CHAPTER II

Delhi and its Basic Services
As compared to the Indian million-plus metropolises, Delhi experienced the highest
demographic growth over the last few decades. The 1951 census recorded a decadal
growth rate of 90.00%\(^1\) owing to the Partition. The decadal growth rate declined to
52.44% in 1961 and thereafter steadily declined to 46.31% for the 2001 census when the
provisional population was 13,782,976. Despite a slowdown in the growth rate, such
demographic expansion has obvious implications for town planning, as the demands on
urban services has been escalating. Delhi was the first Indian city where new ideas of town
planning were launched after Independence and the first Master Plan was implemented in
1962.

This chapter traces the history of Delhi; its growth from a small entity named
Shahjahanabad to what is today the National Capital Territory of Delhi. An outline of this
history provides a framework essential for understanding the trajectory along which the
provision of basic services has evolved over the years, specifically in the context of water
borne diseases.

**URBAN PLANNING AND MUNICIPAL SERVICES**

Delhi has been a capital through centuries and under different emperors. The Rajputs had
their capital in the 11\(^{th}\)-12\(^{th}\) century. Various Sultans ruled Delhi and developed their
capitals at several places in the vicinity of the Qutub Minar. The capital shifted twice to
Agra – once during the last of the Sultan dynasty and then again in the times of Akbar.

Delhi regained its importance as the capital when Shahjahanabad was built up as a walled
city around the Red Fort by Shahjahan. The foundation of Shahjahanabad was laid in 1638.
The new capital (shifted from Agra owing to ‘excessive heat … unfit for the residence of a
monarch’) was named after the emperor himself – Shah-Jehan-Abad. While the royal family
and those connected with the court had their residence inside the Fort, the general
population lived outside in the township. The wall was completed during the reign of
Aurangzeb. While the rich lived near the Fort, the poorer segments resided in the fringes of
the town (Jag Mohan, 1975). The British took over the city from the Marathas in 1803
starting a new chapter in the planned development of infrastructure for the inhabitants of

\(^1\) Decadal growth rate for the urban population was +106.58%
Delhi. Civic services started with setting up of water supply, public toilets, sanitation services and dispensaries. This section outlines the history of development of basic services in Delhi since the 1850s to the present day.

Beginning of the Modern Services

Following the Mutiny of 1857, the British developed the Civil Lines area and moved away from the Walled City. The purpose of setting up the Delhi Municipal Commission was primarily to ensure civic amenities for the Civil Lines area (the seat of the government and the residence of the elite) and to some extent the walled city as well. The Delhi Municipal Commission came into being in 1862 to cater to the needs of about 1.21 lakh inhabitants spread over only 2 square miles. The first meeting of the Commission was held on 23rd April, 1863. The local body evolved over time – it cares now for an estimated 140 lakh population spread across nearly 1400 sq. km. area.

1863 saw the setting up of a series of 'firsts' – sanitation and conservancy system, public latrines, a Unani dispensary in Sadar Bazar and the registration of births and deaths. Fire Services began in 1867 with one fire engine stationed at the Kotwali. Water from some of the wells was found unfit for human consumption and a proposal to set up a waterworks was initiated in 1869. Meanwhile, supply of potable water began through water carts during 1871-72. Street lighting was introduced by the Delhi Municipal Commission with lanterns and lamp posts. The first mass planting of 1600 saplings was done in 1875. The same year also witnessed decentralisation of services and the representation of the community; the 'ilaka' system was introduced to supervise the conservancy activities. Each ilaka was supervised by a three member committee (Civic Guide, 1995).
Delhi Municipal Committee

The Delhi Municipal Commission was classified as a Class I Committee in 1881 and became the Delhi Municipal Committee (DMC). It consisted of 21 nominated members of whom six were government servants. The remaining were non-officials comprising of three Europeans, six Hindus and six Muslims. Elections were held for the first time in 1885. The elected Committee consisted of 4 government officials, 5 nominated and 12 elected members representing the 12 wards.

The total budgetary outlay in 1862 was Rs.94,512; interestingly, 50% of this was spent on the police establishment. Octroi was the main source of income and it generated Rs.82,000. One-sixth of the share was also diverted to military expenditure leaving very little for civic services. To boost finances, house tax was introduced from 1st January, 1902 which yielded an income of Rs.83,327 from 45,558 properties. The initial proposal for house tax was mooted in 1878 (a good 10 years after it had been introduced in Lucknow) but it met with great opposition. By 1902, the owners were not that adamant in opposing it as the burden was to be borne principally by the large numbers of tenants (Gupta 1981). The total income in 1902-03 was Rs.6.24 lakhs and expenditure was Rs.9.25 lakhs. The other sources of fund collection were octroi, animals, wheel tax, tolls, cattle pounds and hackney carriage.

The walled city was meanwhile expanding and its population had spilled over to Pahargunj and other suburbs. In 1881 and later during 1905 there were popular demands for systematic and planned extension of the 'native' areas. The Municipal Committee however did little on this count.

Formation of New Delhi

The constitution of the Committee was further changed in 1912 when Delhi Province was created. The number of ex-officio and elected members was brought down to 3 and 11 respectively. The number of nominated members was raised to 11 undermining the democratic nature of the body. In the same year, the Government decided to build a new capital city for the newly shifted capital (from Calcutta). Following the setting up of the temporary capital of the Government of India in Civil Lines, the Notified Area Committee
of Delhi came into existence on 16th January, 1913. The Delhi Town Planning Committee consisted of Edwin Lutyens and his team of architects and engineers from England who conceived of the new city as a garden city after the then prevailing model in Europe. New Delhi was meant exclusively to be a capital city and was kept separated from Old Delhi by placing vast 'maidans' between the two Delhis. Simultaneously, there were plans to reconstruct the Pahargunj area of Old Delhi which had become highly congested by then; the plan was later abandoned due to resource constraints. Land meant for expansion of Old Delhi was later 'somehow' taken over to serve New Delhi (Ritu Priya, 1993).

With the expansion of Delhi, more local bodies came into being. The District Board for Rural Area was set up as early as 1883 for nearly 300 villages surrounding the city. The Notified Area Committees that were set up included Notified Area Committee, Najafgarh (1910), Notified Area Committee, Mehrauli (1910), Notified Area Committee, Narela (1919), Municipal Committee, Shahdara (1916) and Notified Area Committee, Red Fort Area (1924). In 1921-22, the constitution was again revised and the city was divided into 12 wards. Each ward elected two members – one Hindu and one Muslim. Meanwhile, the Imperial Delhi Municipal Committee was renamed as the New Delhi Municipal Committee (NDMC) in 1926-27.

The founding of New Delhi resulted in a rapid increase in population; an estimated 28% addition took place during 1916-26. This is significant in the backdrop of a declining national trend in the 1921 census when the growth rate showed a drop by 0.03% (Park, 2000). The deteriorating urban ecology of Delhi due to increasing 'congestion of people in houses and of houses on land' as well as the existence of slums had been noted by Hume in 1936 in his Report on Relief of Congestion in Delhi. The Delhi Improvement Trust was set up in March 1937 principally on the recommendation of this report. Development of extension areas and slum clearance were its major activities – primarily to 'sanitise' Old Delhi. In 13 years it managed to re-house only 300 families! The problem of increasing number of urban poor and fresh rural-urban migrants remained largely unsolved and squatter settlements/slums started coming up on the fringe areas of New Delhi (Ritu Priya, 1993).

---

2 The lowest socio-economic category for whom Lutyens had planned for housing, were clerks in the government services.
DEVELOPMENTS FOLLOWING INDEPENDENCE

Post independence, the massive migration of Partition was reflected in the 1951 census. Decadal growth rate was recorded to be 106% for urban Delhi. The Ministry of Rehabilitation was responsible for providing housing to the Punjabi immigrants. A large number of colonies were built in a very short time including Lajpat Nagar, Kailash Colony, Kalkaji, Malviya Nagar in South Delhi, Moti Nagar and Kirti Nagar in West Delhi, around Kingsway Camp in North Delhi and Gandhi Nagar in East Delhi. South Delhi Municipal Committee (1954) and West Delhi Municipal Committee (1955) were formed with the sole purpose of taking care of the civic problems of the refugees. The Punjabi migrants, whose literacy levels were higher than the then resident population of Delhi, were predominantly urban, middle-class and educated (Rao and Desai, 1965). To provide basic infrastructural services three more statutory bodies were formed. These were the Delhi Joint Water and Sewage Board (1926), the Delhi State Electricity Board (1951) and the Delhi Transport Authority (1952).

Municipal Corporation of Delhi

The Delhi Municipal Corporation Act, LXVI of 1957 was enacted by the Parliament on 28th December, 1957. Pending the establishment of the Corporation under a notification of 15th February, 1958, issued by the Ministry of Home Affairs, the Government of India appointed as an interim measure, a Commissioner of Local Authorities to take over the management of all the local bodies, to be later merged in the Corporation. The first general municipal election was held in March, 1958 and the Municipal Corporation of Delhi (MCD) came into being on 7th April, 1958 as a result of amalgamation of nine of the eleven local bodies and Delhi District Board. Only Delhi Cantonment Board and New Delhi Municipal Committee continued to exist as independent bodies. The three statutory bodies providing water, electricity and transport were placed under the overall control of MCD. Later, in 1971, by a Central Ordinance, Delhi Transport Corporation was established.

Initially, there were 34 wards in MCD with 80 elected members. The entire area was divided into 6 Zones. Decentralisation began in 1963 with the formation of Zonal Committees to take care of local matters. The number of elected members was raised to
100 in 1967. The DMC Act 1957 was revised and amended in 1993. Currently, the Municipal Corporation consists of 134 elected members. The Alderman system was also done away with while the term of the house was increased from 4 to 5 years. The House also had representatives from among the elected Members of Parliament (Delhi constituencies) and the Members of the Delhi Assembly. To carry out the day-to-day administration and to settle local problems, the MCD is currently divided into 12 zones and the administration has been decentralised. These are – Central, City, Civil Lines, Karol Bagh, Najafgarh, Narela, Rohini, Sadar Pahargunj, Shahdara (North), Shahdara (South), South and West Zones. Old Delhi falls within the City and Sadar Pahargunj Zones. Najafgarh, Narela and parts of South Zone are primarily rural areas except for some urban agglomerations.
MAP OF DELHI

NARELA ZONE

CIVIL LINES ZONE

ROHINI ZONE

SOUTH ZONE

CENTRAL ZONE

KB ZONE

DELHI CANTT.

NDMC

SHAHORA NORTH ZONE

SHAHORA SOUTH ZONE

WEST ZONE

SP ZONE

55
DDA and Master Plans

At the end of 1955, the Delhi Development (Provisional) Authority was set up to initiate the process of planned development of Delhi. At about the same time the Town Planning Organisation (TPO) was set up in the Ministry of Health to prepare the Master Plan. The first Master Plan of Delhi (MPD-I) was based on a detailed study of Greater Delhi and its residents by Rao and Desai and was sponsored by the Planning Commission. The Delhi Development Authority (DDA) was set up by an act of Parliament and was to act as the sole development agency of Delhi. The MPD-I was basically a land management plan to channelise the growth of Delhi. It had projected a population of 50 lakhs by 1981 and had set 'urbanisable limits' for 1981 which were to be enclosed by a 1 km wide green belt to restrict further urbanisation. Detailed planning was done for renewal of different types of areas, including squatter settlements, adopting different strategies for areas with different qualities.

