REPORT
OF THE STUDY GROUP

ON

ENVIRONMENT

INCLUDING TOURISM, HERITAGE, POLLUTION & DISASTER MANAGEMENT

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0.0 Executive Summary

BROAD ENVIRONMENTAL CONCERNS

The concern of NCR Plan – 2021 has been expressed as a multi-dimensional exercise. And it has been realised that the environment plays a crucial role in establishing paradigm of future development. Environmental concern has been viewed holistically and concerns of both natural as well as built environment, which not only need to be conserved but protected from various forms of natural hazards, has also been taken into account. The Study Group, which was sub divided into three sub-groups working independently, has come up with a coherent and consistent set of recommendations, which should be given adequate weightage at the time of formulating NCR Plan – 2021.

The recommendations are as follows

1. The NCR Plan must achieve rational landuse pattern in order to conserve the vital natural endowments and achieve an Environmentally Sustainable Development Pattern.

2. Land is the most crucial and critical environment resource. One of the major objective of NCR Plan should be to protect and conserve good agriculture land. The detail data on soil for all districts of NCR are available with NBSSLUP, which should be co-related to the land holdings to determine land, which must be kept under agriculture.

3. It appears that there is substantial surplus capacity in the existing urban areas, other than Delhi, to accommodate greater number of population. This may reduce the need for needless conversion of good agriculture land to urban uses. This estimation of surplus potential capacity should be one of the major paradigms of NCR Planning.

4. The analysis of both surface and ground water resources indicate that sufficient water is available, provided it is carefully conserved and managed. The crucial factor is pollution abatement measures. Therefore, landuse allocation has to be carefully carried out.

5. The data on air quality except for NCT Delhi is poor. One time data collected by NEERI at several stations is unreliable. Estimation of pollutants based on mass emission factors, is the alternate indicator of pollution load, but cannot be accepted as measure of air pollution. Fortunately on the basis of field observation and estimation of pollution based on mass emission indicate that outside NCT Delhi except cities like Gurgaon, Ghaziabad, Faridabad, the air is reasonably clear. It would be one of the major paradigms to ensure that the quality of rest of NCR is maintained and it is cleaned up over the NCT Delhi and its surrounding areas by careful landuse and activity assignment.

6. A Committee to recommend location of monitoring station of air and water, and regularly review the status and recommend remedial measures should be setup in each of the sub-regions of NCR. The data should be easily accessible to public.

7. Index of Environmental Quality needs to be established. Data inputs to check the performance of various parts of NCR in relation to these needs be made and regularly monitored. A cell in NCRPB, be created to perform this task.

BUILT HERITAGE CONSERVATION AND TOURISM

8. Apart from the physical constituents of the environment, built environment constitutes heritage and environmental asset. The policy of NCR Plan should be to protect all the identified heritage sites against encroachment and unsightly development.

9. A regional policy should be formulated which should co-ordinate and take advantage of the symbiotic relationship that exist between imperatives of heritage protection and tourism development.

10. This policy should view the conservation of heritage as a development activity, which should generate employment in crafts, and craft, related activities, offer a focus for specific urban design schemes, and become a source of pride and identity for the locality. The potential for using conservation areas to achieve this objective should be explored. The NCRPB should constitute a special committee of experts to draft the necessary guidelines for adoption by each State.

11. The tourism policy should be pro-active to diversify the options available for tourism destinations and activities through the development of smaller tourism circuits. A good goal for this policy would be to ensure that a visitor - or local resident - can be easily persuaded to sample the diverse range of tourism options available within the region for atleast ten days. This should change the mindset of the visitor who spends only a couple of days in Delhi to see the Red Fort, Qutub Minar and Humayun's Tomb, and do some shopping for traditional crafts and handloom products.

12. The Heritage and Tourism sites should be clearly identified on the land use plan to prevent encroachment and inappropriate development. These sites should also receive priority in transportation and other infrastructure planning.

13. The Heritage and Tourism sites should be used as instruments to direct land use policy towards more decentralised patterns of development.

14. A desirable objective of the co-ordinated Heritage conservation and Tourism development policy should be to have Delhi declared a World Heritage City by UNESCO.

NATURAL HERITAGE CONSERVATION

15. The analyses of life resources suggest that human settlement development should respect the spatial requirements of all the natural resources, the Aravalli hill system and the rivers. Area specification regarding the core and its surrounding areas and control over the use of land is essential. Fortunately, the major rivers are generally not highly polluted except Yamuna in Delhi and further south. Control of discharge of effluents, both domestic and industrial, as per Pollution Control Board guidelines should ensure protection and conservation of bio-diversity, which is a major indicator of healthy environment.

16. The pace of urbanization is increasing rapidly in NCR. Hence apart from protecting the special areas and controlling landuse, species tolerant to pollution should be planted along roads and near industries. Research in agriculture and animal husbandry indicate tolerant species of crops, fruits and vegetables. A healthy mix of these should be propagated. For planners perhaps the appreciation of these aspects is required and space requirements, should be understood and planned for. Practices such as Social Forestry, Agro Forestry should be encouraged as this conserves the Bio-Diversity of the area.

17. The major zones identified for studying the biota of NCR are

- Special Protected Areas
- Hilly Areas
- River Systems
- Habitations

18. If we scan the data available on Species Diversity, the data is incomplete. Further research is required in this area for recording and monitoring the Bio-Diversity of the region. A cell for maintaining the Bio-diversity records can be created for this purpose. Also, a simple counting of

number is not enough, the valuable services each species renders to mankind and its vital role in the ecosystem has to be understood. Some of the efforts to protect the biotic wealth of NCR can be by planning landuses in the correct manner, afforestation, protection of existing forests, control of pollution.

19. Special Protected Areas would require restriction in terms of landuse and pollution control in the vicinity to ensure protection of their biotic wealth. Hilly areas would be required not only control of landuse, but also afforestation of the right type of species and control of growth of monoculture. River systems need a lot of research in terms of indicator species. Here introduction of new species to improve quality of aquatic environment can be investigated. Here again the various relationships between the organisers, their relationship with the non-living environment (i.e. the structure and function of the aquatic ecosystem) and response to pollution has to be understood thoroughly as without this knowledge development controls cannot to effective.

20. In case of habitations the value of the right type of plantations whether they are along roads, in parks and other open spaces has to be understood. Also the cropping pattern, type of horticultural species that are grown and their effect on the soil, microclimate has to be understood. Simply marking an area for agriculture or horticulture is not enough if it is going to produce only one crop year after year and thus causing loss in soil fertility. It is common knowledge that increasing usage of insecticides, pesticides, fertilizers are after a certain point detrimental to the environment. Practices such as Social Forestry, Energy Plantation, Agro Forestry have to be understood and their role in improving the environment of the region have to be understood and such practices have to be adapted as NCR has a large area under agricultural landuse and the right type of agricultural practices would go a long way to improve the natural environment here. The population of livestock is another important aspect here. Their requirement of food and fodder is the greatest factor that effects the environment. Their grazing habits at times lead to deforestation. These animals are here to stay. They are the new species and are part of the bio-diversity of the region. There role in the ecosystem positive and negative have to be understood and the negative effects have to be controlled.

DISASTER MANAGEMENT

21. It is essential to carry out vulnerability and risk assessment of the region due to natural hazards. It would be prudent to consider the effects of a potential earthquake of the high magnitude for developing prevention cum preparedness plan.

Earthquake

22. Seismic micro-zonation for selected areas/towns, having high growth rates should be taken up on priority. Such identified areas/towns are NCT Delhi, Noida, Rohtak, Ghaziabad, Faridabad, Meerut, Gurgaon, and Alwar. Subsequently other towns should be taken up for similar exercise deciding the priority based on the growth rates. Seismic micro-zonation, however, on a scale of 1:1,00,000 to 1:50,000 is required for the whole NCR region based on the already available data/indicators.

23. It was noted that India Meteorological Department (IMD) installed an array of telemetric instruments for continuous monitoring of earthquake activities including the occurrence of small magnitude earthquakes in the NCR region. It is suggested that data available be utilized for micro-zonation and for carrying out detailed risk assessment studies for formulating appropriate risk reduction policies and strategies.

Flood

24. Detailed contour maps in the NCR region liable to flood should be prepared on a scale in 1 in 15000 showing contours an interval of 0.3 to 0.5 metre.

25. Different areas on NCR map need to be identified which are liable to flooding in rivers of return period of 5,10, 25, 50 and 100 years or may be due to excessive rainfall of return period of 5,10, 25, 50 years for identifying and deciding areas to be used for different land use categories at regional and sub-regional levels.

26. Keeping in view the geotectonic features of the region, it is observed that rocky ridges, although form a small part of the region (as indicated in Fig.2), yet these act as water divides for recharging the aquifer of the surrounding areas and therefore should be kept preserved.

27. There are certain areas like Rohtak, which are topographically low, and flood prone, as such any development in such areas should be taken up keeping in view that these are also seismically intense zones.

28. It is also observed that in southern part of the NCR, desert is extending eastward, it is suggested that suitable measures should be adopted to arrest the tendency of desert's extension in this part of the region.

29. There should be marking on ground, information on flood levels in areas liable to significant floods on pillars / permanent structures.

Fire

30. The recommendations of the Standing Fire Advisory Committee / Council as contained in their Compendium of Recommendations and as updated should be taken into account while preparing NCR Plan 2021.

31. Database and comprehensive evaluation of risks of growing towns to identify areas in each town vulnerable to fires and available equipments and personnel should be under taken on priority.

32. Areas in cities and towns in the NCR may be classified as

- High Vulnerability, Moderate Vulnerability, Low Vulnerability from fire hazard point of view
- Fire Safety measures for different areas should be worked out based on basic character of cities / towns.

32. Part IV of National Building Code and other related Indian Standards provide safety regulations. These should be followed as guide for formulating Development Control Rules / byelaws by the participating States' for mitigation of the Fire Hazard.

33. Fire Department authorities should be involved in Planning for NCR right from the beginning so that there is a coordinated effort amongst the different participating states.

DISASTER MANAGEMENT ACTION PLAN

34. Risk table should be upgraded based on 2001 census data and subsequently using that data extrapolation for the years 2011 and 2021 should be worked out.

35. It is also suggested that proper Post-Disaster Management Plan should form part of the sub-regional plan. The contents and guidelines for this purpose, required to be followed by the participating States and NCT Delhi should be clearly defined.

36. Keeping in view the hazard risk of NCR, it is recommended that an exercise should be undertaken by participating States for vulnerability and risk assessment of important buildings, infrastructure etc. and suitable action be taken for retrofitting and strengthening.

37. Priority should be accorded to public buildings such as hospitals, educational buildings, power stations, and life line structures and those which are likely to attract large congregation care should also be taken for monuments / heritage buildings.

38. Innovative and emerging construction technologies should be studied and carried out for buildings and structures for implementation as a pilot project.

39. Detailed data base on the occurrence of hazards, damage caused to buildings and infrastructure and the economic losses suffered by various govt. departments, public and private enterprises, agriculture and horticulture and the related infrastructure in the area, should be complied.

40. Proper mechanism should be worked out to collate disasters and mitigation related data available with different sources and to ensure the accessibility and retrieval of the data by R&D institutions, disaster managers and voluntary agencies involved in disaster preparedness, mitigation and management (on cost basis if found necessary).

41. Research studies for buildings and infrastructure through analysis of damage data and model studies should be undertaken and suitable methods of risk assessment for earthquake and flood hazards should be evolved.

42. Necessary amendments to the existing NCR Planning Board Acts/Rules 1985 relating to natural hazards.

43. It is also suggested that the Development Control Rules and Building Bye-laws applicable in the sub-region (participating States) should be appropriately modified, having provisions on safety aspects relating to natural hazards and fire safety.

44. The relevant Town and Country Planning, Development and Municipal Acts of the participating States should be carefully examined and amendments be carried out to incorporate necessary provisions on safety aspects relating to natural hazards.

PROTECTED ZONES

45. The areas/zones as below located in NCR should be protected from land use conversion

- Reserved Forests
- Protected Forests
- Forests other than reserved and protected forests
- National Parks
- Sanctuaries
- Areas with endangered species - Flora and Fauna
- Biosphere Reserves
- Wetlands
- Monuments - National, State, Local
- Heritage/cultural sites
- Protected Tribal Settlements
- Scenic areas
- Resorts/Areas of tourist interest
- Water bodies
- Springs/Water recharge areas
- Other environmental resource areas

ADOPTION OF MINAS

46. The minimal national standards as are applicable for the entire country may be referred from the CPCB document on “Environmental Standards for Ambient Air, Automobiles, Fuels, Industries

and Noise", "Pollution Control Acts, Rules and Notifications Issued There under" and "Standards for Liquid, Solid, gaseous Emissions".

47. The minimal national standards are to be made stringent for a region/place depending on the local requirements, however the standards cannot be relaxed. The standards as applicable presently for NCR may be obtained from the concerned state pollution control boards.

48. The NCR Plan should specify the standards that would made applicable so that the permission for new industries and other developmental projects can be issued accordingly. While deciding on the standards applicable for NCR, the following factors should be considered

- Minimal national standards
- The environmental sensitivity of the region
- The carrying capacity of the receiving water bodies and environment
- The existing quality of environment
- The health requirements in the area

1.0 Introduction

NCR is not a homogenous ecological unit. It has got four distinct physiographic features, which are as follows

1. Ganga - Yamuna Doab, which consist of rich alluvial soil with very good ground water potential
2. Land West of Yamuna, which also, consist of alluvium but of a poorer quality. Ground water in pockets has become saline. Rate of urbanisation in this area is high.
3. Aravalli Hill Systems, which provides a north-south spine stretching from Delhi to Alwar creating watershed of Yamuna river.
4. Desert like condition of Alwar District.

One can notice significant temperature as well as rainfall variation in different parts of NCR. The critical environmental assets of NCR are:

a) The good quality agricultural land;
b) The flood plains of River Yamuna and River Hindon;
c) The Aravalli Hill Systems;
d) The surface water resources, who's quality and quantity are crucial for sustenance;
e) Maintenance of ground water resources from degradation and over exploitation.

The continued degradation of environment caused by urban expansion of Delhi is degrading the entire environment of NCR. For example the Yamuna reaches at Wazirabad in quality B i.e., water which can be used for bathing, swimming, supply of drinking water with treatment. The same river leaves Delhi at Okhla when it reaches quality E i.e., unfit for even animal consumption, irrigation or industrial use. The Aravallis, which provide the climate modifier as well as habitat to large bio-diversity, has been progressively consumed by both authorised as well as unauthorised development.

The NCR was recommended in the Master Plan for Delhi 1962, in order to provide environmentally sustainable development throughout the region. Unfortunately, Delhi was allowed to grow three times its environmentally sustainable population base by 2001. It is now learnt that, Delhi is being planned to support nearly five times its environmentally sustainable base, thereby not only causing consumption of all the vital environmental resources but also create serious environmental burden for rest of the NCR. Therefore, it is of utmost urgency that a complete stock of the environmental resources may be made for the region in order to create a base for achieving sustainable development. In this report we put together the aspects of vital environmental concern, which need to be taken into consideration while formulating the planning paradigms for the development of NCR.

2.0 Land

The NCR must achieve a rational landuse pattern in order to conserve the vital endowments and achieve an environmentally sustainable development pattern. The most critical and crucial environmental resource is land. The hunger for converting land into non-agricultural and abiotic uses, in order to realise the land value potential, is so severe that it would require a very consistent and deterministic policy to achieve this. One of the major objectives of NCR Plan should be to protect and preserve good agricultural land, because most of the lands in NCR belong to prime agriculture category.

The existing cultivated land of approximately 23.92 lakh hectares should be kept preserved for intensive agriculture in order to meet the growing demands for food. This in turn will have impact on the consumption of land to accommodate the growing demand for human settlements. According to the present estimate of population growth and density pattern recommended in the NCR Plan, it could result in 6.8 % of additional land to be brought under habitation. Therefore, it is necessary to review the density pattern of proposed new development as well as a careful estimation of the capacity of existing developed area to accommodate further growth. Apart from Delhi, majority of NCR Towns have, in the main, single storey buildings with substantial incidental space to accommodate further growth. A careful estimation of the potential surplus capacity may reduce the need for needless conversion of good agricultural land to urban uses. **This estimation of surplus potential capacity should be one of the major paradigms of NCR Planning.**

On the other hand, all land under agriculture is of not equal productive capacity. The analysis of soil characteristics, physiography and geology is essential to indicate choice of appropriate strategy for development, based on the paradigms of the characteristics of soil, physiography and geology, which may be used as canvass in delineating development areas.

2.0.1 Land Quality

The quality of soil is normally studied under various parameters like

(i) Erodability
(ii) Bearing Capacity (for structural purposes)
(iii) Productivity, etc.

Productivity more specifically agricultural productivity assumes critical importance as life sustenance depends on production of food crops. Also in the NCR a very large proportion of the population is dependent on agriculture as their sole means of income generation. However, like most other natural resources soil has a limited regenerative capacity and therefore, this study looks at

(a) Productivity index or crop yield index for food cereal production, district-wise
(b) Cropping intensity to find the pressure on land in various districts

Data related to area under various crops and production is available at the district level in various districts statistical handbooks. This data has been used to calculate productivity in tonnes/hectare for a basket of crops (main cereals) to get a comparative pattern of productivity of various districts.

Cropping intensity has been measured by calculating the ratio of the Gross Sown Area (the sum total of the area under various crop types for a year) to the Net Sown Area (the area which is normally available for cultivation and this includes fallow land). Cropping intensity gives a fair measure of productivity and the pressure on the soil for agricultural production.

The analysis on Productivity gives a comparative grading district wise, and it agrees with the analysis of soil quality. Meerut district has the highest productivity with 2.9 tonnes/Hectare of cereal yield while Alwar District has the lowest yield, 0.9 Tonnes/Hectare. It may be added at this juncture, that while soil quality is one of the most important determinants of productivity, external inputs like, better irrigation facilities, superior quality seeds, optimum and sensible use of fertilisers, mechanisation,

optimum size of agricultural holdings and most important a better cropping management system, can substantially increase productivity. Also, while soil quality is an inherent property of land, unless sensibly used in conjunction with good conservation and protection practices, the regenerative capacity may get stressed beyond sustainable limits.

The cropping intensity gives a fair measure of the extent to which land is stressed for agricultural production. The districts in the U.P. Sub-region have a higher cropping intensity than the Haryana districts. However, as the net sown area, changes from year to year, due to vagaries of climate and the fluctuation of the prevailing market conditions in a particular year, cropping intensity does not remain constant. It also depends on the availability of irrigation facilities and application of modern techniques in agriculture. However, in specific cases like Rohtak, the decline in the cropping intensity is remarkable. It was as high as 1.99 in 1976-77 and the latest figure available show that the intensity has dipped to 1.18. In general the cropping intensity of the region is higher than in most other parts of the country, clearly indicating that the region is a food bowl for the nation and agriculture is comparatively more intense and efficient here.

Table 1: District-wise Productivity (Agricultural)

District	Area under Cereals (Ha.)+	Production of Cereals (Tonnes)	Productivity (Tonnes/Ha.)
Ghaziabad	162017	584901	2.40
Meerut	19654	572992	2.90
Bulandshar	1055091	405716	2.60
Sonipat	198100	592256	2.00
Rohtak	250466	415000	1.70
Gurgaon	171256	258000	l.40
Panipat	189000	622000	*5.28
Rewari	125465	245000	*1.95
Faridabad	158641	522000	2.00
Alwar	599868	564002	0.90

Note: + Crop Basket comprising Paddy, Wheat, Jou, Jowar, Bajra and Maize
* Based on Figures available for an unknown number of cereals and therefore this value have not been considered in the grading.

(Source: District Statistical Handbook, 1991)

Table 2: District-wise Cropping Intensity

District	Land available for Agriculture (Ha.)	Total Area under Crops (Ha.)	Cropping intensity
Alwar	489818	706047	1.44
Sonipat	172000	256000	1.48
Gurgaon	185999	270069	1.45
Rohtak	86514	102004	1.18
Faridabad	165700	220400	1.54
Bulandshar	544245	602852	1.75
Meerut	510440	505294	1.62
Ghaziabad	184407	502110	1.65
Rewari	125465	185752	1.48
Panipat	155000	246000	1.58

Source: District Statistical Handbook, 1991

2.1 Soil

NBSSLUP (National Bureau of Soil Survey and Land Use Planning) has done the soil classification on the basis of samples where minute details of the soil were studied scientifically. On the basis of soil association, chemical quality, soil series, soil horizon and sub-order association were considered to arrive at scientific soil taxonomical classification. This classification is now available for all the districts of NCR in the state of Haryana, Rajasthan, Uttar Pradesh and Delhi. **These can be related to the land holding maps to determine the classification of soil for the purposes of designating land, which must be kept under agriculture.**

The soils of NCR can be broadly classified into seven categories by co-relating the taxonomical classification provided by NBSSLUP with physical factors i.e.,

1. Slope
2. Natural Drainage
3. Climate
4. Soil Texture and Structure
5. Soil Erodability
6. Soil pH

The classification is as follows

A) Aravalli Hill with rocky surface
B) Aravalli Pediments
C) Old Alluvial Plains
D) Older Alluvial Plains
E) Recent Alluvial Flood Plains
F) Fluvioeolian Plains
G) Active Alluvial Plains

2.1.1 Major Soil Classification of NCR

A) Soils of Aravalli Hills
Moderately deep undifferentiated soils and rocky land of Aravallis subjected to high run off and severely eroded.

B) Soil of Aravalli Pediment
Very deep, well-drained soils with gentle slope, coarse loamy soils with loamy surface, severely eroded and slightly saline.

C) Soil of Old Alluvial Plain
Moderately drained, fine loamy, calcareous soils with loamy surface, low fertility status, low moisture retention capacity, moderately eroded.

D) Soil of Old Alluvial Plain with Sand Dunes
Large proportion of the surface area is covered by aeolian sands and shifting sand dunes. Low fertility status, severe wind - erosion, low availability and retention of moisture, soils are light in texture, coarse loamy to calcareous soils.

E) Soils of Recent Alluvial Flood Plains
This constitutes the area along the riverine tract of Yamuna and Sahibi characterised by highly stratified river deposits and subjected to seasonal inundation. The soils are sandy to coarse loamy in texture, good quality sub-soil water is available, moderately drained. The soils were of recent origin and composed of mostly stratified layers, sloping from North to South.

F) Soils of Fluvioeolian Plain
Soils vary between calcareous to sandy soils with loamy surfaces. These soils do not have any major soil problem. Soil erosion is marginal with high moisture, and water retention capacity.

G) Soils of Active Flood Plain
The soils are sandy to coarse loamy in texture. Good quality sub soil water is available. Prevention of crops from the havoc of floods may assure good crop growth. The relief and soil conditions cause waterlogging problem during rainy season, the problem gets aggravated due to checking of drainage ways.

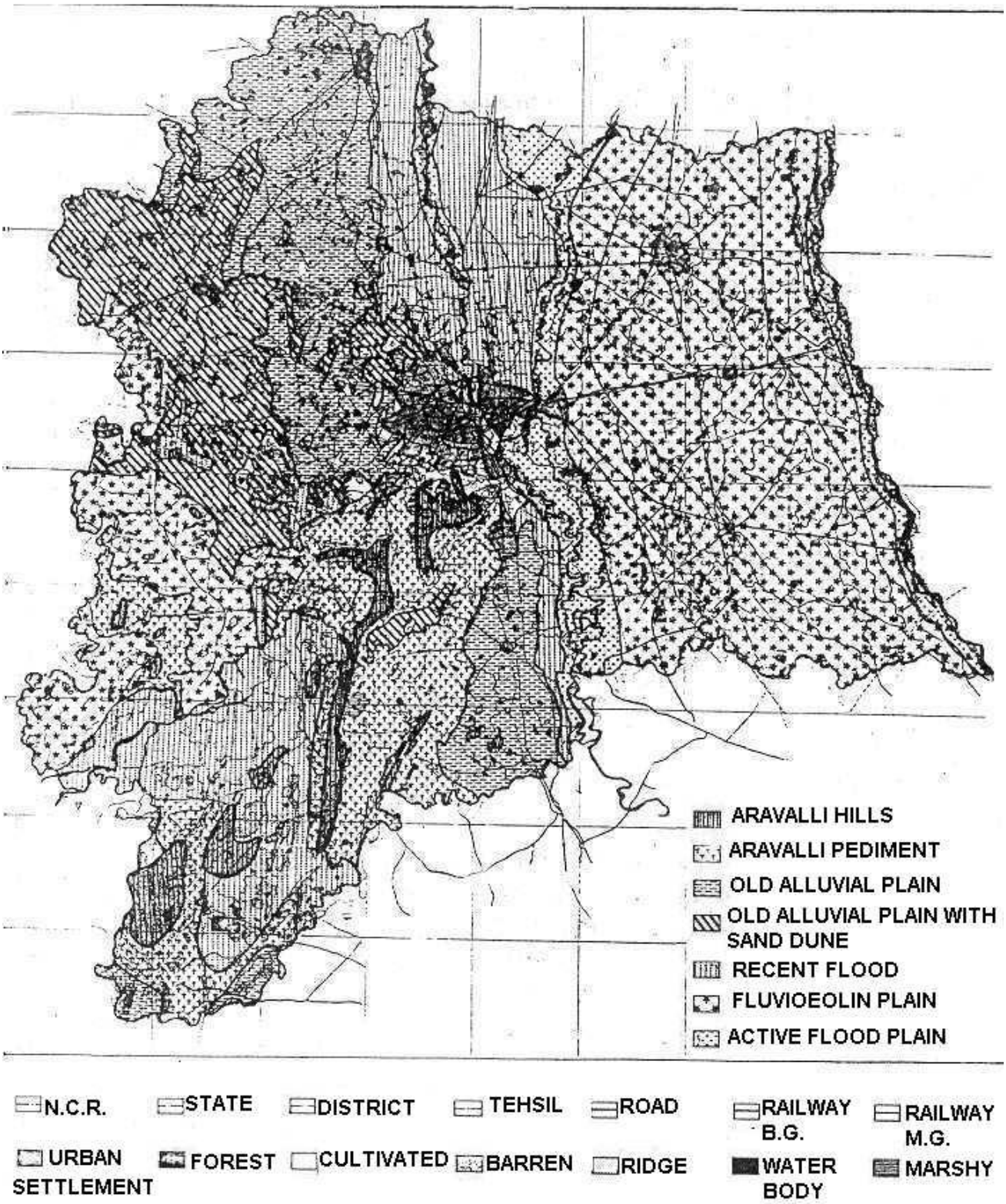

Figure1: NCR - Soil Distribution Pattern

2.1.2 District wise distribution of soil types in NCR

- **NCT Delhi**

  The NCT of Delhi can be divided into four major categories according to soil classification. These classes have very close correlation with vegetation, surface runoff, drainage efficiency and structural bearing capacity of soils. The soils of the NCT have been influenced by Yamuna, the ridge and the winds from SW direction. The NCT of Delhi can be classified into four divisions on the basis of soil formation, which are

  a) Khadar (New alluvium): The soils of recent flood plain account for more 15 percent of the area. This type of soils shows a distinct stratification, being 15 percent on the surface and coarser below. It is usually silt to sandy loam. Here the clay content varies from 15 percent to 17 percent but in lower reaches it is below 10 percent. The soil structure is mainly single grain and mostly calcareous in nature. The four soil series representing the Khadar include Balla, Shahdara, Gokalpur and Madanpur. The Alipur series represents the Transitional Zone between the recent and the old Alluvium.

  b) Bhanger (old Alluvium) 12 percent of the area is covered by soils of Bhanger. These tracts are found in the northwestern part of the territory where 5 soil series have been identified as Alipur, Shera, Narela, Ladpur and Najafgarh. Large areas are affected by water logging due to poor drainage, especially during rainy season. These soils are generally fertile with high moisture content but patches of saline alkaline soil are also found in the area. Sand dunes are present which are formed by aeolian deposits and soils coarse loamy to calcareous in texture.

  c) Dabar Soil (Low lying areas) 1.5 percent of the area is covered by soils of the Aravalli pediment. These soils are represented in the low-lying areas of Delhi and are mostly sandy loam to sandy clay loam. They are all found in the southwestern part of the NCT of Delhi, namely Najafgarh, Palam, Ladpur and Shikarpur. Large areas are covered by saline and alkaline soils due to poor drainage.

  d) Kohi Soil (Rocky areas) 6 percent of the area is covered by soils of the Aravalli Hills, which are subject to high run off and severe erosion. These are composed of quartzites or sandstones of the Delhi ridge. The texture varies from sandy loam to clay loam. Due to the uneven topography, the soils are subjected to a high rate of erosion.

- **Haryana Sub Region**

  a) District Rewari: Soils in this region are sandy to loamy sand (Bhanger) undulating topography, with low water table. District Rewari has 2.4 percent of the soils under rocky land subjected to high runoff and highly susceptible to erosion. 29 percent of the land is under soils of Aravalli Pediment, which are severely eroded and highly saline, confined to Bawal and Rewari Tehsil. 2.6 percent of the soils are under soils of old Alluvial Plain with sand dunes. Some stretches covered by sand dunes are found in the northern portion of the district. Soils are light in texture with low availability of moisture and poor retention capacity. The major part of the soils of district falls under soils of fluvioaeolian plain, which accounts for 65percent of the total area. Mostly these soils are confined to Sahibi flood plain area, which are sandy soils with loamy surface.

  b) District Rohtak: Major part of the District is covered by Soils of Old Alluvium plains where sand dunes account for 68percent of the total area. The soils are formed by aeolian deposits of moderate fertility status and the soils are affected by severe wind erosion. North and North Eastern part of the District are covered by soils of Old alluvial plains, accounting for 17.4 percent of the total area. Soils are coarse loamy to fine loamy in character, and are subject to moderate erosion. Flood plains and basins form two distinct sub-units of this landform, which occupies mostly the southeastern and south-central part of the Rohtak district. Soils of the

Recent Flood Plain accounts for 5.2 percent followed by soils of Fluvioaeolian plain which accounts for 11.5 percent of the total area.

c) District Faridabad: The district is mostly covered by soils of Old alluvial plains, which accounts for 46.5 percent. Soils are moderately drained, fine loamy to calcareous in nature with low fertility status and low moisture retention capacity and severely eroded. Soils of Aravalli Pediment accounts for 26.4 percent of the area. Soils are very deep, well drained with gentle slope, coarse loamy with loamy surfaces, severely eroded and moderately saline. Soils of Recent flood plains accounts for 15.9 percent, of the total soils found mostly along the riverine tract of Yamuna river and subjected to seasonal inundation. Only 2percent of the total area is under Aravalli Hills.

d) District Gurgaon: The soils in this district are mostly rocky surfaces of Aravalli hills except some areas which are sandy loam to coarse loamy in texture .In the northwestern, extreme northern and southern parts of the district, the soils are tropical arid brown soils, water logged, salt affected and medium in texture. About 68 percent of the total area is under the soils of Aravalli Pediment. These soils are very deep, coarse loamy, severely eroded and slightly saline.

e) District Panipat: Soils are moderately drained, fine loamy calcareous with loamy surface and low fertility status. Older Alluvial plain accounts for 65 percent of the total area with low moisture retention capacity and subject to severe erosion. Soils of Recent Flood Plain accounts for 26.5 percent of the total area, which are sandy to coarse, loamy in texture. Soil of active flood plain accounts for 8.5 percent of the total area, these are sandy to coarse loamy in texture and in certain parts cause water logging in rainy season.

f) District Sonipat: Silty loam (khadar) with a slight mixture of sand or stiffy clay due to riverine deposits. Loam (Bhanger) - The soil is compact and stiff, because of addition of silt through canal water. The soil is less granular and has a low water holding capacity. Older Alluvial Soils accounts for 64 percent of the total area, which are mostly fine loamy to calcereous, with loamy surface, low fertility status and moderately eroded. Soils of Recent Flood Plain accounts for 25 percent of the total area characterised by highly stratified river deposits. Soils of Old Alluvial Plain with Sand dunes accounts for 7 percent of the total area of the District, which mainly consists of interdunal plains with aeolian cover. These soils are almost free from salt problems. Soils affected by severe wind erosion and are of light texture, poor moisture content and retention capacity. Soils of Active Flood Plain accounts 4 percent of the total area of Sonipat District. These are formed by the recent river deposits. Good quality of ground water is available.

- **Uttar Pradesh Sub Region**

a) District Bulandshar: The wastelands of the district consist chiefly of the Khadar of the Yamuna and the Usar plains, which are to be found in almost all the blocks of Khurja tehsils. They stretch for long distances through several villages and are quite barren and devoid of vegetation. Khadar of the Yamuna contains much of waste and are always subject to inundation. There is a large tract in the district, which is affected by reh and has turned barren. Such land covers nearly 49,281 hectares and is spread over large patches all over the district. All the tehsils are affected by it, but those of Anupshar and Sikandrabad cover comparatively more area, which are eroded. Nearly $1/5^{th}$ of the total area of the district suffer from soil erosion.

b) District Meerut and Ghaziabad: The Districts consists mostly of alluvial plain with slight slope from north to south or southeast. On the whole the districts have an extra ordinarily fertile soil. The tehsils Baghpat, Sardhana, Meerut and Ghaziabad are richer in organic matter content than tehsils Hapur and Mawana, where the bhoor soil forms small ridges extending irregularly across the plain. Along the Ganga and away from it, the soil has deteriorated for a

considerable distance and much of the area in the east of Garhmukteshwar is occupied by long stretches of sandy soil. The districts can be divided into four physical divisions

(i) Yamuna - Hindon Doab: This tract lies between the Yamuna on the west and the Hindon on the east, which includes the tehsils of Baghpat, Sardhana in Meerut district and tehsil Ghaziabad in Ghaziabad district. The tract, in general, is the most fertile portion of the district, consisting of rich and almost uniformly loamy soil. The northern portion contains rich alluvial soil with excellent fertility but the southern part is made up of inferior land, mostly adjacent to the Yamuna.

(ii) The Central Depressions: This tract, lying roughly between Hindon and the Ganga, which includes the western parts of Sardhana and Meerut tehsils and the eastern part of Ghaziabad tehsils. The soil of the strip between the Hindon and the Ganga is of excellent quality except for poor-sandy soil along the Hindon. This is well-drained tract, except for a small patch near Modinagar in Ghaziabad district.

(iii) The Eastern Uplands: Comprises mainly the tehsils of Mawana and Hapur and parts of the tehsils of Meerut and Sardhana, existence of a series of bhoor strips, the soil generally resembling that of the bhoor ridges adjoining the Ganga Khadar. The entire eastern portion is broken up by Ganga and very poor fertility due to the presence of sand.

