road project involves reclamation of land from sea at many places and passes through no-development zones and mangroves. Currently, the High Court has quashed the various permits obtained for the Coastal Road project. The court has asked the Municipal Corporation of Greater Mumbai (MCGM) to stop work till fresh environment clearances and notifications are obtained after a proper Environmental Impact Assessment (EIA). The Supreme Court (SC) has allowed work to resume on certain stretches but with certain caveats. This breather from SC will help resume work of road construction at least. This is a much needed reprieve for the Project.

Key impact markets

a. The belt between Malad metro station and Kasturi Park Metro station

This belt has large vacant land parcels. Currently, office occupiers are finding it difficult to travel there due to poor connectivity and isolation of the region. The access by road from various parts of MMR takes time due to multiple signals at almost every junction on this route. Once this project is operational, we would see further office space coming up in this belt as it would be accessible from most regions of Western Suburbs and South Mumbai. These catchments also stand to benefit from the Mumbai Metro Line 2 A along with the Coastal Road.

b. Slum clusters in Charkop and Ekta Nagar

Charkop and Ekta Nagar are currently far from major MRTS corridors and connectivity to other parts of Mumbai by road consumes a significant amount of time. Hence, the real estate activity in these areas is constrained due to poor connectivity.

The Coastal Road will provide seamless access to these catchments by Roads and connect them with the Southern and Western parts of Mumbai. Currently, the real estate market is subdued, and we may not witness traction immediately. However, as the market revives, the attractiveness of this location is likely to improve. Even as there is scarcity of land in this catchment, the opportunities arising out of slum redevelopment will generate potential for higher real estate traction. These catchments also stand to benefit from the Mumbai Metro Line 2 A along with the Coastal Road.

Bandra - Versova Sea Link

Official deadline for completion - 2024[11]

The Bandra-Versova Sea Link is being constructed by MSRDC, the agency which constructed the first Sea Link of Mumbai – Bandra Worli Sea Link (BWSL). The Bandra-Versova Sea Link is around 17.17 km long, connecting the Bandra end of the BWSL to Versova. It is almost 3 times the length of the existing BWSL.

The contractor for this Sea Link has been appointed and the work is expected to be completed within 60 months. It is expected to have 3 interchange points at Bandra Bandstand, Carter Road and Juhu Koliwada. The Sea Link will be immensely beneficial to the residents living in these catchments as it would reduce travel time considerably and provide access to business districts in Central Mumbai, South Mumbai and to BKC. As per MSRDC, the Bandra Versova Sea Link is expected to reduce travel time by 45 minutes. With the new State Government in Maharashtra, the project is under review.

Apart from constructing the Sea Link, the authorities must widen the roads leading to its entry and exit points. Currently, these roads are not adequate to carry the load of incremental cars that the Sea link will bring in.

The markets along this Sea Link are mostly saturated with very little scope for real estate traction except via redevelopment of individual buildings.

[11] https://timesofindia.indiatimes.com/city/mumbai/deal-sealed-work-on-versova-sea-link-to-start-next-month/articleshow/65677435.cms

Table:6

4.7.3 SUMMARY OF KEY IMPACT MARKETS

Sr. no.	Key impact markets	Location	Upcoming projects	Project details
1	**Chirle**	Navi Mumbai	MTHL and MUTP 3	Trans-Harbour Link and railway line till Uran
2	**Sonarpada**	Between Kalyan and Taloja	Metro Line 12	Kalyan Taloja Metro
3	**Manpada**	Between Kalyan and Taloja	Metro Line 12	Kalyan Taloja Metro
4	**Hedutane**	Between Kalyan and Taloja	Metro Line 12	Kalyan Taloja Metro
5	**Kolegaon**	Between Kalyan and Taloja	Metro Line 12	Kalyan Taloja Metro
6	**Vadavli Khu**	Between Kalyan and Taloja	Metro Line 12	Kalyan Taloja Metro
7	**Bale**	Between Kalyan and Taloja	Metro Line 12	Kalyan Taloja Metro
8	**Waklan**	Between Kalyan and Taloja	Metro Line 12	Kalyan Taloja metro
9	**Turbhe**	Between Kalyan and Taloja	Metro Line 12	Kalyan Taloja Metro
10	**Pisarve**	Between Kalyan and Taloja	Metro Line 12	Kalyan Taloja Metro
11	**Kasarvadavali to Gaimukh belt**	Thane West	Metro Line 4 and Metro Line 10	Thane-Wadala metro and Thane-Mira Road Metro
12	**Temghar to Kongaon belt**	Bhiwandi	Metro Line 5	Thane-Bhiwandi-Kalyan Metro
13	**Vacant land parcels near Mahakali Caves Metro Station**	JVLR, Andheri East	Metro Line 6	Lokhandwala-Vikhroli Metro
14	**Ulwe**	Navi Mumbai	MTHL and MUTP 3	Trans-Harbour Link and railway line till Uran