The review of MPD-I, by the Town and Country Planning Organisation in 1972-73, noted that the housing deficit was 380,000 in 1970; up from 150,000 in 1961. Slum population was estimated at 1 million. The review noted that extensive unauthorised construction and commercial activities had infiltrated residential areas. The Ridge and the Green Belt were compromised and little care was being taken to minimise environmental pollution. Population density was increasing in Old Delhi as well. The Review commented that there was a preoccupation with higher income residential areas and beautification of Delhi while low cost housing was neglected. Advocating better management, the review commented that development was taking place 'in response more to pressures than according to programmes.'

Slum Clearance

Following the review, slum clearance was taken up as a priority. The MCD which had been handling this job since 1930 was divested of the responsibility. The task was handed over to DDA in February 1974. In the next couple of years, which also coincided with the

3 The 1981 Census had reported a population of 62 lakhs
Emergency (1975-77), 27 Resettlement Colonies were set up relocating population from slums in different parts of the city. All round development was envisaged with roads, parks, dispensaries and community centres. Industrial areas were also set up in the neighbourhood. The DDA constructed a total of 235,000 dwellings for low-income groups in the Resettlement Colonies during 1971-81, most of them between 1975-77.

Despite being based on laudable ideals, the Resettlement Colonies suffered from basic public health and engineering deficiencies. They were located on peripheral low lying waste-lands with poor drainage and outfall. These squatter resettlement colonies were site-cum-services schemes. The Delhi Improvement Trust (DIT) had initially fixed the size of the individual plots at 89 sq. yards. The DDA Master Plan reduced it to 80 sq. yards and later to 55 sq. yards. The final plot size that was allocated was 25 sq. yds. The DIT had conceived of 1-3 rooms, a cooking verandah, a bathing platform and a courtyard. This housing standard was reduced to one small room, a cooking space and a small open space for the 25 sq. yds plots. Neither the DIT nor the DDA planned for provision of adequate safe water and waste disposal. Community latrines were constructed for these resettlement colonies; 1 latrine seat was provided for 20-50 persons; in practice the standard deteriorated to one seat for up to 150 persons (Ritu Priya, 1993).

During the two decades 1971-1990, the housing stock of Delhi increased by almost one million. Of this, 75% consisted of permanent dwelling units and the rest were semi-permanent and temporary units or slums. The DDA contributed 64% of the permanent units. The real beneficiaries were in most cases communities belonging to middle and higher income groups (DDA, 1991).

The rate of resettlement slowed down for several reasons (Nath 1995):

- change in priority in national planning paradigm from slum clearance (and resettlement) to slum improvement
- the unpleasant memory of the Emergency
- the intrinsic deficiencies in the resettlement colonies - long distances from former places of work, poor road and transport services and underdeveloped physical and social infrastructure within the Colonies
- influence of vested interest – 'slum lords, underworld dons and politicians'
Nath (1995) predicted the scenario through the decade 1991-2001 as follows—

- growth of population – upto 14 million by 2001
- further growth of industries and consequent pollution as the government elected in 1993 was ‘interested in encouraging further growth of industries and relaxing anti-pollution control over them’
- proliferation of slums and unauthorised colonies – on account of increase in jobs in industrial and service sectors and, the promise of regularisation of unauthorised colonies and provision of electricity connections to all slums dwellers
- pollution of air and water and traffic congestion
- increase in shortage of water and electricity
- ribbon development along the highways

All these forecasts proved to be right as the decade of the nineties has shown. Unauthorised settlements increased sharply and relocation of slums began again in the late nineties. Pollution, both vehicular and industrial, continued to increase. The Supreme Court, acting on several public interest litigation, passed judgements that polluting industries located in non-conforming areas should be shut down or relocated. The judgement was implemented and a number of industries closed down. It created unemployment on one hand but reduced pollution load to a certain extent. Vehicular air pollution also reduced after most of the diesel transport vehicles switched to Compressed Natural Gas (CNG). While the pollution issue was tackled largely through judicial activism, water and energy shortages continue to be major challenges for the government.

Master Plan of Delhi-II and Regional Plan 2001

1980s was a decade of rethinking. Two major causes were identified (Delhi Development Authority, 1990) for the failure of the MPD-I.

- Extensive in-migration into Delhi with the great majority of the migrants being poor
- Freezing of all land for urban development in the union territory by the government

The DDA alone had the right to acquire and develop land for residential, commercial and industrial or other uses. The number of squatter households had increased 7-fold between
1961 and 1991 from 40,000 to 3,00,000. There were large deficits between demand and supply as far as housing and infrastructure was concerned (Nath, 1995). Targets were claimed to be achieved in two sectors – water (121%) and electricity (100%). The Review observed that basic requirement of water was calculated at a lower standard of 50 litres per capita day (lpcd) and recommended to raise it to 80 lpcd; target for providing sewerage facilities remained at a dismal low of 35%. The principal unsewered areas were Shahjahanabad (and parts of its extension into Pahargunj and Karol Bagh), unauthorised colonies and slums (Nath, 1995). Another major failure of the MPD-I was the poor performance with regard to shifting of non-conforming (including highly polluting and hazardous) industrial units or of markets from their old locations to new ones that had been recommended in the MPD-I itself. Worse still, new units continued to mushroom, often in densely populated residential areas.

The Regional Plan 2001 (RP) was adopted in January 1989 and it envisaged developing the National Capital Region encompassing the states of Delhi, Uttar Pradesh (Meerut, Bulandshahr and Ghaziabad Districts), Haryana (Faridabad, Gurgaon, Rohtak and Sonepat Districts) and Rajasthan (Alwar District). A revised Master Plan of Delhi (MPD-II) was prepared by the central government with the objective that the master plan should conform to the objectives, strategies and policies of the RP. This came into effect on August 1, 1990. Both the plans targeted regulating the growth of commercial activities and of population in the Delhi Urban Agglomeration by diverting the growth to priority towns within the National Capital Region. The two plans had however different projections of population for Delhi. The MPD-II projected a population of 12.8 million for Delhi by 2001 while the RP projected 13.2 million. The Census 2001 put the population at 13,782,976 (Census of India, 2001).

MPD-II continued to be essentially a land use plan for residential, industrial, commercial and other uses. It specified in great detail the floor area ratios (FAR) for different uses and for residential plots of different sizes located along roads of different widths. MPD-II also recognised that some of the policies of MPD-I were 'unrealistic and needs to be changed'. The most important policy changes recommended were:

- Permission of non-residential activities in residential premises, and,
- Significantly high FARs in view of the high price of land.
The MPD-II had estimated that 24,000 industrial units (about 50% of the existing units) from non-conforming areas needed to be relocated. During the MPD-II, industries increased by another 75% and an equal proportion (50%) of industries were still located in non-conforming areas. Some of these imbalances were to a certain extent rectified by the intervention of the Courts. Though quite some industries closed down during the drive following the Court's orders, many of them later reopened. The MPD-II and the RP have been terminated in 2001.

A collaborative project of the Ministry of Environment and Forests, Government of India and the Planning Department, Government of National Capital Territory of Delhi – Delhi Urban Environment and Infrastructure Improvement Project (DUEIIP, 2001) examined the inadequacies in different sectors of infrastructure of Delhi at the end of the MPD-II and the RP. It sought to project infrastructure requirements for 2021, with particular focus on environmental health.

The DUEIIP Report (2001) of the Government of National Capital Territory of Delhi "refuted the contention" that DDA was the major provider of formal housing in Delhi. Between 1957 (when DDA was formed) and 2000, Delhi’s population increased from 3 million to about 14 million. The 11 million increase consisted of about 5.5 million people in the higher income groups (HIG) plus economically weaker sections (EWS) and another 5.5 million people in the "poverty group". The Report pointed out that during this period, one million dwelling units had been provided for by the DDA; the private sector (both formal and informal) provided for another one million units. The shortfall in housing stood at 277,253 units in 1997 and was projected to be 342,000 units by 2002 (DUEIIP, 2001). The Report argued that had there been a housing policy in place, this situation would not have arisen. The DUEIIP Report went on to espouse the cause of the private sector, which it said could build at "six times the rate of the public sector". The principal cause of the failure of DDA, as identified by the DUEIIP Report, was lack of sharing of powers by the Government of India and the Government of Delhi and that "majority of the citizens of

4 The Government of Delhi has consistently been arguing that the lack of its proper control over the key agencies like the Municipal Corporation of Delhi and Delhi Development Authority are major obstacles to planned development.
the national capital are not in control of their own destiny!.

National Capital Territory of Delhi

Delhi was a union territory till 1993 when statehood was conferred, with limited powers. The new state was called The National Capital Territory of Delhi (NCTD). NCTD is spread over an area of 1,484 sq. km and is bound by the states of Haryana and Uttar Pradesh. The NCTD is cared for by 3 local bodies - Municipal Corporation of Delhi (MCD), New Delhi Municipal Committee (NDMC) and Delhi Cantonment Board (DCB). Among these, the MCD caters to the bulk of Delhi's population (about 90%). As per the 2001 census, the population of Delhi is 13,782,976. The MCD is among the largest municipal bodies in the world in terms of the population served and second only to Tokyo with respect to the area covered (Civic Guide, 1995). It covers 1397.3 sq km and includes 238 villages. The NDMC serves 2.88% of the city area while DCB serves a smaller population spread over 2.89% of Delhi.

DEMOGRAPHIC AND SOCIO-ECONOMIC INDICATORS

Population Growth

The first census in Delhi was conducted in 1833; there were 119,860 people in the city excluding the palace residents. The censuses of 1843, 1845 and 1853 registered the population as 131,000, 137,000 and 151,000 respectively. There was a sharp drop in population during the Mutiny of 1857. The population began to increase again from 1860 – more in the suburbs than within the Walls. Famine years of 1861, 1867, 1877 and 1898 witnessed 'distress migration' from areas as far as Rajasthan. The number of men living in the suburbs in the 1870s was far higher than the number of women, in contrast to the city where the ratio was more even. The difference was most marked in the age group 15-45 years. While 5% of the males were literate in the suburbs as many as 25% were literate in the city area. The occupation profile of the males in the city were skewed towards manufacturing, trade, clerks and professional workers. In contrast, in the suburbs, as many as 50% were labourers and others were petty shopkeepers; only one in eighty were in the service sector. Following the Mutiny, population density increased sharply following the
decision to locate the cantonment within the city and have a wide open space around the Fort.

The census of 1846 had recorded 25,000 houses in the walled city, that rose to 38,000 in 1853. The 1881 census found only 17,498 houses, including the suburbs. There was increased building activity in 1880s and 1890s. By 1880s there were demands from time to time to demolish the Wall to expand the growing city but this was opposed by the army. The rate of immigration however slowed down; two-thirds of the immigrants continued to be males. There was a sharp increase in rented dwelling units and squatters on public land. The notion of residing in more healthy and open suburban houses grew as a concept only at the turn of the century. By 1890s, Delhi had become the commercial capital of the Punjab. It had also grown into a major military station. The shifting of the capital of India (from Calcutta) in 1912 further boosted the growth of population.

By 1941, the population of Delhi had increased to 900,000. The 1951 census recorded the population to be 1,744,000 indicating the largest ever decadal growth of around 90%, in the aftermath of the Partition. Table 2.1 shows population and migration into Delhi between 1951 and 1991.