(iv) The Ganga Khadar: The flood plain of Ganga characterised by the existence of several depressions and watercourses. The old high bank stretches from north- east of Hastinapur in Mawana tehsils till the South of Garhmukteshwar is covered by ravines, soils are generally light in texture and poor quality.

c) District Meerut: The soils are deep and generally very fertile, they possess a sandy- loam texture with single grained structure and are reddish brown to yellowish in colour. Major parts of the districts are covered by soils of Fluvio-aeolian plains, which accounts for 58 percent of the total area including Sardhana, Mawana and Meerut tehsils. The soils of Recent Flood Plain, which accounts for 27 percent of the total area, confined mostly in western part of the district and the riverine tracts of Hindon and Yamuna in Baghpat tehsils. Soils of Active flood plain, which accounts for 15 percent of the district, are contained along the flood plain of Yamuna, Hindon and the Ganga.

d) District Ghaziabad: About 71 percent of the district is covered by soils of Fluvioaeolian plain, which are calcareous to sandy, with loamy surfaces in nature. Soil erosion problem is moderate to slight, with excellent fertility status. More than 21 percent of the area are covered by soils of Active flood plains, which are sandy to coarse loamy in texture. Some depressions are found along Ganges and cause water logging. The soils are of recent flood plain, which accounts for 7.1 percent of the area, confined mostly in the eastern part of Ghaziabad and Dadri tehsils.

- **Rajasthan Sub-Region**

a) District Alwar: District Alwar is covered by the soils of Aravalli hills and Aravalli pediments, which account for 16.25 percent and 15.50 percent of the total area respectively. These are moderately deep, undifferentiated and rocky land of Aravallis, subjected to high run off and severe erosion. Soils of Aravalli pediment are very deep, well drained, with gentle slopes, coarse loamy soils with loamy surfaces, severely eroded and slightly saline. Soils of OId Alluvial plains accounts for 5.86 percent of the area of the district.

Major parts of soils of Alwar district is covered by soils of Recent Flood Plain which accounts for 52 percent of the total area, mostly found in the area along the riverine tract of Sahibi, characterised by highly stratified river deposits. The soils are sandy to coarse Ioamy in texture, moderately drained and has a good capacity to retain plant nutrients. Soils of Fluvioaeolian plain accounts for 12.59 percent of the total area of the district, which are calcareous to sandy with, loamy surfaces and have a slight erosion problem.

The soils of the district according to the local classification fall into three broad natural categories - Chiknot, Mattiyar and Bhoor. Chiknot is a stiffish clay found throughout the district except in the tehsils of Tijara and Behror. Mattiyar is a loamy soil and found everywhere except in Tijara and Behror tehsils. The Bhoor is most common in Tijara tehsils.

Table 3: Soil Quality in NCR

Soil Quality	Ghaziabad	Bulandshar	Meerut	Panipat	Sonipat	Rewari	Rohtak	Gurgaon	Faridabad	Alwar	Delhi
A	--	--	--	--	--	2.5%	--	8.58%	2%	16.25%	6%
B	--	--	--	--	--	29%	0.1%	68%	26.4%	15.50%	1.4%
C	--	--	--	65%	64%	--	17.4%	5.6%	46.5%	5.86%	15.15%
D	--	--	--	--	7%	2.6%	68%	7.12%	--	--	12.12%
E	7.1%	--	27%	26.5%	25%	5%	5.2%	8.1%	15.9%	52%	15.50%
F	71.45%	88%	58%	--	--	65%	11.5%	2.8%	--	12.59%	--
G	21.45%	12%	15%	8.5%	4%	--	--	--	9.4%	--	*54.5%
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Note: * Built-up

2.2 Wasteland

Soil degradation is one of the foremost reasons for formation of wasteland. It is a result of one or more processes which has reduced current or potential or both of the soil to produce goods or services. Anthropogenic factors are usually responsible for degradation of land and result in reduction of soil quality. The process may be physical, chemical biological or cultural degradation, generally caused by water erosion and wind erosion, accumulation of salts, and nutrient depletion. From the point of establishing vegetative cover, wastelands have been categorizes into different classes given below

	Water	**Wind**	**Man**	**Other**
• **Utilizable Wasteland**	Sheet erosion Rill erosion Gullied land Ravenous land Water logging Salinity & Sodicity Diara land Marshy Land Bouldery land	Sand dunes Sand bar Coastal Sand	Shifting cultivation Mine spoils Industrial Wasteland Land effected by Road Land affected by kilns Land affected by Burrow pits Strip land	Shallow soils Land Slides
• **Un-utilizable**	Bare rocky land			

Total Area of NCR = 30240 Sq. km = 3024000 ha

Table 4: State-wise Landuse

Landuse	Area		State			
	in hectares	%age	Haryana	Uttar Pradesh	Rajasthan	Delhi
Agriculture	24,19,200	80.00	46.00%	37.30%	13.10%	3.70%
Forests	65,222	2.10	52.20%	30.50%	15.20%	2.10%
Non-Agriculture	1,28,431	9.90	43.30%	38.70%	5.90%	24.20%
Culturable Wasteland	57,484	1.80	41.80%	44.50%	----	1.50%
Grazing Land	36,288	1.20	45.00%	----	42.00%	----
Water Bodies / Lake	8,467	0.30	----	----	----	----
Barren Land	1,41,677	4.70	24.70%	22.30%	39.85%	13.20%
Total	30,24,000	100.00				

Soil erosion has severe adverse impacts on the environment It undermines the productive capacity of an ecosystem. The fertility status and the productivity of soil as a medium for biomass production depend largely on the thickness of topsoil. Besides, topsoil is important for functions such as filtering, storage and transformation of nutrients and water, etc. Soil erosion through its impact on agricultural productivity and environment leads to intensive use of marginal and fragile lands, accelerated run off and soil erosion, pollution of water etc.

2.3 Barren lands

Barren lands have 6 sub-categories

1. Rocky Area
2. Saline Patches
3. Gullied Land
4. Derelict Land
5. Waterlogged Area
6. Quartzite Rocks

According to satellite imageries, 6.5% of total area is under barren land as against 4.7% in the land records. Most of the Gullied lands are concentrated in the Rajasthan, Haryana and Delhi sub-regions around the Aravalli ranges. Land has become barren due to more than one reason in addition to the area shown under this particular category. 53,044 ha of land has become barren over and above the land records in Haryana sub-region, whereas 6672 in U.P., 21 14 in Haryana and 7269 in Delhi. This could be mainly due to urban expansion and proliferation of secondary and tertiary activities.

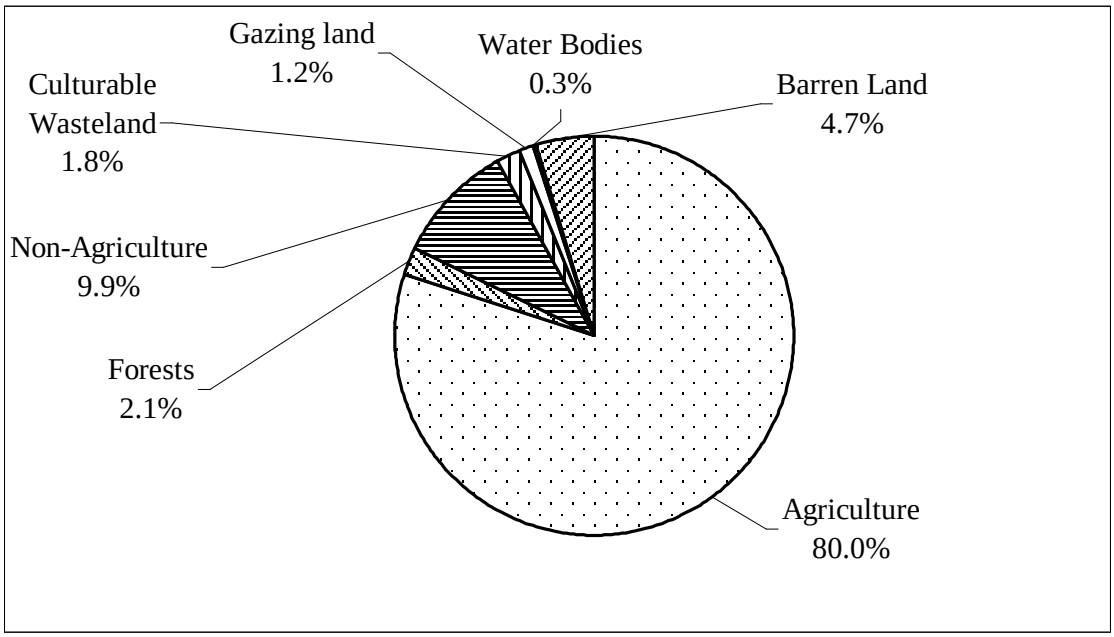

Figure 2: NCR Landuse

2.4 Mineral Resources

From the mineral resources, point of view, the Aravallis is a rich reservoir with considerable deposit of

(i) Barytes
(ii) Felspar
(iii) Quartzite
(iv) Copper

(v) Clay
(vi) Calcite
(vii) Building Stones
(viii) Limestone

Due to unscientific mining and quarrying many areas of the ridge became environmentally degraded. The stone crushers create serious air pollution, which is forty times higher than the prescribed permissible maximum limit for concentration of SPM. As a result mining operation has been stopped by an order of the Government of India, which covers the following areas, which are to be conserved

1) Mehrauli in NCT Delhi
2) Central and Southern part of Gurgaon Tehsil (Sohna and Taoru)
3) Ridge around Ferozpur-Jhirkha and Tijara to Alwar

2.5 Land Suitability Analysis

One of the major objectives of NCR is conservation of existing agricultural land and retains them for intensive agricultural land use. Urban development should be guided towards land, which is unsuitable for agriculture. In order to assess areas suitable for agriculture, data on the soil type has to be referred to. Major soil classification, which would be good for agriculture, is

- Soils of Recent Flood Plain (Classification E)
- Soils of Old Alluvial Plain (Classification C & D)
- Soils of Fluvioeouan Plain (Classification F)
- Active Alluvial Plain (Classification G)

Detail soil capability classification will be required and all prime agriculture land falling in capability classifications I to IV will have to be protected and those falling under V to VIII can be taken for development.

Land suitability for development in the fringe areas has to be carried out for fast growing towns in these areas

1 Faridabad	4 Panipat	7 Ghaziabad
2 Loni	5 Ballabgarh	8 Meerut
3 Sonepat	6 Garhmukteshwar	9 Khurja

This analysis, (overlay technique) would identify areas intrinsically suitable for settlement, agriculture, forestry, industry, and recreation. Further growth in this area should be channelised in areas, which are only suitable for settlement growth. **Master Plans or Development Plans made for towns in this area should incorporate this Land Suitability Analysis for landuse allocation. A matrix can be developed for this.**

3.0 Water

The water resources of NCR can be broadly classified into
a) surface water b) underground water

Apart from the NCT of Delhi, which depends on surface water resources for its urban needs, most other urban areas of NCR depend on underground water. While most of the NCR towns do not depend on surface water, they pollute the resource through discharge of untreated domestic and trade effluent. Therefore the study is divided into two parts
(i) analysis of pollution of surface water resources,
(ii) analysis of ground water potential.

3.1 Surface Water

Four important rivers and their tributaries traverse through the NCR. These are Yamuna, Ganga, Sahibi & the Hindon. River Ganga forms the eastern boundary of NCR. Although the entire NCR is part of the Ganga basin, only a small portion of eastern NCR actually drains into the Ganga. The Yamuna, which more or less makes the central spine of the NCR acts as the major drain of NCR, and most of NCR belong to its drainage basin. The river Hindon and the Sahibi (in the form of Najafgarh nallah) drains into Yamuna. There are many other small streams such as Kali Nadi, Karavan Nadi, Nim Nadi, etc., all of which are part of Yamuna basin. The Ganga within NCR enters the territory at Garhmukhteshwar, but carries very little of its original water resource, as most of it (90 percent) has been diverted at Haridwar through the Ganga Canal. In fact the river until it is replenished by Yamuna at Allahabad (where Yamuna contributes 80 m.a.f. to Ganga's 40 m.a.f.) maintains a lean flow. As a result of depleted flow, the wide bed of Ganga is derelict, and supports seasonal plantation. It cannot be used for inland navigation, nor does it have enough discharge to carry pollutants. Fortunately, there are only three urban settlements on the Ganga basin of NCR, and none of them support major industrial base. The GPD under Ganga Action Plan have not established any monitoring station within NCR as the pollution level is low and does not create serious concern. **This fact of low pollution of Ganga at this stretch needs to be kept in mind for future urban strategy for NCR.**

Every human activity results in the generation of water pollutants, though the nature and quantities of such pollutants vary depending on activities. For the purpose of this study, any impurity in the water arising purely from natural phenomena with no significant role for human activity will not be included for water pollution. Thus the major Sources of water pollution would be grouped into
(i) agriculture
(ii) industries
(iii) animal husbandry
(iv) domestic and municipal use of water

The NCR has five main river courses and water quality data is collected by the Central Pollution Control Board at six stations mainly for the Hindon and the Yamuna. The six stations are at
(i) Najafgarh drain
(ii) Wazirabad
(iii) Okhla Barrage
(iv) Sonipat
(v) Panipat
(vi) Ghaziabad

The major water pollution generators in the UP Sub region are rural populations (Meerut and Ghaziabad), industrial and organic load (Meerut and Ghaziabad). In the Rajasthan sub region, rural population and cattle are major pollution generators. Industrial and organic loads are the major pollution generators in the National Capital Territory of Delhi.

River Yamuna

(A) Hydrological Regime

The main stream of the river Yamuna (also called Kalindi in some reaches), originates from the Yamunotri glacier near Bandar Punch in the ' Mussorie range of the Lower Himalayas at an elevations of about 6587 MSL in Uttarkashi District of Uttar Pradesh. In the first 170 kms. stretch, the tributaries join the main river and the combined stream then forces its way through the Siwalik ranges and emerges in the plains at Tajewala in Haryana. From Tajewala the flow becomes sluggish till the confluence of the river with the Ganga at Allahabad, about 1200 kms. away. The total length of the river from its origin to its confluence with the Ganga at Allahabad is 1576 kms. The main tributaries joining the segment between Tajewala and Allahabad include the Hindon from the right and the Chambal, Sind, Betwa and Ken from the left. The catchment of the Yamuna covers part of Uttar Pradesh, Himachal Pradesh, Haryana, Rajasthan and Madhya Pradesh states and the entire National Capital Territory of Delhi.

(B) Flow Characteristics

The entire stretch of the Yamuna from its origin to destination can be divided into the following reaches

- Upstream to Tajewala
- Tajewala to Wazirabad
- Wazirabad to Jaitpur
- Jaitpur to Etawah
- Etawah to Allahabad

It is seen that during non-monsoon period (October -May), the flow is considerably reduced downstream of Tajewala till the Chambal joins the Yamuna downstream of Etawah. At Tajewala, the Western and Eastern Yamuna canals carry away considerable volume of water. At Wazirabad Barrage in Delhi, during non-monsoon months, the flow in the river is almost negligible.

(C) Abstraction

The river water is abstracted at different points for different uses. At Tajewala itself, nearly the entire flow of the Yamuna is diverted for irrigation through the Western Yamuna Canal for Haryana and the Eastern Yamuna Canal for U.P.

The Yamuna is classified into five district segments due to characteristic hydrological and ecological conditions. These segments are

1. Himalayan Segment - from origin to Tajewala barrage (172 kms)
2. Upper Segment - Tajewala barrage to Wazirabad barrage (224 Kms)
3. Delhi Segment - Wazirabad barrage to Okhla barrage (20 kms)
4. Entrophicated segment - Okhla barrage to Chambal confluence (490kms)
5. Diluted Segment - Chambal confluence (468 kms)

(D) Water Quality Status

While the Yamuna is the source of potable water to the settlements on its banks, it has become a carrier of pollutants from these areas. During its course of about 1400 kms, the river passes through a number of urban and industrial areas where large quantities of domestic and industrial wastewaters are discharged into it, thereby, rendering it unfit for its Designated Best Use.

The NCT of Delhi depends on surface water for its urban needs and discharge of wastewater from the domestic and industrial sectors, pollute the water resources. Delhi falls in the catchment of river Yamuna and occupies about 0.45 percent of the catchment of the river. The Delhi segment of the river Yamuna is about 40 kms long from Wazirabad Barrage to Okhla Barrage. The annual extraction from the river in this stretch is 1500 million cubic meters for irrigation purposes and 1000 million cubic meters for other purposes. Delhi also consumes about 950 million cubic

meters of water from River Ganga and its usage is 481 mcm for irrigation, 445 mcm for domestic use and 26 mcm for industrial and other needs.

The water quality and hydrological character in the Delhi segment is the most polluted as compared to other stretches in terms of two parameters - D.O. and B.O.D. The water quality at both the locations have deteriorated over the years. The dissolved oxygen level had decreased to 1.41 from 8.05 in the Himalayan segment and the BOD level has risen to 17.2 from 2.8. The faecal coliform level is 77x10 MPN/1000 ml as Delhi is polluting the river significantly because it is discharging large quantities of domestic and industrial wastewaters. The Designated Best use of the river thus varies in the Delhi segment. It changes from `B' category at Wazirabad (i.e. suitable for bathing), when it enters Delhi to `D and E' category (i.e., suitable for propagation of wild life, fisheries, and irrigation, industrial cooling and waste disposal) when it leaves Delhi.

Table 5: City-wise Estimated Pollution Loads

Name of town	Flow (MLD)	BOD (M.T. one day)
Yamuna Nagar	28	4.15
Karnal	25	5.45
Panipat	25	5.75
Sonipat	19	8.10
Gurgaon	20	5.05
Faridabad	102	15.15
Delhi	1700	l52.00
Saharanpur	45	6.75
Muzaffarnagar	55	5.25
Ghaziabad	180	27.00
NOIDA	75	11.25
Vrindavan	5	0.75

Source: Yamuna Action Plan, Ministry of Environment & Forests, June 1995

Data from the water quality monitoring stations reveals that the causes of pollution of the river are domestic and industrial wastewater of Delhi in the Wazirabad to Okhla stretch and domestic wastewater from Delhi in the downstream (i.e. Okhla to Vrindavan). Moreover, at Wazirabad Barrage, during non-monsoon months, the flow of the river is almost negligible. Therefore, the chances of dilution of the pollution load are also very feeble. The highest addition of waste load occurs from the NCT of Delhi (about 152 MT/day of BOD load) as compared to the load of other cities (which varies from less than 1 MT/day to 27 MT/day) as estimated by Yamuna Action Plan, Ministry of Environment and Forests. Everyday about 1880 MLD to 2000 MLD of wastewater is discharged into the river from Delhi through 18 drains. More than 95 percent wastewater of Delhi is drained by 5 drains viz., Najafgarh, Sen Nursing Home and Power House drain, Civil Mill Drain and Shahdara Drain.

The increase in population has resulted in increase in the generation of domestic wastewater from 967 million litres /day (1977) to 1700 MLD (1995). The capacity for treatment of domestic wastewater has increased from 445 MLD (1977) to 1270 MLD (1995). When the schemes under the Yamuna Action Plan will be implemented, it is estimated that about 98 percent of the domestic wastewater generated will be treated through 14 Sewage treatment plants. The offending industries are also being brought under the requirement of Water Act, and hopefully the situation will improve in near future.

River Ganga

(A) Hydrological Regime

The Ganga originates at Goumukh under the name of Bhagirathi. After the Alaknanda joins it at Devaprayag, the stream is known as Ganga After flowing some 250kms, the Ganga leave the Himalayas at Rishikesh and turns SW for another 50 kms till it reaches Haridwar where the channel attains a width of 750 m.

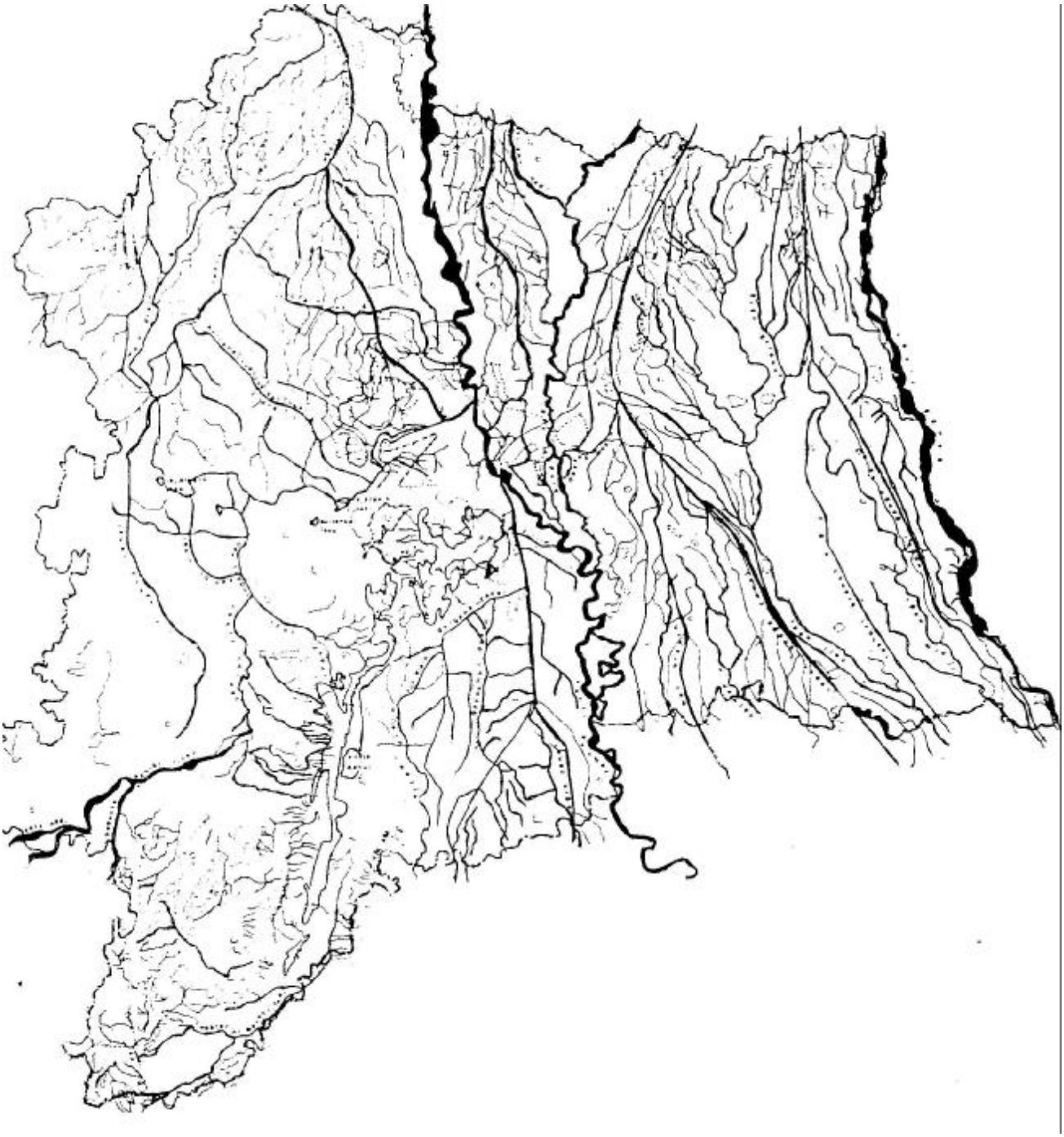

Figure 3: Drainage Pattern

(B) Flow Characteristics

Due to the much higher intensity of rainfall in the Himalayan region, more than 60percent of the water flowing into the Gangetic Basin comes from the Himalayan stream joining the Ganga from the north. The Peninsular stream together hardly contribute 40 percent of water, although the catchment area of the Peninsular streams extends well over 60 percent of the entire Ganga basin. Thus, hydrologically the Himalayan rivers are of greater importance compared to the peninsular streams of the Ganga Basin. Taking the hydraulic characteristics into consideration, the entire 2525 km. course of the Ganga can be divided into 5 major sections. The flow in the Ganga varies seasonally as the main channel and tributaries are all rain fed.

The water flow shows great seasonal fluctuation, especially in the pre-monsoon months the flow of even major tributaries may taper off resulting in a high concentration of pollutants. Sometimes, this concentration may cross-critical limits. For this reason, the smaller tributaries, especially those originating in the Peninsular upland, and the upper reaches of the Ganga and of the major tributaries which have relatively low rate of flow in general are more easily effected discharges carrying pollutants. Some of its major tributaries like the Yamuna, Ghaghara, Kosi, Gandak and Son are large enough to effectively bring down pollution levels by dilution alone.

(C) Abstraction

The river water is abstracted at various points for various uses. Abstractions of water for irrigation purposes is important. A large volume of water is abstracted by the Ganga Canal network at the headworks located at Haridwar for irrigating a major portion of the Ganga-Yamuna doab in Uttar Pradesh, reducing the flow to only 15 billion m per annum at Balawali. At Garhmukhteshwar, the flow; attains a greater volume to 22 billion M per annum. From Haridwar to Naraura (240 ~ km. downstream), the annual flow rises further at Naraura, the Lower Ganga Canal takes off leaving a much reduced flow downstream.

(E) Water Quality Status

Although the Ganga flows along the entire length of the NCR fringing its eastern border, the Central Ganga Authority has not established any monitoring station. Apart from Garhmukhteshwar (Class III town), Anupsahar (Class IV town) and Naraura (Class IV Town), there are no major urban or polluting uses on the Ganga Basin in this stretch.

River Hindon

The river is used by the Uttar Pradesh Irrigation Department for the escape of surplus water from the Ganga to the Yamuna for further transfer to Agra Canal. The Hindon is ephemeral in its initial stages but becomes perennial due to domestic and industrial discharges at Saharanpur. The flow in the upstream areas of the river (including its tributaries, the Har Krishan and Kali) at the confluence point is 568 MLD. The flow through the Khatauli escape is 2880 MLD of which 2250 MLD is diverted at the Hindon Barrage in Hindon Cut Canal for charging the Yamuna. The remaining flow downstream of the barrage is used for irrigation. Wastewaters from Ghaziabad and NOIDA also flow into the river.

Table 6: The Water Quality of the Hindon River

pH	7-8.1
High Solids	300 - 1200 mg/l
TDS	164-700 mg/l
Hardness	240 mg/l (max.} 100 mg/I (min.)
DO	3.3 &7.6mg/l
COD	2 & 23 mg/I
Cu	0.1 x 0.6 mg/l
Pb	0.45 - 1.5 mg/1
Cd	below acceptable limits
Zn	0.15 mg/1 (min.) 0.45 mg/l (max.)
Fe	7.0 mg/l (max.}
Mn	0.1 mg/1 - 0.7 mg/1

Cr	0.1 mg/l - 0.27 mg/1
Arsenic	0.072 mg/1 and 0.098 mg/1
Hg	0.003 mg/l - 0.04 mg/1
N2	1.5 mg/l - 5.8 mg/1
MPN Coliform	700-24000
Total count values	250 + to 400,000
BOD	2mg/l - 18 mg/l

Note: The analysis reveals that pH, Cl, Cd, Zn and total hardness are below acceptable limits throughout the year; TDS, Fe, Cu and Mn are above acceptable limits and COD, Pb, Cr, As and Hg are above rejection limits throughout the year.
Source: GPD, Ministry of Environment & Forests from a study conducted by University of Roorkee, 1988-89

3.1.1 Water Quality

The water quality of the NCR region can be assessed by using the information on pollution from the following sources

- Industries
- Settlements (sewage/domestic)
- Agriculture and Pesticides
- Others

The percent violations over desired level - A, B, C Class of water in river: Ganga and its tributaries falling in the NCR region is given below. (Year: 1998).

Table 7: Water Quality Status for Ganga and its Tributaries falling in NCR region

Location	Desired Class	Existing Class	Critical Parameters
Ganga			
Ganga at Garhmukteshwar	**B**	**C***	T. Coliform
Narora (Bulandsahar)	**B**	**C***	T. Coliform
Kalinadi			
U/S of Gulaothi Town in Bulandsahar	**C**	**E***	BOD, T. Coliform
Kannauj (Before Conflict)	**E**	**E***	BOD, T. Coliform
Hindon			
After Confl. with R.Krishna & Kali Near Binauli Town, Meerut		**E**	DO, BOD, T. Coliform
Ghaziabad D/S	**C**	**E**	DO, BOD, Free Ammonia
Yamuna, Haryana			
Hathnikund	**A**	**C**	T. Coliform
Kalanaur	**C**	**C**	
Sonipat	**C**	**C**	
Yamuna, Delhi			
Wazirabad (palla), Delhi, CPCB	**C**	**D**	T. Coliforms
Ring Road, Delhi, CPCB	**C**	**D**	T. Coliforms

*Current data inadequate, information based on previous year data

Table 8: Indicators of Organic Pollution for River Ganga and its Tributaries in 1998

Location	Dissolved Oxygen (in mg/l)				Biochemical Oxygen Demand (in mg/l)				Chemical Oxygen Demand (in mg/l)			
	Max	**Min**	**Mean**	**n**	**Max**	**Min**	**Mean**	**n**	**Max**	**Min**	**Mean**	**n**
Ganga												
Ganga at Garhmukteshwar	9.0	7.0	8.1	12	4.2	2.0	3.1	12	12.0	8.0	9.8	12
Narora (Bulandsahar)	9.0	7.7	8.3	12	3.0	2.0	2.5	12	10.0	7.0	8.3	12
Kalinadi												
U/S of Gulaothi Town in Bulandsahar	NA	NA	NA	0	9.0	5.0	7.0	2	37.0	34.0	35.5	2
Kannauj (Before Conflict)	8.0	6.0	7.3	12	5.0	3.0	4.0	9	42.0	10.0	23.0	11
Hindon												
After Confl. with R.Krishna & Kali Near Binauli Town, Meerut	2.0	0.0	2.0	3	10.0	3.0	7.0	3.0	59.0	32.0	43.3	3
Ghaziabad D/S	4.2	2.0	3.1	12	12.0	7.0	8.4	12	48.0	25.0	36.8	12
Yamuna, Haryana												
Hathnikund	13	7.0	9.6	9	1.0	1.0	1.0	9	4.0	2.0	3.0	9
Kalanaur	11	6.0	8.4	9	1.0	1.0	1.0	9	15.0	2.0	7.7	9

Sonipat	12	5.0	8.2	9	1.0	1.0	1.0	9	20.0	1.0	10.0	9
Yamuna, Delhi												
Wazirabad (palla), Delhi, CPCB	11	5.0	7.2	9	2.0	1.0	1.1	9	20.0	0.0	10.5	9
Ring Road, Delhi, CPCB	6.0	0.0	4.6	9	9.0	1.0	3.3	9	52.0	8.0	23.0	9

Table 9: Bacteriological Parameters for River Ganga and its Tributaries Year in 1998

Location	**Faecal Coliforms In (mpn/100ml)**				**Total Coliforms In (mpn/100ml)**			
	Max	**Min**	**Mean**	**n**	**Max**	**Min**	**Mean**	**n**
Ganga								
Ganga at Garhmukteshwar	--	--	--	--	--	--	--	--
Narora (Bulandsahar)	--	--	--	--	--	--	--	--
Kalinadi								
U/S of Gulaothi Town in Bulandsahar	7.972	5.914	7.399	2	12.644	10.597	12.073	2
Kannauj (Before Conflict)	13.528	13.528	13.528	1	14.691	11.608	14.043	2
Hindon								
After Confl. With R.Krishna & Kali Near Binauli Town, Meerut	8.517	5.394	7.558	3	12.301	10.069	11.421	3
Yamuna, Haryana								
Hathnikund	5.193	2.303	4.449	9	8.132	5.521	7.183	9
Kalanaur	5.635	3.401	5.054	9	8.294	5.991	7.378	9
Sonipat	6.040	4.500	5.467	9	8.517	0.000	7.743	9
Yamuna, Delhi								
Wazirabad (palla), Delhi, CPCB	6.620	4.007	5.515	9	11.019	6.685	9.287	9
Ring Road, Delhi, CPCB	11.523	6.697	10.176	9	12.196	8.648	11.121	9

Additional data as is available from the NEERI Report on Carrying Capacity, which may be referred to.

3.1.2 Water Pollution

The detailed water pollution information in the NCR is available primarily with respect to the river Yamuna because continuous monitoring is being carried out by the Central Pollution Control Board.