Sr. no.	Key impact markets	Location	Upcoming projects	Project details
15	**Vacant land parcels and industrial sheds near Mahanand Metro Station**	Goregaon East	Metro Line 7	Dahisar-Andheri East Metro
16	**Wadala Truck Terminus**	Wadala	Meto line 4 and Metro Line 11	Thane-Wadala Metro and Wadala-CSMT Metro
17	**Kalher-Anjurphata-Bhiwandi belt**	Bhiwandi	Metro Line 5	Thane-Bhiwandi-Kalyan Metro
18	**Industrial units in SEEPZ-Powai belt**	JVLR, Powai	Metro Line 6	Lokhandwala-Vikhroli Metro
19	**The belt between Malad Metro Station and Kasturi Park Metro Station**	Malad West	Coastal road and Metro Line 2	Marine Drive to Kandivali and Dahisar - Mandale Metro
20	**Kashimira**	Mira-Bhayandar	Metro Line 10	Thane-Mira Road Metro
21	**Vacant land parcels in Kanjurmarg**	JVLR, Kanjurmarg East	Metro Line 6	Lokhandwala-Vikhroli Metro
22	**Marol-MIDC belt**	Andheri East	Metro Line 3	Colaba-Bandra-SEEPZ Metro
23	**Undeveloped mill lands**	Lower Parel	Metro Line 3	Colaba-Bandra-SEEPZ Metro
24	**Bandra-Kurla Complex**	BKC	Metro Line 2 and Metro Line 3	Dahisar-Mandale Metro and Colaba-Bandra-SEEPZ Metro
25	**Slum clusters in Charkop and Ekta Nagar**	Charkop	Coastal road and Metro Line 2	Marine Drive to Kandivali and Dahisar-Mandale metro
26	**Slum clusters in Malad East to Kandivali East belt**	Malad East to Kandivali East	Metro Line 7	Dahisar-Andheri East Metro
27	**Food Corporation of India (FCI) warehouses**	Borivali East	Metro Line 7	Dahisar-Andheri East Metro
28	**Dharavi redevelopment**	Dharavi	Metro Line 3	Colaba-Bandra-SEEPZ Metro

Mumbai Metropolitan Region
Infrastructure and Key Impact Markets by 2030

Knight Frank

All maps are for representational purpose not to scale

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8
Offices

1,400+
PEOPLE

Contact

Knight Frank India
Headquarters
Paville House, Near Twin Towers
Off Veer Savarkar Marg
Prabhadevi
Mumbai 400 025

Report Authors

Vivek Rathi
Director - Research
vivek.rathi@knightfrank.com

Yashwin Bangera
Vice President - Research
Yashwin.bangera@knightfrank.com

Nibodh Shetty
Consultant - Research
nibodh.shetty@knightfrank.com

Pradnya Nerkar
Associate Consultant - Research
pradnya.nerkar@knightfrank.com

Key Contacts

ADVISORY, RETAIL & HOSPITALITY
Gulam Zia
Executive Director
gulam.zia@in.knightfrank.com

Rajeev Vijay
Executive Director - Advisory
rajeev.vijay@in.knightfrank.com

Saurabh Mehrotra
National Director - Advisory
saurabh.mehrotra@in.knightfrank.com

CAPITAL MARKETS
Tushar Rane
Executive Director
tushar.rane@in.knightfrank.com

Sharad Agrawal
Executive Director
sharad.agrawal@in.knightfrank.com

FACILITY MANAGEMENT
Ram Devagiri
Executive Director & Head
ram.devagiri@in.knightfrank.com

INDUSTRIAL & ASSET SERVICES
Balbirsingh Khalsa
National Director
balbirsingh.khalsa@in.knightfrank.com

Pinkesh Teckwani
National Director
pinkesh.teckwanii@in.knightfrank.com

OFFICE AGENCY & LRG
Viral Desai
National Director
viral.desai@in.knightfrank.com

PROJECT MANAGEMENT
Deben Moza
Executive Director
deben.moza@in.knightfrank.com

RESEARCH
Rajani Sinha
Chief Economist & National Director
rajani.sinha@in.knightfrank.com

RESIDENTIAL
Girish Shah
Executive Director
girish.shah@in.knightfrank.com

AHMEDABAD
Balbirsingh Khalsa
Branch Director
balbirsingh.khalsa@in.knightfrank.com

BENGALURU
Shantanu Mazumder
Senior Branch Director
shantanu.mazumder@in.knightfrank.com

CHENNAI
Srinivas Ankipatti
Senior Director
srinivas.ankipatti@in.knightfrank.com

HYDERABAD
Samson Arthur
Branch Director
samson.arthur@in.knightfrank.com

KOLKATA
Swapan Dutta
Branch Director
swapan.dutta@in.knightfrank.com

NCR
Mudassir Zaidi
Executive Director - North
mudassir.zaidi@in.knightfrank.com

PUNE
Paramvir Singh Paul
Branch Director
paramvirsingh.paul@in.knightfrank.com

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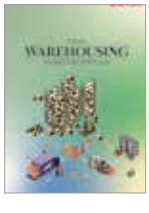

We like questions, if you've got one about our research, or would like some property advice, we would love to hear from you.

ADVISORY, RETAIL & HOSPITALITY
Gulam Zia
Executive Director
gulam.zia@in.knightfrank.com

Rajeev Vijay
Executive Director - Government and Infra. Advisory
rajeev.vijay@in.knightfrank.com

Saurabh Mehrotra
National Director - Advisory
saurabh.mehrotra@in.knightfrank.com

RESEARCH
Rajani Sinha
Chief Economist & National Director
rajani.sinha@in.knightfrank.com

CORPORATE - MARKETING & PUBLIC RELATIONS
Girish Shah
Executive Director
girish.shah@in.knightfrank.com

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