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (000's)</th>
<th>Net Decadal Increase (000's)</th>
<th>Per Cent</th>
<th>Total No. of Immigrants (000's)</th>
<th>% of Immigrants in the Decadal Increase of Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>1744</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1961</td>
<td>2659</td>
<td>915</td>
<td>52.3</td>
<td>544</td>
<td>56.5</td>
</tr>
<tr>
<td>1971</td>
<td>4066</td>
<td>1407</td>
<td>52.9</td>
<td>525</td>
<td>37.3</td>
</tr>
<tr>
<td>1981</td>
<td>6220</td>
<td>2154</td>
<td>53.0</td>
<td>1229</td>
<td>57.0</td>
</tr>
<tr>
<td>1991</td>
<td>9421</td>
<td>3201</td>
<td>51.5</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>


Migrants contributed to more than half the increase in the population during 1951-61, after the partition. More importantly, during 1971-81 there was a boom in the growth of industries and the land mafia was also born and to a great extent institutionalised. The provisional estimate of the 2001 census has recorded the population of Delhi as 13,782,976 on 00:00 hrs of 1st March, 2001. The decadal growth rate was 46.31% signifying a slow-down over the previous decade. The national growth rate (provisional)
was 21.34%. The population of Delhi accounted for 1.34% of the total population in the country and occupied the 18th rank among the States in the 2001 census.

Table 2.2: Population Density of Delhi

<table>
<thead>
<tr>
<th>Civic Body</th>
<th>Density of population (persons/sq. km.)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1981</td>
</tr>
<tr>
<td>NDMC</td>
<td>6,388</td>
</tr>
<tr>
<td>DCB</td>
<td>1,982</td>
</tr>
<tr>
<td>MCD (Urban)</td>
<td>13,547</td>
</tr>
<tr>
<td>MCD (Rural)</td>
<td>476</td>
</tr>
<tr>
<td>MCD (Total)</td>
<td>4,195</td>
</tr>
<tr>
<td>Delhi (Urban)</td>
<td>9,745</td>
</tr>
<tr>
<td>Delhi (Rural)</td>
<td>507</td>
</tr>
<tr>
<td>Delhi (Total)</td>
<td>4,194</td>
</tr>
</tbody>
</table>


Delhi has witnessed rapid growth of population and a comparison of the population densities will give an indication of the degree of urbanisation that has taken place (Table 2.2). A few densely populated urban areas in MCD were redesignated as rural during the late 1980s. This explains the increase in the density of population in rural areas between 1981 and 1991, and, the slight fall in density in urban areas. The population density for Delhi was 9,294 persons per sq. km. in the 2001 census, more than double that of 1981. The annual estimates of population of Delhi by the Office of the Registrar General of India have been presented in Table 2.3.

Table 2.3: Annual Estimates of Population

<table>
<thead>
<tr>
<th>YEAR</th>
<th>As on 1st March</th>
<th>As on 1st July</th>
<th>As on 1st October</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991</td>
<td>9,420,600</td>
<td>9,538,300</td>
<td>9,615,100</td>
</tr>
<tr>
<td>1992</td>
<td>9,756,500</td>
<td>9,858,900</td>
<td>9,958,000</td>
</tr>
<tr>
<td>1993</td>
<td>10,104,500</td>
<td>10,223,200</td>
<td>10,313,100</td>
</tr>
<tr>
<td>1994</td>
<td>10,468,400</td>
<td>10,587,700</td>
<td>10,680,900</td>
</tr>
<tr>
<td>1995</td>
<td>10,837,900</td>
<td>10,965,200</td>
<td>11,061,700</td>
</tr>
<tr>
<td>1996</td>
<td>11,224,400</td>
<td>11,355,500</td>
<td>11,454,800</td>
</tr>
<tr>
<td>1997 *</td>
<td>11,622,300</td>
<td>11,758,100</td>
<td>11,860,900</td>
</tr>
<tr>
<td>1998</td>
<td>12,034,400</td>
<td>12,17,500</td>
<td>12,281,400</td>
</tr>
<tr>
<td>1999</td>
<td>12,461,000</td>
<td>12,606,500</td>
<td>12,716,800</td>
</tr>
<tr>
<td>2000</td>
<td>12,902,700</td>
<td>13,053,400</td>
<td>13,167,600</td>
</tr>
<tr>
<td>2001</td>
<td>13,360,100</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Office of the Registrar General of India
Demographic Indicators

Crude birth rate declined from 33.10 per 1000 population in 1951 to 21.1 per 1000 population in 1997 (Table 2.4). About 90% of the total population of Delhi is urban. Comparing the all-India urban crude birth rate, in 1971, the all-India figure was 30.1/1000 population while that for Delhi was 24.20 /1000 population. This gap is observed to even out by 1997 – 21.5/1000 population for urban India and 21.1 per 1000 population for Delhi.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude Birth Rate</td>
<td>33.10</td>
<td>29.20</td>
<td>24.20</td>
<td>26.80</td>
<td>28.52</td>
<td>24.93</td>
<td>21.1</td>
</tr>
<tr>
<td>All India</td>
<td>41.70</td>
<td>41.20</td>
<td>38.90</td>
<td>35.60</td>
<td>30.90</td>
<td>29.30</td>
<td>28.90</td>
</tr>
<tr>
<td>Crude Death Rate</td>
<td>9.00</td>
<td>8.20</td>
<td>7.09</td>
<td>6.61</td>
<td>6.35</td>
<td>6.70</td>
<td>5.40</td>
</tr>
<tr>
<td>All India</td>
<td>22.80</td>
<td>19.00</td>
<td>14.90</td>
<td>12.50</td>
<td>9.80</td>
<td>9.00</td>
<td>8.90</td>
</tr>
<tr>
<td>Infant Mortality Rate</td>
<td>84.00</td>
<td>70.80</td>
<td>62.70</td>
<td>52.07</td>
<td>32.37</td>
<td>29.81</td>
<td>NA</td>
</tr>
<tr>
<td>All India</td>
<td>146</td>
<td>129</td>
<td>129</td>
<td>110</td>
<td>80</td>
<td>72</td>
<td>72</td>
</tr>
</tbody>
</table>


Note: CBR and CDR : per 1000 population; IMR : per 1000 live births

Similarly, crude death rate declined in Delhi from 9.00 per 1000 population in 1951 to 5.40 per 1000 population in 1997. Comparing the figures for 1996, crude death rate in Delhi was 6.70 per 1000 population and all-India urban crude death rate was 6.50 per 1000 population. The corresponding figures for 1997 are 5.40 per 1000 population and 6.50 per 1000 population for Delhi and urban India respectively. In terms of infant mortality rate, Delhi fares comparably with the urban IMR of the major states except Kerala and Karnataka whose indicators are better.

Delhi ranks among one of the worst states in terms of female population per thousand males. However, one has to be careful in interpreting this statistic since there are significant numbers of single males migrating to Delhi for employment.
It is interesting that there has been a decline in the sex ratio (Graph 2.1) throughout the century with the sex ratio never regaining the 1901 level of 862 females per 1000 males. There was a systematic decline till 1941 (715) and 1951 saw a turn around. Between 1951 and 1991, there was a steady increase from 768 to 827. The 2001 census recorded a fall in sex ratio from the 1991 level in a contiguous block of north Indian states and union territories – Himachal Pradesh (976 to 970), Punjab (882 to 874), Chandigarh (790 to 773), Haryana (865 to 861) and Delhi (827 to 821). Even the 'BIMARU' states registered an increase in the sex ratio. A similar pattern of declining sex ratio may be noted in another contiguous block of western Indian states and union territories – Gujarat (934 to 921), Daman & Diu (969 to 709), Dadra & Nagar Haveli (952 to 811), Maharashtra (934 to 922) and Goa (967 to 960).

Within Delhi, however, there was variation in sex ratio across nine revenue districts. The lowest of 783 was noted in New Delhi which has only 1.25% of the population. The highest was 851 in North-East district which has 12.80% of the population. Between 1991 and 2001, sex ratio increased only in North and North-East districts while all other districts registered a fall.

**Socio-Economic Characteristics**

The literacy rate (Table 2.5) has shown a steady improvement over the years and in fact compares very well with the all India averages. However a persistent gap remains over the years between male and female literacy rates.
Table 2.5: Literacy Rate in Delhi

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>19.86</td>
<td>31.99</td>
<td>42.99</td>
<td>60.75</td>
<td>63.71</td>
<td>79.28</td>
<td>82.01</td>
<td>87.37</td>
</tr>
<tr>
<td>Female</td>
<td>6.03</td>
<td>15.25</td>
<td>32.34</td>
<td>42.55</td>
<td>47.75</td>
<td>62.60</td>
<td>66.99</td>
<td>75.00</td>
</tr>
<tr>
<td>Total</td>
<td>14.06</td>
<td>25.01</td>
<td>38.36</td>
<td>52.75</td>
<td>56.61</td>
<td>71.94</td>
<td>75.29</td>
<td>81.82</td>
</tr>
</tbody>
</table>


The estimates of Gross State Domestic Product (GSDP) is available for 1993-94 to 1999-2000 at constant prices with base year 1993-94 (Government of Delhi, 2002). Analysis of sectoral growth in GSDP at current prices indicate that the primary sector comprising of agriculture, livestock, forestry, fishing, mining and quarrying and also the secondary sector comprising of manufacturing, electricity, gas, water supply and construction are on the decline. The tertiary sector comprising of trade, hotels, restaurants, transport, storage, communication, finance, insurance, real estate, business services and public administration has emerged as the major contributor in the economy of Delhi. Between 1993-94 and 2000-01, the contribution of the primary sector to the GSDP declined from 3.92% to 1.40% and that of the secondary sector declined from 25.61% to 20.20%. For the corresponding period, the contribution of the tertiary sector increased from 70.47% to 78.40%. The reason for this trend has been attributed to rapid urbanisation, reduction of agriculture and allied activities and substantial increase in the growth of the services sector. The closure of the polluting industrial units has contributed to the decline in the secondary sector.

In real terms the GSDP for Delhi registered an annual compound growth rate of 8.41% between 1993-94 and 2000-01. During 2000-01, at constant prices, the annual growth rate of GSDP was 4.5% as compared to the all-India growth rate of 4%. At constant prices(1993-94), during 1993-94 to 2000-01, per capita income for Delhi grew at an annual compound growth rate of 4.45% as compared to the national rate of 4.20%.

In the agriculture and allied activities sector, the decline in real terms has been associated with the ban imposed by the Delhi High Court in 1994 on the slaughtering of animals in the Slaughter House and, the output of floriculture being much less during 1999-2000. Mining and quarrying is a minor economic activity in Delhi partly due to the topography.
Further such activities have been curtailed because of the ban on quarrying of stone and extraction of badarpur within Delhi. The manufacturing sector had been playing a substantial role till 1995 when a major chunk of big industrial units causing pollution were closed by the Court. Again in 1999, under the orders of the Supreme Court several additional units were closed for controlling environmental pollution. As a result there has been a decline in the contribution to GSDP from the manufacturing sector. Within the secondary sector, the contribution from the construction sector has been consistently growing. In the tertiary sector the trade, hotels and restaurants sector, has been one of the major contributors accounting for approximately one-fifth annually to the GSDP. Transport, storage and communication is another sector that has been growing consistently. Financing, insurance, real estate and business services has been a major contributor to the economy. In 1993-94 this sector contributed to one-fourth of the total GSDP, and that increased to about one-third by 2000-01. Community, social and personal services sector has been growing over the period at an annual compound growth rate of 18.4%. However, a major part of this growth is explained by the increase in public administration services.