32. Pollution of the Yamuna is perhaps the most severe in the 22 km. stretch in Delhi because of the heavy concentration of people and industries. The urban area of Delhi has registered a growth of 288 percent with the urban population growing more than 40 times in this century. The industries have grown more than tenfold in the last four decades (1951-91). As a consequence of the above, a rational quantification of wastewater and sewage generated due to rapid industrialisation and urbanisation reveals the following

- A total of 1759 MLD of wastewater is generated in the 5 sewerage zones of Delhi. Whereas domestic Sources contribute 78 percent of wastewater containing 64 percent of the total BOD load generated, industries generate 5 percent of wastewater containing 2 percent of BOD load. The rest is through other Sources like commercial areas institutional areas, servicing shops etc.
- Most of the large industries and many medium and small-scale industries have their own treatment systems.
- Of the total pollution load generated in the 5 sewerage zones of Delhi, 71 percent of wastewater containing 74percent of the BOD load is trapped for STP's through sewer lines/open drains.
- While the volume does not undergo any significant change, the BOD content of the trapped sewage reduces to 65 percent en route the STP's. This is due to self-decomposition of organic matter and individual treatment provided by industries.
- An overall performances (reduction of BOD, of 57percent is observed in the operation of STP's. This is due to
  - Most of the sewage treatment units have no provision for secondary treatment
  - The units with such provisions operate inter-mittently, as a result, the biological system cannot maintain its active state
  - Some part of the incoming sewage remain untreated because of actual handling capacity being less than the assigned capacity of the STP's

Table 10: Physical Parameters for River Ganga and its Tributaries Year in 1998

Location	Temperature (in deg. C)				pH				Turbidity JTU/NTU				Total Dissolved Solids mg/l				Total Fixed Dissolved Solids mg/l			
	Max	Min	Mean	n	Max	Min	Mean	n	Max	Min	Mean	n	Max	Min	Mean	n	Max	Min	Mean	n
Ganga																				
Ganga at Garhmukteshwar	28	12	20.6	12	8.0	7.5	7.9	12	280	20	62	12	728	380	503.5	12	NA	NA	NA	0
Narora (Bulandsahar)	27	13	21.1	12	8.0	7.6	7.9	12	240	20	50	12	673	238	352.4	12	NA	NA	NA	0
Kalinadi																				
U/S of Gulaothi Town in Bulandsahar	27	27	27	1	8.0	8.0	8.0	2	NA	NA	NA	0	396	343	368.5	2	NA	NA	NA	0
Kannauj (Before Conflict)	31	15	24.3	12	9.0	8.0	8.2	12	183	32	80	12	--	--	--	--	--	--	--	--
Hindon																				
After Confl. With R.Krishna & Kali Near Binauli Town, Meerut	32	15	26	3	8.0	8.0	8.0	3	NA	NA	NA	0	435	295	357.8	3	NA	NA	NA	0
Ghaziabad D/S	29	12	20.8	12	8.0	7.0	8.5	12	180	20	48	12	665	410	510.4	12	NA	NA	NA	0
Yamuna, Haryana																				
Hathnikund	34	14	25	9	8.0	7.0	7.9	9	NA	NA	NA	0	--	--	--	--	--	--	--	--
Kalanaur	35	16	26.9	9	8.0	8.0	8.0	9	NA	NA	NA	0	--	--	--	--	--	--	--	--
Sonipat	34	15	26.7	9	8.0	8.0	8.0	9	NA	NA	NA	0	--	--	--	--	--	--	--	--
Yamuna, Delhi																				
Wazirabad (palla), Delhi, CPCB	31	14	26.1	9	8.0	8.0	8.0	9	NA	NA	NA	0	--	--	--	--	--	--	--	--
Ring Road, Delhi, CPCB	35	15	27.8	9	8.0	7.0	7.8	9	NA	NA	NA	0	--	--	--	--	--	--	--	--

Table 11: Mineral Constituents for Ganga and its Tributaries in 1998

Location	Conductivity u mho/cm				Total Alkalinity mg/l				Sulphates mg/l				Calcium ($CaCO_3$) mg/l				Magnesium mg/l				Hardness mg/l				Chlorides				Sodium			
	Max	Min	Mean	n	Max	Min	Mean	n	Max	Min	Mean	n	Max	Min	Mean	n	Max	Min	Mean	n	Max	Min	Mean	n	Max	Min	Mean	n	Max	Min	Mean	n
Ganga																																
Ganga at Garhmukteshwar	280	190	221	12	14	10	13	12	25	12	18	12	200	100	152	12	160	42	82	12	340	158	234	12	16	12	14	12	NA	NA	NA	0
Narora (Bulandsahar)	220	150	193	12	17	8	12	12	20	14	16	12	186	100	138	12	160	30	81	12	346	150	219	12	15	10	12	12	NA	NA	NA	0
Kalinadi																																
U/S of Gulaothi Town in Bulandsahar	675	570	623	2	NA	NA	NA	0	67	39	53	2	595	170	383	2	225	150	188	2	820	320	570	2	57	10	34	2	80	35	73	2
Kannauj (Before Conflict)	530	270	397	12	220	76	154	12	84	9	28	12	120	43	76	12	94	9	41	12	136	104	117	12	37	14	27	12	26	12	15	11
Hindon																																
After Confl. With R.Krishna & Kali Near Binauli Town, Meerut	630	508	576	3	NA	NA	NA	0	41	12	31	3	160	118	144	3	145	35	88	3	305	190	232	3	31	14	25	3	62	25	47	3
Ghaziabad D/S	580	350	483	12	32	20	26	12	39	25	31	12	310	174	234	12	260	80	121	12	560	260	355	12	42	25	35	12	NA	NA	NA	0

- After treatment, a total of 254 MLD of effluent from Okhla, Keshopur, Coronation Pillar STP's is withdrawn for irrigation purposes. This takes away about 20 percent of the 1 19 MT of BOD coming out of all the STP's. The rest flows into the drains.
- Of the 17 major drains forming the drainage system in Delhi, 8 have already been trapped and diverted to STP's the Kushak-Barapulla drain is partially trapped whereas the Najafgarh, Shahdara Sen Nursing Home, Power House and Civil Mill drains are still untrapped and flow into the Yamuna. The Kalkaji and Tughlakabad drains are also untrapped and flow into the Agra Canal.

The pollution loads received by the different drainage systems is as follows

- Najafgarh drain receives 57 MT of BOD (491 MLD) from various STP's and 49 MT BOD (150 MLD) of untrapped sewage.
- Shahdara drain receives 2 MT BOD (45 MLD) from STP and 76 MT (274 MLD) of untrapped sewage.
- 28 MT of BOD (99 MLD) of untrapped sewage and 0.1 MT (9MLD) from STP's goes to the other flowing drains.
- The Agra Canal also receives 55 MT BOD (477 MLD) through treated effluent from STP's.

All the drains contributing to the Yamuna receive a total of 195 MT of BOD (1048 MLD) but actually discharge (as per CPCB's observations) only 6lpercent of this load. The difference in BOD load is due to sedimentation and oxidation of organic matters within the drain and that inflow is due to percolation and evaporation.

During the dry weather in the absence of much water in the Yamuna the river in Delhi's stretch resembles an open sewer. Despite the fact that 50 percent of the total BOD contributed by the drains is reduced right at their outfall points due to sedimentation of settlable BOD, the water quality of the river is nowhere near its designated use of bathing (desired BOD of 5mg/1 category B).

- BOD estimation using the Streeter - Phelps model under critical flow reveals that BOD varies from 25mg/1 to 14 mg/I. **Hence either the flow in the river should be augmented or pollution load curtailed.**
- If drains are made to comply with the MINAS limit of CPCB (BOD upto 50 mg/1), the BOD load in the river does not fall below 8.7 mg/l.
- **The desired quality cannot be achieved even if the flow in the river is augmented to 10 cubic mts as recommended by CWC.**
- A combination of CPCB's MINAS limit and CWC's suggestion for flow augmentation also does not yield desired results.
- **The necessary flow augmentation is estimated to be about 21,000 MLD after complying with MINAS standards for achieving the BOD of 5 mg/1 at ghats near ISBT.**

The population of Delhi will grow as a result, of which the wastewater generated will also increase. The existing treatment capacity is about 22percent of the total future requirements. Moreover, for the disposal of treated effluents, large agricultural areas are required. 50 percent of the NCT of Delhi will be urbanised by 2010 AD and the balance of 740 sq. km will be grossly inadequate because of competing demands. **This consideration would have serious impact on MPD 2021, where a population of 23 million is envisaged covering all available land.**

3.1.3 Pollutants from Fertilisers

The National Capital Region has a substantial area under agricultural landuse. The pressure on these lands is high, with most areas having multiple cropping - the use of fertilisers is also high. It has been estimated that 10 to 15 percent of the nutrients added to the soils through fertilizers eventually find their way to the surface water system (Alderfer & Lovelace, 1977). High nutrient contents are seen to stimulate growth of algae in surface water, often leading to eutrophication. Certain nutrients like ammonia and nitrites above certain levels of concentration can be toxic for human use. Studies indicate that 0.5 mg/1 inorganic Nitrogen and 0.01 mg/1 of organic phosphorus in water usually stimulates undesirable algal growth in the surface water. Run off from arable lands may contain

Nitrogen upto 70 mg/1 and phosphorus ranging from 0.05 to 1.1 mg/1 of effluent water (Alderfer & Lovelace, 1977). This clearly indicates that the run off from arable land can raise the nutrient level to considerable degree in stream water.

Table 12: Consumption of Fertilizers

District	Annual fertiliser consumption (in tonnes)	Area under agriculture (in Hectares)	Rate of consumption (in tonnes per hectare)
Ghaziabad	55585.0	59851	0.56
Bulandshar	55189.0	64029	0.85
Meerut	57465.0	105507	0.56
Faridabad	20950.0	254000	0.08
Gurgaon	12274.0	256147	0.05
Sonipat	18727.0	225000	0.09
Panipat	44282.0	246000	0.18
Rohtak	20148.0	544822	0.06
Rewari	171 12.5	165068	0.10

Source: District Statistical Handbook, 1991

Table 13: Percentage of Various Fertilisers Used

District	N (%tage)	P (%tage)	K (%tage)
Ghaziabad	72.60	25.00	2.50
Bulandshar	76.50	21.80	1.90
Meerut	80.70	17.20	2.10
Faridabad	72.10	27.50	0.40
Gurgaon	68.56	51.05	0.61
Sonipat	79.40	19.00	1.60
Panipat	77.70	19.60	2.70
Rohtak	76.60	25.00	0.40
Rewari	74.30	24.10	1.60
Alwar	I 71.50	27.50	1.50

Source: District Statistical Handbook, 1991

Table 14: Rural BOD Load Intensity

Tehsil Block	Load (gms)	Rural area (hectares)	Intensity (gms/hectares)
Meerut	15467784	815.6	18964.9
Mawana	15588272	1055.9	l4575.6
Sardhana	17206512	864.5	19908.0
Baghpat	20998440	1055.2	20525.7
Bulandshar	20829584	1191.2	17486.0
Sikandarabad	19975561	466. 0	42866.0
Khurja	15174752	1106.2	11909.9
Anupshar	14947800	I555.2	11046.2
Siana	12055984	-----	-----
Rohtak	97442946	1125.8	86554.5
Maham	7014570	507.1	15852.7
Jhajjar	15819550	1505.5	8607.6
Khatauli	4444140	-----	-----
Bahadurgarh	2918970	551.5	16172.2
Gurgaon	14248110	2659.5	5557.8
Pataudi	4254570	-----	-----
F. Jhirkha	11955620	802.8	14889.9
Nuh	8595450	646.9	15287.1
Faridabad	-----	-----	-----
Ballabgarh	1049510	591.4	1774.2
Palwal	14172450	1597.1	10144.l
Hathin	5628840	-----	-----
Sonipat	9922020	1265.1	7855.2
Gohana	6281160	895.7	7028.2
Gannaur	4440840	-----	-----
Panipat	28509990	1208.8	25585.5
Rewari	21251950	1009.4	2I05.4

Source: District Statistical Handbook, 1991

3.1.4 Organic Pollution Hazard

The water channels flowing through the region are subject to high loads of organic pollution generated predominantly by human and cattle waste, that are fed into these channels, without any treatment. The information relating to the organic pollution potential is given in terms of B.O.D. load released into the water channels as a result of surface drainage outfalls. In this study, the pollution potential is calculated on the basis of rural and urban population and cattle population in each tehsil / block, using per capita B.O.D. (in grams) load figures that were worked out for each State after rigorous studies conducted by the Central Pollution Control Board for the Ganga and Yamuna Basin in 1984. The Tehsil Block wise rural and urban population along with cattle population were computed from the statistical handbooks of the various districts within the NCR. These figures were then multiplied by the respective average per capita pollution load figures, for each of the three states namely, Haryana, Uttar Pradesh and Rajasthan as arrived at in the C.P.C.B. study on Ganga and Yamuna Basins.

The product indicates the B.O.D. generation potential of each tehsil in the NCR. However, these figures do not give a reasonable idea as far as the study is concerned. Therefore, these figures were divided by the respective rural and urban areas of each settlement so that the intensity of pollution potential can be studied. In the case of rural areas, the disposal of the waste occurs more on land than directly in water bodies. As a consequence, the load generated in the rural areas gets dissipated over a larger territory, reducing the hazard considerably. However, in rural settlements, where the density of population is high, the need for having an organised system of waste disposal is called for. Again the animal dung in rural areas are systematically collected and are largely used up as fuel leaving very little going into water channels as actual waste. In the case of urban areas, the quantum of organic pollution load in each urban locality is of relevance for assessing the water pollution hazard - but the actual manner of disposal of the load is of greater importance for control and management of pollution. The level of pollution is considerably higher where there are no proper infrastructure for waste disposal and when there are large diaries, feed lots, slaughterhouse or tanneries.

The BOD load intensities display substantial variation with Faridabad tehsil (1774.2 g/Ha) having the lowest and Rohtak tehsil (86554.5 g/Ha) having the highest. Most of the tehsils show intensities lying in the range of 8000 g/Ha and 17000.0 g/Ha.

As has been mentioned before, the Ganga drains the eastern boundary of the NCR. By and large, the impact of polluting uses is low because of the long distance the pollutants travel to reach the channel. There is no direct discharge of effluents into the channel but an idea can be got about the water pollution status in the Uttar Pradesh sub-region.

For quality management of river water in India, a combined chemical, bacteriological and ecological yardstick was developed during a 5-year pilot study programme on the Yamuna river. The yardstick consists of 8 indices, 5 concentration oriented and 3 effect oriented, reflecting different aspects of water pollution

1. The Bacterial Pollution Index (BPI)
2. The Nutrient Pollution Index (NPI)
3. The Organic Pollution Index (OPI)
4. The Industrial Pollution Index (IPI)
5. The Pesticide Pollution Index (PPI)
6. The Production Respiration Index (PRI)
7. The Benthic Saprobity Index (BSI)
8. The Biological Diversity Index (BDI)

Each of the indices will be derived from a set of one or more monitoring parameters; that may vary according to regional requirements. All indices are calculated to fall in a numerical range from 0-100, where 0 represents totally unacceptable environmental conditions, and .l 00 stands for a pristine environment.

The results of the monitoring activities are- expressed in a single graph; called an AMOEBA, that depicts the actual status of pollution in relation to target objectives. The targets will be set on the basis of an evaluation of ecological risk. Rational formulation of any pollution control programme for a water body needs to define water quality: objectives (target) for that water body in a sound scientific manner. These objectives are used as yardstick to identify the areas in need of restoration; extent of pollution control needed, prioritisation of pollution control programme and effectiveness of pollution control efforts. Using the Yamuna River's 5 years data on the water quality the indices, are calculated and presented in the AMOEBA form the suggested target values for NPI, QPI, IPI, PPI, BSI, BDI & PRI are 90, 80; 60; 80, 80, 70, 70 and 80 respectively. These targets are suggested based on various water quality objectives identified by the CPCB under its various pollution control programmes.

3.1.5 Pollution from Trade Effluents

The total quantum of water consumed in the industrial sector is substantially lower than that consumed in the agricultural and domestic sectors. However, industrial effluents have a higher concentration of pollution. Though industrial effluents are normally discharged at specific points, they are ultimately released into main water channels, thereby polluting them. Again are towns like Panipat, Bhiwadi etc. trade effluents are often discharged into open fields, which have a potential of polluting the ground water. Moreover, in most of the industrial areas within the NCR, majorities of the industries do not have effluent treatment facility and, therefore, effluents discharged are often toxic and harmful to human health.

The State Pollution Control Boards have in most cases identified the offending industries. It is mandatory, under the Water Act for these industries to file environmental audit reports. However, in the absence of specific legal control, most industries, do not file these audit reports in the useful and desirable manner, resulting in the absence of information as to the degree of office.

There is some data available from the Pollution Control Board offices at Faridabad, Gurgaon and NOIDA, as to the chemical composition and quantum of trade effluents - generated by various industries. This data has been constructively used to establish a comparative status of industrial effluent pollution generated in the various districts of the NCR.

Two parameters of water quality, especially BOD & COD load has been taken into consideration. A list of industry types, which are water polluting has been prepared and based on the data available with reference to quantum of effluent discharged and BOD & COD loads generated by sample cases of these various industrial types, the concentrated of BOD & COD in the trade effluents have been calculated.

This data, in conjunction with the number of industries pertaining to each type will help to establish a comparative status of trade effluent related pollution.

3.2 Ground Water

In the NCR, ground water is an important developmental resource. The majority of the districts in the NCR are substantially dependent on ground water for consumption in both domestic and non-domestic uses. In this study, the ground water has been studied in terms of spatial variations in availability (quantum, depth and quality) consumption pattern, extent of exploitation and finally the impact of ongoing developmental activities on the quality of ground water.

The ground water table in the NCR, mostly follows the surface topography displaying substantial variations in depth. It is as shallow as l m.b.g.l. in the N.C.T. of Delhi to more than 44m.b.g.l. in Alwar district in the Rajasthan sub region. Generally in the northern parts of the region, the depth is shallow (ranging between 2 to 5 m.b.g.l.) The depth is at its extreme in the southwestern part of the NCR In the areas adjoining the line of the Yamuna River, (mostly in the U.P. sub region) inter district variations are substantial. The depth to water table in the central part i.e. in and around the N.C.T. Delhi varies greatly from as shallow as l m.b.g.l. in Central Delhi to 25.5m.b.g.l. in South Delhi.

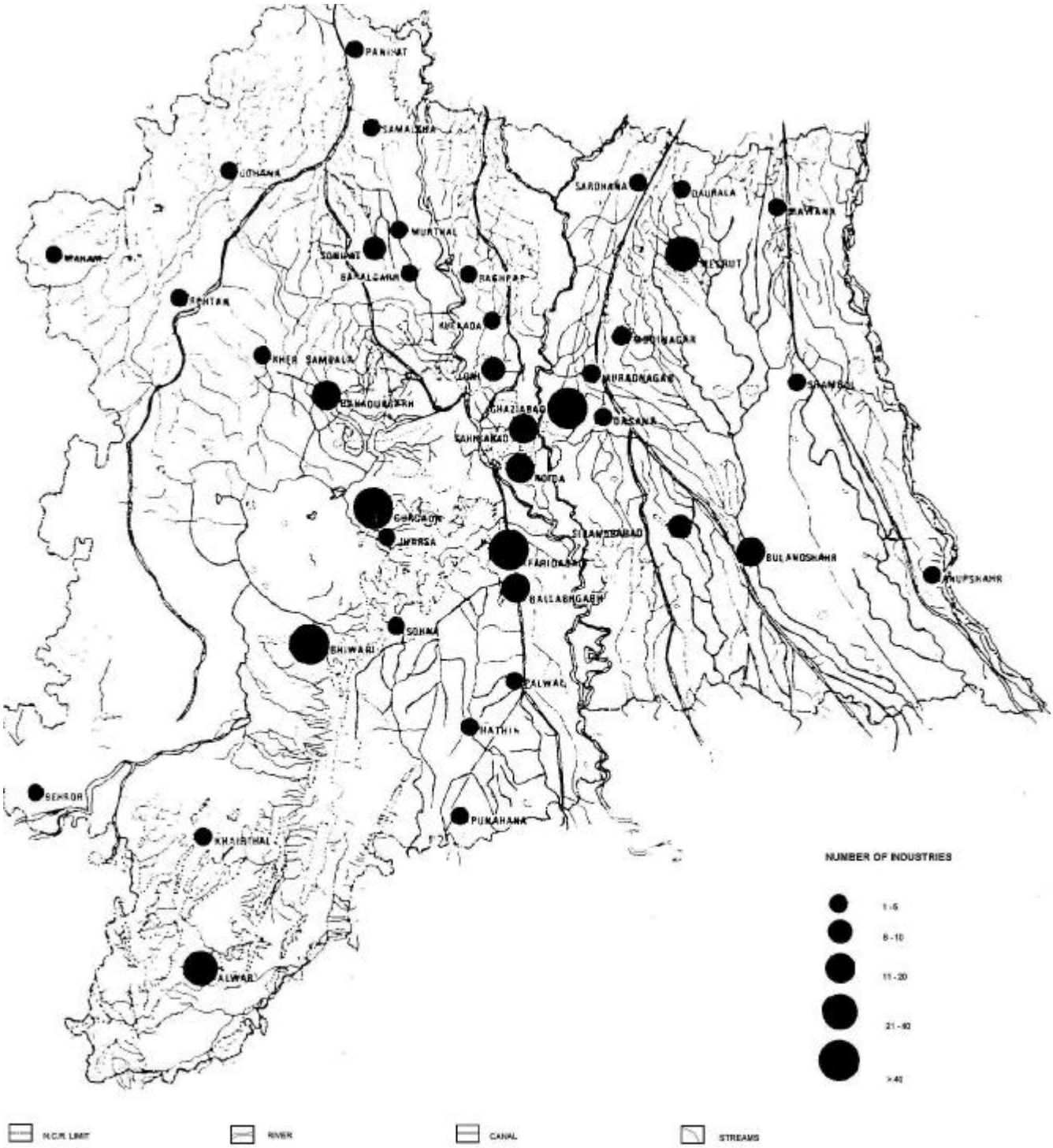

Figure 4: Water Polluting Industries in Urban Areas

There is a recharge zone (with the water table sloping away from it in all directions with a gradient of 1 to 2 m per km.), which lies in an elongated fashion in NW-SE direction from Baraut in U.P. The direction of ground water flow in the better part of the region is towards the river draining the area.

The ground water resources of Delhi are limited and their utilization for irrigation on large scale does not seem to be possible. Furthermore, extensive chemical tests have indicated that except for isolated wells, the ground water of Delhi area is generally brackish and unfit for drinking or irrigation.

The depth of water table is as shallow as 1 m.b.g.l., in Central Delhi to 25.5 m.b.g.l. in South Delhi, adjacent to the Aravalli outcrop. There is a prominent ground water discharge area located in the southwestern parts of Delhi. Considering the ground water quality, one can say that areas with fresh water over saline water exist in parts of Delhi where the thickness of the fresh water zone is generally not more than 50 to 60 m. The Northwestern and Southwestern part of NCT have saline water at all levels. The NCT of Delhi has 428.07 MCM utilisable ground water resources and ground water balance available is 140.79. About 67 percent of ground water is developed.

N.C.T. of Delhi comprises almost a flat plain land with a cluster of sand dunes in the southern part and a long rocky ridge extending roughly from North-North east to South - Southeast. The plains on either side of the ridge slope away from it. Geological formations include Quaternary deposits; post Delhi intrusive and Algonkian (Delhi system). Ground water in this area near surface occurs under unconfined conditions. The depth of water level show wide variations and water table slopes away from the ridge on either side.

Table 15: Depth of Ground Water below Ground level and its Hydro-geological Conditions in NCR

Sub-Region / Tehsil / Town	Land Contour AMSL (mts)	Ground water Contour AMSL(mts)	Depth of Ground Water B.G.L (mts)	Hydro-Chemical Conditions				
				A	B	C	D	E
Haryana (Sub-region)								
Panipat Tehsil (including Samalkha tehsil)	220-230	225	5	A				
Sonipat Tehsil	220-230	210-220	10	A	B			
Sonipat Town	220	210	10					
Ganaur Tehsil	220	215-220	5	A				
Gohana Tehsil	220-230	220-205	15	A			D	
Gohana Town	-----	220	10					
Rohtak Tehsil	220-230	205-210	10-15		B		D	
Meham Tehsil	220	205-215	5-15		B		D	
Bhadurgarh Tehsil	220	210-215	5-10		B		D	
Bhadurgarh Town	-----	210	10					
Gurgaon Tehsil	220-240	195-230	10-25					
Gurgaon Town	220	210-215	5-10		B		D	
Sohna Town	200	195	5		B			
Taru Town	260	255	5		B			
Pataudi Tehsil	220-260	220-250	10		B		D	
Jhajjar Tehsil	220-240	215-230	5-10		B		D	
Jhajjar Town	220	210	10					
Nuh Tehsil	200	185-195	5-15		B			
Nuh Town	200	190	10					
F.P. Jhirkha Tehsil	200-220	185-210	10-15		B		D	
F.P. Jhirkha Town	220	210	10					
Rewari Tehsil	240-280	220-245	20-40		B			
Rewari Town	240	230	10					
Balwal Tehsil	260-280	240-275	5-25		B	C		
Balwal Town	260	250	10					
Faridabad Tehsil	200	185-195	5-15		B			
Faridabad Town	200	190-195	5-10					
Palwal Tehsil	200	185-195	5-15		B		D	
Palwal Tehsil	200	190	10					
Hattin Tehsil	200	185-190	10-15		B		D	
Hattin Town	200	190	10					

U.P. Sub-Region Meerut District								
Mawana Tehsil Mawana Town	220-230 220	210-220 215	10 5	A				
Sardhana Tehsil Sardhana Town	220-230 -----	220-230 225	10 5	A				
Baghpat Tehsil Baghpat Town	220-230 220	210-230 215	10 5	A				
Meerut Tehsil Meerut Town	220-230 220	215-225 215	5 5	A				
Ghaziabad Tehsil Ghaziabad Town	200-220 -----	205-230 210-215	10-15 5-10	A	B			
Garhmukteshwar Tehsil	200-220	200-210	10	A				
Hapur Tehsil Hapur Town	200-220 -----	205-220 210-215	15 5-10	A				
Dadri Tehsil	200-220	195-210	5-10	A				
Bulandshar Tehsil Bulandshar Town	200-220 200	185-205 I 90	15 10	A				
Sikandrabad Tehsil Sikandrabad Town	200 200	190 195	10 5	A				
Khurja Tehsil Khurja Town	185-200 200	185-190 190	10 10	A				
Anupshar	185-200	195-190	10	A				
Siana Tehsil	200	190-195	5-10	A				
Rajasthan Sub-region								
Alwar Tehsil Alwar Town	260-280 260	240-250 250	10-40 10	A				E
Ramgarh Tehsil Ramgarh Town	220-280 240	210-240 230	10-40 10	A	B			
Tijara Tehsil Tijara Town	260-300 280	255-275 260	5-25 20	A	B			
Bhiwadi Town	260	250-255	5-l0					
Kishangarh Tehsil Kishangarh Town	260-320 300	250-290 280	10-30 20	A		C		E
Mandawar Tehsil	280-340	265-300	15-40			C		E
Behror Tehsil	300-340	265-295	35-45					E
N.C.T. Delhi	220-240	[210-225	10-15	A	B			

Legend: A Stands for Fresh Ground Water
B Fresh Ground Water is overlain by Saline Water
C Saline Ground Water is over Lain by Fresh Water
D Areas Where Ground Water is Saline at All Levels Except Local Patches
E Localised Saline Pockets

Source: CGWB and top sheets (S.O.I)

3.2.1 Salinity and Major Ions

The extent of mineralisation in shallow ground water of N.C.T. of Delhi area varies considerably from one part to another. In the eastern parts across Yamuna river and in the closed basin of Chattarpur, the ground water is characterised by low salinity. It is moderate to high in northern parts whereas at several places in Western and Southern Western parts, it is fairly high.

E.C. values exceeding 2000 micr/siemens/cm. have been observed in 8 out of 30 samples in Delhi area. The present chemical analysis data is based on 30 samples from Hydrograph Network stations and this data is not sufficient to make general conclusions. However, there are several detailed investigations conducted for ground water of Delhi area, which give information about distribution of salinity, and various other ions.

Among the major anions, bicarbonate is the leading anion in most of the E.C. ranges of low mineralisation. There is progressive increase in sulphate and chloride ions with increase in salinity and these are predominant in ground water from areas with high salinity. Among cations, sodium is the predominant cation in ground water at most of the places.

Fluoride Fluoride concentrations in shallow ground water in Delhi area is most than permissible limit of 1.5 mg/1 at several places (Table No. 5.4). Out of 27 samples, fluoride concentrations in case of 5 samples are more than the permissible limit.

Nitrate Nitrate concentrations in shallow ground water of Delhi area are more than the permissible limit of 45 mg/1 in case of 11 samples out of 30(36.7 percent). There is a prominent ground water discharge area located in the central parts of Rohtak District and South Western part of Delhi, where the ground water table is converging from all sides. The quartzite-ridges located mainly in parts of Delhi.

Gurgaon and Alwar form a ground water divide, and the water table slopes away in both the east west in gradients ranging between 3 to 5 meters/km. The direction of flow from Southern and South West areas is towards the Sahibi river and subsequently to the ground water discharge area in South Western parts of Delhi and Central parts of Rohtak district. The central parts of Faridabad and Gurgaon districts also form discharge area with the flow direction converging near Hathin in Faridabad district and ultimately flowing out to river Yamuna.

3.2.2 Nature of Acquifers

In the areas underlain by alluvium deposits, the shallow acquifers holds groundwater in unconfined state. The deeper acquifers are more unconfined in nature. Tube wells drilled down to 300m or more along the Ganga and Yamuna (in district Panipat and Sonipat) generally yield more than 150 cum./hr.) . In these parts the transmissibility of acquifers generally varies between 1000-300 sq. m /day. In the eastern parts of Sonipat district, and Delhi N.C.T. and along both sides of Yamuna the acquifers are fairly thick but discontinuous in nature. Wells in the area, which generally yields about 50-100 cum./hr. of ground waters. In the area along the Sahibi and in the Rewari district too, the acquifers are fairly thick and discontinuous and tube wells drilled down 100m more yield 50-100 cum./hour. In area characterised by weathered residue and fractured zones having secondary porosity, consolidated formation of ground water in unconfined conditions occur. Here tube wells have yield prospects in the range of 5-20 cum./hr for appreciable drawdowns.

3.2.3 Water Quality

Ground water at deeper levels in Delhi area is moderately to highly saline. E.C. values over 10,000 micro-siemens/cm have been observed in some of the samples of deeper wells in Delhi area. The region can be broadly classified under four heads:

i) Area with fresh water at all levels
ii) Area with fresh water over saline water
iii) Areas with saline water over fresh water
iv) Areas with saline water at all levels

1. Areas with fresh water at all levels

The presence of such areas is in parts of Panipat and Sonipat District falling along the Yamuna rivers, in the north eastern part of the Sahibi river, in the north eastern part of the Sahibi rivers basin, in the northern parts of Alwar district, in the Alwar valley and the inter montane valleys of Alwar district. In the U.P. sub-region, the areas lying between Yamuna and Ganga, except for portion in the western parts of Ghaziabad district, fall under this category.

2. Area with fresh water over saline water

Such areas exist in most parts of the Haryana sub region. Delhi and the western parts of Ghaziabad district where the thickness of the fresh water zone is generally not more than 50 to 60m. Here saline or brackish water is overlain by fresh water and salinity in areas with depth.

3. Areas with saline water over fresh water

The presence of areas under this category is marked in Sonipat town and surrounding areas and in the eastern parts of Sahibi rivers basin.

4. Areas with Saline water at all levels

The areas having saline water at all levels occur in the north western part of Sonipat District western parts of Rohtak district, north western and southern parts of Gurgaon district parts of Rewari district,

southern parts of Faridabad district, north western and south western part of N.C.T. of Delhi and in the north eastern part of the Sahibi river basin.

3.2.4 Water Balance and Availability

The ground water availability in the various districts of the NCR shows substantial variation. The districts in the Uttar Pradesh sub-region are comparatively richer is ground water resources, with Meerut having the highest quantum (91761 mcm/yr).

The districts in the Haryana Sub-Region are poor in ground water availability particularly Rewari (306.1 mcm/yr) and Faridabad (363.59 mcm/yr).

At the sub region level the Rajasthan Sub Region (81.5 percent) is the highest in ground water development. Haryana sub region is comparatively poor with only 57.87 percent of its ground water resources having been developed. This figure is substantially lower than the regional level figure of 70.22 percent).

3.2.5 Analysis of Consumption Pattern and Ground Water Development

Analysis of information of ground water consumption has been done to establish the nature and extent of exploitation in the various districts of the NCR; the consumption pattern and to understand the dependence of agricultural activity on the groundwater resources. The analysis reveals that in all the districts of the NCR approximately 15 percent of the total replenishable ground water resource is abstracted annually for domestic and industrial uses.

In irrigation uses, there is wide spatial variation in consumption. This conclusion is on the basis of the percentage of consumption with reference to the net draft of ground water. Rewari district (61.7 percent) has the highest consumption percentage agricultural uses followed by districts Faridabad (47,26 percent), Alwar (41 percent) and Gurgaon (41.3 percent). The consumption percentage in the remaining districts range between 13 and 25. Also in terms of ground water development Rewari district records a high percentage (90 percent). This leaves a small percentage future abstraction, making the situation critical. District Faridabad (73.25 percent) Alwar (66.0 percent) Gurgaon (64.83 percent) and Ghaziabad (64.0 percent) also show a high level of ground water resource exploitation.

Another interesting feature is that ground water provided for non-agricultural uses percentage of the net draft in most districts is very high. In other words, the dependency on ground water resources for domestic industrial uses is very high (except in District Rewari). This fact asserts the importance of protecting the quality of ground water.

3.2.6 Ground Water Pollution

Having appreciated the necessity and importance of ground water re availability in the National Capital Region. It becomes imperative that such resources are available in a consumable quality.

Ground Water resources available at s levels often get polluted due to leaching of trade effluent waste that are polluting in nature. A study of these types of industries which are potential ground water pollutants of the following industrial typologies and the parameters that have ground pollution potential.

A review of the industrial types in the various industrial areas within the N indicates that almost all industrial areas have industrial types, which are potential ground water pollutants. The problem is more pronounced where

(i) The effluent are discharged without treatment,

(ii) The drainage system for carrying these effluents are either not proper or do exist and effluents are discharged into open fields. Some glorious examples Gurgaon, Panipat and Bhiwadi towns.

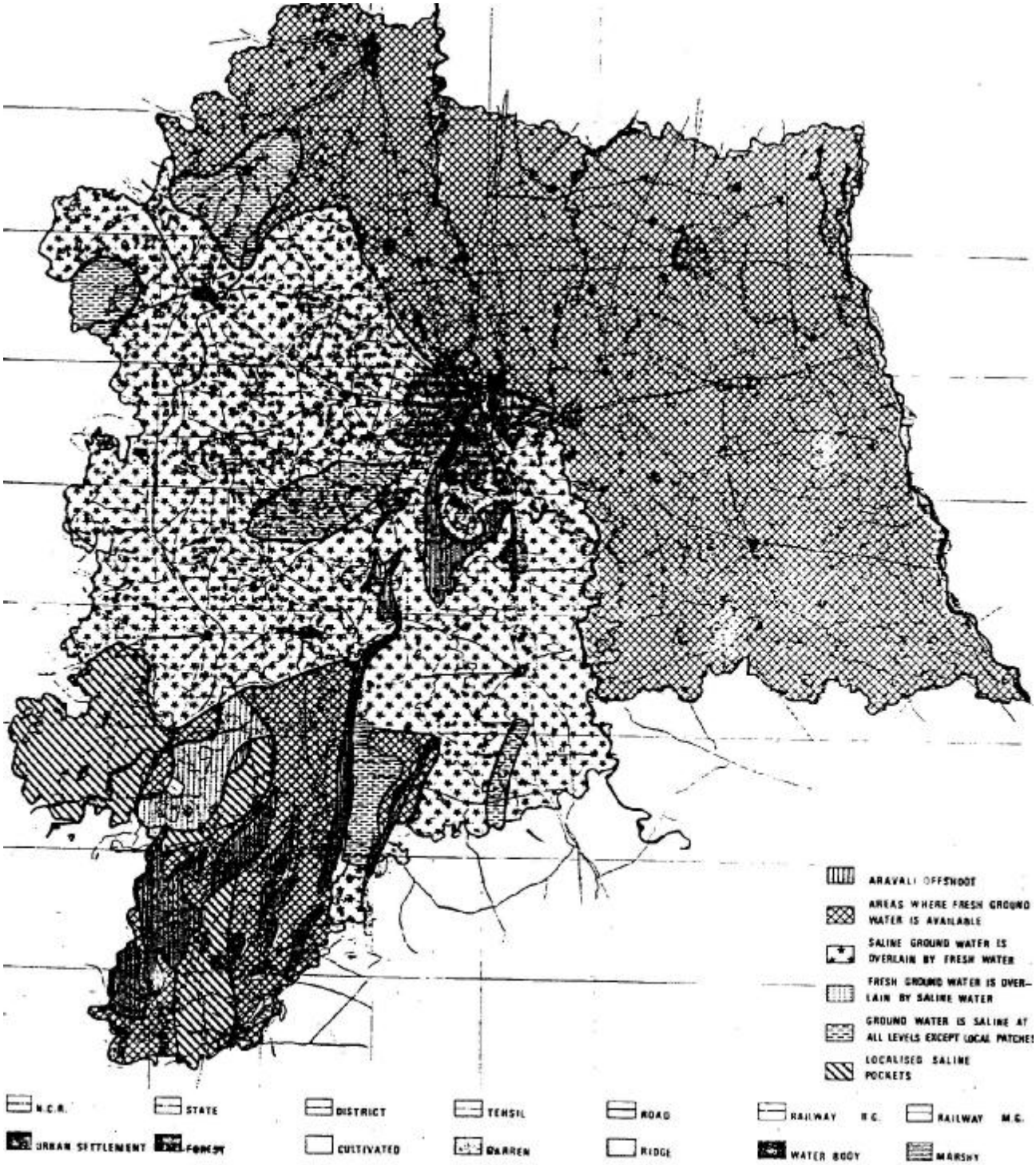

Figure 5: Ground Water (Hydro-Chemical Conditions)

3.2.7 Conclusion

The analysis of both surface and groundwater resource indicates that the endowment is sufficient provided it is carefully conserved and managed. The crucial factors are pollution abatement measures, which the country has taken up earnestly. Some areas, however, show constraints of water availability. These factors will play a crucial role in formulating settlement policy for NCR.

4.0 Air

Of the five fundamental physical constituents of environment Air is one. It is vital for all forms of aerobic life. Also air is the medium of transportation of both fragrance as well as pollution. It is a recyclable resource. However, the increasing levels of discharge into the air through the use of vehicles, and industrial process is causing concern, as polluted air has direct co-relation with health, since polluted air causes number of diseases of the respiratory tract. There are two aspects of air pollution

(i) Concentration of pollutants in the vicinity of the source of pollution, either point or linear,
(ii) Dispersal of pollutants spatially due to movement of wind.

In this study attempt has been made to identify the sources of pollution and estimate the ambient concentration. The dispersal pattern, unfortunately, cannot be scientifically determined because of paucity of climatological data, which is discussed in the later part of the chapter. However, based on the prevailing direction of wind, the direction of dispersal can be indicated.

4.0.1 Air Pollution

The World Health Organisation (WHO) has classified Delhi as one of the 10 most polluted cities in the World along with Mexico City, Seoul and Beijing. The CPCB is monitoring ambient air quality regularly at 6 locations in Delhi for measuring Sulphur dioxide (SO_2) Nitrogen dioxide (NO_2) and Suspended Particulate Matter (SPM).

The summary of the data available with CPCB for the ambient air quality monitoring stations falling within the National Capital region is given below:

The Air Quality Monitoring Stations established in the National Capital Region (NCR) are as follows

- Delhi
  1. Nizamuddin
  2. Ashok Vihar
  3. Shazada Bagh
  4. Shahdara
  5. E.S.I Dispensary, Najafgarh Road
  6. Janakpuri
  7. Siri Fort
  8. N.Y. School, Sarojini Nagar
  9. Town Hall
- Faridabad
  1. Escorts Medical Centre
- Alwar
  1. RIICO Pump House
  2. Regional Office
  3. Gaurav Solvex

The stations having high or critical ambient air quality in Delhi, Faridabad and Alwar are given below

Table 16: Ambient Air Quality

City/ location	Area class	Annual mean concentration (µg/m^3)		
		SO_2	NO_2	SPM
City-Delhi				
• Shahdara	Industrial	Low	Low	High
• Janakpuri	Industrial	Low	Medium	Critical
• Siri Fort	Industrial	Low	Low	Critical
• N.Y School, Sarojini Nagar	Industrial	Low	Medium	-
• Town Hall	Industrial	Low	Medium	-
City-Faridabad				
• Escorts Medical Centre	Industrial	Low	Low	High
City-Alwar				
• RIICO Pump House	Industrial	Low	High	Medium
• Regional Office	Residential	Low	High	Critical

Note: Unit - µg/m^3
Source: National Ambient Air Quality Status, 1998Central Pollution Control Board, MOEF

In Delhi, the status and trends in annual mean concentration of Sulphur di oxide from 1990 to 1998 shows that concentrations of Sulphur di oxide are increasing during the past several years though these are well within the National Ambient Air Quality Standards. There had been upward trend in Annual Mean concentration of Sulphur di oxide in most of the year's upto 1992, thereafter the trend was either stable or was downward.

The status and trends in annual mean concentration of Nitrogen at Delhi from 1990-98 indicates that nitrogen dioxide concentration are increasing and the annual average has increased to about 1.3 to 1.5 times during 1998 in comparison to annual averages of 1990 which seems to be coincidental with the spectacular increase in vehicular population in the mega city. The annual average concentration of nitrogen dioxide during past 9 years i.e., 1990-98 varied between 23.4 $\mu g/m^3$ to 36.8 $\mu g/m^3$ in residential areas while between 23.4 $\mu g/m^3$ to 36.8 $\mu g/m^3$ in industrial areas which had been well within the prescribed air quality standards of 60 $\mu g/m^3$ for residential areas and 80 $\mu g/m^3$ for industrial areas.

The levels of suspended particulate matter in ambient air of Delhi depicted frequent violations of 24 hrs air quality standards for SPM ranging from 56% to 100% in residential areas, while 3% to 42% violation in industrial areas and its problem is of immediate concern as since its general level remain consistently high during past several years. Annual average suspended particulate matter fluctuated between 300 $\mu g/m^3$ to 409 $\mu g/m^3$ against annual average standard of 140 $\mu g/m^3$ in residential areas and between 314 $\mu g/m^3$ to 436 $\mu g/m^3$ in industrial areas. The fluctuation pattern of annual averages was not very systematic indicating that origination and presence of suspended particulate matter in Delhi's environment are not only contributed by vehicular and industrial activities but also significantly because of soil originated particles and re-suspended dust generated by strong winds and construction activity.

The concentration and the status of respirable particulate matter (RSPM) or PM_{10} from March 1998 to December 1999at Bahadur Shah Zafar Marg indicated that 24 Hrs. average SPM fluctuated between 56 $\mu g/m^3$ to 820 $\mu g/m^3$ during the period March 1998 to December 1999.
(Source- CPCB document NAAQMS/14/1999-2000)

Major sources of air pollution in Delhi are vehicles, thermal power plants, industries and domestic coal burning.

4.0.2 Vehicular Pollution

An estimated 2000 MT of pollutants are emitted in the atmosphere everyday within Delhi. Vehicular sources contribute 64 percent (1300 MT as per data 1993) of total pollutants followed by thermal power generation (16 percent), industrial emissions (13 percent) and domestic (7 percent). Vehicular pollution has increased by almost 50 percent over 6 years from 1987 to 1993 due to the astronomical rise in vehicular population. Petrol driven vehicles constitute 93 percent of total vehicles and are accountable for 81 percent of the total pollutants emitted. The Central Pollution Control Board (CPCB) monitored the ambient air quality at the major traffic intersections in order to assess the impact of vehicular emission on ambient air quality and compared it with the one at IARI Campus (which is a pollution free site). The Carbon Monoxide (CO) levels were much higher than the prescribed standards i.e., Sensitive area (1000 ppb); Residential area (2000 ppb); Mixed use (5000 ppb).

4.0.3 Emission from Thermal Power Plants

An estimated 302 MT/day of pollutants are emitted from the thermal power plants. The thermal power stations are the second worst polluters in Delhi (contribute to 24% of total air pollution). The Badarpur (BTPS) and the Indraprastha Power Station (ITPS) together contributes 149 tonnes of Suspended Particulate Matter (SPM) and 90 tonnes of SO_2 every day. The stack emission is of the order of 6000-7000 g/cu/m from ITPS, 8000-9000 g/cu/m from BTPS as against the standard of 150 g/cu/m. Despite the huge amount of pollutants emitted these power plants cannot be shifted outside the city limits as they contribute significantly to the power needs of Delhi.

4.0.4 Air Pollution and its impact on human health

In order to appreciate the environmental concern for air pollution, a discussion on the major air pollutants and their impact on human health may be useful. These are

(i) S.P.M. - Suspended Particulate Matter
(ii) SO_2 - Sulphur Dioxide
(iii) NOX - Oxide of Nitrogen
(iv) CO - Carbon Monoxide.

These four types of air pollutants are measured at various stations set up by CPCB, SPCB's. The other types of air pollutants, such as lead, volatile organic compounds etc. are not yet regularly measured. The standards of concentration in ambient air as prescribed in the air act (1981) are proposed to be revised to make them more responsive to ground realities. The proposed National ambient air quality standard (AAQS) has been discussed subsequently.

4.0.5 Impact on Health

S.P.M. It is a general for air borne particles either visible (such as smoke) or invisible. It generally creates dirt and acts as an irritant to respiratory tract; it can carry metals, sulphates, nitrates, etc. and is known to be occasionally carcinogenic. Particulates between 5 microns can penetrate deep into the respiratory system.

$S0_2$ AAQS specifies 0.035 ppm or 80 kg per cu.m. The length of exposure has definite co-relation with the level of affectation in the respiratory tract. It also affects vegetation and higher concentrations can lead to acid rain.

NOx AAQS specifies .053 ppm or 100 micro grams per cu.m to 200 micro grams per cu.m. The length of exposure has definite co relation with the level of affectation. Continued exposure results in Bronchitis, Pneumonia, and other lung infections. It can create photochemical smog, and is produced by petrol diesel driven vehicles, industries and also by certain chemical processes.

CO AAQS specifies 9 ppm or 10 micro grams per cu.m to 28 micro grams per cu.m. It is a colourless, odourless gas, which can be lethal at high concentrations (500ppm). 25 ppm can aggravate cardio vascular disease. Generally produced by petrol driven vehicles. Therefore cities with densely built up area and high volume of vehicles pose serious threat.

It has been observed that all the pollutants results from increasing uses of fossil fuel for generating energy. The energy study of the National Capital Region has been done for commercial energy sources (which are mostly) used in urban centres) i.e. Electricity, LPG, Petrol/Diesel, Kerosene and Coal.

4.0.6 Air Pollution due to Energy Consumption

- Electricity

  Electricity is considered to be prerequisite for any development. Consumption of electricity increases with improvement in living standards and changing lifestyles. The two most important aspects of electricity scenario are the Generation and Consumption characteristics.

  Generation: There are 6 thermal power plants in the NCR Delhi has 3 coal based thermal power plants (at Badarpur, Rajghat and I.P.Estate) and one gas based power plant. Haryana sub-region of NCR has 2 power plants, one in Panipat and the other in Faridabad. Uttar Pradesh sub-region has one coal based plant and one gas based plant in Dadri. There is no power plant in Rajasthan sub-region. Dadri plant is one of the four central stations in the northern region (i.e. Singrauli, Rihand, Unchahar and Dadri), which only generate and do not distribute separately, instead they feed directly into the Northern Grid. The other plants distribute separately to the respective regions. The additional demand for power is met with by drawing from the Northern Grid. The power demand of Rajasthan sub-region is met partly by the

generating stations of the State Electricity Board and partly by withdrawing from the Northern Grid.

Information on the Capacity, Generation and fuel consumption (over the past few years) of the power stations in NCR have been obtained. Analysis shows that

- Badarpur plant has the highest capacity (705 MW) followed by Panipat (650 MW) and Dadri (630 MW) (92-93 FIG.).
- Badarpur plant generates maximum units (4577 GWH) as compared to other plants. Panipat generates about 2670 GWH followed by I.P.Estate whose generation is 1387 GWH. Rajghat produces about 565 GWH (92-93 FIG.).
- The production from the power stations have been steadily increasing especially for Faridabad and Panipat power stations and the production fluctuates in case of other stations e.g. Badarpur which produced 4150 GWH in 90-91, 3979 GWH in 91-92 and 4577 GWH in 92-93.
- Most of the thermal power stations are coal based i.e. coal is the main fuel used in the stations. The quantity of coal consumed varies in different plants. I.P.Estate plant uses comparatively less coal to produce one unit of electricity (i.e. about 0.74 KG/KWH) as against 0.83 KG/KWH used by the other stations on the average. (92-93 FIG) Furnace oil is also used and the consumption varies from 0.007 KL/KWH to 0.03 KL/KWH.

Consumption: Regarding the consumption pattern of electricity, data was collected for Delhi and various circles in the different sub-regions for the present. Analysis of situation revealed some interesting points

- The consumption of energy of Delhi is 6334.09 GWH, which is more than that of the Haryana State, which is 6051.15 GWH (90-91 FIG).
- The sector-wise consumption pattern of Delhi is as follows: Domestic consumption (58 percent), Commercial (20 percent), Industrial (33 percent), others (9 percent). Compared to other circles, one can observe that domestic consumption is about l9percent in Faridabad, 28 percent in Sonipat and 23 percent in Gurgaon. This shows that domestic consumption in Delhi is very high as compared to other circles.
- Domestic consumption has increased from 28 percent to 38 percent over the past decade. This may be because of rise in living standards, which is characterised by change to higher living standards, which is characterised by change to more energy intensive lifestyles. Considering the fact that Delhi has the highest per capita income in the country and more than double the national average, one can easily conclude that this has resulted in the increase in the purchasing power to acquire more electricity-based appliances/gadgets. Delhi's load is 1500-1600 MW but the total capacity of Delhi based power plants is 1298 MW. That means the additional 300-400 MW has to be drawn from elsewhere (only if the power plants run to their full capacity, which is never the case. In that case more power has to be drawn).

- <u>LPG</u>

Data of LPG sales to various urban centres in the NCR was collected and analysed. Findings are listed below

Distribution: About 70 percent (i.e. 45 out of 64 cities) of cities in Uttar Pradesh sub region do not have LPG distribution outlets. Size class wise analysis of LPG distribution outlets show that all Class I cities have outlets. But about 25 percent of Class II cities, 50 percent of Class III Cities, 96 percent and 92 percent of Class IV and V cities do not have LPG distribution outlets Studies show that LPG is the cheapest and heavily subsidized fuel in the country which is not only more efficient but less

time consuming. Therefore, keeping this in view, the non-existence of outlets is a significant disadvantage. This means that either the towns not having outlets have to depend on the neighbouring towns located may be many kms. away or fall back on other non-commercial sources e.g. firewood, cow dung cakes etc. The situation in Haryana is comparatively better. In Haryana 56percent of cities do not have outlets for LPG (i.e. 18 out of 32 cities in Haryana sub-region.) All Class I and Class II cities have outlets, but 25 percent of Class III cities, 78 percent of Class IV cities do not have outlets. None of the Class VI cities have distribution centres.

Consumption: The average consumption per household is 137 kg / year i.e. 11.4 kg / month. The LPG consumption of Delhi is 221000 tonnes (91-92 FIG.), which are about 2.7 times that of Haryana State and 2.4 times that of Rajasthan State. The per capita consumption of Delhi therefore amounts to approximately 26 kg. In Uttar Pradesh LPG consumption is comparatively more in cities like NOIDA (2804 MT amounting to 19 kg per capita), Dadri (502.39 MT which is 15 kg. per capita) followed by Anupshahr (14 kg) and Muradnagar (12 Kg.) This may be due to the fact that more number of people may be using LPG as cooking fuel or they may be supplying to the neighbouring settlements, which do not have distribution centres. In Haryana, LPG consumption is more in cities like Palwal (166 MT which is about 20 kg per capita), Gurgaon (2204 MT which is 16 kg. per capita), followed by Rohtak (2820 MT i.e. 13 kg. per capita). Alwar in the Rajasthan sub-region consumes 2365 MT is 11 kg per capita.

- Petrol (MS) and Diesel (HSD)

  Data of MS and HSD sales to various urban centres have been collected from different oil companies. Findings are given below

  Distribution: About 45 percent of cities in Uttar Pradesh sub-region have no petrol/diesel distribution outlets. All Class I and Class II cities have distribution centres but 20 percent of Class III and 75 percent of Class IV cities respectively do not have diesel outlets. 75 percent of Class V cities are without any petrol or diesel outlets. In Haryana the situation is relatively better with all Class I, II and III Cities having distribution centres. Only 7 percent and 34 percent of cities do not have petrol outlets and only l6 percent of Class V cities are without diesel outlets. All the cities in the Rajasthan sub-region have distribution outlets.

  Consumption: The petrol and diesel consumption of Delhi are 363326 MT and 81 1340 MT respectively (92-93 FIG.) The petrol consumption of Delhi is much higher than Haryana State totals of 116209 MT and 135481 MT of Rajasthan State. Petrol and diesel consumption is comparatively high in cities of Meerut district in Uttar Pradesh sub-region. Cities like Meerut show petrol/diesel consumption of 124138 MT/ 332658 MT followed by Baraut (7093 MT/57639 MT), Baghpat (46769 MT/40376 MT) etc. All of these cities having high consumption pattern may be serving to the neighbouring centres. In Haryana, the cities having higher consumption are Faridabad (10775 MT/ 17877 MT), Gurgaon (5060 MT / 10074 MT), Rohtak (4332 MT / 14130 MT) etc. Alwar has a consumption of 2117 MT / 5275 MT (petrol/diesel consumption).

- Kerosene

  Data of kerosene supply to urban centres is available from the district supply officers of respective districts. Therefore district wise figures were considered for purposes of comparison.

  Consumption: The consumption of Delhi is 236565 MT as compared to 153437 MT of Haryana State and 267602 MT of Rajasthan State. In Uttar Pradesh, Meerut district has the highest consumption (25588 MT), followed by Ghaziabad and Bulandshar (18568 MT). In Haryana, Faridabad district has about 17868 MT consumption followed by

Rohtak (14514 MT) and Gurgaon (1 1460 MT). Alwar district shows 10287 Mts consumption of kerosene. (92-93 FIG.)

- Coal
  Coal is supplied to various railway stations apart from being supplied to various power plants, cement plants, fertilizer plants etc. Data on coal supply to various railway stations in NCR have been obtained.

4.0.7 Energy and Pollution

The 63 cities in National Capital Region were studied to find the relationship between energy consumption and air pollution levels. The energy consumption was studied in terms of commercial energy sources i.e. coal, petroleum and diesel. The pollution parameters, which were considered, were Sulphur dioxide, Nitrogen dioxide and Particulate matter.

The Air (Prevention & Control of Pollution) Act 1981 forms the basis for controlling air pollution in the country. The main function of the Central Pollution Control Board as per this Act is to improve the quality of air and to prevent, control or abate air pollution in the country. The Central Pollution Control Board as per section 16(2) h of the Air Act 1981 is required to lay down air quality standards. For the purpose of laying down standards geographical areas were categorised into 3 classes viz.

- Industrial & mixed use (I)
- Residential & rural (R)
- Sensitive (s), which includes hill stations, national parks and monuments. The following standards were laid down in the year 1982.

The Central Pollution Control Board regularly monitors air quality under the National Ambient Air Quality Monitoring (NAAQM) scheme. There are six urban centres in the National Capital Region where monitoring of air quality takes place. These centres are Alwar, Delhi, Dharuhera, Faridabad, Ghaziabad and Modinagar.

The regularly monitored data collected by Central Pollution Control Board is inadequate for arriving at the air pollution scenario of various urban centres in the NCR. Air pollution is caused by combustion of various forms of fossil fuel such as coal, oil etc in industries, homes, automobiles etc. The mass of pollutants depends on the

(i) quantum of fuel burned,
(ii) emission factor of appliance using it
(iii) the climatic factor which determines the mixing height.

The mass of pollutants over a particular area can be converted into units of □g/m compared against the standards of ambient air quality prescribed by Air Act.

The Methodology adopted for assessing the pollution levels in cities is given below

(a) To assess the level of pollutants emitted due to consumption of commercial energy, data showing district wise and citywide consumption of petrol, diesel, LPG, kerosene and coal was collected. Fuel consumption according to type for various large and medium units included in the list of the 17 polluting categories of industries for all the districts of NCR was also collected. Similarly, vehicular pollution emission is assessed on the basis of the number of vehicles on particular corridors of movement.
(b) Tables showing the Emission Factors for major pollutants from different fuel types, mass emission characteristics of different vehicles in grams/litre of fuel consumed and mixing depth (in meters) in Delhi on a monthly basis from January to August was also been obtained.
(c) Three major pollutants considered are $S0_2$, NOx and Particulates.

Consumption of various fuel types are multiplied with their respective emission factors and vehicular pollution is also assessed in a similar way. The computation of the above products gives the total

amount of air pollution generated from all sources for each place in kilograms per day. Point sources of pollution are not being considered due to lack of adequate data. The determination of the mixing depth allows the assessment of concentration of pollutants over space. To determine the volume of air in a particular place, the area is multiplied by the mixing depth. In this case, nighttime conditions in January have been considered because, conditions are worst. The summation of the total pollution load generated divided by the volume of air gives the concentration of pollutants per unit volume of air. However, this depicts results, which are considered to be uniform over space. This exercise allows determinations of the level of air pollution from various sources and their concentration over space. Detailed data was collected by way of random sampling of the polluting categories of industries of large and medium scale from the State Pollution Control Boards of Faridabad, Gurgaon, Ghaziabad and Alwar. The pollution generated on the basis of fuel use was also calculated. The total quantum of pollution generated as per industrial type was thus been determined. A total of 31 categories of industries was studied. The 31 categories were as per the Central Pollution Control Board classification. To assist analysis, the 51 categories of industries was grouped as follows

GROUP A: Basic Industry
GROUP B: Agro Based Industry
GROUP C: Chemical Industry
GROUP D: Miscellaneous Industry

The total $S0_2$, NOx and SPM emissions from each group of industry was calculated and it was found that the group B of industries is most widely distributed. The results reflect that the cities showed greater pollution levels with the combination of major industries. All the cities had emissions within the prescribed limits of sulphur dioxide and particulate matter except in the case of Rewari where particulates were beyond prescribed limits. Comparing all these cities (even though the limits have been exceeded) the ranking of the cities in decreasing order of pollutants. The cities were analysed in terms of their pollution levels for the purpose of comparison with ambient air quality standard. The results reveal that

1. With respect to sulphur dioxide in 95.24percent of cities (i.e. 60 out of 63 cities), emissions are within the prescribed limits. The three cities where emissions exceed the limits are Mawana, Taoru and Daurala in decreasing order.
2. With respect to nitrogen dioxide in 80.95percent of cities (i.e. 51 out of 3 cities), emissions are above the prescribed limits.
3. With respect to suspended particulate matters in 90percent of cities (i.e. 57 out of 63cities) emissions are within the prescribed limits.

The 6 cities exceeding the standards are Daurala, Mawana, Khurja, Baghpat, ~ Modinagar and Kithor. It is only in the case of oxides of nitrogen that emissions are much above the standards prescribed.

4.0.8 Pollution Load by Towns

The air pollution (tonnes/per day) because of inter city traffic moving on intra urban road network of town have been calculated. The ambient pollution level has been calculated on the basis of volume of traffic and the mode of traffic and the distance the traffic most likely to traverse.

Table 17: Pollution Load (in' 000 tonnes/day) in NCR Towns

City/Town	SPM	$S0_2$	NO_x	1000 T/Day	Tonnes/Day
Delhi NCT	7.9310 3.0540	0.7240 0.2604	36.4560 14.0710	45.1110	45,111.0
Meerut	3.0510 0.0030 1.2740	0.2580 0.2024 0.0510	14.0580 0.0130 3.9610	17.3850	17,385.0
Faridabad	0.3570 0.9170 1.3530	0.0250 0.0260 0.0630	1.3660 2.5950 4.4670	5.2860	5,286.0
Ghaziabad	1.3020 0.0510	0.0530 0.010	4.3240 0.1430	5.8830	5,883.0
Rohtak	0.3770 0.0750	0.0170 0.0035	1.2990 0.0600	1.7710	1,771.0

Alwar	0.0460 0.0150	0.0040 0.0170	0.2180 0.6800	0.9800	980.0
Panipat	0.1520 0.0220	0.0180 0.0070	0.7160 0.0620	0.9770	977.0
Noida	0.0950	0.0090	0.4480	0.5520	552.0
Hapur	0.0970	0.0060	0.4530	0.5560	556.0
Sonipat	0.0600 0.0050	0.0050 0.0076	0.2888 0.0340	0.4004	4,000.0
Gurgaon	0.9400 0.0089	0.0090 0.0038	0.4460 0.0980	1.5057	1,505.0
Bulandshar	0.0970 0.0080	0.0060 0.0013	0 4540 0.0310	0.5973	597.3
Modinagar	0.5350	0.0050	1.6710	2.2100	2,211.0
Khurja	0.5460	0.0170	1.6450	2.2080	2,208.0
Rewari	0.5880 0.0065	0.0200 0.0030	1.9310 0.0220	2.5705	2,570.0
Basant	0.4180	1.9370	2.3770	4.7320	4,732.0
Sikanderabad	0.0320	0.0016	0.1480	0.1816	181.6
Palwal	0.1020	0.0020	0.4760	0.5800	580.0
Bahadurgarh	0.0170	0.0010	0.0700	0.0880	88.0
Mawana	0.3920	0.0190	1.8120	2.2230	2,233.0
Pilkhna	0.0430	0.0020	0.1995	0.2445	244.5
Muradnagar	0.0180	0.0010	0.0820	0.1010	101.0
Sardhana	0.1460	0.0080	0.6800	0.834	834.0
Jahjangirabad	0.0110	0.0006	0.0510	0.068	68.0
Loni	0.0006	-----	0.0030	0.009	9.0
Khekea	-----	-----	-----	-----	-----
Gulathi	0.0410	0.0029	0.1890	0.2329	232.9
Dadri	0.0380	0.0020	0.1760	0.2160	216.0
Gohana	0.0620	0.0030	0.2880	0.3530	353.0
Siana	0.0150	0.0001	0.0715	0.0866	86.0
Shikarpur	-----	-----	-----	-----	-----
Deba1	0.0190	0.0008	0.0870	0.1068	106.8
Jhijjar	0.0340	0.0017	0.1557	0.1914	191.4
Hodal	0.0500	0.0020	0.2290	0.2810	281.0
Garhmukteshwar	0.5095	0.0150	1.5680	2.0925	2092.0
Baghpat	0.2910	0.0150	1.3580	1.664	1664
Bhairthal	0.0160	0.0007	0.0730	0.0897	89.7
Jewar	0.0110	0.0060	0.0520	0.6360	63.6
Ganaur	0.0410	0.0021	0.1840	0.2271	227.1
Anupshar	0.0150	0.0007	0.0700	0.0857	85.7
Kithaur	0.1890	0.0090	0.8720	1.0700	1070.0
Samalkha	0.0200	0.0013	0.0940	0.1153	115.3
Dasna	-----	-----	-----	-----	-----
Sohna	0.0500	0.0026	0.2310	0.2836	283.6
Behror	0.0280	0.0013	0. 1270	0. I 563	156.3
Chhaprauli	0.0410	0.0013	0.1880	0.2303	230.3
Narora	0.0080	0.0005	0.0390	0.0475	47.5
Aurangabad	0.0060	0.0002	0.0290	0.0352	35.2
Tijara	0.0030	0.0001	0.0140	0.0171	17.1
Bhiwadi	0.0040	0.0002	0.0180	0.0222	22.2
Maham	0.0260	0.0012	0.0180	0.0452	45.2
Hastwapur	0.0260	0.0012	0.1180	0.1452	145.2
Kalanaur	0.0730	0.0036	0.3390	0.4156	415.6
Beri	0.0110	0.0005	0.0510	0.0625	62.5
Lawar	0.0170	0.0007	0.0780	0.0957	95.7
Sewalkhas	-----	-----	-----	-----	-----
Phalanda	-----	-----	-----	-----	-----
Parikshitgarh	0.0850	0.0027	0.3900	0.4777	477.7
Hailey Mandi	-----	-----	-----	-----	-----
Pahasu	0.0070	0.0005	0.0345	0.0420	42.0
Kharkhode	0.0110	0.0046	0.0510	0.0666	66.6
Muradnagar Ord Fac.	0.0860	0.0046	0.4010	0.4916	491.6

Tikai	-----	-----	-----	-----	-----
Taoru	0.1240	0.0040	0.5690	0.6970	69.7
Shahjahanpur	-----	-----	-----	-----	-----
Ferozpur Jhirkha	0.0250	0.0013	0. 1140	0.1403	140.3
Doghat	-----	-----	-----	-----	-----
Khanpur	-----	-----	-----	-----	-----
Pataudi	0.0140	0.0008	0.0660	0.0808	80.8
Bugeasi	-----	-----	-----	-----	-----
Karnawal	-----	-----	-----	-----	-----
Facitnagar	-----	-----	-----	-----	-----
Agarwal Mandi	-----	-----	-----	-----	-----
Dharuhera	0.0540	0.0028	0.2490	0.3058	305.8
Babugarh	-----	-----	-----	-----	-----
Kharkhoda	0.0860	0.0046	0.4010	0.4916	491.6
Kalchhina	-----	-----	-----	-----	-----
Daurala	0.3910	0.0118	1.5470	1.9498	1949.8
Dankaur	0.01000	0.0005	0.0470	0.0575	57.5
Patala	-----	-----	-----	-----	-----
B.B. Nagar	0.0040	0.0002	0.0205	0.2470	24.7
Basuma	0.0650	0.0025	0.3000	0.3675	367.5
Bawal	0.0050	0.0002	0.0250	0.0302	30.2
Niwadi	-----	-----	-----	-----	-----
Punahana	0.0180	0.0010	0.0840	0.1030	103.0
Rori	-----	-----	-----	-----	-----
Aminagar Sara1	-----	-----	-----	-----	-----
Jahangirpur	-----	-----	-----	-----	-----
Chatari	-----	-----	-----	-----	-----
Farnkhanagar	0.0050	0.0003	0.0230	0.0283	28.3
Hathin	0.0140	0.0006	0.0650	0.0796	79.6
Kheri Sampala	0.0250	0.0012	0.1150	0.1412	141.2
Nuh	0.0068	0.0003	0.0310	0.0381	38.1
Dujana	-----	-----	-----	-----	-----
Hasanpir	0.0020	0.0001	0.0100	0.0121	12.1
Dundahera	0.0150	0.0007	0.0720	0.0877	87.7
Bilaspur	-----	-----	-----	-----	-----
Kakoda	-----	-----	-----	-----	-----

It as observed that Ghaziabad and Meerut have the maximum pollution load of 3.53 t/day and 3.57 t/day respectively; Khurja is observed to have the least pollution. It may be noted that pollution load in urban centres shall be much higher than estimated depending on the ownership and travel distance by various modes within the town. Without conducting detailed origin and destination survey of every urban mode this cannot be done. However, considering that vehicle ownership is low compared to NCT of Delhi in rest of NCR, and apart from few cities such as Ghaziabad, Meerut, Faridabad, and intra-urban movement by vehicular traffic is unlikely to be heavy. Although some increase may be anticipated, it is unlikely to be very significant.

5.0 Heritage and Tourism

5.1 Heritage - NCR

Heritage and Tourism Management is a new area of concern for the NCR Plan. Hence no review of earlier plans has been undertaken.

Perhaps on account of its absence from the earlier plan, the heritage of the region has suffered through neglect, and ironically also due to the various acts of omission and commission attributable to the 'planned' development of urban settlements and industrial areas.

While the few monuments protected by ASI or State Archaeology have survived reasonably intact, a much larger number of unprotected monuments have suffered due to neglect, vandalism and encroachments since there was no mechanism to prevent it in the Regional Plan. The unprotected monuments refer to those monuments, which have not yet been identified as culturally valuable, but are nevertheless, good examples of cultural/historical heritage, which should be provided, with some level of protection.

Another valuable area of heritage that is being slowly obliterated are the still extant examples of traditional urbanscape. This is because neither the Centre/State Archaeological Protection Acts recognise them as possessing heritage value. These areas may or may not contain individual buildings which qualifying for protection, but when considered as an ensemble, they represent valuable heritage worthy of being conserved.

A similar background characterises the tourism management scenario. Many individual sites have been developed to cater to either leisure or pilgrimage tourism within the region, but when viewed in the larger perspective of the region, they add up to be only piecemeal strategies for specific sites. Such uncoordinated strategies fail to capitalise on the tremendous potential of tourism development as a major agency for purposefully directing land use and generating economic development in the region.

There is of course, a close and symbiotic relationship between the imperatives of tourism and heritage conservation, which the uncoordinated piecemeal strategies of heritage protection and tourism development has failed to exploit so far.

5.1.1 Identification of Heritage sites

The number of Centrally and State protected monuments in the NCR is as follows

Table 18: Number of protected monuments in various States of NCR

Protection/ State	Haryana	Uttar Pradesh	Rajasthan	Delhi	Total
Centrally Protected	63	26	03	166	258
State Protected	01	02	17	N.A	20

Besides the above legally protected monuments, the Indian National Trust for Art and Cultural Heritage (INTACH) have 'Listed' a large number of monuments as being worthy of receiving protection in the NCR, as follows

Table 19: Number of Monuments listed by INTACH

Haryana	Uttar Pradesh	Rajasthan	Delhi	Total
334	NA	85	1208+26 Conservation Areas	1627+26 Conservation Areas

It may be noted that the above list is not complete. Further listing work should be undertaken by the appropriate authorities. The details of the list so far completed is available in the INTACH library. This list is indicative of the rich potential for bringing to light the extraordinary heritage/history of this region. It also begins to identify the existence of conservation areas, which require immediate attention in the new regional plan.

5.1.2 Policy for protection of Heritage sites

There are currently three instruments to provide protection to heritage sites

a) Central legislation for protection of nationally significant monuments: The Ancient Monuments and Archaeological Sites and Remains Act of 1958.
b) State legislation for protection of monuments of State significance.
c) The respective Town and Country Planning legislation's of each State, which regulate the land use around the monuments.

All the Centrally protected, State protected and listed buildings should be identified with their footprints on the Master Plan/Zonal Plan of each town or the District level plan. Specific requirements for their protection should be specified, and may vary according to the level of significance. NCRPB should constitute a special committee of experts to draft the necessary guidelines for adoption by each State.