SETTLEMENT PATTERNS

Delhi shows great diversity in its settlement patterns. The New Delhi Municipal Committee (NDMC) corresponds to the area that was developed when the capital of India shifted from Calcutta to Delhi and in the post-independence period witnessed a further boost in its development. The government institutions and state owned residences form the bulk of NDMC. Delhi Cantonment Board (DCB) exclusively caters to the military installations, offices and residences. Both these local bodies are therefore planned areas with relatively little violations in terms of civic laws. In terms of infrastructure, these areas are well provided for. The resident populations are socio-economically and politically well empowered. However, these two local bodies account for only about 5% of the area and about 10% of the population of Delhi. In contrast, the Municipal Corporation of Delhi (MCD) caters to 90% of the resident population of Delhi spread over 85% of the total area. It is in the MCD areas that Delhi has 'expanded' – with new colonies being set up or allotted by the Delhi Development Authority (DDA) and unauthorised settlements mushrooming as well.
Settlement Types

Delhi is growing at the rate of about 1000 persons per day and about 350,000 per year. Of these 350,000 additional persons - 225,000 result from intrinsic growth and the rest are accounted for by migration. Provision of housing to this growing body of population is an enormous task. Delhi Development Authority (DDA) was set up in 1957 with the principal objective of developing land and providing housing. Between 1957 and 2001, the population of Delhi increased from 3 million to about 14 million i.e. 11 million. About half of this population are living in housing provided by the DDA in a wide range of housing from those meant for High Income Groups (HIG) to Economically Weaker Sections (EWS), including Resettlement Colonies. The other half (more than 5 million people) are poor and are living in sub-standard housing. Upto 31.03.98, the DDA had constructed 258,230 units and 240,000 resettlement units and another 21,760 units were under construction. 525,000 units had been provided for through Co-operative Group Housing Schemes. There are 1 million housing units in the private sector both formal and informal (i.e. unauthorised).

Considering the settlement pattern in the urban areas under the jurisdiction of the MCD, about 60% of the population are in planned areas, 20% in Jhuggi-Jhonpri (JJ) (slum and squatter) clusters and Unauthorised Colonies and, another 20% in resident Resettlement Colonies. An average of about two lakh persons migrated to Delhi annually during the 1990s, while about 9.5 lakhs were living in notified slums. Apart from this, another 20 lakhs are housed in JJ clusters. The population residing in JJ clusters was 2.03 million in 1993-94 and was projected to increase to 3.25 million by 2001, which would correspond to 26.5% of total urban population (CSO 1999). The DUEIIP (2001) puts the population residing in JJ clusters at 3 million in 1997 – about 24.5% of the total population. Further, 15% were residing in unauthorised/regularised colonies, 13% in resettlement colonies and 9% in urbanised villages – all of which has been classified as "substandard housing" by the Delhi Urban Environment and Infrastructure Improvement Project (2001). The different settlement types in Delhi are:

- Planned colonies
- Unauthorised colonies
- Regularised colonies (which were unauthorised to begin with)
• Slums / JJ clusters
• Resettlement Colonies
• Urbanised villages
• Villages (rural)

Planned Areas

The planned areas include the area under the New Delhi Municipal Committee (NDMC) which corresponds to the capital built by Lutyen and his team and, other parts of New Delhi. These are the areas where infrastructure facilities have been developed in a planned manner and services are available to the residents. The older settlements in the Walled City and Old Delhi have also been integrated into the planning process and civic infrastructure has been made available to populations living in these areas. Planned colonies have been added in MCD areas over time, with proper services. They were generally developed by the DDA and later handed over to MCD for maintenance and provision of day to day services.

Resettlement Colonies

It is critical to note that these are essentially planned areas. They are constructed by the state to relocate the slum population. The first such effort was made in the early 1960s. Squatter settlements were removed from government and private lands and 2-room tenements were provided to 3,560 households. The policy later changed to providing partially developed plots the size of which was initially fixed at 80 square yards (sq. yds.). The plot size reduced over the years to 40 sq. yds., 25 sq. yds. and finally 12.5 sq. yds.

Slum clearance work received a major thrust in 1974 when this job was transferred from Municipal Corporation of Delhi (MCD) to Delhi Development Authority (DDA) by the Government of India. The DDA took it up as a mission during the Emergency years – 1975 to 1977. 27 resettlement colonies were constructed in the peripheries of the city during this period and 120,000 squatter households were relocated. The resettlement colonies were site-cum-services schemes. Each family was provided a plot of 25 sq. yds.
These colonies were provided with roads, parks, public toilets, shops, schools, dispensaries and community centres. Industrial areas were also provided for in nearby areas to provide employment. The emphasis was on 'resettlement' and not just 'relocation'.

Despite these guiding principles, there were several major deficiencies in the resettlement colonies (Ritu Priya, 1993). They are summarised as follows:

- The colonies were located on low lying waste land often along drains and ditches that were essentially unsuitable for human habitation.
- Resettlement colonies were set up in the trans-Yamuna area without developing an adequate drainage system as was recommended in the Master Plan.
- The area of individual plots was lowered from an initial of 89 sq. yds. (recommended by the Delhi Improvement Trust) to 25 sq. yds. (allotted by the DDA) leading to serious compromises in public health standards.
- Adequate water supply and proper waste disposal system was not provided.
- The minimum standard of public latrines was fixed at one seat for 20-50 persons which in actual practice was often as bad as one seat per 150 persons. As a result open defecation particularly by children is a common practice.
- Parks almost invariably deteriorated into dumping areas for solid wastes and wastewater.
- The remote location of the resettlement colonies implied that communities were far away or cut off from their previous employment and facilities including health institutions/services.

Over time, these resettlement colonies have become densely populated, more than had been originally envisaged. In addition to intrinsic growth of the relocated families, there are a large body of tenants in the settlement units that often stand three to four stories high. Further, squatter settlements have mushroomed around all the resettlement colonies. Unauthorised construction and small household industries have become major problems. In some of these colonies, sewers have later been constructed but majority of the households do not have space for constructing toilets. Some of the households however encroached on the common space and constructed toilets which open directly to
the open drains with consequent complications. The open spaces in most of the resettlement colonies have been encroached upon by squatters.

In 1992 the DDA introduced the Revised Resettlement Policy. This had two major premises:

- No fresh encroachment would be permitted on public land
- Encroachments till 30.01.1990 will not be removed without providing alternatives

Since the mid-1990s, there has been a new spurt in relocating slum clusters. Relocation of clusters is being done only in those cases where land is required to be made available to the land owning agency for 'public interest projects'. The land owning agency has to make a specific request to this effect and should also be ready to partially bear the cost. Rs. 44,000/- is required to relocate one slum household – of which Rs. 29,000/- is contributed by the land owning agency, Rs. 10,000/- is contributed by the Delhi Government for provision of services and Rs. 5,000/- is contributed by beneficiary. The services are provided by the Slum & JJ Department of the Municipal Corporation of Delhi.

**Unauthorised Colonies**

Unauthorised colonies are built by promoters, builders and the land mafia on land that is generally not meant for human habitation as per the Master Plan. This is due to demand for housing (or land for that purpose) which has not been available at an affordable cost to significant numbers of population who have had no option but to take recourse to settling in such illegal colonies in the hope that they will be 'regularised' over time. The promoters are generally local landlords, property dealers or politicians and often varied mixtures of these – forming thereby the 'land mafia'.

The unauthorised colonies typically come up around villages in the peripheries of the city. The promoters generally belong to the dominant caste/s of the concerned village. In most instances the designated land use was either agricultural or fallow land. The customers for these lands are typically low and middle income group individuals and a significant proportion of them are in the services sector – formal or informal. They then construct the dwelling units. At this stage the complicity of the local police, MCD and DDA officials
come into play without which the physical structure cannot be built since each of these agencies have a surveillance mechanism to check illegal and unauthorised construction.

The unauthorised colonies being illegal entities do not qualify for any services including piped water supply, sewerage, sanitation and electricity. People generally access electricity by illegal means but do not have options for piped water and sewerage. Not all of these residents are poor and in fact there is a large spectrum of socio-economic groups that live in the unauthorised colonies. These colonies are regularised periodically, following which they become eligible for provision of basic services, for which developmental charges are levied.

**Jhuggi-Jhopri (JJ) Clusters**

Jhuggi-Jhopri (JJ) clusters or squatter settlements are encroachments on public or private lands and are illegal settlements. They are essentially 'kutcha' dwelling units (huts); many families in JJ clusters manage to climb the economic ladder and construct 'pucca' dwelling units over time. JJ clusters are notified under the Slum Improvement and Clearance Areas Act (1956) and become eligible for benefits under this Act. They are not entitled for any individualised services but are provided with community level services like public hydrants, tankers, latrine blocks\(^5\), street lighting, dhalaos (dustbins) for collection of domestic wastes, paved pathways and drains. They are also eligible for relocation/resettlement schemes. The details of the relocation schemes have been described in detail in the earlier section on resettlement colonies. It is important to distinguish between JJ Clusters from JJ Colonies which are resettlement colonies of the 1960s batch.

About 25% of Delhi's population resides in these JJ clusters — 3 million in 1997. There were 1,100 clusters with about 600,000 jhuggies in 1997. 713 clusters were located on 1,838 acres of land owned by DDA alone or jointly with other agencies. 87 clusters are situated on about 146 acres of land belonging to the Land and Development Office. The remaining clusters are located on land owned by railways, other government agencies and private owners. About a third of the clusters have less than 100 jhuggies and another one-third have between 100 and 500 jhuggies. The rest are bigger with 5% of the clusters having 1001-

\(^5\) Pay and use Jan Suvidha complexes with toilets and bathrooms are provided at community level; mobile toilet vans wherever Jan Suvidha complexes cannot be provided. More such pay and use complexes have recently been constructed under the Yamuna Action Plan.
1500 jhuggies and another 6% having more than 1500 jhuggies (DUEIIP, 2001). The key issues and deficiencies in the provision of these services that have been identified by the DUEIIP Report are (DUEIIP, 2001):

- Standard norms for basic services are too low
- Inadequate environmental services infrastructure
- Ineffective delivery and service maintenance
- Inadequate social support systems particularly health centres and schools
- Lack of co-ordination and consultations between authorities, NGOs and communities

Villages

Delhi has 238 villages some of which have been engulfed in the urbanisation process at various stages of the expansion of the city. The 'rural' villages still have agriculture as the principal means of livelihood. Parts of the village have diversified into other economic activities like manufacturing industries and agro and food based industries. Villages where land (including agricultural land) was taken up for the expansion of the city are known as 'urbanised villages'. They are surrounded by planned city areas. The landowners are paid suitable compensation as per the prevailing rates; the current rate is Rs 1.6 million per acre and is likely to be undergo an upward revision in the near future. The compensation money is generally invested in setting up industries within the villages or in real estate where houses or dwelling units are constructed with the specific purpose of sale or rent. The quality of houses built depend upon the socio-economic group of tenants that the village attracts and is a function of the location of the village within Delhi. An important feature of these villages – both rural and urbanised – is that Municipal bye-laws are not enforceable within the village limits, also called the 'ladhora'. As a result, little regulation can be enforced in terms of the buildings constructed or the industries set up. There is always a pressure from the influential and powerful segments of the rural population to notify more areas as extended ladhora where business and construction activities can be carried out in an unrestricted manner which, in turn, attract more population into an infrastructure-constrained situation.
WASTE MANAGEMENT IN DELHI

Solid Waste

Munasinghe (1994) has distinguished between 3 types of urban solid wastes. These can be classified as:

- Municipal solid wastes, including paper, plastics, glass, metals, street sweepings and general refuse from households, commercial and institutional establishments. In some countries he notes, sludge from sewage and water treatment plants are co-disposed with municipal solid wastes
- The second category consists of hazardous and industrial wastes. These include heavy metals, dioxins and polycyclic aromatic hydrocarbons. Major characteristics of this group include their toxicity to humans, ignitability, infectiousness and potential for ecological damage.
- Waste generated by health care services and hospitals is considered separately as clinical or medical wastes. This includes pharmaceutical, pathological and infectious wastes like syringes, needles, chemicals (aerosols/disinfectants) and low level radioactive wastes (X-rays, radiation vials).