A similar process must be initiated for the protection of Conservation Areas in the NCR. While the Central and State legislations ensure physical protection of the building /site, they have not been able to control the development of the land appurtenant to the actual protected area.

This is where it is possible to employ the instrument of the Town and Country Planning legislation to protect the area around the protected monument. Unfortunately, this instrument has seldom been employed effectively in the process of making the Master Plan. Even in the privileged circumstances of Delhi it has not been done, and this is primarily because the possibility of doing so has not been recognised. The NCRPB should focus on this issue to achieve the objectives of legally protecting the cultural heritage of the region.

Each TCP legislation has provisions for the development of 'Special Areas'. Each State should use this instrument to declare the area around protected monuments to be "Special Areas" and make area level plans for an area covering 300 metres around it. These plans should clearly indicated the nature of development which can and cannot take place within this area in conformity with the prescriptions provided in the Central and State archaeological protection legislation.

In addition appropriate agencies should be engaged to complete the listing of monuments and conservation areas of all the towns in the NCR on a priority basis. This listing should be clearly identified in the respective Master Plan of each town, and the respective District level plans, and the nature of protection as per paragraph 3.6 above should be duly worked out.

In addition to protected/listed monuments, it is not unlikely that in view of the rich history of this region that hidden or not-yet-excavated sites also exist. The respective departments of archaeology should indicate where they reasonably expect to find underground ruins, and these areas should be duly identified in the Master Plan for each town and the respective District level plans. Buildings proposed to be constructed in these areas should require a no-objection certificate from the relevant departments of archaeology before the building plans are sanctioned.

If evidence of historic buildings are revealed during the excavation for foundation, then the appropriate departments of archaeology should be allowed a specified period of time to record the evidence from this site and remove any artifact that is found before construction activity is permitted to proceed.

A distinction needs to be made between the legally protected buildings and the "listed" buildings. The "Listed" buildings do not require the same level of scientific protection as the Centrally and State protected monuments. Here the principles of conservation, which permit intervention following approved guidelines, should be followed.

In particular, buildings, which are lived in, or could be reused for other more contemporary purposes should be prioritised for conservation, and financial incentives should be made available for their development.

Table 20: Heritage Monuments / Sites in NCR

District	Name of Place	Description of Site	Legal Protection
Rajasthan Sub-Region			
Alwar District	1.	Bala Fort	State Protected
	2. Alwar	Musirani Ka Chaatri & Sagar	
	3. Alwar	Museum & City Palace	
	4. Alwar	Company Baag	
	5. Alwar	Fateh Jang Gumbad	
	6. Alwar	Andheri & Adapara	
	7. Near Siliserh	Garvagi	
	8.	Bhurasid	
	9. Along SH13	Kushalgarh Fort	
	10. Near Tuara	Ladarwada Fort	
	11. Near Tuara	Suraj Mukhi	
	12. Near Tuara	Jain Temple	
	13. Near Tuara	Bharathari Ki Gumbad	
	14. Near Tuara	Lal Masjid	
	15. Neemrana (NH18)	Neemrana Fort	
	16. Along (SH10)	Kesroli Fort	
	17.	Vijay Sagar	
	18. Alwar	Siva Temple	Centre Protected
	19. Bhangadh	Ancient Site	
	20. Pandrupol	Ancient Remains	
Haryana Sub- Region			
Faridabad District	21. Lakarpur		Centre Protected
	22. Anangpur		
	23. Ghosipur Sarai		
	24. Aitmadpur		
	25. Mawai		
	26. Sikri		
	27. Gaothpuri		
	28. Khatalla		
	29. Banchari		
	30. Banchari	Kosminar	
	31. Hodal	Kosminar	
	32. Palwal	Kosminar	
	33. Kusalipur/Khusropur	Kosminar	
	34. Aurangabad		
	35. Bhulwana		
	36. Alapur		
	37. Bamnikhera		
	38. Nagla Ausanpur	Kosminar	
	39. Bridge at Bhuriya Nala		
	40. Suraj Kund		
	41. Near Lohina (Gaunchchi Drain)	Kosminar	
	42. Near Bhulwana	Kosminar	
	43. Agwanpur	Kosminar	
	44. Phulwari	Kosminar	
Gurgaon District	45. Sarai Ali Vardi Khan		
	46. Farruknagar		
Sonipat District	47. Akbarpur Barosa	Kosminar	Centre Protected
	48. Baiyanpur		
	49. Gannaur		
	50. Jagdishpur		
	51. Jawahri		
	52. Panchi Gujran		
	53. Rajpur		
	54. Sonipat		

	55. Sonipat - Tomb of Khwaja Khisr		
Panipat District	56. Jatipur	Kos Minar	Centre Protected
	57. Riwana	Kos Minar	
	58. Mahana	Kos Minar	
	59. Panipat City	Kos Minar	
	60. Panipat (South)	Kos Minar	
	61. Siwah	Kos Minar	
	62. Kala Am	Obelisk	
	63. Panipat	Bab-E-Faiz Gate	
	64. Panipat	Kabuli Bagh Mosque Enclosure	
	65. Panipat	Ibrahim Lodi's Tomb	
Rohtak District	66. Rohtak City	Khokhrakot (Arch. Monument)	State Protected
	67. Maham	Shahjahan Ki Baoli	Centre Protected
Uttar Pradesh Sub-Region			
Meerut District	68. Alamgirpur	Mound Known as Parsu Ram Ka Khera	Centre Protected
	69. At the Junction of Meerut Delhi Road	Cemetry	
	70. Barnawa	Mound Known as Lakha Mandap	
	71. Hastinapur	Mound knowns as Ulta Khera + Mound of Raghunathji	
	72. Meerut	Andhra Court, High Brick Fortress - Built by Mahi	
	73. Meerut	Cemetry on the Meerut Race Course	
	74. Meerut	Tomb of Shah Peer	
	75. Meerut	Begum's Palace	
	76. Mustafabad	Raja Karan-ka-Khera	
	77. Sardhana	Begum's Palace	
	78. Sardhana	Roman Catholic Church	
	79. Sardhana	Tomb of Sardhana Cemetry	
	80. Servara	Two Mounds(Kheras) named Khorkali & Jalapar	
	81. Karkhera	Ancient Mound at Keseri	
	82. Meerut	Baleshwarnath Mandir (Sadar Bazar)	State Protected
	83. Meerut	Begum Samru Mahal (Sadar Bazar)	
Bulandshar District	84. Ahar	Several Large Tumuli Kheras	
	85. Aurangabad - Chandok	Ruins of Chandrani -ka- Mandir	
	86. Bulandshahr	Balai Kot or Upper Fort	
	87. Bulandshahr	Large Mound Moti	
	88. Bulandshahr	2 Cemetries	
	89. Dankaur	Masonry Tank, Ancient Temple	
	90. Indor	Ahirpura Mound, Lesser Temple Mound	
	91. Indor	Kundanpura, Great Temple Mound	
	92. Indor	Paridguna Mounds including 4 mounds	
	93. Indor	Lofty Mound with small village perched on E/NE Side of it	
	94. Shikarpur	Khera or Mound called Talapatnagri or Myaji Khera	
Ghaziabad District	95. Gulistanpur	Ancient Site	Centre Protected

In order to publicise the importance of the heritage of the region, it is recommended that the NCRPB could take atleast two specific initiatives, viz.,

1. Institute awards for buildings which have been well protected/conserved; and,
2. Bring out a bi-yearly report on "The State of Heritage Properties in the NCR"-sub region wise. This report should identify,
    a) A list of monuments at risk
    b) List of professional craftsperson and Master craftsperson
    c) Incentives available for conservation work
    d) Guidelines for conservation of conservation areas
    e) Progress made in documentation of heritage property

5.2 Heritage - NCT of Delhi

Zaffar Hassan in 1911 had identified 1321 monuments in Delhi, and this number has also been reflected in MPD-2001. Unfortunately because there was no positive policies for the conservation, over the years this number has reduced to 1208, which has been compiled by INTACH recently and has also been notified by Municipal Corporation of Delhi as heritage buildings.

Table 21: List of Heritage Buildings in the area under jurisdiction of the Municipal Corporation of Delhi (MCD)

Zone	Name of the Building	Location
Zone A (Walled City	Idgah	West of Paharganj
	Lady Reading Health School	Sadar Bazar
	Dispensary Lady Reading Health School	Sadar Bazar
	Outer Gateway Qila Qadam Sharief	Nabi Karim
	Inner Gate Qila Qadam Sharief	Nabi Karim
	Mosque, Qila Qadam Sharief	Qila Qadam Sharief
	Gateway of Qadam Sharief Shrine	Nabi Karim
	Qadam Sharief Shine	Nabi Karim
	Firoz Shah's Mosque	Nabi Karim
	Kunwari Begam Ka Burj Qadam Sharief	Nabi Karim
	Enclosure Walls, Qila Qadam Sharief	Qadam Sharief, Nabi Karim
	Tomb	Tail Mill Road, Ram Nagar
	Hari Masjid	Chuna Mandi Paharganj
	Mosque	Chitra Gupta Road, Paharganj
	Chitra Gupta Temple	Paharganj
	Haveli	Opposite Hare Krishan Guest House, Paharganj
	Mosque	116, Main Bazar Road, Paharganj
	Municipal Corporation Primary School	Main Bazar Road, Paharganj
	Residence	110, Gali Krishna, Paharganj
	Residence	104, Gali Krishna, Paharganj
	Tomb	Outab Road
	Mosque/Imambara	Outab Road
	Shivalaya	New Delhi, Railway Station
	Mosque	New Delhi, Railway Station
	Police Station	Sadar Bazar
	Balika Chaman	New Delhi, Railway Station
	Northern Railway Rest House	Connaught Place
	Sahindi Masjid	Lahori Gate
	Gular Wali Masjid	Fatehpuri
	Ghazi-Ud-Din's Mosque	Fatehpuri
	Muhtasib's Mosque	Fatehpuri
	Gateway	Tilak Bazar, Fatehpuri
	Masjid Ramzan Shah	Fatehpuri
	Haveli	Bazar Naya Bans, Fatehpuri
	Durga Mandir Shivalya	Fatehpuri
	Hauzwali Masjid	Naya Bans, Fatehpuri
	Tahawwur Khan's Mosque	Naya Bans, Fatehpuri
	Residence	306, Kuncha Sanjogiram, Naya Bans, Fatehpuri
	Fatehpuri Masjid	Chandni Chowk
	St Stephens Church	Chandni Chowk
	Bhowani Shankar Ki Kacheri	Fatehpuri, Chandni Chowk
	Dharamshala Rai Sahib Lala Laxmi Narayan	Church Mission Road, Fatehpuri
	Bhairav Mandir	Chandni Chowk
	Municipal Corporation Primary Girls School	Kuncha Ghasiram, Chandni Chowk
	Gateway	322, Kuncha Ghasiram, Chandni Chowk
	Gateway	154 Kuncha Ghansiram, Chandni Chowk
	Namak Haram Ki Haveli	Kuncha Ghansiram, Chandni Chowk
	Namak Haram Ki Haveli	316, Kuncha Ghansiram, Chandni Chowk
	Gateway	759, Katra Neel, Chandni Chowk
	Shivalaya Kunniji Maharaj	793, Katra Neel, Chandni Chowk
	Shivalaya	515, Katra Neel, Chandni Chowk
	Manakchanda Visvesvaranath's Shivalaya	577, Katra Nil, Chandni Chowk

	Bada Shivalaya	701, Katra Neel, Chandni Chowk
	Residence	574, Katra Neel, Chandni Chowk
	Shivalaya Ghanteshwar Mahadev	598, Katra Neel, Chandni Chowk
	Residence	575, Katra Neel, Chandni Chowk
	Residence	596, Katra Neel, Chandni Chowk
	Dhumimal's Shivalaya	602, Ghanteshwara Mahadav, Katra Neel, Chandni Chowk
	Residence	649, Katra Neel, Chandni Chowk
	Pandit Hari Ramji Ka Shivalaya	689, Katra Neel, Chandni Chowk
	Dharamshala	Bagh Diwar, Fatehpuri
	Temple School	Bagh Diwar, Fatehpuri
	Residence	508, Haveli Haider Quli, Chandni Chowk
	Haveli	507, Haveli Haider Quli, Chandni Chowk
	Residence	509, Haveli Haider Quli, Chandni Chowk
	Residence	499, Haveli Haider Quli, Chandni Chowk
	ANZ Grindlays Building	534, Chandni Chowk
	Union Bank of India Building	628, Chandni Chowk
	Oriental Bank of Commerce Building	681, Chandni Chowk
	Gateway to Katra Neel	Katra Neel, Chandni Chowk
	Lala Chunna Mal's Haveli	Katra Neel, Chandni Chowk
	Mirza Ghalib's House	2298, Gali Qasim Jan, Bailimaran, Chandni Chowk
	Mirza Ghalib's In-Laws House	Ballimaran
	Mahadev Mandir	S.P Mukherji Marg
	Old Delhi Railway Station	S.P Mukherji Marg
	Police Station	Chandni Chowk
	Punjab National Bank Building	458, Katra Mohan, Chandni Chowk
	MCD Office	Kucha Bagh, Chandni Chowk
	Hakim Mihr Ali Shah's Mosque	Gali Kucha Bagh, Chandni Chowk
	Sunehri Masjid	Chandni Chowk
	Northbrook Fountain	Chandni Chowk
	Gurudwara Sis Ganj	Chandni Chowk
	Central Baptist Church	Chandni Chowk
	Gujrati Temple	1739, Dariba Kalan
	Hardayai Municipal Public Library	Gandhi Ground, Chandni Chowk
	Gateway	2255, Kaudiya Pul, Chandni Chowk
	Bhagirath Palace	Chandni Chowk
	Fort View Hotel	Chandni Chowk
	St. Mary's Church	S. P Mukherji Marg
	Gateway of Zinat Mahal	Lal Kaun
	Office Block	Bazar LaI Kuan
	Gateway	Bazar LaI Kuan
	Gateway	Farash Khana off Bazar Lal Kaun
	Yogmaya Mandir	Kuncha Sanjogiram Bazar, Naya Bazar
	MCD Dispensary	Lal Kuan
	Residence	Mohalla Roadgran, Lal Kuan
	Graves enclosure of Nawan Iradatmand Khan & Nawab Masayar Khan	Mohalla Roadgran, Lal Kuan
	Gateway	Bazar Sikriwalan, Fatehpuri
	Sikriwalans Mosque	Bazar Sikriwalan, Hauz Quazi
	Masjid Mubarak Begum	Bazar Sikriwalan, Hauz Quazi
	Hauz Qazi Mosque	Hauz Quazi Chowk, Fatehpuri
	Gateway	Gali Qasim Jan, Fatehpuri
	Residence	2168, Gali Qasim Jan, Ballimaran, Chandni Chowk
	Haveli	2160, Ahata Kale Saheb, Bailimaran, Chandni Chowk
	Hindustani Dawakhana	Ballimaran, Chandni Chowk
	Gateway	3639,ChawriBazar
	Shri Digamber Jain Naya Mandir	Fatehpuri
	Anand Aushdhalya	Bailimaran, Chandni Chowk
	Shri Agarwal Digamber Jain Panchayati Mandir	Fatehpuri
	Residence	2293, Dharampura, Fatehpuri

	Residence	2218, Dharampura, Fatehpuri
	Shri Digambar Jain Maru Mandir	Fatehpuri
	Prakash Nursery School	Dharampura, Fatehpuri
	Commercial-cum-Residential Building	Fatehpuri
	Residence	2942, Katra Kushal Rai, Kinari Bazar, Chandni Chowk
	Residence	1961, Katra Kushal Rai, Kinari Bazar, Chandni Chowk
	Ram Nath Inder Devi Trust	Kinari Bazar, Chandni Chowk
	Jain Temple	Kinari Bazar, Chandni Chowk
	Naugharana	Kinari Bazar, Chandni Chowk
	Residence	West end of Kinari Bazar, Chandni Chowk
	Nawab Sahib's Mosque	Kinari Bazar, Chandni Chowk
	Gateway	Near Panchayati Jain Mandir
	Residence	Dariba Kalan, Chandni Chowk
	Jain Temple	1541, Dariba Kalan Chandni Chowk
	Jain Temple	1513, Dariba Kalan, Chandni Chowk
	Gate to Kuncha-I-Ustad Hamid	Krishna Gali, Jama Masjid
	Indraprastha Hindu Girls Senior Secondary School	Jama Masjid
	Lal Mandir	Chandni Chowk
	Kasturba Zanana Hospital	Darayaganj
	Chatta Agha Jan Masjid	Darayaganj
	Bridge Near Lahore Gate, Red Fort	Red Fort
	Baoli	158, Red Fort
	Army Barracks	Red Fort
	Mosque of Ghaziuddin Khan	Ajmeri Gate
	Anglo - Arabic Public School	Ajmeri Gate
	Rehmani Masjid	Ajmeri Gate
	Commercial Building	Ajmeri Gate
	Residence	4642-4649, Ajmeri Gate
	MCD Primary Boys School	290-295, Ajmeri Gate
	Residence	4110-4141, Gali Shah Tara, Ajmeri Gate
	Guler Wali Masjid	Kuncha-I-Shah Tara, Ajmeri Gate
	Unchi Masjid	Kuncha-I-Shah Tara, Ajmeri Gate
	Qabronwali Masjid	Kuncha-I-Shah Tara, Ajmeri Gate
	Residence	4346, Kuncha-I-Pandit, Ajmeri Gate
	Residence	504, Kuncha Pati Ram, Bazar Sitaram
	Nav Jyoti Public School	939, Kuncha Pati Ram, Bazar Sitaram
	Jain Mandir	908, Kuncha Pati Ram, Near Hauz Qazi
	Residence	901, Kuncha Pati Rani, eazar Sitaram
	Residence	908, Kuncha Pati Ram, Near Hauz Qazi
	Residence	834, Mohaila Imli, Bazar Sitaram
	Holy Trinity Church	Turkman Gate
	Badi Masjid	Turkman Gate
	Telion Ka Phatak	Turkman Gate
	Kalan Masjid	Turkman Gate
	Lal Darwaza Bazar	Bazar Sita Ram
	L. Madan Mashal Lal Ayurvedic Bazar Sita Ram Charitable Dispensary	Bazar Sita Ram
	Haveli	2549 Churiwalan, Bazar, Sita Ram
	Municipal Corporation Ayurvedic Dispensary	1424, Bazar Sita Ram
	Haksar Haveli	Bazar Sita Ram
	Bhartiya Bal Sadan Society	Bazar Sita Ram
	Dharamshala Lala Pyarey Lal Madho Ram	Bazar Sita Ram
	Amrudwali Mosque	Bazar Sita Ram
	Residence	2837, Rehman Building, Bazar Sita Ram
	Anjuman Masjid	Bazar Sita Ram, Chandni Chowk
	Tomb of Shah Turkman	Mohalla Qabrustan, Turkman Gate
	Tomb Raziya Sultan	Bulbuli Khana, Turkman Gate
	Mosque	Bazzar Matya Mahal, Near Jama Masjid
	Mosque Shah Gulam Ali	Kuncha Mir Hashim, Turkman Gate
	Dargah Shah Gulam Ali	Kuncha Mir Hashim, Turkman Gate

	Residence	3460, Netaji Subhash Marg, Daryaganj
	Sunehri Masjid	West of Netaji Subhash Marg, Daryaganj
	Shri Digamber Jain Mandir	Delhi Gate
	Masjid Daiwali	Kuncha Chetan, Daryaganj
	Jain Temple & School	Daryaganj
	Hotel Moti Mahal	Netaji Subhash Marg, Daryaganj
	Residence & Commercial Building	4, Netaji Subhash Marg, Daryaganj
	Commercial Street	8-14, Netaji Subhash Marg, Daryaganj
	Residence, Commercial Building	15-16, Netaji Subhash Marg, Daryaganj
	Commercial Street	19-23, Netaji Subhash Marg, Daryaganj
	Street With 14 Buildings	26-40, Netaji Subhash Marg, Daryaganj
	Dargah Shah Shabir Baksh	5051, Netaji Subhash Marg, Daryaganj
	Masjid Beriwali	5052, Netaji Subhash Marg, Daryaganj
	Police Station	Daryaganj
	Residence, DCP Central	Daryaganj
	H.M. D.A.V Middle School	Daryaganj
	Shroff Eye Hospital	Daryaganj
	Hindi Park Housing Area	Hindi Park, Daryaganj
	Mosque	Hindi Park, Daryaganj
	City Wall South Darya Ganj	Daryaganj
	MorteIla Tower	Daryaganj
	Residence	Ansari Road, Daryaganj
	Residence Dr. Ansari's House	Ansari Road Daryaganj
	Phatak Halish Khan	Tilak Bazar, Fatehpuri
	Gateway	Ballimaran, Fatehpuri
	Allahabad Bank Building	Chandni Chowk
	Town Hall	Chandni Chowk
	Company Bagh	North of Town Hall
	Gateway To Katra Nawab	Chandni Chowk
	State Bank of India	Chandni Chowk
	Residence	1222, Chandni Chowk
	Mahabir Jain Bhawan	1417, Chandni Chowk
	Haveli of Ahsanullah Khan	Bazar Sikriwalan, off Lal Kuan
	Residence	5012, Phatak Bans, Lal Kuan
	Residence	5051, Bazar, Sikri Walan
	Lal Kuan	Bazar Lal Kuan
	Residence	962, Kuncha Pati Ram, Bazar Sita Ram
	Residence	505, Kuncha Pati Ram, Bazar Sita Ram
Zone B (Karol Bagh)	Shikargah	Jonti village, Kanjhaola
	Haveli	Jonti village, Kanjhaola
	Well	Jonti village, Kanjhaola
	Temple	Jonti village, Kanjhaola
	MughaI Tahk	Kanjhaola
	Shivalaya	Jonti village, Kanjhaola
	Milestone/Memorial	Tikri Border, Rohtak Road
	Ramjas S.S. School	Anand Parbat
	Tibbia College	New Rohtak Road
	Residence	New Rohtak Road opposite Tibbia College
	Lal Masjid	Northern end of Faiz Road, Karol Bagh
	Bari Masjid	Bara Hindu Rao
	MCD Co-Ed School	Rani Jhansi Road, Bara Hindu Rao
	MCD Dispensary	Bara Hindu Rao
	Shidion Ki Masjid	Karol Bagh
Zone C (Civil Lines)	Tank	Kuraini Village, Narela
	Wall Mosque	Kuraini Village, Narela
	Memorial	Azadpur Market, G.T. Road
	Coronation Memorial	Kingsway Camp
	Coronation Park	Kingsway Camp
	Embankment	Majnu Ka Tila
	Ammunition Store	Mall Road, Civil Line
	Ammunition Store	Mall Road, Civil Line

	Ammunition Store	Brig. S.K Majumdar Marg, Mall Road, Civil Line
	Colonial Building	Engineers Office, Brig. S.K. Majumdar Marg, Mall Road, Civil Line
	Pathan Ki Masjid	Mall Road, Civil Line
	Mosque	G.T Road Opp. State Bank Colony
	Gateway of Mahaldar Khan's Garden	G.T Road
	Gateway	G.T Road
	Faculty of Arts	Delhi University
	Delhi University Office	Delhi University
	Gwyer Hall	DeIhi University
	St. Stephen's College	Delhi University
	Chapel	St. Stephen College
	Principal's Residence	St. Stephen College
	Guard House	Hindu College
	Old Secretariat	Civil Line
	I. P. College for Women	Civil Line
	Defence Science Centre	Ring Road, Vidhan Sabha
	National Institute of Communicable Diseases	Civil Line
	Meena Devi Jindal Medical Institute & Research Centre	Civil Line
	Sant Parmanand Hospital	Civil Line
	Mosque of Shah Wajid	Roshanara Garden
	MCD Primary School	Roshanara Garden
	Residential Building	Roshanara Garden
	Dharamshala	Subzi Mandi
	MCD Primary School	Roshanara Road
	Hindu Rao Hospital	Civil Line
	Methodist Church	Tis Hazari
	Queen Mary’s School	Tis Hazari
	Principal's Residence	Tis Hazari
	Mosque	Tis Hazari
	St. Stephen's Hospital	Tis Hazari
	St. Stephen's Hospital Chapel	Tis Hazari
	Residence	10, Under Hill Road, Civil Line
	Residence	8, Under Hill Road, Civil Line
	Teacher Hostel	Raj Niwas Marg, Civil Line
	BM Gange Girls School	43 Raj niwas Marg, Civil Line
	Residence	19, Raj niwas Marg, Civil Line
	Chapel	19 Raj niwas Marg, Civil Line
	Delhi United Christian Sr. Sec. School	Civil Line
	Paul’s Sadan	Civil Line
	St. Xavier's School	Civil Line
	Butler Memorial Girls School	Boulevard Road
	Residence	Boulevard Road
	Residence	North East of St. Stephen
	Hospital	Boulevard Road
	St. Stephen's Community Centre	Rajpur Road
	St. Anne's School	Rajpur Road
	Residence	Court Road, Rajpur Road
	Cambridge Brotherhood	Court Lane, Civil Line
	Hotel Oberoi Maidens	Civil Line
	Exchange Store	Civil Line
	Residence	17, Sham Nath Marg
	Canal Rest House	Qudsia Bagh
	Maharaja Agrasen Park	Boulevard Road
	Shia Masjid	Mori Gate
	Suiwali Masjid	Mori Gate
	Ghulam Nabi's Mosque	Mori Gate
	Burhya's Mosque	Mori Gate
	Gulerwali Masjid	Ram Bazar
	Hamilton Road School	Mori Gate

	James Skinner's House	Kashmere Gate
	Dargah Panja Sharif	Kashmere Gate
	Badrudin's Grave	Kashmere Gate
	Residence	Chotta Bazar, Kashmere Gate
	Bengali Club	Kashmere Gate
	Kashmere Gate Market	Kashmere Gate
	N.C.C.Office	Kashmere Gate
	Residence	Lala Sultan Singh Estate, Kashmere Gate
	School	Kashmere Gate
	Lal Masjid	Kashmere Gate
	Colonnaded Building	MCD Office, Kashmiri Gate
	Circular Baradari	MCD Office, Kashmiri Gate
	Madarsa Amima Islama Arbad	Bara Bazar, Kashmere Gate
	Ayurvedic Dispensary	Kashmere Gate
	Office of the Election Commission	Kashmere Gate
	Hamid Ali Khan's Mosque	Kashmere Gate
Zone - D (New Delhi)	Kucheri Court for Traffic Offences	Kashmere Gate
	Water Bastion	ISBT, Kashmere Gate
	NCC Office	Traffic Court, Kashmere Gate
	Gallows Bastion	Kashmere Gate
	Office of Northern Railways	Kashmere Gate
	St. James Church	Kashmere Gate
	St. James Annexe	Kashmere Gate
	Skinner Family's Cemetery	Kashmere Gate
	Delhi College of Engineering	Kashmere Gate
	Archaeological Museum	Kashmere Gate
	Delhi Institute of Technology	Kashmere Gate
	Commemorative Column	Lothian Road, Near Post Office
	Post Office	Kashmere Gate
	Nigam Bodh Ghat	Kashmere Gate
	Northern Railway Officers Rest House	Mukherjee Road
	Lothian Bridge	Mukherjee Road
	Nili Chhatri Temple	Yamuna Bazar
	Jail	Salimgarh Fort
	Museum	Salimgarh Fort
	Ammunition Rooms	Salimgarh Fort
	Market	Club Road off Boulevard Road
	Lok Nayak Jai Prakash Narayan Hospital	Jawahar Lal Nehru Marg
	Lok Nayak Hospital Administrative Block	Jawahar Lal Nehru Marg
	Mosque Mehndiyan	Near Maulana Azad Medical College
	Nursery Mosque	North of Maulana Azad Medical College
	Chaunsath Chamba	West of Maulana Azad Medical College
	Dargah	West of Maulana Azad Medical College
	Enclosure	West of Maulana Azad Medical College
	Memorial	Maulana Azad Medical College
	Jamiat Ulama Hind Masjid	Bahadur Shah Zafar Marg
	Tomb of Shaikh Muhammad Sahib	South of Vikas Marg
	Mosque	South of Vikas Marg (DDA)
	Matka Pir	Mathura Road, South-West corner of Pragati Maidan
	Hammam Purana Qila	Mathura Road
	Tomb Delhi Zoo	Mathura Road
	Azimganj Sarai	National Zoological Park, Sundar Nagar
	Mosque	Lal Bahadur Shastri Marg
	Do Siriya Gumbad	Nizamuddin village
	Tomb	Nizamuddin Villa
	Gateway	West of Nizamuddin Village
	Gateway	Nizamuddin Village
	Khan-E-Dauran Khan's Mosque	Nizamuddin Village
	Tomb	Nizamuddin Village
	Northern Gateway of Dargah complex	Nizamuddin
	Tomb	North-West comer of Baoli, Nizamuddin Village

	Chini Ka Bhurj	Nizamuddin Village
	Tomb of Bai Kodaldai	Nizamuddin Village
	Arcaded Building	Nizamuddin Village
	Gateways to Inner Enclosure of Dargah	Nizamuddin Village
	Dalan of Itqad Khan	Nizamuddin Village
	Enclosure of Nawab Mustafa Khan	Nizamuddin Village
	Majlis Khana	Nizamuddin
	Jamaat Khana Mosque	Nizamuddin
	Tomb	Dargah Complex, Nizamuddin
	Dalan of Mirdha Ikran	Dargah Complex, Nizamuddin
	Langar Khana	Dargah Complex, Nizamuddin
	Eastem Gateway of Dargah	Dargah Complex, Nizamuddin
	Gateway of the House Mirza Jahangir	Dargah CompIex, Nizamuddin
	Residential	Nizamuddin Village
	Gateway Leading to the Tomb of Atgan Khan	Nizamuddin Village
	Dalans	Argah Khan's Tomb Complex
	Bari Ka Gumbad	East of Argah Khan's Tomb Comp.
	Gateway	On the main entry from Mathura Road, Nizamuddin Village
	Well	East of Chaunsath Khambha, Nizamuddin
	Gateway	North-West Chaunsath Khambha
	Mirza Galib tomb	Nizamuddin Village
	Kali Masjid	Nizamuddin Village
	Gateway of Inner Kot	Nizamuddin Village
	Bastion of Inner Kot	Nizamuddin Village
	Tomb of Khan – I - Jahan Tilangani	Nizamuddin Village
	Wall of Inner Kot	Nizamuddin Village
	Shiv Mandir	'G' Block Nizamuddin West
	Chakarwali Masjid	At the intersection of Lodi Road and Mathura Road
	Tomb	South of D.P S., Mathura Road
	Wall Mosque	South Of D.P S., Mathura Road
	Well	Humayun's Tomb Complex
	Well	Sunder Nursery, Nizamuddin
	Mosque	Sunder Nursery, Nizamuddin
	Tomb	Northern side of Humayun's Tomb
	Grave Platform	North of Humayun's Tomb
	Chilla Nizamuddin	North of Humayun's Tomb
	Tomb of Sayyid Yasin	Mathura Road, Nizamuddin
	Gateway	Nizamuddin, East Mathura Road
	Western Gateway	Kotla Mubarakpur, South Ext.
	Residence	Kotla Mubarakpur, South Ext.
	Boli and Well	North of Mubarak Shah's Tomb, Kotla Mubarakpur, South Ext.
	South Gate of Kotla Mubarakpur	Mubarak Shah's Tomb, Kotla Mubarakpur
	Gumti	South of Chaupal Village, Kotla Mubarakpur
	Bridge	North - West edge of Kotla Mubarakpur
	St. Paul's Cathedral	Hospital Marg, Bhogal
	Mosque	Masjid Marg, Bhogal
	MCD Office	Jal Vihar, Shiv Mandir Marg, Lajpat Nagar
	Shivalaya	Jal Vihar, Shiv Mandir Marg, Lajpat Nagar
	Gateway of Temple	Kilokari Village
	Domed Building	Kilokari Village
	Tomb of Kale Khan	Sarai Kale Khan
	Gumti of Shaikh Ali	Defence Colony
	Gateway	Defence Colony
	Tomb of Basti	Defence Colony
	Mosque of Basti	Defence Colony
Zone F (South Delhi)	Temple	NH – 8, Naval Area, Rao Tula Ram Marg
	Two Temples	Rao Tula Ram Marg
	Tomb	Rao Tula Ram Marg
	Gateway	CAMS Complex, Cantonment

	Qasai Wala Gumbad	Vasant Vihar
	Mosque	Vasant Vihar
	Tomb	Vasant Vihar
	Baoli	Vasant Vihar
	Bara Lao Ka Gumbad	Vasant Vihar
	Tomb Known as Baradari	Vasant Vihar
	Mosque	Basant Lok Mkt., Vasant Vihar
	Garden Wall	Vasant Vihar
	Mosque	DTC Depot, Vasant Vihar
	Wall Mosque	Sector-5, R.K. Puram
	Wall Mosque	Sector-5, R.K. Puram
	Mosque	Sector-5, R K. Puram
	Residence	214, Village Munirka
	Malik Munirka Mosque	117, Village Munirka
	Mosque	Between Sector 3 & 4 R. K. Puram
	Mosque of Haji Langa	Sector-3, R.K. Puram
	Haji Langa Gumbad	Munirka
	Gateway	Sector-3, R.K. Puram
	Tomb	Sector-3, R.K. Puram
	Tomb	Mohmmadpur Village
	Chaupal	Mohmmadpur Village
	Tomb	Mohmmadpur Village
	Mosque	Mohmmadpur Village
	Domed Building	Mohmmadpur Village
	Well'	Humayunpur Village
	Maluk Chand Ka Gumbad	Humayunpur Village
	Dalan	Humayunpur Village
	Gumti	Humayunpur Village
	Hauz Khas Tank	Distt. Park, Safdarjung Enclave
	Munda Gumbad	Distt. Park, Hauz Khas
	Idgah	Hauz Khas Village
	Turret	Hauz Khas Village
	Plinth	Deer Park, Hauz Khas Village
	Mosque	Deer Park, Hauz Khas Village
	Kali Gumti	Deer Park, Hauz Khas Village
	Wall Mosque	Deer Park, Hauz Khas Village
	Tuhfewala Gumbad	Deer park, Hauz Khas Village
	Well	F-Block, Green Park
	Barah Khamba	Green Park
	Structure Unknown	Green Park
	Enclosure Wall of Kharera Village	Green Park
	Mosque	Kharera Village
	Mosque of Darwesh Shah	Gulmohar Park
	Bridge	Siri Fort Residential Complex
	Bulbulki	Siri Fort Residential Complex
	Baradari	Shahpur Jat Village
	Building	Masjid Moth, South Extn.
	Gateway	Masjid Moth
	Tomb	Gautam Nagar
	Tomb	Near L.S.R. College
	Gateway	Lala Lajpat Rai Marg
	Tomb	Zamraodpur Village
	Tomb	Zamraodpur Village
	Tomb	Zamraodpur Village
	Tomb	Near H No. 88, Zamraodpur Village
	Tomb	Lane 62, Zamraodpur Village
	Mahavir Library	N-Block G K.-1
	Gateway	Kalkaji Mandir
	KaIka Mandir	Kalkaji
	Dharamshala	Kalkaji Mandir, Kalkaji
	Bund	Mahipalpur Village
	Mahal	Mahipalpur village