For disposal of solid wastes in general there are two main alternatives, incineration and sanitary landfills. Each of these has its advantages and disadvantages. Incineration can cause air pollution and is a more expensive and complicated alternative. However, it is useful for reducing the bulk of the waste and disposing of toxic or hazardous waste. Sanitary landfills are more appropriate for handling non-combustible wastes and the ashes from incineration. For most municipal solid wastes it is the appropriate method of disposal. No matter which of these methods is adopted, ensuring environmentally safe disposal requires direct involvement by governments in planning and regulation because disposal has large externalities and economics of scale that make competitive provision non-viable. However, for collection of urban solid wastes, contracts with private parties are both feasible and being practised in developing countries. Till date, 50 to 70% of solid wastes in developing countries are collected by municipal sanitation departments.

The management of solid wastes generated in a city is also an important responsibility of the civic authorities. The Central Pollution Control Board (TEDDY 1999) had conducted
a two-year survey of the management of solid wastes by the two civic agencies, the NDMC and the MCD. It was found that there was no significant change for the better over the years in the overall management of solid wastes within the city. Further, the landfill sites were found to be grossly polluted in terms of the land, water and air environment at these sites. Table 2.6 presents the comparative picture on solid waste collection across different Indian cities.

Table 2.6: Solid Waste Generation and Collection in Major Indian Cities (1994)

<table>
<thead>
<tr>
<th>City</th>
<th>Solid Waste Generated</th>
<th>Solid Waste Collected</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmedabad</td>
<td>1500</td>
<td>1200</td>
<td>80</td>
</tr>
<tr>
<td>Bangalore</td>
<td>2130</td>
<td>1800</td>
<td>85</td>
</tr>
<tr>
<td>Mumbai</td>
<td>5800</td>
<td>5000</td>
<td>86</td>
</tr>
<tr>
<td>Calcutta</td>
<td>3500</td>
<td>3150</td>
<td>90</td>
</tr>
<tr>
<td>Delhi</td>
<td>3880</td>
<td>2420</td>
<td>62</td>
</tr>
<tr>
<td>Lucknow</td>
<td>1500</td>
<td>1000</td>
<td>67</td>
</tr>
<tr>
<td>Chennai</td>
<td>2675</td>
<td>2140</td>
<td>80</td>
</tr>
<tr>
<td>Patna</td>
<td>1000</td>
<td>300</td>
<td>30</td>
</tr>
<tr>
<td>Surat</td>
<td>1250</td>
<td>1000</td>
<td>80</td>
</tr>
</tbody>
</table>


Delhi's solid waste collection is the lowest compared to that of the major Indian cities. All the metros and other major cities have collection of 80% and above while one-third of Delhi's solid waste remains uncollected at any point of time. This has serious implications, in the context of waterborne diseases, particularly if uncollected waste is not stored in proper bins and percolates to contaminate groundwater.

The Conservancy and Sanitation Engineering Department (CSE) of the Municipal Corporation of Delhi is responsible for collection and disposal of solid waste, street sweeping and cleaning of open drains. The CSE also maintains 332 major nullahs carrying sewage and 2900 km of drains. Further, there are 1583 septic tanks, mainly in resettlement colonies. In addition, there are four sanitary landfill sites (in use) for disposal of garbage at Ghazipur, Bhalaswa, Sanjay Gandhi Transport Nagar and Okhla.

The current daily generation of municipal solid waste is about 6,500 tonnes with an average composition of – 38.6% bio-degradable, 34.7% silt and 26.6% recyclable. 35 sweepers are
employed per 10,000 persons which is higher than the other metro cities. The three urban local bodies have 773 trucks of 4 tonnes capacity. At 2 trips per truck, it is possible to dispose of all the solid waste daily (DUEIIP, 2001). Gross managerial inefficiencies and poor maintenance of vehicles remain principal obstacles to proper collection and disposal of solid waste. Further, no services are provided for unauthorised colonies that account for about 20% of the population. It is therefore obvious that the solid waste generated in those colonies are not reflected in the official statistics. Disposal of solid waste is being "carried out by landfilling in an unscientific manner at four disposal sites" (DUEIIP, 2001). Biomedical and industrial waste are also reaching these landfill sites to a significant extent. All this implies contamination of groundwater with organic matter and chemicals.

According to the World Development Report 1994, public utilities (like piped water supply, sanitation and sewerage, solid waste disposal and collection), can deliver major benefits in terms of economic growth, poverty alleviation and environmental sustainability, but 'only when they provide services that respond to effective demand'. However, the nexus of service and environmental concerns is a complex one. To understand this, one can consider the pattern in which people demand water supply and sanitation services. The first priority of a family is to secure an adequate water supply at a reasonable cost. This is followed by the need to secure a private, convenient and sanitary place for defecation. In the initial phases, much governmental assistance and effort goes into providing these basic services. The very success in meeting these requirements gives rise to a second round of demands, namely, the removal of wastewater from the household, neighbourhood and finally the concerned city. Where cities succeed in this direction, the next problem that looms large is how to protect the environment from the degrading effects of ever-growing, large and concentrated pollution loads.

The relationship between each of these variables and the environment is complex. However one of the most significant effects on the environment concerns the removal and disposal of liquid and solid wastes. Here it is of utmost importance to see how disposal facilities are planned and executed. In many countries under-investment in municipal sewage relative to water supply in densely populated cities, is an area requiring serious attention.
Munasinghe (1994) outlined three essential steps in a water management programme in the context of solid waste collection and disposal.

- Firstly, there must be source reduction (or waste minimisation) to reduce the amount and toxicity of wastes through changes in design, technology or input mix; this finds place as part of a pollution prevention strategy.
- Secondly, waste reuse, recycling and recovery will reduce the load.
- Finally, there must be mechanisms for appropriate collection and disposal of remaining wastes.

Liquid Waste

In addition to water supply, the Delhi Jal Board (DJB) is responsible for safe disposal of liquid waste including maintenance of the sewage treatment plants and about 3,000 km of underground sewers. 55% of the urban population is being served by the sewer system. There are 7 Sewage Treatment Plants (STPs) and several more are under construction. The current total capacity is 1573 million litres per day (MLD). Most of the trunk sewers are heavily silted and non-functional at places due to poor maintenance. Sewage therefore cannot reach the STPs. The Delhi Jal Board claimed in June 2000 that 1,332 MLD was being treated, amounting to 85% of the capacity. A study by the Central Pollution Control Board (CPCB) has been quoted by the DUEIIP Report (2001) stating that despite the DJB's claims, only 950 MLD (60% of the installed capacity) of sewage was reaching the STP and is being treated.

An analysis of the sanitary situation of the poorer localities of Delhi is interesting. Outfall sewers exist in 10 resettlement colonies (22%). Out of 108 urban villages under MCD, sewerage exists in just 69 villages (64%). The 8th Five Year Plan laid stress on completing work on sewerage in both resettlement colonies and urban villages. The situation in JJ Colonies and resettlement colonies developed by the DDA is indeed serious. The sullage flows in open surface drains which ultimately reach the Yamuna river. Out of the 17 drains, 5 carry 95% of the pollution load. These were previously meant to be rain water drains but due to the lack of sewage systems, sullage/sewage is also being discharged into them.

6 There are plans to augment the treatment capacity to a total of 2282 MLD
WATER SUPPLY IN DELHI

In the early 19th century the prevalent diseases in Delhi were cholera, malaria and Delhi Sore (Gupta, 1981). Public health considerations gained importance as the military presence in the city increased. The diseases were considered to be caused by water borne contagion, transmitted through running water, brackish well water and water-logged pools. The dried up Ali Mardan canal was reopened to provide drinking water in 1821. The water was over exploited, particularly for irrigation, and therefore dried up in about two decades. The availability of water from this source led to the neglect of wells and in 1843, as many as 555 of the 607 wells in the city were found to be brackish. By 1867, the canal was restored but the wells continued to decline. Fresh water was additionally accessed from the springs in the Ridge and from Jhandewalan.

Waterworks and Water Board

In 1867, the Punjab Sanitary Commissioner suggested building a waterworks to tap the Yamuna water. Planning for the waterworks began in 1869. In 1889 construction began with a loan, twelve years after the Lahore waterworks scheme was successfully completed and operational. The water supply wells were located at Chandrawal village on the banks of the Yamuna. The residents were shifted out and resettled at New Chandrawal village. The walled city was supplied first followed by the western suburbs and finally the Civil Lines. When the canal’s supply became erratic and scanty there were applications for private connections. In 1892, the Municipality banned the chamars from using the public standposts; but the resolution was later withdrawn. The safe water from the waterworks led to a reduction in the incidence of cholera, typhoid and 'Delhi Boil'. The consumption of water increased with more house connections, further drying up of canals and wells and the need to flush the open drains to avert plague. The Civil Lines area was served from 1911.

The Joint Water Board was set up in 1925 by the Delhi Municipality and the New Delhi Municipality. Larger proportions of water were being diverted to the Notified Area, New Delhi and the Cantonment. The Delhi Municipality refused to pay. The new capital continued to gain in importance and the most developed municipal service, the water supply system, was used to serve the 'new' at the cost of the 'old'. To meet the growing requirements
of the expanding city, water works at Chandrawal, Wazirabad and Okhla were gradually constructed and expanded. Ranney wells and tubewells were also sunk and commissioned.

In 1957, the Water Board was replaced by the Delhi Water Supply and Sewage Disposal Undertaking of the Municipal Corporation of Delhi. The Undertaking had the sole responsibility for management of the water supply and liquid wastes of Delhi, including the sewage treatment plants. It supplied water in bulk to the NDMC and Cantonment Areas; in MCD areas supply was through a network of reservoirs, pumping stations and distribution mains. The Delhi Water Supply and Sewage Disposal Undertaking was reconstructed as the Delhi Jal Board (DJB) in 1998 and has been converted from a semi-autonomous undertaking to a Department of the Government of Delhi.

**Surface Water Sources**

At present the surface water sources in Delhi are the River Yamuna, Upper Ganga Canal and Western Yamuna Canal. The points at which each of these sources are being tapped and treated are presented in Table 2.7:

<table>
<thead>
<tr>
<th>Source</th>
<th>Tapped at</th>
<th>Treated at</th>
</tr>
</thead>
<tbody>
<tr>
<td>River Yamuna</td>
<td>Wazirabad</td>
<td>Chandrawal Plant</td>
</tr>
<tr>
<td>Upper Ganga Canal</td>
<td>Murad Nagar, U.P.</td>
<td>Bhagirathi Plant</td>
</tr>
<tr>
<td>Western Yamuna Canal</td>
<td>Bawana, Haiderpur</td>
<td>Haiderpur Plant</td>
</tr>
</tbody>
</table>

*Source: Office of the Chief Executive Officer, Delhi Jal Board, 2000*

Delhi has a fixed share of raw water in the River Yamuna and the Ganga Canal. There is not much scope of further harnessing fresh water from any of these above sources. During the summer months, efforts are made to harness additional supplies from neighbouring states. The amount of fresh water being harnessed at the three sites are:

- Haiderpur water works: 425 cusec per day
- Wazirabad and Chandrawal water works: 420 cusec per day
- Bhagirathi plant: 200 cusec per day
Table 2.8 presents the physico-chemical, bacteriological and biological parameters of the raw water being tapped from the Western Yamuna Canal at the water treatment plant at Haiderpur. This provides an indication of the quality of raw water.

Table 2.8: Different Parameters of Raw Water: Western Yamuna Canal, Haiderpur

<table>
<thead>
<tr>
<th>I. Physico-Chemical</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>Hazy</td>
</tr>
<tr>
<td>Odour</td>
<td>Earthy</td>
</tr>
<tr>
<td>pH value</td>
<td>7.8</td>
</tr>
<tr>
<td>Turbidity</td>
<td>65 MTU</td>
</tr>
<tr>
<td>Electrical Conductivity</td>
<td>280 mho</td>
</tr>
<tr>
<td>Chlorides</td>
<td>6.0 mg/l</td>
</tr>
<tr>
<td>Nitrites</td>
<td>0.004 mg/l</td>
</tr>
<tr>
<td>Ammonia</td>
<td>0.04 mg/l</td>
</tr>
<tr>
<td>Dissolved Oxygen</td>
<td>6.4 mg/l</td>
</tr>
<tr>
<td>Oxygen Absorption (3 minutes)</td>
<td>0.36 mg/l</td>
</tr>
<tr>
<td>pH, Alkalinity</td>
<td>Nil mg/l</td>
</tr>
<tr>
<td>Total Alkalinity</td>
<td>68 mg/l</td>
</tr>
<tr>
<td>Chlorine Demand</td>
<td>1.1 mg/l</td>
</tr>
<tr>
<td>Residual Alumina</td>
<td>-</td>
</tr>
<tr>
<td>Total Hardness</td>
<td>86 mg/l</td>
</tr>
<tr>
<td>Cyanides as CM</td>
<td>Absent</td>
</tr>
<tr>
<td>Nitrates</td>
<td>0.88 mg/l</td>
</tr>
<tr>
<td>Fluorides</td>
<td>0.1 mg/l</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>II. Bacteriological</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Coliform/100 ml - MPN</td>
<td>11 X 10⁵</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>III. Biological</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2500 members/1000 ml</td>
</tr>
</tbody>
</table>

Source: Office of the Additional CEO, Delhi Jal Board, 2000

The Yamuna River Corridor

The 25 km stretch of the River Yamuna extending from Wazirabad to Okhla has been considered to be 'perhaps the most threatened riverine ecosystem in world' (Kumar and Babu, 2001). Delhi has three distinct geomorphic units – rocky tracts, alluvial uplands and riverine zones. The riverine zones are characterised by floodplains (3100 hectares), seasonal pools (40 hectares) and marshy areas (110 hectares).

The river is regulated in the Delhi stretch with three barrages – Wazirabad Barrage, Yamuna Barrage and the Okhla Barrage – to control the flow of the river for the major part of the year except during the floods. The inputs and outflows in the Delhi stretch of the river are summarised as follows:
Sewage generated in Delhi is carried by 17 major drains with their outfall into the river in the Wazirabad-Okhla stretch. The Central Pollution Control Board puts the average daily production of sewage in Delhi at 2100 million litres.

The water balance profile indicates a peak flow in July ($2.3 \times 10^9$ million cubic metres) and reaches normal flow in October. 81% of the total water enters the Delhi area during the three monsoon months. Soil moisture studies have indicated negative balance for nine months implying reduction of ground water levels of the area. Soil moisture is however positive during the monsoon and large amount of water is available which is more than sufficient for saturating the floodplain aquifers. The maximum lean season depth of the water table was found to be 3 metres in the floodplain and neighbouring areas. Recharge of the ground water during the monsoon led to an increase in the ground water level from 3 metres to 2.28 metres.

The study tested water quality at Palla where the river enters Delhi from Haryana; this represented the raw water quality for Delhi’s water supply. Total coliforms/100 ml was 5766.16 and faecal coliforms/100 ml was 1904.69. Water quality was also tested at Nizamuddin to assess the impact of untreated waste water discharge into the river. Number of total coliforms/100 ml was found to be 154764.50 and number of faecal coliforms/100 ml was 148454.50 – a three-fold rise in total coliforms and an eighty-fold rise in faecal coliforms implying discharge of enormous amounts of untreated sewage with adverse implications for downstream residents.

**Ground Water Sources**

Ground water is harnessed through ranney wells and tubewells. The tubewells sunk by the Delhi Jal Board (DJB) are deep bore and are fitted with chlorinators. Ranney wells are sunk first vertically deep into the ground. The boring is then done radially in different
directions. This enables the groundwater to flow into the main bore under its natural pressure. Water is chlorinated before distribution.

According to estimates made by the Central Ground Water Authority (CGWA), the total annual groundwater recharge potential in Delhi is as follows (TOI 1999):

- Roof-top rain water harvesting - 6 million cubic metres (mcm)
- Check dams in ridge areas - 2 mcm
- Dewatering and refilling of Yamuna flood plain - 78 mcm
- Bhatti Mines excavated pits/mine areas - limited additional scope for recharging
- Storage tanks - negligible
- Najafgarh Jheel/drain - 10 mcm

Natural recharge to groundwater has reduced due to shrinkage of open area as a consequence of increased construction. Groundwater levels have also registered a marked decline. Unplanned disposal of solid and liquid wastes has simultaneously caused a deterioration in the quality of the groundwater. Given a per capita demand of 363 lpcd, and a total water demand of 4.8 mcm per day, groundwater plays a major role in fulfilling the demand, especially in areas without piped supply. There are about 100,000 groundwater extraction structures registered with the CGWA though about 400,000 such installations are estimated to be in use. In view of the demand-supply position, newer techniques such as rooftop rain water harvesting are being promoted by CGWA to augment groundwater storage by such artificial recharge method. The CGWA is being supported by the DJB and other non-governmental organisations in its efforts.

**Availability and Consumption of Delhi Jal Board Water supply**

Table 2.9 presents data on availability of piped water supplied by the Delhi Jal Board to the citizens of Delhi.
Table 2.9: Availability of Water in Delhi

<table>
<thead>
<tr>
<th>Year</th>
<th>Population (Lakhs)</th>
<th>Average Supply (Million litres/day)</th>
<th>Per capita Availability (Litres/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1951</td>
<td>17.5</td>
<td>190</td>
<td>108</td>
</tr>
<tr>
<td>1961</td>
<td>26.5</td>
<td>440</td>
<td>166</td>
</tr>
<tr>
<td>1977</td>
<td>41.0</td>
<td>785</td>
<td>190</td>
</tr>
<tr>
<td>1981</td>
<td>62.0</td>
<td>1150</td>
<td>185</td>
</tr>
<tr>
<td>1991</td>
<td>93.7</td>
<td>2160</td>
<td>231</td>
</tr>
<tr>
<td>1995</td>
<td>105.0</td>
<td>2860</td>
<td>272</td>
</tr>
<tr>
<td>2001 *</td>
<td>128.0</td>
<td>3250</td>
<td>254</td>
</tr>
</tbody>
</table>

* - Projection


These figures suggest that the per capita availability of piped water supply has been growing steadily and is at present well above the WHO recommendation of a minimum of 70 lpcd for urban areas. The per capita availability, in gross terms, has increased by nearly 135% between 1951 and 2001 for households with piped water supply.

Availability of water has been defined by the water supply bodies as "total supply of water per person." This supply includes transmission loss of water. The estimates take into account the approximate individual requirements of domestic consumers, industrial and commercial requirements\(^7\), fire protection (@1% of the total demand), garden use (@67,000 litres per hectare), free public hydrant supplies and special uses like hotels and other institutions. According to the Delhi Jal Board, the total loss is approximately 30%.

Of this transmission and distribution losses account for 10%, organisational losses such as cleaning of water mains is 5% and the remaining losses are due to thefts and pilferage. The average per capita availability is arrived at by including the quantity actually consumed by industries and other public facilities along with domestic consumption. The average is therefore much above the actual per capita requirement of water. In fact, added to this is the total loss of 30% including theft and pilferage.

It is of interest to compare how Delhi fares with other Indian cities. Table 2.10 presents water supply situation across several major cities (Barah et al 1998).

---

\(^7\) @ 445,000 litres per day per hectare in Delhi and 28% of the total demand in Bombay
Table 2.10: Water Supply in Indian Cities

<table>
<thead>
<tr>
<th>City</th>
<th>Population coverage of water supply</th>
<th>Water demand* (lpcd)</th>
<th>Water availability (lpcd)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delhi</td>
<td>98.56%</td>
<td>363</td>
<td>237</td>
</tr>
<tr>
<td>Bombay</td>
<td>95.00%</td>
<td>180</td>
<td>137</td>
</tr>
<tr>
<td>Hyderabad</td>
<td>100.00%</td>
<td>120</td>
<td>65</td>
</tr>
<tr>
<td>Madras</td>
<td>95.63%</td>
<td>200</td>
<td>47</td>
</tr>
</tbody>
</table>


Among the Indian cities for which figures are available in this study, Delhi's population coverage of water supply is high, and Hyderabad reportedly has 100% of its population covered by piped water supply. However, in terms of per capita demand of water, Delhi's requirement is very high and about 65% of the demand is met, in aggregate terms. Hyderabad with a full coverage is able to meet only 54% of the demand. In terms of meeting the per capita demand, Bombay's performance remains best at 76.1%, while Madras is able to fulfil only a meagre 23.5% of the demand.

The Chief Engineer of the Delhi Jal Board claimed 'we meet about 88% of the entire requirement of the city and the rest is met by underground water' (Indian Express, August 6, 2001, New Delhi). The article quoted other experts that the total sewage outfall into the Yamuna was far more than what could be accounted for against DJB supplies. Currently, about 1470 million litres of raw water are being drawn daily from the Yamuna River. The standard norms demand that 80% of this water should return as treated wastewater; i.e. 1170 million litres. In the dry season, about 2800 million litres of wastewater are being discharged to the Yamuna. This implies that a significant proportion of the daily requirement of water is being met by accessing groundwater (DUEIIP, 2001). Consumption of untreated groundwater has been repeatedly implicated as a causal factor for cholera in a number of studies in Delhi.