	Ruins	Mahipalpur Village
	Ruins	Sector-Pkt.-9, Vasant Kunj
	Enclosure Wall	Vasant Kunj
	Ruins	Vasant Kunj
	Tomb	Katwaria Sarai Village
	Dalan	Katwaria Sarai Village
	Mosque	Kalu Sarai Village
	Chaupal	Kalu Sarai Village
	Gateway of Mosque	Adhchini Village
	Mosque	Adhchini Village
	Gateway	Adhchini Village
	Wall Mosque	Malviya Nagar
	Wall Mosque	Malviya Nagar
	Wall Mosque	Lal Gumbad Complex
	Wall Mosque	Malviya Nagar
	Wall Mosque	Malviya Nagar
	Mahal	Malviya Nagar
	Mosque	Malviya Nagar
	Enclosure	Malviya Nagar
	Enclosure	Sheikh Sarai-I
	Dukh Bhanjan Gurudwara	Sheikh Sarai, Phase-I
	Kharbuze Ka Gumbad	Sheikh Sarai, Phase-I
	Tomb of Shaikh Alauddin	Sheikh Sarai, Phase-I
	Tomb	Sheikh Sarai, Phase-I
	Tomb	Sheikh Sarai, Phase-I
	Tomb of Shaikh Salahuddin	Sheikh Sarai, Phase-I
	Mosque	Sheikh Sarai, Phase-I
	Mosque	Sheikh Sarai, Phase-I
	Tomb	Sheikh Sarai, Phase-I
	Tomb	Sheikh Sarai, Phase-I
	Majlis Khana	Sheikh Sarai, Phase-I
	Mosque	Khirki Village
	Mosque	Khirki Village
	Tomb of Shaikh Usman Saiyah	Khirki Village
	Lal Gumbad II	Panchsheel Enclave
	Madarsa Zeenatul	Panchsheel Enclave
	Northern Gateway of Chiragh Delhi	Chiragh Delhi Village
	Circular Bastion and Chattri	Chiragh Delhi Village
	Eastern Gateway and Walls of Chiragh Delhi	Chiragh Delhi
	Southern Gateway and Walls of Chiragh Delhi	Chiragh Delhi
	Western Gateway of Chiragh Delhi	Chiragh Delhi
	Eastem Gateway of Inner Enclosure	Chiragh Delhi
	Tomb of Roshan Chiragh Delhi	Chiragh Delhi
	Mosque of Farukhsiyar	Chiragh Delhi
	Tomb	Chiragh Delhi
	Tomb of Shaikh Zainuddin	Chiragh Delhi
	Tomb of the Grand Daughter of Shaikh Farid Shakarganj	Chiragh Delhi
	Mosque	Chiragh Delhi
	Mahfil Khana	Chiragh Delhi
	Tomb	Chiragh Delhi
	An Enclosure	Chiragh Delhi
	Tomb	Chiragh Delhi
	Majlis Khana	Chiragh Delhi
	Grave Enclosure	Chiragh Delhi
	Gateway Chiragh Delhi	Chiragh Delhi
	Gateway	Near H No.344, Chiragh Delhi
	Tomb	Chiragh Delhi
	Tomb of Haji Khanam	Near H.No.344, Chiragh Delhi
	Turret	Near H.No.344, Chiragh Delhi
	Jain Temple	Near H.No.341, Chiragh Delhi
	Hanuman Temple	Chiragh Delhi

	Kos Minar	Mathura Road
	Tomb	M.B. Rd. Lado Sarai
	Tomb	Lado Sarai
	Mosque	Lado Sarai
	Tomb of Shaikh Haidar	M.B. Road
	Residence	Saidul Ajaib Village
	Plinth of Mosque	Saidul Ajaib Village
	Baoli	Press Enclave
	Tomb-Kala Gumbad	Tughlaqabad Institutional Area
	Well	Tughlaqabad Institutional Area
	Plinth And Well	Tughlaqabad Fort
	Embankment	Tughlaqabad Fort
	Kos Minar	Badarpur Sarai
	Northern Gateway	Badarpur Sarai
	Central Gateway	Badarpur Sarai
	Shahi Masjid	Badarpur Sarai
	Southern Gateway	Badarpur Sarai
	Kos Minar	Mathura Road
	Qutub Rest House	Mehrauli
	The Farmhouse Restaurant	Mehrauli
	Metcalfe's Folly 1, 2	Mehrauli
	Colonial Building	Mehrauli
	Mosque	Mehrauli
	Chaumukha Darwaza	Mehrauli
	Anang Tal	Lalkot Excavation
	Residence	Ward-1, Mehrauli
	Mosque of Wafati Shah	Mehrauli
	Mehrauli Public Library	Mehrauli
	Haveli	Ward-l, Mehrauli 159
	Residence	Ward-1, Mehrauli
	Temple of Jog Maya	Ward-1, Mehrauli
	Priest's Residence	Ward-1, Mehrauli
	Residence	10/6 Ward-1, Mehrauli
	Baradari at Jog Maya Temple	10/4 Ward-1 Mehrauli
	Primary School	Ward-1, Mehrauli
	Residence	6653, Ward-I, Mehrauli
	Residence	10/8, Mehrauli
	Prachin Sidh Shri Hanuman Mandir	Mehrauli
	St. John's Church Complex	Mehrauli
	Mosque of Quazian	Near Mehrauli
	Primary Health Centre	Mehrauli
	M.C.D. House Tax Office & Ward-1, Vocational Training Centre	Mehrauli
	Wall Mosque	Ward 1, Mehrauli
	Gateway	1081, Ward-1, Mehrauli
	Residence	1018, Ward-1, Mehrauli
	Original Gateway of Dargah Sharif	Ward-1, Mehrauli
	Residence	994, Ward-7, Mehrauli
	Noori Masjid	965, Ward-7, Mehrauli
	Dilkusha Mosque	Mehrauli
	Residence	324, Ward-4, Mehrauli
	Residence	299, Ward-4, Mehrauli
	Residence	300, Ward-4, Mehrauli
	Residence	294, Ward-4, Mehrauli
	Well	Ward-4, Mehrauli
	Residence	445, Ward-3, Mehrauli
	Residential	Street 431-436, Ward-3, Mehrauli
	Residence	260, Ward-2, Mehrauli
	Residence Gateway of Mohalla	450, Ward-3, Mehrauli
	Residence	341, Ward-4, Mehrauli
	Residence	341, Ward-4, Mehrauli
	Residence	254, Ward-4, Mehrauli

	Residence	359, Ward-4, Mehrauli
	Residence	535, Ward-5, Mehrauli
	Chowk	Ward-5, Mehrauli
	Residence	554, Ward-5, Mehrauli
	Residence	646, Ward-5, Mehrauli
	Residence	667, Ward-5, Mehrauli
	Residence	515, Ward-5, Mehrauli
	Shops Cum	Residence 494, Ward-6 Mehrauli
	Chaupal	Ward-6, Mehrauli
	Sarai Wali Masjid	Ward-7, Mehrauli
	Shops Cum Residence	796, Ward-6, Mehrauli
	Gateway Leading To Residential Cluster	802, Ward-6, Mehrauli
	Gateway	936, Ward-7, Mehrauli
	Residence	813, Ward-6, Mehrauli
	Residence	435, Ward-6, Mehrauli
	Commercial Cum Residential Street	Ward-6, Mehrauli
	Hazi Jamal-ud-Din Building	877, Ward-6, Mehrauli
	Residence	Behind 877, Ward-7, Mehrauli
	Gateway	Ward-6, Mehrauli
	Hijron Ka Khanqah	Ward-6, Mehrauli
	Shop Cum Residence	848, Ward-8, Mehrauli
	Veterinary Clinic	882, Ward-6, Mehrauli
	Kali Chand Building	895, Ward-8, Mehrauli
	Mosque	Ward-8, Mehrauli
	Tomb	Mehrauli
	Dargah of Hazrat Shiekh Abdul Haq Muhaddis Dahlvi	Mehrauli
	Dalan Adjacent to Grave of Sayyid Niyaz Muhammad	Mehrauli
	Naalnandon-Ki-Masjid	Mehrauli
	Godown	Ward-6, Mehrauli
	Sarai of Shaikh Inayatullah	893, Ward-8, Mehrauli
	Tomb	892,Ward-8, Mehrauli
	Hauz-I-Shamsi	Ward-8, Mehrauli
	Two Mosque	Ward-8, Mehrauli
	Tomb	Ward-8, Mehrauli
	Auliya Masjid	Ward-8, Mehrauli
	Jharna	Ward-8, Mehrauli
	Pankhe Wali Mosque	Mehrauli
	Mosque of Maulana Jamali	Ward-8, Mehrauli
	Mosque &Tomb	Ward-8, Mehrauli
	Mosque	Ward-8, Mehrauli
	Mosque	Ward-8, Mehrauli
	Tomb & Mosque of Makhdum Samauddin	Ward-8, Mehrauli
	Gateway/Tomb	Mehrauli
	Northern Gateway of Dargah of Qutub Sahib	Mehrauli
	Dargah & Mazar of Saika Baba	Mehrauli
	Gateway of Maulana Fakhruddin	Mehrauli
	Residence	Dargah of Qutub Sahib, Mehrauli
	Mosque	Dargah of Qutub Sahib, Mehrauli
	Grave & Mosque of Motamad Khan	Dargah of Qutub Sahib, Mehrauli
	240 Tomb of Maulana Fakhruddin	Dargah of Qutub Sahib, Mehrauli
	First Gateway of Farrukhsiyar	Dargah of Qutub Sahib, Mehrauli
	Inner Gateway of Farrukhsiyar	Dargah of Qutub Sahib, Mehrauli
	Dargah of Khawaja Qutubuddin Baktiar Kaki	Dargah of Qutub Sahib, Mehrauli
	Tomb of Khwaja Abdul Aziz Bastami	Dargah of Qutub Sahib, Mehrauli
	Mazar of Hazart Qazi Hameeduddin Nagauri	Dargah of Qutub Sahib, Mehrauli
	Mosque & Grave of Zabita Khan	Dargah of Qutub Sahib, Mehrauli
	Mosque of Qutub Sahib	Dargah of Qutub Sahib, Mehrauli
	Baoli of Qutub Sahib	Dargah of Qutub Sahib, Mehrauli
	Majlis Khana	Dargah of Qutub Sahib, Mehrauli
	Graveyard	Dargah of Qutub Sahib, Mehrauli
	Gateway	Dargah of Qutub Sahib, Mehrauli

	Grave of Murad Bakht	Dargah of Qutub Sahib, Mehrauli
	Tomb	Dargah of Qutub Sahib, Mehrauli
	Entrance Gateway	Dargah of Qutub Sahib, Mehrauli
	Gultashi Wali Masjid	Dargah of Qutub Sahib, Mehrauli
	Gateway	Dargah of Qutub Sahib, Mehrauli
	House of Mirza Babar	Ward-8, Mehrauli
	Walled Garden	Ward-8, Mehrauli
	Tomb Enclosure	Ward-7, Mehrauli
	Tomb	Ward-7, Mehrauli
	Tomb of Shaikh Sulaiman	Ward-7, Mehrauli
	Tomb	Ward-7, Mehrauli
	Gateway	Ward-7 Mehrauli
	Gateway	1003, Ward-7, Mehrauli
	Metcalfe's Boat House	DDA Park, Mehrauli
	Gate Posts	DDA Park, Mehrauli
	Well	DDA Park, Mehrauli
	Well	DDA Park, Mehrauli
	Tomb	DDA Park, Mehrauli
	Tomb	DDA Park, Mehrauli
	Mosque	DDA Park, Mehrauli
	Mosque	DDA Park, Mehrauli
	Walled Enclosure	DDA Park, Mehrauli
	Two Arched Dalans	DDA Park, Mehrauli
	Colonnade	DDA Park, Mehrauli
	Mosque	DDA Park, Mehrauli
	Mosque & Tomb	DDA Park, Mehrauli
	Mosque	DDA Park, Mehrauli
	Mosque	DDA Park, Mehrauli
	Mosque	DDA Park, Mehrauli
	Enclosure	DDA Park, Mehrauli
	Arched Dalan	DDA Park, Mehrauli
	Walled Mosque	DDA Park, Mehrauli
	Canopy	DDA Park, Mehrauli
	Walled Mosque	DDA Park, Mehrauli
	Ruins	Balban's Tomb
	Tomb	DDA Park, Mehrauli
	Dalan	DDA Park, Mehrauli
	Tomb	DDA Park, Mehrauli
	Wall	DDA Park, Mehrauli
	Tomb Enclosure	DDA Park, Mehrauli
	Tomb of Khan Shahid	DDA Park, Mehrauli
	Stables	DDA Park, Mehrauli
	Mosque	DDA Park, Mehrauli
	Arched Dalan	DDA Park, Mehrauli
	Tomb	DDA Park, Mehrauli
	Tomb	DDA Park, Mehrauli
	Mosque of Maulana Majduddin	DDA Park, Mehrauli
	Guard Houses	DDA Park, Mehrauli
	Domed Building	DDA Park, Mehrauli
	Ashoka Mission	DDA Park, Mehrauli
	Baghichi Ki Masjid	DDA Park, Mehrauli
	Mosque Ladha Sarai	Mehrauli
	Plinth of Wall Mosque	DDA Park, Mehrauli
	Takya of Kamli Shah	Ladha Sarai, Mehrauli
	Gateway	Mehrauli
	Mosque & Domed Building	Mehrauli
	Mosque	Ward-8, Mehrauli
	Mosque	DDA Park, Mehrauli
	Chihaftan Chihalman	DDA Park, Mehrauli
	Tomb	DDA Park, Mehrauli
	Enclosure	DDA Park, Mehrauli
	Sohan Burj	DDA Park, Mehrauli

	Mosque & Domed Gateway	DDA Park, Mehrauli
	Plinth of Mosque	DDA Park, Mehrauli
	Mosque	DDA Park, Mehrauli
	Idgah	Mehrauli
	Tomb	Near Idgah, Mehrauli
	Tomb of Shaikh Shihabuddin	Near Idgah, Mehrauli
	Platform	Mehrauli
	Chillagah	Mehrauli
	Mosque	Badarpur Road, Mehrauli
	Metcalfe's Folly 3	Mehrauli, Mahipal Pur Road
	Badi	Mahipal Pur Road, Mehrauli
	Dadabari Jain Mandir	Mehrauli
	Ruin of Arch	Andheria Mode, Mehrauli
	Saubate Tomb	Kishangarh, Mehrauli
	Enclosure Walls	Kishangarh Pahari, Mehrauli
	Mosque	Kishangarh Pahari, Mehrauli
	Gateway	Kishangarh Pahari, Mehrauli
	Enclosure	Kishangarh Pahari, Mehrauli
	Wall Mosque	Kishangarh Pahari, Mehrauli
	Ruins	Kishangarh Pahari, Mehrauli
	Embankment	Sultanpur
	Baoli	Sultanpur
	Unnamed	Ward-8, Mehrauli
	Unknown Structure	DDA Park, Mehrauli
	Building Un-known	DDA Park, Mehrauli
Zone G (West Delhi)	Delhi Gate, Najafgarh	Najafgarh
	Jami Mosque	Najafgarh
	Residential-cum-Commercial	Najafgarh, Main Street
	Residential-cum-Commercial	Najafgarh
	Dharamshala	Near Temple Chowk, Najafgarh
	Residence	Najafgarh, adjacent to the Arya Samaj Mandir
	Police Station	Najafgarh
	Mosque	Police Station compound, Najafgarh
	Haveli	Mitraon Village, West of Najafgarh
	Domed Chattri	Mitraon Village, West of Najafgarh
	Samadhi of Mitra Sen	Mitraon Village, West of Najafgarh
	Temple	Mitraon Village, West of Najafgarh
	Haveli	Mitraon Village, West of Najafgarh
	Ruins of Haveli	Mitraon Village, West of Najafgarh
	Dalan	Main Highway, Mitraon Village
	Tomb of Rana Sahib	East of Najafgarh
	Minar	Hashtsal village, West of Vikaspuri & North of Uttam Nagar
	Hati Khana	Hashtsal village
	Dalans	Hashtsal village
	Residence	Pehladpur village, Palam Road, Near Air Force Museum
	Residence	Pehladpur village, Palam Road
	Residence	Pehladpur village, Palam Road
	Tomb of Sohel	Adjacent to Indira Gandhi International Airport
	Gateway	Mehram Nagar, opposite Indira Gandhi Airport
	Mosque	Mehram Nagar, opposite Indira Gandhi Airport
	Eastem Gateway	Mehram Nagar, Domestic Airport
	Enclosure Walls	Sarai Mehram Nagar, opposite Domestic Airport
	Katra	North of Mehram Nagar
	Garden of Mehram Khan	North of Mehram Nagar
Zone H (North West Delhi)	Well	District Park, adjacent to Police Station, Shalimar Bagh
	Wall	Swami Narayan Rd., Shastri Nagar
	Police New Clothing Depot	Shahzada Bagh, Old Rohtak Road
	Ruins	Ring Road, Shakurpur

Note -All the zones refer to the planning zones of MPD-2001

Out of these 1208 monuments, 166 are centrally protected monuments by ASI, some of the important such monument have been shown in map enclosed. These are protected under 1958 ASI Act. Besides these the State Govt. is proposing to notify about 150 monuments as per tentative list given by Deptt. of Archeology.

Table 22: Building Listed under ASI in MCD Area

1. Adham Khan's tomb
2. Adilabad
3. Aisarwala mosque and tomb
4. Ajmeri Gate
5. Amir Khusraw's tomb
6. Arab-Sarai
7. Ashokan rock-edict
8. Ashokan pillar
9. Atga Khan's tomb
10. Badayun Gate
11. Badli-Sarai
12. Bagh-i-Alam-ka-Gumbad and mosque
13. Bahadur Shah Zafar's Palace (Lal Mahal)
14. Bandi-Poti-ka-Gumbad
15. Boali, Ghiyaspur
16. Boali, Maharuli (Gandak-ki-Baoli)
17. Baoli, Munirka
18. Baoli, Ridge
19. Bara-Gumbad
20. Bara-Khamba, Kharera
21. Bara-Khamba, Nizamuddin
22. Barapula
23. Bare-Khan-ka –Gumbad and Chhote-Khan-ka-Gumbad
24. Bhure-Khan-ka-Gumbad
25. Bijay Mandal
26. Biran-ka –Gumbad
27. Biwi-Dadi-ka-Gumbad
28. Bu-Halima's Garden
29. Buhlul Lodi's tomb
30. Chauburji
31. Chaunsath-Khamba
32. Chhota-Batashewala-Mahal
33. Chhoti-Gumti
34. Chor-Minar
35. Darya Khan's tomb
36. Delhi Gate
37. Flagstaff Tower
38. Ghaziud-Din Khan's tomb, Ghiyathud-Din Tughluq's, Tomb and Muhammad-bin
39. Toughluq's grave
40. Hauz-Khas monuments including Firuz Shah's tomb
41. Hauz Shamsi and Mosque
42. Humayun's tomb
43. Idgah
44. Iron pillar
45. Isa Khan's tomb
46. Jahanara's Wall
47. Jahanppanah Tomb
48. Jahaz - Mahal
49. Jamali -Kamali's Mosque and Tomb
50. Jantar - Mantar
51. Jawid Khan's Tomb
52. Kala - Gumbad
53. Kali - Gumti
54. Kashmiri Gate
55. Khairul-Manazil-Masjid
56. Khan-i-Khanan's tomb
57. Khirki - Masjid
58. Kos - Minar
59. Kotla Firoz Shah including Ashokan pillar
60. Jami - Masjid

61. Lakkarwala tomb
62. Lal - Bangla
63. Lal - Darawaza
64. Lal - Kot
65. Lal - Qila Red Fort including Naubat – Khana, Diwan – i – Am, Diwan – i – Khas, Moti Masjid, Hammam, Sawan – Bhadon, etc.
66. Lodi Bridge
67. Lothain Road Cemetery
68. Madhi -Masjid
69. Makhdum -Sahib's mosque
70. Mirza Jahangir's tomb
71. Mirza Muzaffar Sahib's tomb (Bara Batashewala Mahal)
72. Mosque Dargh Qutbud-din Bakhtyar Kaki
73. Moth –Masjid, Mahrauli
74. Mubrak Khan-ka-Gumbad
75. Mubarak Shah's mosque and tomb
76. Muhammad Shah's tomb
77. Muhammadwali mosque
78. Munda - Gumbad
79. Mutiny Telegraph memorial
80. Nai – ka – kot
81. Najaf Khan's tomb
82. Nichoson Cemetery
83. Nila - Gumbad
84. Nili - Masjid
85. Nizamud -Din's tomb
86. Pir - Ghaib
87. Punjabi Gate
88. Purana – Qila including Sher – Mandal, Qila -i- Kuhna - Masjid
89. Qila Rai Pithora
90. Qudsiva - Bagh Gateway
91. Qudsiya - Bagh mosque
92. Qutub monuments including Alai Minar, Alai Darwaza, Alaud -Din's tomb, Iltutmish's tomb, Quwwatul - Islam Masjid, Qutub Minar, etc
93. Rajon – ki – Bain
94. Rajpur Cemetery
95. Raushanara's tomb and Baradari
96. Sabz -Burj
97. Safdar - Jung's tomb
98. Sakri - gumti
99. Satpula
100. Shah Alam Bahadur Shah's Tomb
101. Shaikh Kabirud - Din's tomb
102. Sher Shah's Gate or Moti gate
103. Shikargah-Kushk
104. Shish Gumbad
105. Sikandar Lodi's tomb
106. Siri Fort
107. Sultana Raziya's tomb
108. Sultan Ghari's tomb
109. Sundarwala - Burj
110. Sundarwala - Mahal
111. Sunahari - Masjid
112. Tin - Burjiwala Gumbad
113. Masjid(Tohfewala)
114. Tripolia Gateways
115. Tughluqabad Fort
116. Ugrasen – k i- Baoli
117. Unnamed tombs and Mosque, Munirka
118. Wall mosque
119. Wazirabad Bridge
120. Wazirabad mosque
121. Wazirpur –ka - Gumbad
122. Yusuf Qattal's tomb

Table 23: Proposed List of Monuments / Sites by INTACH

Name of the Monument	Present Location
1. Qadam Sharif	Nabikarim, Paharganj
2. Tomb	Qutab Road, Paharganj
3. Imambara	Qutab road, Paharganj
4. Haveli of Mirza Ghalib	Ballimaran, Chandni Chowk
5. Haveli of Nawab of Laharu	Ballimaran, Chandni Chowk
6. North Brook Fountain	Bhai Mati Das Chowk, Chandni Chowk
7. Gale Way of Zinat Mahal	Lal Kuan
8. Lal Kuan	Lal Kuan
9. Mosque of Ghaziuddin Khan	Near Ajmeri gate
10. Madarsa of Ghaziuddin Khan	Near Ajmeri gate
11. Turkman Gate	Asaf Ali Road
12. City Wall [Delhi Gate to Rajghat]	South of Daryaganj
13. Mortello Tower	South of Daryaganj
14. Shikargah	Jhouti Village
15. Haveli	Jhouti Village
16. Well	Jhouti Village
17. Temple	Jhouti Village
18. Tank	Jhouti Village
19. Shivalaya	Jhouti Village
20. Minaret	Tikri Border
21. Boli Bhatyari Mahal	Southern Ridge Near Karol bagh
22. Gateway	Panchkuan Road
23. Embankment	Talkatora Garden
24. Malcha Mahal	Sardar Patel Road
25. Gateway	Delhi Golf Club
26. Tomb	Delhi Golf Club
27. Tomb of Sayyid Abid	Delhi Golf Club
28. Vaulted Tomb	Delhi Golf Club
29. Plinth	Delhi Golf Club
30. Bara Khamba	Delhi Golf Club
31. Tomb	Delhi Golf Club
32. Tomb	Delhi Golf Club
33. Mir Taqi Tomb	Delhi Golf Club
34. Mosque	Delhi Golf Club
35. Tomb	Delhi Zoo
36. Azinganj Sarai	Delhi Zoo
37. Turret	Lodi Garden
38. Gateway	Lodi Garden
39. Mosque	Lodi Garden
40. Mosque	Lodi Garden
41. Tomb	J,N, Stadium
42. Chhattri	J,N, Stadium
43. Tomb	J,N, Stadium
44. Tomb	Lodi Road Flyover
45. Gateway	Nizamuddin Village
46. Tomb	National Stadium [Opp. Delhi High Court]
47. Tomb	National Stadium [Opp, Delhi High Court]
48. Shiv Mandir	Nizamuddin West near G Block
49. Tomb	Northern side of Unmayun Tomb
50. Chilla Nizamuddin	Northern side of Unmayun Tomb
51. Mahal	Jal Vihar East of Lajpat Nagar-1
52. Shivalaya	Jal Vihar East of Lajpat Nagar-1
53. Delhi Gate	Najafgarh
54. Domed Chattri	Milran Village
55. Temple	Mitran Village
56. Minar	Hastal Village
57. Hathi Kana	Hastal Village
58. Sarai Sohel	Near IGIA
59. Tomb of Sohel	Near IGIA
60. Gateway	Mehram Nagar
61. Enclosure Walls	Mehram Nagar
62. Kaha	Mehram Nagar

63. Garden of Mehram Khan	Mehram Nagar
64. Maqbara paik	Near GT Karnal Road
65. Ammunition Store	Mall Road within Mall Apartments
66. Ammunition Store	Mall Road within AIR warehouse
67. Ammunition Store	Mall Road within Delhi Govt. Flats complex.
68. Ammunition Store	Mall Road within Defence area
69. Gateway	Rana Pratap Bagh
70. Guard House	Hinu College Delhi University
71. Guard House	Northern Ridge
72. Guard House	Northern Ridge
73. Guard House	Northern Ridge
74. Mori Bastion	Near Mori Gate
75. Water Bastion	Near Rana Pratap, ISBT
76. Nili Chattri	Yamuna Bazar
77. Temples[2nos]	Rao Tularam Marg
78. Bara Lao	Behind Basant Lok Market Vasant Vihar
79. Garden Wall	Behind Basant Lok Market Vasant Vihar
80. Hajilinga Gumbad	Sector 3. R.K Puram, Opp. DDA Flats Munirka
81. Gateway	Sector3,R.K. Puram, Opp. DDA Flats Munirka
82. Bijri khan Tomb	Sector3, R.K Puram, Opp. DDA Flats Munirka
83. Tomb	Sector3,R.K. Puram, Opp.DDA Flats Munirka
84. Kaliguints	Deer Park, Hanzkhas Village
85. Wall Mosque	Deer Park, Hanzkhas Village
86. Mosque of Darvesh Shah	Gulmohar Park
87. Tomb	Gautam Nagar Gulmobar Enclave
88. Tomb	Zamarupur Village
89. Tomb	Zamarupur Village
90. Tomb	Zamarupur Village
91. Tomb	Zamarupur Village
92. Tomb	Zamarupur Village
93. Tomb	Near N Block GK-1
94. Bund	Mahilpalpur Village
95. Mahal	Mahilpalpur Village
96. Ruins	West of Sultan Gari Tomb
97. Enclosure	South of Sultan Gari Tomb
98. Ruins	South East of Sultan Gari Tomb
99. Mosque	Kaln Sarai Village
100. Tomb	Sadana Enclave
101. Baradari	Sadana Enclave
102. Abuja	Sadana Enclave
103. Tomb	Savitri Nagar Sheik Sarai,Phase-1
104. Tomb of Shaikh Salahussain	Savitri Nagar Sheik Sarai,Phase-1
105. Kos Minar	Badarpur
106. Northern Gateway	Badarpur
107. Central Gateway	Badarpur
108.Southern Gateway	Badarpur
109. Kas Minar	Mathura Road
110. Chumachi Khan Tomb	Mehrauli
111. Southern Galeway and Walls of Chiragh Delhi	Chiragh Delhi
112. Eastem Galeways and Walls of Chiragh Delhi	Chiragh Delhi
113. Circular Bastion and Chhattri	Chiragh Delhi
114. Northern Galeway of Chiragh Delhi	Chiragh Delhi
115. Tomb	12B/1, Mehrauli
116. Jhama	Jahaz Mahal Mehrauli
117. Tomb	Ward7, Mehrauli
118. Tomb	Ward 7, Mehrauli
119. Quli Khan Tomb	DDA Park Mehrauli
120. Makalle`s Boat House	DDA Park Mehrauli
121. Tomb	DDA Park Mehrauli
122. Tomb	DDA Park Mehrauli
123. Two Arched Dalans	DDA Park Mehrauli
124. Mosque	DDA Park Mehrauli
125. Canopy	DDA Park Mehrauli
126. Ruins	DDA Park Mehrauli

127. Tomb Enclosure	DDA Park Mahrauli
128. Tomb of Khan Shahid	DDA Park Mehrauli
129. Stable	DDA Park Mehrauli
130. Mosque	DDA Park Mehrauli
131. Building	DDA Park Mehrauli
132. Arched Dalan	DDA Park Mehrauli
133. Tomb	DDA Park Mehrauli
134. Tomb	DDA Park Mehrauli
135. Guard House	DDA Park Mehrauli
136. Domed Building	DDA Park Mehrauli
137. Bagichi Masjid	DDA Park Mehrauli
138. Tokya of Kamal Shah	Ladha Sarai
139. Gateway	Mehrauli
140. Domed Building	DDA Picnic Hut , Mehrauli
141. Mosque	Mehrauli
142. Chihattan Chihalman	Mehrauli
143. Tomb	DDA Park Mehrauli
144. Enclasure Wall	DDA Park Mehrauli
145. Mosque and Domed Gateway	DDA Park Mehrauli
146. Plinth of Mosque	DDA Park Mehrauli
147. Mosque	DDA Park Mehrauli
148. Metcalfe's Folly	DDA Park Mehrauli
149. Sanbate Tomb	Mehrauli
150. Rani Mahal	Kishan Ganj
151. Dara Shikoh Library Building	Kashmere Gate

The balance monuments, however, are at present receiving no protection and are under threat. The MPD-2021 is conscious of this problem and is proposing to bring all these monuments under its purview. It is hoped that the various Zonal Plans will incorporate these monuments in detailed planning stage for their survival. It is intended that MPD-2021 will be a digitized map and proposals are being considered to incorporate the footprints as many of the listed monuments in the MPD-2021 Plan. This will be a great step towards the long-term conservation and protection of these monuments.

A detailed hydrological study of the city may be undertaken to identify all the natural heritage sites. This may also be incorporated in the MPD-2021 to ensure their protection. Some sites that have been suggested tentatively are as under

- Bhalswa Lake
- Okhla Barrage Pondage
- Wazirabad Pond Pondage · Sites along Agra Canal
- Najafgarh Drain
- Specific sites along Yamuna River Water Front
- North, South & Central Ridge

The policy of the Master Plan has been to protect all these valuable assets by appropriate landscaping including making of urban forests, regional parks, district parks, green buffers etc. Some views have also been expressed by INTACH on natural heritage of Delhi, which consists of urban forests, wetlands, paleo channels, lineaments etc. In addition to the above it will be appropriate to declare 26 conservation areas. With this thrust on conservation there is a proposal to apply by the concerned agency for declaring Delhi a World Heritage City.

Table 24: List of Conservation Areas

1. Chandni Chowk
2. Katra Neel-Fatelopuri - Kuncha Ghasiram
3. Bazaar Lal Kuan – Hauz Qazi - Ajmeri Gate - Bazaar Sita Ram – Turkman Gate
4. Dharampura - Kinari Bazaar - Dariba
5. Jama Masjid
6. Red Fort – Salimgarh
7. Daryaganj
8. Lothian Road - Bara Bazaar - St. James Church Area - Kashmir Gate Area
9. Firoz Shah Kotla - Khuni Darwaza - Area Surrounding MAMC
10. Purana Qila - Lal Darwaza - Delhi Zoo

11. Hazrat Nizamuddin
12. Humayun's Tomb - Sundar Nursery - Barapullah
13. Connaught Place
14. Jantar Marrtar
15. Central Vista
16. New Delhi Bungalow Zone - Safdarjung Tomb
17. Lodhi Gardens
18. The Delhi Golf Club
19. Dargah Qutub Ud Din Bakhtiar Kaki - Zafar Mahal
20. Mehrauli Bazaar
21. Qutub Complex - DDA Archaeological Park
22. Chirag Delhi
23. Vijay Mandal - Begumpur - Sarai Slrahji - Lal Gumbad - Sarva Priya Vihar
24. Hauz Khas - Deer Park
25. Tughladabad - Adilabad - Nai Ka Kot
26. Army Cantonment

Delhi is already a part of the Golden Triangle of National Tourism Development policy. However, the monuments that are actually exposed to tourists are very limited. It is proposed that by exposing more of these monuments and conservation sites, many smaller tourist circuits can be developed within Delhi itself to promote tourism with two objectives

(i) To ensure the conservation of monuments
(ii) To generate tertiary employment opportunities

A Heritage Foundation has also been established by DDA to undertake conservation projects in different parts of the city depending upon their merits. Initial work of the Foundation has already started which is to give awards for best-maintained heritage buildings every year.

DDA has also constituted an Expert Sub-Group for Conservation for formulation of MPD-2021. The Sub-Group is in advance stage of its working and as soon as the report is made available by them, the same will also be available to the NCR Planning Board for their reference and consideration.

5.3 TOURISM

Considerable development of tourism has taken place in each State through the respective Departments of Tourism. The respective State Departments have been very active and have developed a variety of tourist sites in their State.

The Ministry of Tourism, Government of India, has prepared Guidelines to be followed by State Governments/Union Territories for the preparation of 20 year Perspective Plans for development of sustainable tourism.

All States may be requested to furnish this information for the area covered under the NCR for consideration by the NCRPB. From these proposals, the NCRPB should formulate a regional strategy for the development of tourism.