It is interesting to take a look at the arbitrary standard of calculating requirement by the Delhi Jal Board – 270 lpcd for planned colonies, 153 lpcd for regularised colonies and 50 lpcd for unauthorised colonies and other areas (DUEIIP, 2001). It is a gross violation and undermining of the WHO norms, right at the planning stage with further inadequacies and
inequities when it came to actual distribution. It is evident that there is no scientific rationale behind this distribution as the planned colonies get the average arrived at by adding the requirement of industries and wastage, whereas the less privileged communities are provided with only half to one-fourth without actually explaining the reasons thereof. The DUEIIP (2001) does not identify the reasons for this inequity though criticising the state of affairs. Delhi Cantonment Board and New Delhi Municipal Committee emerge as the most privileged areas with a per capita supply of 509 lpcd and 462 respectively; at the other end of the spectrum, Mehrauli Zone of the Delhi Jal Board has a per capita supply of 29 lpcd only.

The production of treated water is 600 million gallons per day (MGD). Total raw water available from surface and ground water sources is 630 MGD. Does the camouflaging of industrial use of water affect the DJB statistics on water supply and consumption? To find an answer to this question we have looked at how consumption of water by different categories in Delhi has been increasing since 1980-81 till 1999-2000.
Table 2.11: Water Connections and Consumption by Category of Consumer

<table>
<thead>
<tr>
<th>Year→</th>
<th>80-81</th>
<th>90-91</th>
<th>95-96</th>
<th>96-97</th>
<th>97-98</th>
<th>98-99</th>
<th>99-2K</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of unmetered connections</td>
<td>13143</td>
<td>226960</td>
<td>315687</td>
<td>284917</td>
<td>29.217</td>
<td>297182</td>
<td>300102</td>
</tr>
<tr>
<td>Domestic consumption (lakh kilo-litres)</td>
<td>1542</td>
<td>4013</td>
<td>4114</td>
<td>8377</td>
<td>8120</td>
<td>8451</td>
<td>8451</td>
</tr>
<tr>
<td>Industrial / Commercial Consumption (lakh kilo-litres)</td>
<td>411</td>
<td>527</td>
<td>627</td>
<td>1478</td>
<td>1408</td>
<td>1491</td>
<td>1491</td>
</tr>
<tr>
<td>Total water consumption (lakh kilo-litres)</td>
<td>1953</td>
<td>4540</td>
<td>4741</td>
<td>9855</td>
<td>9528</td>
<td>9942</td>
<td>9942</td>
</tr>
<tr>
<td>Per capita consumption (lpcd) Not available</td>
<td>220.63</td>
<td>196.92</td>
<td>229.50</td>
<td>229.50</td>
<td>229.50</td>
<td>229.50</td>
<td>229.50</td>
</tr>
</tbody>
</table>


Table 2.11 shows that in the last 20 years, number of metered connections have increased by about 2.75 times and unmetered connections by about 2.25 times. In 1981, there were approximately 45,000 industrial units. Industries increased by 89% for the period 1981-91 and in 1991 there were 85,000 units. Industries increased by 47% during 1991-96; there were 1,25,000 units in 1996. By 1999, there were 1,40,000 industrial units – a 12% addition during 1996-99 (DUEIIP, 2001). 7,29,000 persons were employed in industries in Delhi in 1990 and 11,36,000 persons were employed in 1996 (Government of Delhi, 2000). Between 1981 and 1999, industrial units increased by 211.11%.

The DUEIIP Report (2001) points out that in 2000, 37,000 industrial units were located either in conforming areas or had been proposed for regularisation. Another 25,000 units were cottage industries or single hand industries. The remaining 64,218 units were in non-conforming areas (about 50% of the total units). Officially, industrial water consumption increased by only 166.80%. During this period, industrial consumption of water as a proportion of total water consumption reduced from 21.04% in 1981 to 15.00% in 1999. This is evidently an under estimation as a lot of water used by the industries is recorded as "domestic". The closure of industries has not made much difference.
It is interesting to look at the changes in consumption pattern of electricity between 1981 and 1999. Domestic consumption increased by 313% and industrial consumption increased by 324%. Industrial consumption of electricity as a proportion of total electricity consumption increased from 25% in 1981 to 32% in 1999. The revenue collection system of electricity supply agency is more efficient and effective than the water supply agency. It is only recently that the Delhi Jal Board has been getting its act together in matters of bringing unmetered connections under the revenue net. During the same period, population increased by 115% and domestic water consumption increased by 448%. However, the increase in per capita consumption has been marginal during the period for which data is available (1990-91 to 1999-2000) – 220.63 lpcd to 229.50 lpcd.

The aggregate figures discussed above therefore fail to capture the reality of the situation in terms of access to safe water sources and availability of adequate quantity across different socio-economic groups within Delhi. Several studies have highlighted the lack of availability of adequate quantity of water to the poorer households (Barah et al 1998, Mazumdar 1983, Kundu 1994, Zerah 2000, Dasgupta 2001). There is variation in the exact quantity available to the households as reported by these studies. However, they all highlight the fact that the urban poor of Delhi has very little access to adequate quantity of safe piped water supply. According to estimates made by the DJB the population covered by piped water had grown from 48.6% in 1967 to 90% by 1992. The crucial question is what proportion of this 90% population's demand was met by piped sources of water?

The Delhi Urban Environment and Infrastructure Improvement Project (DUEIIP, 2001) has explored the inequity in water supply and has observed that 10% of the population has no piped water supply and 30% has grossly inadequate access. It estimated that, in 1995, nearly two-thirds of the population lived in sub-standard housing and infrastructure across different settlement types. Further, DUEIIP reported that 40% of the population in Delhi were below the poverty line. In essence, poverty coupled with settlements with poor infrastructure conditions implied that at least half the population of Delhi did not have access to more than 25 lpcd, and some, even less.
Barah (1998) reported that per capita consumption of water in Delhi ranged from 313 lpcd in affluent households to 140 lpcd in relatively less well off households and a meagre 16 lpcd for the slum households in 1992-93. Indirect evidence is provided to the question of distribution of water across socio-economic classes by a study conducted by the Asian Development Bank (ADB) in 1991-92 through analysis of 1000 water bills of households in Delhi sampled by social class (Table 2.12).

Table 2.12 : Analysis of 1000 Water Bills

<table>
<thead>
<tr>
<th>Income class</th>
<th>Monthly Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affluent Class</td>
<td>47 kl</td>
</tr>
<tr>
<td>Middle Class</td>
<td>34 kl</td>
</tr>
<tr>
<td>Lower Income Group</td>
<td>25 kl</td>
</tr>
<tr>
<td>Urban Poor (with home connections)</td>
<td>21 kl</td>
</tr>
</tbody>
</table>


The ADB study findings relate to consumers with legal metered connections who have relatively better availability of water. The households belonging to the lowest socio-economic group reported by Barah are users of free public hydrant supply and therefore receive lower quantities. It is again reiterated that the urban poor in Delhi are receiving water far below the WHO benchmark and therefore remains highly vulnerable to waterborne diseases.

**Supply of Potable Water**

**Deep Tubewells**

The deep tube wells are often not laid deep enough. The chlorinators need regular maintenance. The use of chemicals and the manpower employed to operate the chlorinators has to be carefully monitored. The safety of the water supplies therefore depends crucially on the human resource deployed. When chlorinators are out of order it may take up to several weeks to set them right. Non-supply of bleaching powder may also be a source of potential breakdown of the safety chain. Outbreaks of cholera and other water borne diseases such as viral hepatitis A and E and enteric fever have occurred in clusters which are supplied by deep tubewells lacking regular chlorination for either or some of the reasons
Supply of water through deep tubewells (with chlorinators) is prevalent in some resettlement and regularised colonies of South and Central Zones and the rural areas. Deep tubewells are also the most important and often the only source of water supply in the co-operative group housing societies (owned by the middle class), where almost as a rule they run without chlorinators.

Ranney Wells

Ranney wells have a minor contribution to make in the total water consumed in Delhi. The Delhi Jal Board operates 30 Ranney Wells in Narela, Civil Lines and Shahdara (South) Zones that are located near the Yamuna River. These are wells bored deep into the ground with lateral channels that facilitate entry of sub-soil water in to the main bore. The water is drawn through pumps and supplied through piped network after chlorination. The main risks of contamination lie in inadequate treatment of the water before consumption. Otherwise, like the municipal piped water supply these are a relatively safe source of water.

Sintex Tanks

Sintex tanks are another theoretically safe source of water. These are placed in notified JJ Clusters and are regularly filled by tankers of the DJB. The tankers are filled from the different filling points of the DJB which receive piped supply. However, contamination does occur due to people dipping their buckets and other containers into these Sintex tanks.
Tankers

Tankers of the Delhi Jal Board supply water by making trips to areas without piped water supply where the community fills up their containers. It is quite common to see containers or rubber pipes being dipped into these tankers, leading to possible contamination. After the formation of the DJB, tanker services were greatly augmented and in the summer of 2002 there were about 1000 tankers in operation in the field daily with each tanker making an average of about 3-4 trips. Unauthorised colonies have been included in the network of tanker supply in a major way. The Delhi Jal Board, in a notification in 2000, banned the sale of water through private tankers. Private water supply companies were directed to carry the message on their tankers 'not to be used for drinking purposes' and also not to sell it for that purpose. However, for bulk consumers like hotels, food trades and in congregations like marriage parties, private tankers continue to supply drinking water. DJB also has facilities to provide drinking water through tankers for such occasions, on payment.

Deep Bore Handpumps/Pumps

Deep bore handpumps are a suspect source and more likely to be unsafe than safe. It has been found that in areas where sanitation is poor and open defecation is common, water table upto depths of 60-80 ft maybe contaminated. In addition technical flaws in not making them deep enough make them unsafe as well. Deep bore pumps with attached filtration or treatment plants are safe. Contamination from deep bore pumps with treatment facilities are rare since these are better maintained as they belong to either institutions (hotels, commercial complexes) or the more affluent.

Shallow Handpumps

Shallow handpumps are mainly used by the lower socio-economic groups and usually draw contaminated ground water from the superficial water table. The DJB, as a policy, paints these in red colour as a signal of the dangers involved in consuming this water. This practice was started since the 1988 epidemic but was implemented in a sloppy manner. During 1998, for the first time, a larger number of handpumps were painted red but only a few were accompanied by written warnings - 'not safe for drinking purposes'. Despite such 'warnings'
handpumps remain the mainstay of water supply for majority of the urban poor as also in unauthorised colonies where piped supply is either not available or quantities are insufficient due to the pressure being low or inadequate duration of supply. Even though mothers (and often fathers) may collect drinking water from safe sources which entails paying for the water or incurring travel costs, it is very often the case that children playing in the open drink water directly from the handpumps.

The Problem of Booster Pumps

Booster pumps have become a common method of augmenting water supply in homes in the middle and upper income groups. These pumps augment quantity at the cost of the quality of water. They have proved to be notorious for sucking in contaminants through minor cracks in the pipelines (if otherwise present). They cause a wide spectrum of waterborne diseases; in 1994, booster pumps in conjunction with faults in the piped supply caused a major Hepatitis E outbreak in Govind Puri and Kalkaji Janta Flats (Central Zone) along with sporadic cases of Cholera and Enteric Fever between January and March. Manual boosters are installed by puncturing DJB pipelines in low income colonies (typically in resettlement colonies and JJ clusters) with public hydrant supplies to augment supply, particularly in low pressure situations. They are as harmful as electrically operated booster pumps.

Access to Potable Water

Given the ground conditions of water sources and water supply networks, it is important to examine the accessibility to safe water sources and the availability of adequate safe water in different colonies. In the absence of adequate safe water, communities take recourse to accessing unsafe sources to meet their requirements and become vulnerable to waterborne diseases including diarrhoeal diseases.