It is recommended that the following tourism strategy could be adopted for the region.
Diversify the tourism potential of the region by identifying regional/local circuits of tourism
Integrate the potentials of cultural and leisure tourism
Develop better transportation linkages to ensure the development of regional/ local tourism networks
Through fiscal incentives promote the development of tourism related infrastructure, for example, guesthouses, small hotels/restaurants, crafts outlets, etc.

Tourism must be recognised as an important generator of employment, and as an instrument to decentralise urban development. Hence it must become a key element in the land use policy. In a similar manner, it must also become a key element in the employment sector.

Table 25: Tourist Interest Sites in various sub-region of NCR

District	Name of Place	Description of Site	Remarks
Rajasthan Sub-Region			
Alwar District	1. Siliserh	Siliserh Lake	Tourist Resort
	2. Near Gadar	Jai Samand Lake	
	3. Alwar	Aravali Hotel	
	4. Near Siliserh	Lake Palace	
	5. Near Alwar	Meenal	
	6. On Jaipur Highway	Tiger Den	
	7. On (NH8) Near Behror	Midway	
Haryana Sub-Region			
Faridabad District	8. Canal		Rest House / Dak Bungalow
	9. Near Faridabad Town		
	10. Near NH2		
	11. Sikri		
	12. Near Godhpuri		
	13. Manpur		
	14. Siha		
	15. Rd. to Hodal from Firozpur Jhirka		
	16. Bhulwana	Dabchik	Tourist Resort
	17. Badhkal Lake Complex		
	18. Sunbird Complex		
	19. Hemitage Complex	Surajpur	
	20. Aravalli Golf Course		Golf Course / Clubs etc
Gurgaon District	21. Sohna	Barbet	Tourist Resort
	22. Gurgaon	Shama	
	23. Dumduma	Magpie + Saras	
	24. Sultanpur		
	25. DLF Golf Course		Golf Course / Clubs etc
	26. Kot Khandewla	Silver Glades Golf Club	Golf Course / Clubs etc
	27. Sakat pur	Golden Green Golf Club	Golf Course / Clubs etc
	28. Tikli	Meadows Golf Club	Golf Course / Clubs etc
	29. Chandnagar		Rest House / Dak bungalow
	30. Firozpur Jhirka		
	31. Farrukhpur		
	32. Sohna		
	33. Taoru		
	34. Nuh		
	35. Pataudi		
	36. Bhora Kalan		
Sonipat District	37. Rai	Ethnic India Complex	Tourist Resort
	38. Gohana		Rest House / Dak Bungalow
	39. Silana		
	40. Kakroi	Western Yamuna Canal	
	41. Thana Khurd	Western Yamuna Canal	
	42. Juan		
	43. Near Baiyanpur	Kosminar	
	44. At Grand Trunk Road		
Rewari District	45. Rewari	Sand piper	Tourist Resort
	46. Dhaurhera	Jungle Babbler	
Panipat District	47. Samalkha	Blue Jay	Tourist Resort
	48. Kala Amb	Blue Jay	
	49. Panipat	Sky Lark	
Rohtak District	50. Rohtak City		Rest House / Dak Bungalow
	51. Bainsi	Near District Boundary	
	52. V. Chandi (Near Dist. BDry)	Near District Boundary	
	53. Lahli	Road to Rohtak from Kalnaur	
	54. Near Northern Railway Line		
	55. Near Dobh		
	56. Sampla		
	57. Tilyar Lake Resort		Tourist Resort

	58. Bahadurgarh	Gauriyya	
	59. Maham	Noarang Complex	
Uttar Pradesh Sub-Region			
Meerut District	60. Irrigation Guest Houses (along river fronts)		
Ghaziabad District	61. Garhmukhteshwar		Rest House / Dak Bungalow

Table 26: Scenic Sites in NCR

District	**Description of Site**		
	Ecological Oriented Sites	**Rivers / Streams**	**Lakes / Tanks / Wetlands**
Rajasthan Sub-Region			
Alwar District	Siriska Palace Hotel and Tiger Sanctuary	Ruparel	Jai Samand Lake
	Aravali Peaks	Arvari	Vijay Sagar
	Bhangarh Point-3/4 Ml. N of Bhamgarh		Training Bund
	Kankwarhi Pt. - 1.5 Ml. E of Kankwarhi		Mangalasagar Tank
	Sirawas 1.5 Ml. 0 SW of Sirawas		Baleta
	Alwar Fort		Mansorovar
	Bhursaid Pt, 1M W. of Infantry Line		Tijara Bund
	Bandraul Pt. overlooks pass Thana Ghazi * Bairath, S of Bandaul		Jai Sagar Bund
	Bharaich 0.5 M. W of Bharanch		Deoti Bund
	Birpur		Atariya Bund
	Bilali		
Haryana Sub-Region			
Faridabad District	Yamuna - River Front -Flood Plains	Bhuriya Nala	Badhkal Lake
	Sites Along Agra Canal		Peacock Lake
			Dhauj Lake
	Aravalli Hills		Sulkhari Lake
Gurgaon District	Kotla Dahr Jhal	Indori Nadi	Najafgarh Jheel
	Samarthala	Ghata Badshahpur Nala	Baratpur Jheel
			DamDama Lake
			Sultanpur Lake
			Khalipur Jheel
			Chandini Jheel
			Sangel Ujina Jheel
Sonipat District	Yamuna River Front	Drain No. 8	Oxbow Lake at Kundli (NH1)
	Sites along W. Yamuna Canal	Abandoned Canals Near Rabhra (West of Drain 8)	Teha (Lake)
Rohtak District	Yakubpur	Nai Nallah	Batherah Jheel
	Fatehpur		Kiloi Lake
			Dadri Lake
			Kote Kalal Surah Lake
			Surah Jheel
			Bhindavas Jheel
Uttar Pradesh Sub-Region			
Meerut District	River Ganga Waterfront	Burhganga Tributary	Makanpur
	River Hindon Waterfront	Soti Tributary with Ganga	Kharoli
	River Yamuna Waterfront	Krishni Tributary with Hindon	Sobhapur
	Hastinapur	Banganga - with Hindon	Basantpur
			Sainthli
Bulandshar District	Hindon Junction with Yamuna		Aurangabad
			Mustafabad
			Bhil Akbarpur
			Nai Basti
			Chandoli
			Pargana Dadri
			Sunphera
			Aliabad

			Gangaraul of Sikandrabad
			Thasrana & Amirpur in Dankaur & Ferozpur
			Sarangpur & Saryal of Pargana Khurja
			Machar of Pargana Jewar
Ghaziabad District	Hindon Waterfront	Eastern Yamuna Canal	Wetlands of Hindon
	Yamuna Waterfront	Hindon Cut Canal	Dadri
	Okhla		Kuchesar
	Asola		Khurrampur

Conclusions

The Subgroup on Heritage and Tourism strongly recommends that a regional policy should be formulated which should co-ordinate and take advantage of the symbiotic relationship that exists between the imperatives of heritage protection and tourism development.

This policy should view the conservation of heritage as a development activity, which should generate employment in crafts, and crafts related activities, offer a focus for specific urban design schemes, and become a source of pride and identity for the locality. The potential for using conservation areas to achieve this objective should be explored. The NCRPB should constitute a special committee of experts to draft the necessary guidelines for adoption by each State.

The tourism policy should be pro-active to diversify the options available for tourism destinations and activities through the development of smaller tourism circuits. A good goal for this policy would be ensure that a visitor - or local resident - can be easily persuaded to sample the diverse range of tourism options available within the region for atleast ten days. This should change the mindset of the visitor who spends only a couple of days in Delhi to see the Red Fort, Qutub Minar and Humayun's Tomb, and do some shopping for traditional crafts and handloom products.

The Heritage and Tourism sites should be clearly identified on the land use plan to prevent encroachment and inappropriate development. These sites should also receive priority in transportation and other infrastructure planning.

The Heritage and Tourism sites should be used as instruments to direct land use policy towards more decentralised patterns of development.

A desirable objective of the co-ordinated Heritage conservation and Tourism development policy should be to have Delhi declared a World Heritage City by UNESCO.

It may be noted the baseline data used to prepare this brief report is incomplete and inadequate for the preparation of a detailed policy report. Hence it is recommended that special efforts must be undertaken to obtain better data, and monitor development in this sector in future. Also the time available to prepare this report has been inadequate. To mitigate these intrinsic problems, it is recommended that the NCRPB should constitute a special group or cell to look after this important sector of regional planning and they should be mandated to undertake the necessary work-studies required to underpin the final policy that will be formulated by the NCRPB.

6.0 Natural Heritage

Earth's plants, animals, and micro-organisms - interacting with one another and with the physical environment in ecosystems, form the foundation of Sustainable Development. Biological Diversity or Bio diversity is the term given to the variety of life on Earth and the natural patterns it forms - it is the totality of genes, species and ecosystems in a region. The wealth of life on Earth today is a product of hundreds of millions of years of evolutionary history. Over the course of time human cultures have emerged and adapted to the local environment, discovering, using, and altering local biotic resources. Many areas that now seem "natural" bear the marks of millennia of human habitation, crop cultivation and resource harvesting. The domestication and breeding of local varieties of crops and livestock have further shaped bio diversity. Bio-diversity contributes to sustainable development and its conservation is a critical component of wise resource use. Information on the bio-diversity of the area is very crucial specially to estimate the effect that anthropogenic activities would have on this diversity.

Harmful consequences of development on the natural resources are often not detected at an early stage. Over a period of time they lead to significant alteration in species composition/diversity in the ecosystem. Species, which are more sensitive to pollutants, can get diminished or deformed; on the contrary some of them can develop tolerance to the changed environment. Organisms thus act as indicators of the quality of a particular habitat and environment. Such organisms are known as bio-indicators. Attempts can be made to monitor the changes in the biological environment by

i) Establishing - Species Diversity Index

Species Diversity is generally expressed as the ratio of the number of species to the number of individuals in a given community or habitat (the species diversity index was calculated according to Shannon and Weaver in 1963). Major application of this has been observed in studies done in relation to aquatic ecosystems. Studies done at various places along the River Ganga indicate that the Species Diversity Index of phyto plankton was maximum upstream and this index sharply declined at bathing ghats and sewage discharge points indicating that in clean water species diversity index is higher than the diversity in polluted water.

ii) Finding and Studying - Indicator Species

Physiological or behavioral responses of organisms exposed to pollutants serve as important indicators of the environment. Indicators occurring or existing in polluted environment accumulate toxic substances and suffer physiological stress i.e., diminished rate of growth, impaired reproductive capacity or modified behavior etc. Another groups of organisms, which are very sensitive to the exposure of pollutants, disappear quickly and their reduction in number finally changes the species composition/diversity of the affected site. Once the level of pollution is estimated only the species, which can tolerate pollution, can be propagated in that area. Also, species that mitigate pollution can be introduced. Some studies have been undertaken by the CPCB in relation to pollution tolerant species.

6.1 Bio-Diversity of NCR

Any action to conserve bio-diversity would first begin by studying the bio-diversity. The bio-diversity of NCR is being studied by dividing NCR into four divisions. They are as follows

i)	Special Protected Areas	- National Parks, Sanctuaries and Forests
ii)	Hilly Areas	- Aravalli
iii)	River Systems	- Ganga, Yamuna
iv)	Habitations	- Open spaces in urban areas, agricultural lands

Although, ideally the data on Bio-Diversity of various components of NCR should have been available, whatever little data is available has been studied. Further data has to be collected, as this is a crucial area of concern.

- **Special Protected Areas**

  These include the various National Parks and Sanctuaries within the NCR. Their importance, species diversity and problems have been identified.

  1) Sariska National Park

     Sariska National Park is a hilly dry deciduous forest ecosystem in the heart of Aravalli range with sandy valleys carrying scrub-thorn and grasslands. It is situated in the southern part of Tehsil Alwar, Alwar District, and Rajasthan, covering an area of 800 sq. kms with a core area of 498 sq. kms. The tract is mainly hilly with two big plateaus, Kankwari and Siraska. Sariska itself is a wide valley, which starts from Baran Tal Gate and ends before Thana Ghazi. The hills maintain the Aravalli character of sharp hogback ridges with a striking homogeneity. The forests are dominated by 'dhak' with belts of 'salai' on steep dry slopes 'cheela' in valleys. The dry tropical forests vary in composition and quality. Bamboo grows to a limited extent along the moist and cool parts of the tract. 'Jamun', 'Arjun' and 'Baher' are found in most depressions and on nala banks. The ground cover is constituted by 'ber', 'chapren', 'fargen', 'adusa' and 'damosar'. The dried and fallen leaves of 'dhak' help the herbivores to tide over the fodder scarcity during summer months.

     With an average rainfall of 650mm, water becomes a major limiting factor for the wild animals. The wide assortment and abundance of wild animals in the open dry deciduous thorn forests of Sariska stand out as adequate testimony to ecological adjustment and adoption. Sariska has the characteristic fauna of dry zone - Sambar, Chital, Nilgai, Chousinga, Chinkara, Caracal, Jungle Cat, Wild Bear, Shrikes, Paradise - Flycatcher, Blossom headed and Alexandrine Parakeets, Patridges and Peafowl.

     Sariska is also a Project Tiger Reserve. The tiger is again a symbol of the country's wilderness. The flow of nutrients through the complex web of nature in the forest ecosystem culminates in the tiger. Micro-organisms break up plant and animal residues to form humus, which accounts for soil fertility. The resultant diverse vegetation provides food for herbivores, insects, birds and mammals besides conserving soil and enriching water and weather regimes. Among a host of predators and scavengers that thrive on this productivity the tiger stands supreme is most of our forests. The well being of the tiger is thus synonymous with the health of India's wilderness. Measures should be undertaken for full utilization of the environmental attributes of this area.

  2) Sultanpur National Park

     Sultanpur National Park is a wetland eco-system situated in Gurgaon District, 15 kms west of Gurgaon in Haryana State. It covers an area of 13,727 ha including a core area of 144 ha containing the main lake.

     The National Park is a group of shallow freshwater lakes and associated marshes. The lakes and marshes flood during the monsoon and in years of adequate rainfall, retain water until at least March or April. In recent years of low rainfall only a few small pools remain by mid-winter, some 30 cm. in depth. Consequently, pumping of ground water is undertaken each year to maintain some waterfowl habitat. In years of adequate rainfall, Sultanpur becomes a very important wintering area for a wide variety of waterfowl; notably, pelicans, ducks, geese and cranes.

     Some of the waterfowls observed are Pelecanus Onocrotalus, P.Crispus, Phalacrocorox Carbo, Herons, Egrets, Mycteria Lecucocephala, Plataba Leucorodia, Phoenicopterus ruber, Anser anser, A. indicus, grus grus, Fulica atra, Chlidonias hybrida, Ducks-wigeon, gadwall, common teal, shoveler, pochard. Shorebirds includes white-necked stork, white ibis, black ibis, spoonbill, comb duck, saras crane, purple moorhen, painted snipe. Many species of raptors occur in this area, including the imperial eagle, greater spotted eagle, and tawny eagle and marsh harrier.

The natural vegetation of the region is semi-arid scrub, but 78 per cent of the buffer zone is under cultivation. There are small areas of Typha species and Phragmites specially around several of the jheels, and some emergent vegetation within the lakes, particularly in the core area. Extensive sedge marshes, particularly to the north of the main lake, from a loose mosaic with areas of dry grassland.

The core area is managed primarily as a waterfowl reserve and tourist attraction. The buffer zone encompasses 17 revenue villages. There is high level of disturbance from tourist activity, particularly when water levels are low and birds are concentrated in a small area. Siltation caused by soil erosion in the catchment areas is increasing. The excavation of sand from nearby lime and brick industries also poses a serious threat to the National Park. Landuse practices in the catchment, heavy grazing, cropping pattern, expanding settlements and construction of farm houses and other buildings have caused siltation and impeded the natural flow of water into the lake. Also, the land slopes gently northwards through a region of innumerable stabilized sand dunes, the climate and soil are not conducive to the existence of permanent water bodies, and thus saline flashes predominate by late winter even in years of normal monsoon rainfall.

3) Indira Priyadarshini Sanctuary

A wildlife sanctuary has recently been established by the Delhi Administration. The Sanctuary site is 13.2 sq. kms consisting of tract of degraded land opposite the infamous Bhatti mines close to Haryana border. It encompasses the wastelands of Arola, Maidan Garhi and Shaurpur. The main function of the sanctuary is to create a natural buffer and arrest environmental deterioration. The area was once rich in vegetation and animal life, most of which have succumbed to the pressures of human activity. According to officials, 45 species of avifauna, 23 species of animals still exist in the area. While langurs and porcupines are common, even Nilgai have been spotted. The major problems of the area are inadequate groundwater reserves, extraction of fuel wood by villagers, illegal quarrying, and mafia elements safeguarding the interests of quarry owners. Appropriate management measures have to be taken to control these problems and to safeguard the sanctuary.

Apart from the areas designated as Sanctuary or National Park, there are some sensitive ecosystems, which need to be protected for environmental improvement of NCR, Two wetlands identified by WWF are

- Yamuna Wetland
- Najafgarh Jheel

4) Yamuna Wetland

The wetland is located 28° 30'N, 77° 22'E to 28° 46'N, 77 ° 13'E on the eastern outskirts of Delhi. The site has an area of 20,000 ha (35 kms stretch of Jamuna River 10 kms south to 10 kms north of the city). The area is largely contained within bunded embankments, the narrow floodplain along the Jamuna still constitutes a wetland - small areas of marsh remain in a mosaic of arable land, pasture, waste ground, and urban development.

The principal vegetation of the area consists of large areas of water hyacinth (Eichhornia crassipes), particularly near the barrages, and reed - beds with species of Typha and Phragmites, chiefly around the islands in the river. At low water levels, much of the exposed riverbed is cultivated. The area is also a very important feeding and rooting area for a wide variety of both resident and migratory waterfowl. In winter, many thousands of ducks, chiefly Anas strepera, A crecca, A. acuta and A. clypeata have been observed. The muddy island provides secure roosting sites for large number of gulls and terns, and there is a very large winter roost of swallows and martins (Hirun dinidae) in the reed-beds. Many shorebirds, especially Tringa glariola, Calidris minuta, C. temminckii, Philomachus pugnax, and Glareola maldivanum occur on passage and to a lesser extent also in winter.

As the city of Delhi continues to expand, new urban and industrial developments and an intensification of current land use will continue to erode the few remaining areas of semi-natural marsh. Also, pollution from domestic and industrial sources is a growing problem and is already at a critical level along certain stretches of the river.

5) Najafgarh Jheel

Najafgarh jheel forms part of Najafgarh drain, which is largely a Flood Control drain (leaving aside the 12 km. or so of sewage disposal activities within the capital) and meandus from Outer Ring Road through the villages of Kakrola, Ambrahi and Chawla to finally end at Dhandsa regulators at the Haryana border.

Today, hardly anything of the jheel remains due to accelerating pace of urban development adjacent to it. Prior to this onslaught, the drain was flanked on both sides by a thin veil of wattles, growing on the slopes. For the most part of the year the drain was seemingly empty although a large number of birds and animals were resident. It was with the coming of the winter, that flamingoes flocked here. In the adjoining fields two species of crane were common-red necked Saras Crane and Damoiselle Crane. Apart from these, spoonbills, ducks, porchard herons, pelicans, white ibises, bareheaded geese etc., were seen here.

As per the Ramsar Convention, any wetland consistently supporting more than 20,000 waterfowl should be listed as priority areas for conservation, measures. If serious studies were done in relation to Najafgarh Jheel one could have saved this wetland. As of today, it has diminished resulting in loss to its bio-diversity.

Added to these areas certain stretches of flood plains of River Hindon, River Ganga and marshy areas near Mawana should be studied in terms of their species richness and their role in environmental improvement. These could also be considered for protection.

These sensitive ecosystems are areas of prime concern. Efforts to conserve and protect these areas have to be undertaken. A complete listing of their Biodiversity has to be undertaken. Though the types of species are known in most of the exact numbers are not known. Hence a Bio-Diversity Index cannot be done. Also, researches are inadequate in terms of identifying indicator species. Appropriate landuse planning measures have to be taken in the vicinity of these areas to ensure their sustenance.

- **Hilly Areas**

The hilly area in NCR is mainly the last flank of the Aravallis traversing from Alwar in the south to Delhi in the north.

1) The Delhi Ridge

The Ridge in Delhi is actually aril extension of the Aravalli hills that enter Gurgaon from south and sprawl towards Delhi in the form of a tableland, some five kilometers across. Sixteen kilometers south of the city, the range splits, with one branch turning sharply to re-enter Gurgaon, and the other, continuing in a north-eastern direction, virtually bisecting Delhi and tapering off at the west bank of the Yamuna. Officially the Ridge has been divided into four zones. Outside the city limits, lies the Southern Ridge, 6200 ha. in area, which is private land. The south-central Ridge, 626 ha. in area, lies where Mehrauli is -and where quarrying and construction work has devastated it almost completely. Within the city, just north of Dhaula Kuan, lies the still green Central or New Delhi Ridge 864 ha. in area. The smallest section, the Northern or Old Delhi Ridge, 87 ha. in area, lies between Civil Lines and the University of Delhi. The last two portions form the "green lung" of urban Delhi. It provides the increasingly polluted capital with oxygen as well as absorption of pollutants, it blocks the dust and hot winds ('loo', that sweep across the city in summer), it acts as a massive sound insulator, absorbing some of the hubbub of the city. The Ridge is unique to Delhi. No other city can boast of such a rich diversity in greenery. While there are a number of city parks, green spaces with natural vegetation are few. The ecological and educational advantages of

the Ridge areas are incomparable with the sterile, artificial beauty of the city parks. The Ridge represents a forest community - it is a dynamic living entity composed of a varied plant and animal life.

Physiographically the Ridge falls under the Kohi or Pahari (Hillsides) division of Delhi. This low plateau is mostly composed of bare and unconsolidated micaceous rocks. Its soil is mainly dry and sandy, lacking humus, and supporting sparse vegetation. The vegetation of the Delhi Ridge is a thorn scrub. Such forests are found distributed in the arid and semi-arid zones of the earth. In the classification of the forest types developed by Champion and Seth (1968) the Ridge forests fall in the category of 'tropical thorn forests' and more specifically as 'semi-arid' open scrub of 'salch' forests. But in the present state the Delhi Ridge has become a synthetic vegetative stand where native plants are found in co-existence with planted exotics, many of them naturalized plants. There are some species of plants on the Ridge, which occur throughout the year, they exhibit slightly stunted growth, wax coatings and thick or succulent leaves. These species, the permanent vegetation of the Ridge occur in clumps and do not cover the ground densely, leaving ample space between them. This is typical of open canopied scrub where there is abundant sunlight and no competition for light. There are about 20 native species of trees and 7 native species of shrubs.

Along with these native plants, there are a large number of introduced trees and shrubs, which have in time, become naturalized. These number to around 8 species of trees and two shrubs. As the monsoon arrives a large number of annuals sprout, carpeting the otherwise stony and rather bare forest floor. By January their whole life cycle is completed. 10 common species have been identified. Apart from these there are aquatic flora comprising of algae, ferns and angiosperms.

The Delhi Ridge, when still in an undisturbed natural scrub forest was a rich repository of animal life. The fauna was supposedly rich enough in diversity to be compared with that of nearby forests of Rajasthan. Though there has been a gradual decline of the animals from 1930s about 1 1 species of mammals, 95 species of arthropods butterflies, moths, ants, bees, wasps, dragonflies etc. and 291 species of birds can still be identified on the Ridge.

Today the Ridge is causing concern. One is rarely far from some sign of human activity, be it a petrol pump, a school or park, a juggi colony or a police camp. The major activities leading to the destruction of the Ridge have been: construction of buildings, roads and establishment of human settlements, by the government as well as private parties, conversion of forest into parklands and miscellaneous activities like garbage dumping, lopping for fuel and fodder, and grazing by the livestock.

2) Aravallis at Gurgaon

Geologic studies indicate that the main Sohna-Ferozpur Jhirka ridge consists of Alwar and Ajabgarh formation characterized by great variety and abundance of igneous intrusions. 80 per cent of the area is covered by arid brown and sierozem soil: Rest is forest and hill soil. Hill slopes are practically soil less.

As per revised classification of the Indian Forests by Champion and Seth, the natural forests of the tract have been placed in sub-group 6-B i.e. 'Northern Tropical Thorn Forests'. Natural forests on Aravallis and at its foothills have poor composition and density. It is the result of soil-erosion by water and wind over a period of millions of years and excessive biotic interference in the last century or so. Scrub vegetation of Aravallis is in the last stages of degradation and as per Champion and Seth's revised classification of forests, these forests, come under Northern Dry Deciduous Forests sub-group (Type 5-E 1 and its degradation stages 5-E 1/DS1).

About 95 per cent of the forest areas are situated along railway lines, canals, roads, drains and flood protection bunds in the shape of linear strips. These strips mainly pass through agricultural fields or wastelands and were part of these lands before acquisition for the present use. So these strips are devoid of natural vegetation. Prior to transfer of these strips to forest department for management respective departments planted shade giving trees such as Shisham, Neem, Siris etc., on some of these strips. But success was very poor. After taking over the management, forest department raised plantations of more useful species in these strips in successive years. At present most of these are forest plantations of various ages. *Acacia nilotica* (kikar), Eucalyptus hybrid, *E.Canaldulensis* (safeda), *Dalbergia sisoo* (shisham), *A. tortilis* (Israeli kikar), *Prosopis juliflora* (vilayati kikar), *Albizia procera* (siris), *Azadirachta indica* (Neem), *Melia azadirach* (bakain). *Cassia siamea* plantations have been raised successfully. Kikar constitutes about 75 per cent of the total crop.

Near and within habitations, ornamental and shade giving trees exist. The common species planted in such areas are - *Delonix regia* (gulmohar), *Cassia fistula* (amaltas), *C. siamea*, *Azadirachta indica* (neem), *Parkinsonia aculeata*, *Kegelia pinnata*, *Ficus religiosa* (peepal), *Ficus bengalensis* (barh), *Melia azadirach* (bakain), *Terminalia arjuna* (arjun), *Pongamia pinnata*, *P.glabra*, *Alianthus exelsa* (maha neem), *Dalbergia sisoo* (shisham) etc. The flora includes in total 45 species of trees, 42 species of shrubs, 14 climbers and 29 grasses.

3) Aravallis at Alwar

The Aravallis makes its appearance in the district from the northeast in Tijara subdivision and runs southward. These hills are low in the north and east, but become more prominent as one more southwards. The hilly ranges enclose between them fertile valleys and alluvial plains.

Hills of Alwar support dense to sparse vegetation, with a number of reserved forests. The forests of the district fall under the category of dry deciduous forests (subsidiary edaphic type of dry tropical forests). These forests have no important timber tree species, but they are valuable for the protection of soil and production of grass, fuel, katha etc. Some of the shrubs provide twigs utilized for basket making. A dense growth of Dhak (*Anogeissus pendula*) is mostly restricted to shallow, bouldery, gently to steep slopes and is generally absent on flat terrain and occurs as a pure crop. Associates like khair (*Acacia catechu*) are found mixed with it. Cheela (*Butea frondosa*), kikar (*Acacia arabica*), Ber (*Zizyphus* spp.), Lod silai (*Grewia flanescens*) and Har singar (*Nyctanthes abortistis*) are common associates. Bamboo (*Dendrocalmus strictus*) generally occurs in the cool and shady nalas in Dhak forest. Other xerophytic bushes are seen in the central and southern parts. Northern parts of Tijara, Tapukrah, Fatehabad and Mandawar forests have scanty bushes of Ber, kikar, khair etc. Except where the slopes are precipitous the hill slopes are covered with Dhak, while salar (*Bosewellia serata*) is usually found in upper slopes and ridges. Recently afforestation and plantation work has been taken up mainly on barren areas, hilly tracts and plain areas, fencing hills to regenerate degraded Dhak forests etc. The rights and privilege allowed to the public in these forests consist of grazing, removing of firewood, grass cutting etc.

Generally speaking, all the mammals found in Indian plains are available in the district. Alwar forests have been famous for wild life from ancient times and were a favourite resort of the Mughal Emperors, Akbar and Jahangir, for hunting tigers, panthers, etc. In these forests, pig and other animals found shelter. The demand for animals increased as the pressure of population increased. Demand for more, agricultural land resulted in cutting down of these 'roondhs'. Besides, the forests as a whole suffered seriously and it is only now that attempts are being made to rehabilitate them. Reckless killing of wild life by migrant population has depleted their tribe in the district. Only a few years ago, large herds of spotted deer were seen between Khairthal and Smailpur and near Mandawar. These, however, are no more to be seen there now. Similar is the case with Nilgai and fowl (locally known as 'titar' and 'bater'), though the latter replenish themselves rather quickly. Wild boars were found in large

numbers, especially in Jhamuwas and Fatihabad 'roondhs'. The 'roondhs' have since been cut down and land brought under cultivation.

The hills, ravines and plains of Alwar district support different varieties of fauna: mammals, fishes, reptiles and birds. Apart from deer and 'Sambhar' (*Cervus unichor*), antelope hyena, tiger, wild hog and wolf are encountered. Fish, turtle, crocodile, water snakes, frogs and leeches are also found. Among the reptiles of squamatic order, mention may be made of lizards and snakes. At least 10 different varieties of both these are seen in the area. A large number of common and migratory birds of different species are also found. Alwar forests, especially those around Sariska, Ismailpur, Ajabgarh, Sirawas, Siliserh, Narainpur, etc. give shelter to different animals. Deforestation on a large scale by local people for fuel and other purposes and indiscriminate killing of wild life in the past has resulted in their emigration or depletion. However, in the Sariska game sanctuary, one can still see a wide variety of wild life.

The natural surroundings and abundance of lakes and 'bunds' create suitable habitat for different species of fishes and other aquatic fauna. During the rainy season, the rivers get connected with one another and thus serve as an ideal breeding ground for fishes. The best variety of fishes is the 'Rohu' (*Labeo rohita*) which has long been held in high esteem. Among other fishes described by Powlett, 'Murak' and 'Kalawat' of the large variety are good. 'Sol' (large) and 'soli' (small) are liked by the local people. Chalwa are the little fish served on skewers at breakfast tables. 'Pariya' and'bawas' are large and inferior fish. 'Temara' and 'Sanka', are both small and very bony. 'Singi' (small) and 'Ker' (large) are both indigestible. Besides the fishes, allegators locally known as Goh, measuring upto 12 ft., are also found in Siliserh, Jai Samand, Mangalsar, Jai Sagar and depressions of Ruparel river. Other reptiles of the aquatic fauna are the turtle and water snakes. Among amphibians that can be counted are frogs and toads and the important annelid is the leech (Jonk).

The reptiles of squamate order, which cover lizards and snakes, are found in the district. The main types of lizards and snakes available in the district are: Asian House Geoek; Common Garden lizard; Slow worms; Desert Monitor; Common Warm Snake; Sand Boa; Indian Ery; Russels Viper; Common Cobra; and common Krait. The local snake charmers and experts known as Gyarus have, however, reported various types of snakes, including Kankraita, Nagad Bansi, Kalgindar, Ghora Pachar, Phool Pagar, Pauna Sarp, Chital; Puniya Sarp and; Lal Sarp. In addition, python (*Python molurus*) or Ajgar, which measures upto 6 metres and weight over 75 kg are also found in the district.

Government of India, notification on Aravallis dated 9th January’ 1992, has declared Aravallis as a sensitive ecosystem and has imposed some development controls. The notification broadly prohibits location of industry, all mining operations, cutting of trees, grazing of cattle, construction of any cluster of dwelling units and electrification in specified areas such as - Reserved and Protected Forests falling in District Gurgaon and Alwar, Sariska National Park, Gair Murnkin Pahar, Gair Mumkin Reda, Gair Mumkin Behed, Banjar Beed and Rundh (Roondh).

Although the area where development is prohibited has been mentioned proper maps of these areas have to be obtained from village panchayats. Without proper demarcation of areas on a map these controls may be difficult to implement. As for sensitive ecosystems the complex Bio-Diversity of Aravallis has to be recorded and in the meantime an EIA of settlements adjoining Aravallis - whether existing or expanding has to be undertaken. Also, proper buffers to control air pollution from adjoining industries and roads have to be provided.

- **River Systems**

  Of all the earth's ecosystems, rivers are the most dynamic having as their primary function, the transportation of water. They also carry to the sea the load of dissolved and particulate output of

crustal weathering and erosion from land. River composition itself is determined by - various weathering regimes, the characteristics of flood plains and drainage basins, hydrographic situations and occurrence of floods. The load carried by the rivers exhibit a wide spectrum of physical and chemical characteristics. These materials enter the river through diverse pathways and are utilized, modified and stored by complex chemical reactions resulting in a dynamic equilibrium that sustains the living systems in the river basins. Indiscriminate dumping of sewage, usage of fertilizers, cutting of trees, channelization are some of the major reasons for the pollution of rivers today. Few rivers in the world today are 'pristine' or free flowing.

Apart from studying water quality - physical and chemical characteristics of these rivers their bio-monitoring is also an indicator of water quality. Research is being carried out on various river systems and the following hydro-biological features are being studied

i) Plankton - phytoplankton, microphytes, algae, fungi, bacteria, phages, enterovirus, zooplankton, protozoa, nematodes, insects
ii) Fish
iii) Amphibians - turtles, crocodiles
iv) Mammals - blue dolphin, and
v) Macrophytes

The studies involve sample collection and taxonomical identification, identification of pollution indicators, detailed cellular and molecular studies and identification of macrophytes. These studies help in not only indicating the water quality but also possible usage of the species for pollution control and protection of banks.

Bio-monitoring of the Yamuna has been carried out at Hindon and Okhla and some information of the river Ganga is available at the stretch extending from Garhmukteshwar to Naurora. Varying numbers of fishes, phytoplankton, zooplankton etc. are observed at various stages and seasons. List of species for certain stretches of the river are available for certain seasons. An analysis of the data indicates that industrial pollution is affecting the population of these species and proper monitoring and treatment of effluents is required for conserving the biodiversity of the system.

1) Yamuna River

The river is mainly influenced by the input of domestic sewage. The levels of pesticides are very low, and quite constant. Heavy metal contents are mainly attributable to geo-chemical sources. Out of the functionally different groups of organisms, only the benthic macrofauna species show a significant response to the gradients of pollution load. This may be due to increased sedimentation of organic matter leading to high biological activity in the benthos.

A study done by Indo-Dutch Fact Finding Mission also observed a total of 59 benthos, 178 phytoplankton and 83 zooplankton species between Palla and Juhika stations.