Inadequacy forces people to supplement the piped supply with alternative means. These individual initiatives too vary according to the affordability of the household and have consequences for the quality of the water procured. There are three main alternatives – handpumps, electric (motor) pumps and booster pumps. Handpumps are found across all income classes. It is expected that wherever handpumps are found in higher socio-economic
classes, better informed residents would not be using water from the handpump for drinking purposes. Thus it is the lower socio-economic groups, who have both limited access to piped supply and limited resources to invest in alternatives other than shallow handpumps, that are exposed to the maximum risks of consuming contaminated water.

The lowest income groups reside in the Jhuggi Jhopri clusters. For these clusters, Pipelines have been laid and public hydrants/public standposts have been installed in these clusters. Water supply is generally intermittent and the per capita availability is inadequate to meet even drinking and cooking requirements. Water from safe sources is also provided to these communities through Sintex tanks and tankers (of the DJB). These households by and large cannot afford individual handpumps and therefore one finds shallow handpumps which have been built through community initiatives.

When a JJ cluster is relocated to a new site, safe water supply is always one of the most critical vulnerability factors. The responsibility of providing safe water to a relocated cluster is the responsibility of the Slum & JJ Department. In the current phase of relocation during the 1990s, these clusters faced severe water supply problems. There were diarrhoeal disease outbreaks in some of these clusters, including deaths of several children that took place on account of drinking contaminated water from a private tanker. Cholera began to be regularly reported from some of the newly relocated clusters. In a few clusters, where HUDCO was involved in the provision of basic amenities, the situation was better.

The households in the unauthorised colonies are relatively better off socio-economically than the communities residing in the resettlement colonies and slum clusters. They however depend entirely on individual initiatives for procuring water. While shallow handpumps remain a major source through which ground water is accessed, electric pumps are also popular among the middle-income groups residing in the unauthorised colonies. Deep bore tubewells are found mainly among the upper income categories as these call for substantial investments. The middle-income groups install tubewells of relatively less depth and the water drawn is not of satisfactory quality.

Inadequacy or non-availability of sufficient quantities of piped water supply, forces individuals to resort to alternatives which can prove to be harmful. However, there are
certain situations when threats from these increase due to the operation of certain external factors. In Delhi, the summer and monsoon months create a set of circumstances when the lower income groups are exposed to much greater levels of contamination of their water supplies. During summer, the demand for water goes up while the supply of water is often reduced due to a fall in the raw water made available from the river (Yamuna) upstream. This shortage in water availability (primarily due to increased demand) is reflected in higher domestic storage of water. Storage practices therefore become crucial in determining the quality of the water which is then being used by a particular household. The risks of contamination faced by the poorer households is greater since they can least afford the better means of storage and also because they are hit the hardest by the shortfalls in piped supply. As a result, greater domestic contamination occurs in these families as they have less water available for maintaining domestic and personal hygiene.

During the rainy season, the problem is quite different. The soluble nature of faecal and other waste matters implies greater and faster dispersion of the wastes. As a result, groundwater gets contaminated more easily than during the dry months. Contamination of ground water in turn means that all income classes who are dependent on it get affected. The ability of the poor in taking steps to purify this water is the least.

There are basically two systems of purification followed at the household level. Amongst the poorest sections (JJ Clusters and Unauthorised Colonies), the municipal authorities distribute chlorine tablets on a regular basis for use in all containers where water is being stored by the household. The higher socio-economic classes undertake individual initiatives like filtration devices and/or boiling the drinking water.

The Voluntary Health Association of India in their report 'Civic Neglect and Ill Health' had exposed the abject neglect of large sections of populations with regard to water, sanitation and health care in Delhi. The above discussion establishes that in general, there are a number of settlements which suffer from the common problems of poverty, high population densities, frequent population movements, poor supply of (piped) safe drinking water, and, lack of sanitation and sewage facilities. It is in this 'urban environment' of Delhi that waterborne diseases like cholera and gastro-enteritis flourish.
Quality of water available to a household is also determined by the method of waste disposal which in turn is a function of the neighbourhood factors and available infrastructure. The relationship between the quality of water and the manner of waste disposal is particularly important when water is drawn from individual sources. In planned areas, with proper sanitary latrines and sewerage systems, accumulated wastes pose less threat to the water available to the household.

The resettlement colonies are serviced by community latrines which are generally connected to septic tanks. The septic tanks need careful adherence to standards during construction and subsequent maintenance. Improper maintenance and lack of timely clearing out of these tanks have proved to be an important cause of ground water contamination. With the water table getting contaminated, the household which relies on handpumps is at a greater risk. Of course the depth from which the water is drawn as well as the extent to which the water table is contaminated would determine the actual extent of exposure. The service provider is responsible for maintaining these community latrines as well as the septic tanks. In addition, open defecation (mostly by children) is a major factor adding to contamination of the superficial water table.

Unauthorised colonies do not have any sewer lines. The community in JJ clusters cannot afford to construct individual sanitary latrines. As a result, open defecation is a major cause of groundwater contamination. For the higher income groups, sanitary latrines are connected to individual septic tanks. Due to improper construction and maintenance of these, water table contamination is common. Thus, for all those who are forced to rely on individual initiatives for their water supply, ensuring proper waste disposal methods becomes critical for maintaining the quality of the water consumed. Unfortunately, solid waste collection and disposal is beyond the realm of the individual household. This is an obligatory function of the local bodies under the Acts governing them. While these services are deficient to varying extents in JJ clusters, resettlement colonies and urbanised villages, the unauthorised colonies by virtue of their legal status (or the lack of it) are not entitled to these services. Again, it follows that as the built-up area (area under occupation) increases within an unauthorised colony, the groundwater would get increasingly contaminated, more so where open defecation is a common practice.
In households in unauthorised and regularised colonies, residents who can afford, construct sanitary latrines that are connected to septic tanks as sewerage services are non-existent. Almost as a rule, the households also have handpumps. Due to improper construction of the septic tank, it is often the case that the septic tank contaminates the groundwater which the handpump is drawing and as a result faecal contamination of the drinking water occurs giving rise to waterborne diseases and specially diarrhoeal diseases.

Contamination of piped supply

The piped water supplied by the DJB from the water treatment plants is liable to contamination while it travels through the distribution network. Contamination is common where joints/valves lie close to sewers. Problems also arise in areas such as the Walled city and Old Delhi where the pipes have become old and corroded. During the study period, Nabi Karim in the Sadar Pahargunj Zone, witnessed a major cholera outbreak with nearly a hundred people falling ill. The pipelines in the area were changed. In the newer areas where PVC pipes have been laid, contamination occurs where the pipes have not been laid deep enough and therefore get damaged easily. In 1992, the KD and ND Blocks in Pitampura, Rohini Zone also had a diarrhoeal diseases outbreak. It was investigated by the National Institute of Communicable Diseases (NICD) and the cause was attributed to the breakage of the PVC pipes which were laid close to the surface on one of the main roads where vehicular traffic was heavy. Contamination can occur in the vicinity of households owing to leakage in the service pipelines or pipe lines that pass close to or often through open drains. The pipes used at the household level require to be changed every ten years but preventive maintenance is rarely practised.

Urbanised villages are a special case. The pipelines for water and sewage are laid through the narrow lanes of the village where adequate space is not available. Contamination of the water by the sewers through which the pipes frequently pass is a common phenomenon.

There is greater felt need for water supply than sewers. Water pipes are also technically much easier to install than sewer connections, which often require demolition of existing toilets. As a result, it is a common feature in regularised colonies to find water connections
without adequate sewer connections. Individuals in these cases discharge their wastes into street drains. These street drains drain into open nullahs which often do not have smooth flows and are not equipped to handle large volumes of liquid waste. As more and more vacant land is brought under construction for residential purposes, the drains become clogged with the increasing amounts of liquid waste discharges (and also dumping of solid waste). When water pipes are laid in these regularised colonies, they cut across these existing street drains. Water supplied through these pipes is susceptible to contamination from the stagnant or poorly flowing street drains.

Later when sewer lines are laid down, because of lack of planned laying of pipelines at the time of setting up of the colonies, safety norms are violated, leading to water and sewer lines being laid down in close proximity. In such situations, where intermittent water supply is a rule, contaminants often get sucked in from the sewer lines through minor cracks and other damages in the pipes whenever there is negative pressure in the water lines.

The primary responsibility of maintaining water quality surveillance is that of the Delhi Jal Board. Each water treatment plant has its own water quality surveillance team and laboratory that checks water quality in areas that are served by water from the respective water treatment plants.

It is undisputed that the quality checks for water leaving the plants is very stringent; however, there are possibilities of contamination of piped water supplies during the transmission process. This was confirmed through informal interviews with members of the water quality surveillance teams. Cross checking among different units or by central units can make the system transparent and effective.

The MCD and the NICD also maintain water quality surveillance on a random basis through their field staff. Several NGOs and the Mobile Health Services of the Directorate of Health Services have also joined this endeavour. Discussions with these agencies revealed that:

• shallow handpumps, almost as a rule, test unfit for human consumption
• deep bore tubewells also often test unfit – particularly from areas that are endemic for water borne diseases
• tankers and community Sintex tanks of the Delhi Jal Board generally tested fit
public hydrants were also by and large safe, except for instances of focal contamination
illegal piped connections sometimes failed the test because of tampering of pipelines and resultant contamination
often, service pipes of individual households were not properly maintained or passed through drains; in those cases water from the consumer end of the household tested unfit though the main supply was fit for human consumption
domestic contamination of a laboratory proven safe supply was high and a matter of concern as these can be tackled by correcting factors associated with storage – intermittent supply, irregularity and inadequacy – as also by improvement of personal hygiene.
drawing of water by the use of online boosters also render the piped supply unsafe, as has been established by laboratory tests.

Dhar (2000) tested water samples from 23 colonies/areas of Delhi vulnerable for water borne diseases during the vulnerable season. The study reported that
overall, 72% of non-piped sources and 34% of piped sources tested unfit
93% of shallow handpumps tested unfit
all deep bore tubewells failed the test
legal piped supply – in individual households and public hydrants tested unfit for 37.5% and 31.6% of the samples respectively
60% of illegal piped supplies in individual households tested unfit
100% of deep bore handpumps tested unfit

It can thus be concluded that the ground water in Delhi is highly contaminated, irrespective of the depth from which it is accessed and the piped water supply is also liable to be contaminated for a complex set of reasons.

In-migration coupled with high intrinsic growth rate pose challenges to provision of housing and infrastructure which the state has failed to cope with adequately. Though resource constraints may exist in absolute terms, Delhi, being the capital city has always had the privilege of higher resource inputs as compared to other metropolitan cities. The distribution and utilisation of resources for planning and maintenance of infrastructure has been
disproportionate resulting in large groups of population remaining deprived of civic amenities. The planning process has not accounted for the needs of the under-privileged and whatever facilities are available for these sections are for the most part positive fallout of 'votebank politics'. The implication of this for public health is immense. Lack of adequate safe water supply and safe disposal of solid and liquid wastes has had obvious impacts for water borne diseases. The following chapter describes the time trends of cholera in India. The arrival of the El tor strain in Delhi and its subsequent emergence as one of the hotspots of cholera in the country. *Vibrio cholerae* El tor succeeded due to failures in providing the minimum basic amenities for the vulnerable population in Delhi.