This includes 15 stations out of which 5 falls within NCR. Palla is relatively clean, ~lkhla's heavily polluted, Hindon sometimes intermediately polluted and Mazawali and Palwal are intermediately polluted.

2) Ganga River

Under the Ganga Action Plan, the entire stretch of the Ganga has been divided into three reaches viz. - Upper Reach, Middle Reach and Lower Reach. There are three sampling stations in the Upper Reach, which fall within the boundaries of NCR. These are Garhmukteshwar, Anupshahr and Rajghat Narora.

As mentioned before the studies indicate a reduction of Bio-diversity in areas, which are polluted. Activities of concern at the stations falling in NCR along Ganga are Community Bathing, Cremation and Post Cremation Activity, Point/Non-point Domestic Effluents and Agricultural Runoff.

Many more pollution monitoring stations along Ganga, Yamuna, Hindon, Kali and Sahibi are required to get a proper account of the effect of pollution, pollution load and the bio-diversity of the river systems. Biological applications, for pollution control can also be experimented in areas of polluted water.

- **Habitations**
  These include both the urban and rural settlements. Bio-diversity is observed in a large variety of crops that grow in these areas (cereals, pulses, spices, fruits, vegetables) and livestock type. In urban-areas the open spaces - parks and roadside plantation, canal side plantations are areas where biotic resources manifest themselves. In the NCR the major cereals grown are - rice, jawar, bajra, corn, wheat and jow. Pulses include - gram, moong, arhar, mash and masur. Major oilseeds are til and groundnut. Apart from these cotton, sugarcane, potato, tobacco is also grown. Spices such as chillies, ginger turmeric, cardamum, betalnut, coriander are grown. A large variety of vegetables and fruits are also grown. Major fruits being mango and citrus fruits and all types of vegetables are grown as this region has a composite to arid and climate. Variety in genetic composition is observed in the crops and fruits. This genetic diversity is helpful in increasing yields and making crops tolerant to changing environmental conditions.

  Major livestock reared in this area are - ox, cow, buffalo, horses, mule, donkey, goats, sheep, camel, pigs and poultry includes - hen, cock, duck and turkey. Here also, their genetic variety is of great significance for increasing milk and meat production apart from increasing their tolerance to environmental changes.

  In urban areas and small towns a hierarchy of open spaces is observed. Starting from a totlot, neighbourhood park, district park, we have regional parks and finally in certain areas city forests. Here the species of trees and plants are mainly flowering, fast growing and of ornamental variety. They function as noise buffers, pollution absorbers, temperature moderators and aquifer recharge areas in a predominantly hard surfaced area. Green buffers around industries and roadside plantation are mainly monoculture plantations but they also have a very important role in absorbing noise and air pollution.

  Apart from these cities are a major repository of a wide variety of avifauna, animals insects etc. which are unrecorded and which definitely play an important role in an urban ecosystem.

6.2 Conclusion

The analyses of life resources suggest that human settlement development should respect the spatial requirements of all the natural resources, the Aravalli hill system and the rivers. Area specification regarding the core and its surrounding areas and control over the use of land is essential. Fortunately, the major rivers are generally not highly polluted except Yamuna in Delhi and further south. Control of discharge of effluents, both domestic and industrial, as per Pollution Control Board guidelines should ensure protection and eon5ervation of bio-diversity, which is a major indicator of healthy environment.

The pace of urbanization is increasing rapidly in NCR. Hence apart from protecting the special areas and controlling landuse, species tolerant to pollution should be planted along roads and near industries. Research in agriculture and animal husbandary indicate the tolerant species of crops, fruits and vegetables. A healthy mix of these should be propagated. For planners perhaps the appreciation of these aspects is required and space requirements, should be understood and planned for. Practices such as Social Forestry, Agro Forestry should be encouraged as this conserves the Bio-Diversity of the area.

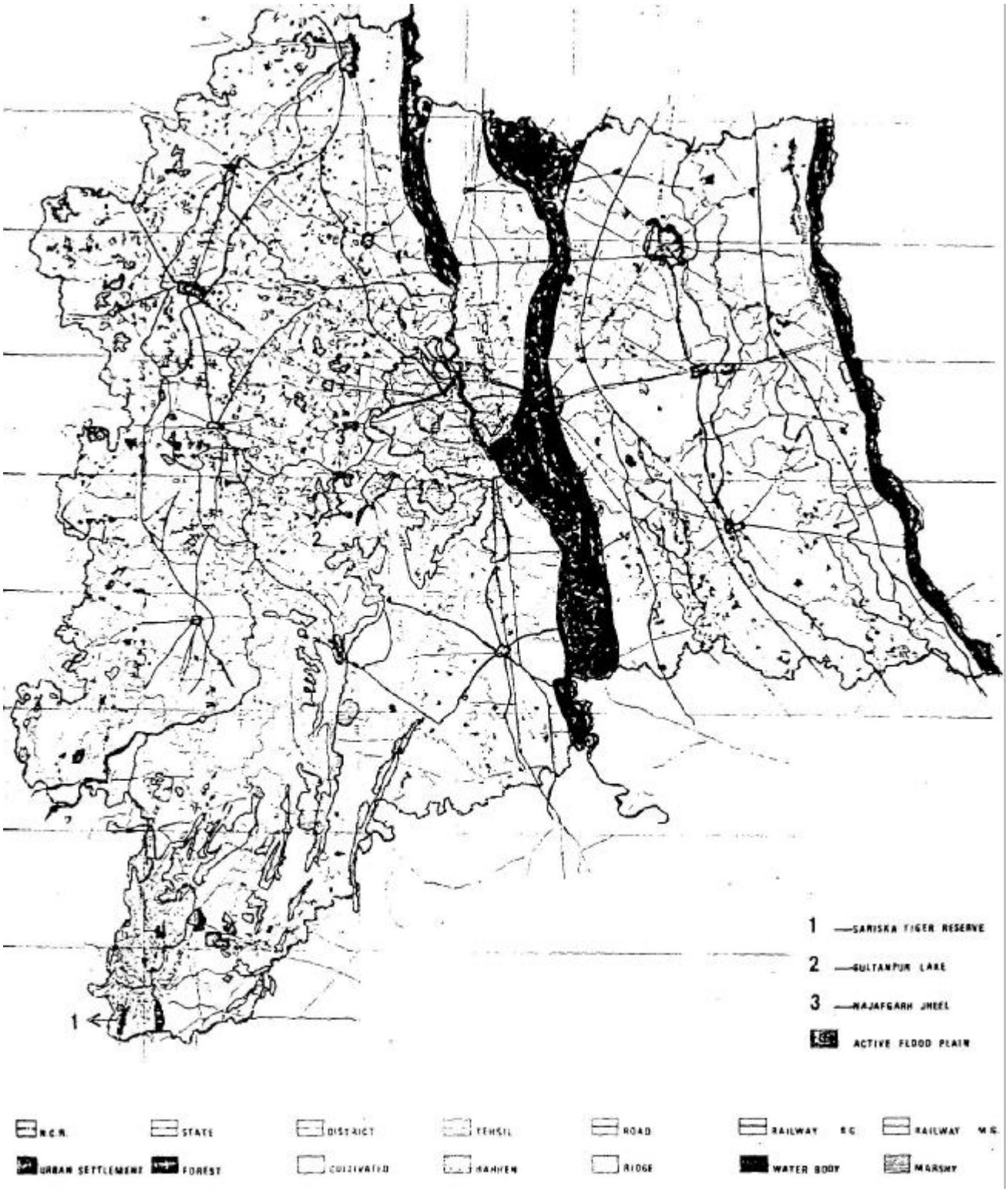

Figure 6: Environmentally Sensitive Areas

6.3 Strategy for Management of Bio-Diversity of the NCR

The major zones identified for studying the biota of NCR are

i) Special Protected Areas
ii) Hilly Areas
iii) River Systems
iv) Habitations

If we scan the data available on Species Diversity, the study is incomplete. Further research is required in this area for recording and monitoring the Bio-Diversity of the region. A cell for maintaining the Bio-diversity records can be created for this purpose. Also, a simple counting of number is not enough, the valuable services each species renders to mankind and its vital role in the ecosystem has to be understood. Some of the efforts to protect the biotic wealth of NCR can be by planning landuses in the correct manner, afforestation, protection of existing forests, control of pollution.

Special Protected Areas would require restriction in terms of landuse and pollution control in the vicinity to ensure protection of their biotic wealth. Hilly areas would require not only control of landuse, but also afforestation of the right type of species and control of growth of monoculture. River systems need a lot of research in terms of indicator species. Here introduction of new species to improve quality of aquatic environment can be investigated. Here again the various relationships between the organisers, their relationship with the non-living environment (i.e. the structure and function of the aquatic ecosystem) and response to pollution has to be understood thoroughly as without this knowledge development controls cannot to effective.

In case of habitations the value of the right type of plantations whether they are along roads, in parks and other open spaces has to be understood. Also the cropping pattern, type of horticultural species that are grown and their effect on the soil, microclimate has to be understood. Simply marking an area for agriculture or horticulture is not enough if it is going to produce only one crop year after year and thus causing loss in soil fertility. It is common knowledge that increasing usage of insecticides, pesticides, fertilizers are after a certain point detrimental to the environment. Practices such as Social Forestry, Energy Plantation, Agro Forestry have to be understood and their role in improving the environment of the region have to be understood and such practices have to be adapted as NCR has a large area under agricultural landuse and the right type of agricultural practices would go a long way to improve the natural environment here. The population of livestock is another important aspect here. Their requirement of food and fodder is the greatest factor that effects the environment. Their grazing habits at times lead to deforestation. These animals are here to stay. They are the new species and are part of the bio-diversity of the region. There role in the ecosystem positive and negative have to be understood and the negative effects have to be controlled.

To conclude though the role of Bio-diversity is very important, it is also very complex and knowledge and data available in the context of NCR is in a piecemeal manner. But with the available data a broad strategy can be formulated which could be listed down as actions to be taken related to the various zones under which the diversity has been studied and recorded.

6.4 Restricted Activities in the Specified Area of Aravalli Range

As per the notification of the Ministry of Environment & Forests, Govt, of India dated 7.5.1992, the Central government has prohibited the carrying on of the following processes and operations, except with its prior permission, in the areas specified in the Table appended to the Notification

1) Location of new industry including expansion/modernization;
2) All new mining operations including renewals on mining leases;
3) Existing mining leases in sanctuaries/national parks and areas covered under Project tiger
4) Mining being done without the permission of the competent authority;
5) Cutting of trees;

6) Construction of any cluster of dwelling units, farmhouses, sheds, community centers, information centers, and any other activity connected with such construction (including roads and part of any infrastructure relating to);
7) Electrification (laying of new transmission lines).

7.0 Disaster Management for NCR

1. The approach paper formulated in connection with NCR Plan 2021 for study group on Environment including Tourism, Heritage, Pollution and Disaster Management etc. by the National Capital Region Planing Board, under the heading 'Disaster Management' reads as below

i) In the Regional Plan 2021, no specific policies and programmes were envisaged

ii) In view of the Gujarat Earthquake, the Board has taken a view to include disaster management in the regional context. As per vulnerability atlas of India, 1997 the National Capital Regions lies in Zone IV.

The occurrence of earthquakes in and around Delhi are attributed to the following prominent tectonic features

a) The Sohna Fault
b) Aravalli Fault
c) The hidden Moradabad fault in the Indo-Gangetic Basin
d) Sonepat – Delhi – Sohna Fault
e) Junction of Aravalli and Sohna Fault
f) Delhi – Haridwar Ridge

2. There were 24 epicentres of earthquakes in the region. The epicentres of earthquakes located, close to these lineaments were confined to Sangam Vihar, Maidan Garhi, Ghatorni, Rajokri, Nathupura, IGI Airport, Shahbad Mahamudpur Bharthal, Sagarpur, Chanakyapuri, Inderpuri, Pusa Institute, Najafgarh, Motiakhan, Sagarpur, Ranikhera, Gujrawala Colony and near northern edge of the reserved forest (Ravindra Rangshala).

3. Besides, there are several other parallel faults inferred from geomorphological studies. The earthquake activity in Delhi and neighbourhood is related to tectonic activity along the faults present.

4.

iii) Similarly, the region lies in the flood prone area and inundation during monsoon is a regular feature. As per the past history of the floods in the Ganga and Yamuna sub-basin, the districts affected are Meerut, Ghaziabad & Bulandshahar in U. P. and Panipat and Sonepat in Haryana.

iv) Other disasters in the Region, which need to be attended, are fire hazards and Hazardous Industries in the Region.

v) There is a need to make suitable provisions in the Regional Plan 2021 to ensure that all the member states make necessary policies and programmes and amendments in Building bye-laws / Master Plans to provide for the requisite safety feature in respect of natural and man-made hazards. Ministry of Urban Development and Poverty Alleviation has already issued a notification with regard to make suitable provision in building byelaws in Delhi to construct earthquake resistant buildings in Delhi. Similar policies / strategies should be adopted for the region.

vi) Therefore, it is imperative for the study group to examine this area and suggest policies and programmes for the perspective year 2021. "

5. Accordingly the Sub Group met a number of times and studied various aspects related to disaster management. The group was having the benefit of a number of studies conducted by Building Materials and Technology Promotion Council (BMTPC) and other organisations /expert(s), namely

i) Vulnerability Atlases of National Capital Territory Delhi, Uttar Pradesh, Haryana and Rajasthan by BMTPC
ii) Report of the Expert Group on Natural Disaster Prevention, Preparedness & Mitigation having bearing on Housing and Related Infrastructure,

Part 1 Techno Legal Aspects
Part 2 Guidelines for Improving Hazard Resistant Building and land Using Zoning

iii) Population Projection for the National Capital Region 1996-2021 by Prof K.S. Natrajan (Ex – Deputy Registrar General), Census of India.
iv) Seismo- Tectonic Atlas of India and its Environs by Geological Survey of India.
v) Study on Drainage System and Flood Control Including Water Resources in capital Region by Water and Power Consultancy Services (India) Limited
vi) Flood Atlas of India, Central Water Commission

7.1 Special Geographical / Geotectonic Features in NCR

A) Seismic Tectonic Map of NCR

NCR falls between 76º - 78º 30'N longitude and 27º 15' – 29º 30' E latitude. A seismic tectonic map of the region is given in Figure X.

B) Physiographic features

Structurally controlled, denudational ridges of the Aravalli mountain chain enter the National Capital Region (NCR) from South in the Alwar district of Rajasthan. These linear ridges depict mature topography with flat tops and extend in general NNE – SSW direction passing through the districts of Gurgaon and Faridabad in Haryana before culminating in Delhi. These ridges are interspersed with vast sandy and alluvial plains.

- In the southwestern part of the NCR, less prolific linear ridges extend in the general strike trend of the Aravallies in the Rewari district of Haryana.
- Northwestern and northern part of the NCR, the area to the west of Yamuna river is mainly flat with a rolling topography and is occupied by a thick pile of unconsolidated sediments with a general slope towards South. Panipat, Gohana, Sonipat, Rohtak and Jhajjar areas are covered by these sediments.
- Various types of obstructive dunes have formed in Rewari, Gurgaon, Faridabad and Alwar districts. Some of these are stabilised, others are active with eastward migration direction.
- Northeastern, and eastern part of the NCR, the area between Yamuna and Ganga rivers in the districts of Meerut, Ghaziabad, Bulandshahar of Uttar Pradesh and partly Delhi form a flat country overlain by alluvium.
- Rohtak forms a structural depression manifesting as a closed basin with no discharge outlet.

C) Drainage

- Ganga river forms the eastern boundary of the NCR and is an important perennial river in the fringe part.
- Yamuna is the other perennial river, which enters the NCR from north and drains through Panipat, Sonepat and Delhi before flowing in Southeastern direction to Uttar Pradesh.
- Ephemeral rivers like Dohan, Sahibi and Krishnawati originate from the Aravalli hills in the southwestern part and flow in a northerly direction through Rewari, Jhajjar and Rohtak.
- In the eastern part the Kali Nadi forms a prominent channel.
- Rest of the area is criss-crossed by small water channels, few big drains and canals.

D) Stratigraphy

Quaternary	Holocene	Yamuna Younger	:	Micaceous sand, silt and clay
		Yamuna Older Alluvium		Coarse, fine sand, clay in the paleochannels, abandoned channels
		Active dunes & stabilised dunes	:	Aeolian sand
	Upper to Middle Pleistocene	Ambala Older Alluvium	:	Fluvial and aeolian sand with clay. Layers of kankar at various levels
Proterozoic	Delhi Super Group	Jabgarh Group	:	Slates, phyllites and quartzite with minor limestone
		Alwar Group	:	Mainly quartzite with subordinate schists

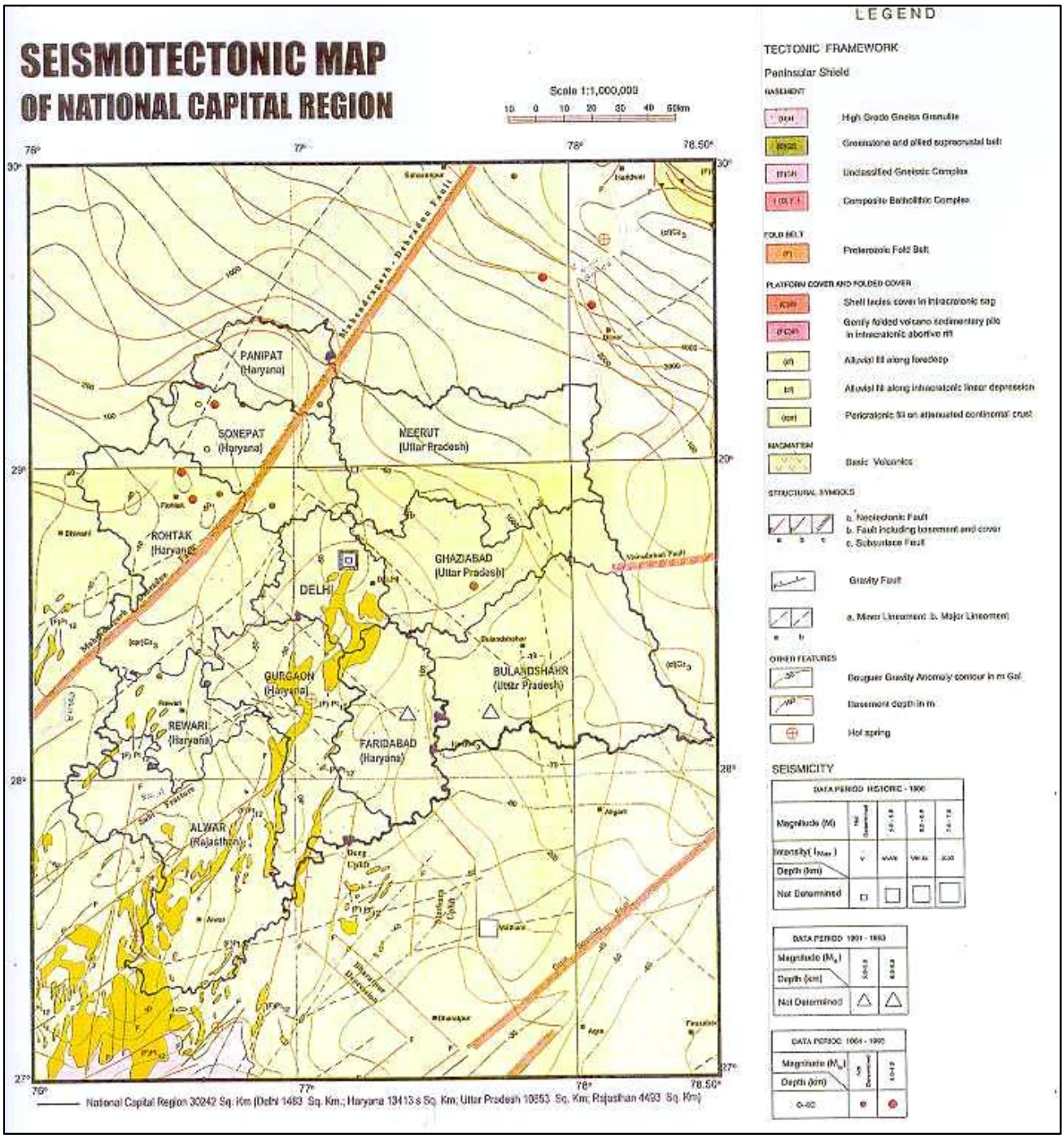

Figure 7: Seismo-tectonic Map of NCR

E) Geology

Alwar Group comprises massive, fine to medium grained quartzite with inter calations of carbonaceous and garnetiferous schists. In the National Capital Region rocks of Alwar Group form the principal component of the rocky ridges occurring in Delhi, Gurgaon, Faridabad and Alwar districts. Number of pegmatites and quartz veins intrude the rocks of this Group. Clay, silica sand, Badarpur sand and quartz crystals occur in pockets and are being mined.

Ajabgarh Group is constituted mainly by slates, phyllites and quartzites with minor limestone. Rocks of this Group form linear ridges in the Rewari district and northern part of Alwar district. Good quality slate is being mined from the outcrops in Rewari district.

- Ambala Older Alluvium occupies Panipat, Sonepat, Gohana, Rohtak and Jhajjar in the northwestern and northern parts of the NCR. It is constituted mainly by alternating sand and clay in the northern part of the region whereas towards south it is clay dominant. Kankar occurs as lenses, pockets or layers at various levels in this alluvium and is used locally as a cementitious material.
- Active dunes and stabilised dunes are composed of aeolian sand. These are of obstructive type having formed near the ridges in the districts of Rewari, Gurgaon and Faridabad due to eastward migration of sand form desert.
- Yamuna Older Alluvium occurs in the districts of Panipat, Sonepat and is confined to the paleochannel and abandoned channels of the Yamuna river. It comprises coarse to fine sand, silt with occasional kankars. Yamuna Younger Alluvium occupies the area east of Yamuna river up to the Ganga river in the districts of Meerut, Ghaziabad and Bulandshahar. It is constituted by thick pile of unconsolidated micaceuous sands with silt and clay.

F) Structure

- The NE – SW extending Mahendragarh – Dehradun fault is a subsurface feature, which passes through the northern and western parts of the NCR. The Rohtak topographic low could be related to this lineament.
- Rocks of the Delhi Super group, which form prominent ridges in this region, define a lineament as the axis of a fold belt.
- The southern part of the NCR has a number of N – S and NE – SW extending neotectonic faults.

G) Seismicity

- The NCR has experienced earthquakes since ancient times. This region falls in seismic zone IV as per Indian Standard IS 1893.
- Earthquakes in this region are mainly shallow focus and lie within the alluvium covered northern part in collinearity with the Mahendragarh – Dehradun fault.
- Earthquakes in historic and pre-instrumental period lie in the close proximity to the Yamuna river course between Delhi and Mathura.
- Thus the earthquakes recorded in this region show clustering around Rohtak and Delhi.
- The earthquakes of Himalayan origin i.e. Kangra earthquake of 1905, Uttarkashi earthquake of 1991, Chamoli earthquake of 1999, were also severely felt in this region and had also caused some damage.
- This region has also felt earthquakes centred in the N.E. part and the western part of the country. Recent Bhuj earthquake was also felt, though no severe damage was reported.

H) Points to be taken into account

i. Rocky ridges form a very small part of this region. These ridges act as water dividers for recharging the aquifer of the surrounding areas and hence should be preserved.
ii. Rohtak area is a topographic low and is flood prone. All further development should be done keeping in view that it is also a seismically intense zone.
iii. Migration of desert eastward, in the southern part of the NCR is to be checked.

7.2 History of Hazards noted in the Past

1. Earthquakes

Table 27: Earthquakes in NCR with more than 5.0 magnitude on Richter Scale

Year	Month	Date	Time of origin (GMT)	Latitude ^{O}N	Longitude ^{O}E	Focal Depth (Km.)	Magnitude Ritcher Scale
1720	07	15	-	28.4	77.1	-	6.5
1803	09	1	-	27.0	77.0	-	6.8
1809	00	00	-	30.00	79.0	-	6.0
1842	01	16	-	27.0	78.0	-	5.5
1842	03	05	-	30.0	78.0	-	5.5
1956	10	10	15:31:36:0	28.2	77.7	-	6.7
1960	08	27	15:58:59:2	28.2	77.4	109.0	6.0
1966	08	15	02:15:28:0	28.67	78.93	5.0	5.6

(Source: IMD Catalogue)

1. The above table gives list of earthquakes of Richter magnitude 5.0 and higher only, a large volume of data on earthquakes of lower magnitude is available in IMD, which must be considered in the hazard proneness of different areas in the NCR from the planning point of view.

2.

2. Floods

3. As per WAPCOS' report on ' Study on Drainage System and Flood Control Including Water Resources in National Capital Region', flood scenario in the region can be explained as follows

4.

5. NCR experiences floods due to the perennial rivers the Ganges, in the eastern part, Yamuna in north to south eastern part; ephemeral rivers like Dohan, Sahibi and Krishnawati in southwestern part and Kali Nadi in the eastern part.

6.

a) Ganga basin

33. The plains of main Ganga are frequently visited by floods besides the normal inundation during monsoon, which is an annual feature. Abnormal floods are reported to have occurred once or twice in every decade resulting in heavy damages to property and loss of life.

34.

Table 28: Frequency of severe floods in NCR districts of U. P.

District	River	Years of severe floods
Meerut	Ganga	1933, 1942, 1947, 1948, 1955, 1956,1957, 1958, 1960, 1975
Ghaziabad		1985, 1987, 1988, 1989
Bulandshar		1924, 1939, 1942, 1945, 1948, 1955 to 1958, 1975, 1985, 1988

The three most severe flood events were recorded during July 1960 are Aug – Sept 1975 and Aug 1988.

- 1960 Flood

  The river started rising in the middle of July. At Garhmukhteshwar Railway bridge the river crossed the medium flood level of 652.00 ft. (198.73 M) and recorded a level of 652.25 ft. (198.8M) on 26.7.60, which was the highest level of the season.

  At Narora, it crossed the flood level of 586.00 ft. (178.61 m) in the last week of July and recorded a level of 587.50 ft. (179.11m), which was the maximum of the season.

- 1975 Flood

  For 18 days river remained above danger level at Narora. The total rainfall at Bulandshar was 652 mm against the normal of 452.5 mm from the period from 1st June to 31st August.

- 1988 Flood

  35. All the three districts in U.P. sub-region were affected by floods in the main Ganga river system.

  36.

b) Yamuna Sub- Basin

37. The general nature of flood problem in the Yamuna system is spilling on flood plains, erosion of river banks and drainage congestion in low lying areas. The districts affected in Haryana by

spilling are Panipat and Sonepat and in UP-Meerut and Bulandshahar. The river course is unstable in the portion where the Yamuna is the boundary between Haryana, NCT of Delhi and Uttar Pradesh. Drainage congestion is experienced in Haryana and U.P. in the respective low-lying areas.

38.

39. The plains of river Yamuna had experienced heavy floods in the years 1924, 1947, 1955, 1956, 1976, 1978 and 1988. With respect to the instantaneous maximum peak discharge, the 1978 flood (with varying estimate) was the highest on record. However the seven day volume of discharge at Tajewala during the 1924 flood event was the largest comprising two closely following flood waves.

40.

41. In the year 1947, the Yamuna passed a high flood discharge at Tajewala. The record flood occurred on the 25th September causing immense damage all along its course. During 1955 floods, many low-lying areas on the either bank of Yamuna were badly affected. In October 1956 floods, the gauge at the old Railway Bridge registered 206.44m. In August 1976 flood event, even the previous record of 1956 was surpassed and the old Delhi Railway Bridge recorded peak flood level of 206.7 m.

42.

43. In the monsoon of 1977 parts of Rajasthan, Haryana and the NCT of Delhi of the Yamuna Basin suffered unprecedented flood havoc. This was caused by the Sahibi river, which originates in Rajasthan and traverses a distance of 222 kms before entering Delhi territory at Dhansa Bund and out falling into Yamuna River through Najafgarh drain. Major breaches took place in the national highway between Delhi and Jaipur. The Delhi – Alwar railway line was also breached at Khalilpur. A large number of villages and towns viz Farukhnagar, Jhajjar, Bhadurgarh etc. in Haryana were cut off for days together. The maximum observed discharge at Masani (Haryana) about 79 km upstream of Dhansa Bund was 3014 cumecs. Najafgarh drain which has a capacity of 3000 cusecs (84.96 cumecs) passed a discharge of about 6500 cusecs for a number of days. In the process, the banks of the drain were overtopped resulting in flooding of urban colonies of Delhi situated in the vicinity. A number of roads including part of the Ring Road were flooded. Delhi and Haryana thus suffered extensively due to 1977 floods of the Sahibi, which was the worst in more than a century.

- September 1978 Flood Event

  44. The 1978 flood was a very severe flood in the history of the Yamuna river. A discharge of over 20,000 cumecs was estimated to have passed at Tajewala in the early morning hour of 3rd Sept 1978. However, the flood peak at Tajewala estimated to be over 20,000 cumecs got moderated to 7100 cumecs at Delhi due to breaches in the rural embankments upstream resulting in flood detention estimated to be of the order of 3330 million m3 (27 lakh acre feet). But for the breaches in embankments downstream at Kalanaur Railway Bridge and dispersal of floodwaters peak discharge at Delhi railway bridge could have been 11000 and 14000 cumecs.

3. High Wind Storm

Some parts of Delhi in a narrow strip suffered severe damage caused by a ‘tornado’ in March 1978 with an estimated wind speed of 200 km/h. But these are freak occurrences not amenable to forecasting and preparedness.

7.3 Vulnerability and Risk Assessment of the Region due to Natural Hazards

1. Earthquake

Seven earthquakes of Ritcher Magnitude 5.5 to 6.8 are known to have occurred in the UT of area of Delhi or close to it since 1720 AD. Two major lineaments namely Delhi-Haridwar ridge and Delhi-Moradabad faults pass through the territory, both having potential of generating earthquakes of magnitude upto 6.5 to 6.7 Normal depth of 30 km may be assumed for these earthquakes. It will be prudent to consider the effects of such a potential earthquake for developing a **prevention-cum-preparedness plan.**

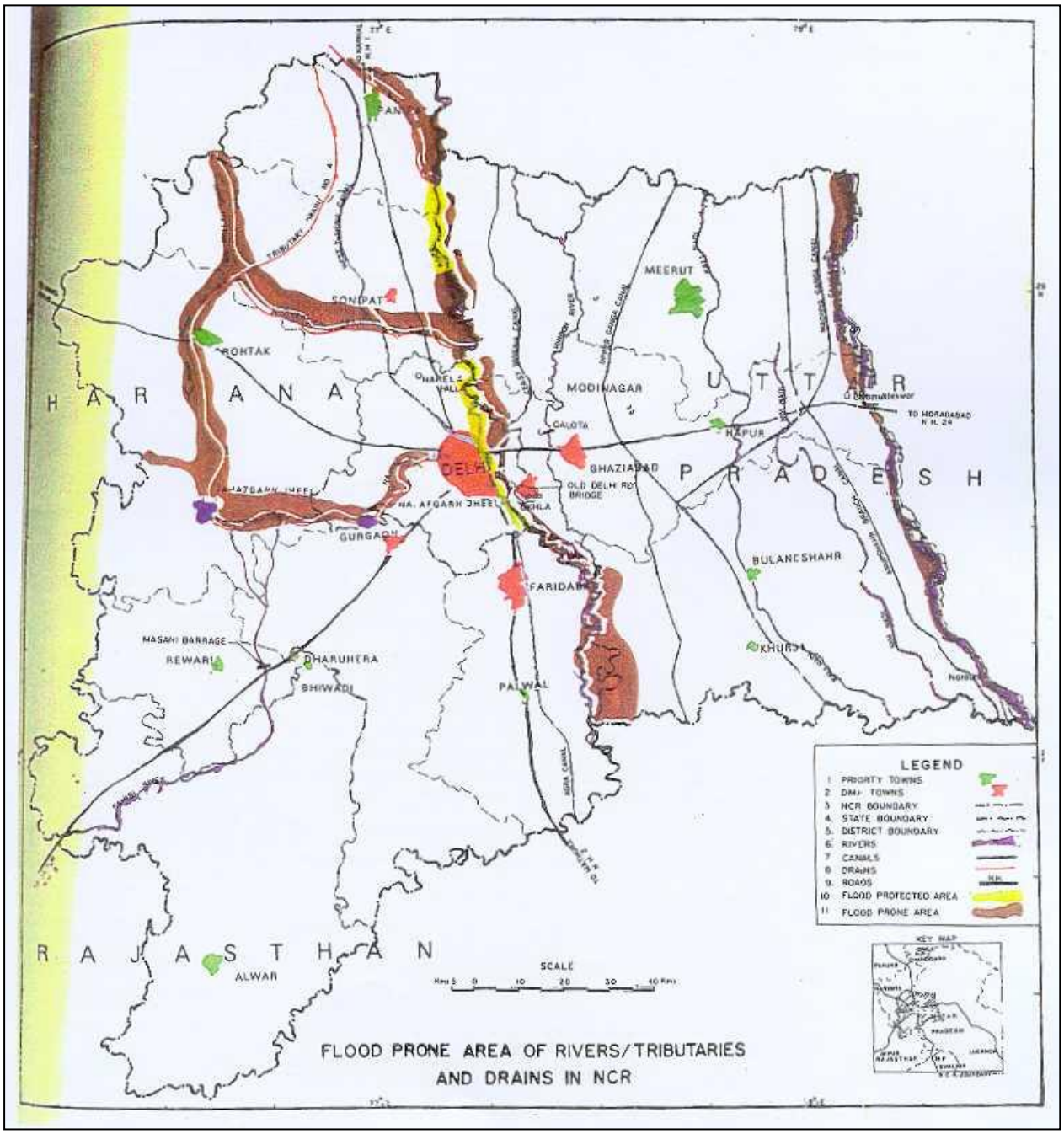

Figure 8: Flood – Prone Area of Rivers / Tributaries and Drains in NCR

NCR region falls in seismic zone IV as per seismic zone map of Indian Standard IS 1893. This gives the area liable to mm intensity VIII and is considered as High Risk Zone. Such intensity may cause following damages.

a) Fright and panic, also persons driving motorcars are disturbed. Here and there branches of tree break off. Even heavy furniture moves and partly over turns. Hanging camps are damaged in part.
b) Most buildings of **Type C** i.e. RCC buildings may have small cracks in walls, fall of large pieces of plaster, pan tiles slip off, cracks in chimneys, parts of chimneys falls.

Type B buildings covering ordinary brick buildings, large block and prefabricated type, building in natural stone may suffer heavy damage causing large and deep cracks in walls, and **Type A** houses covering field stone, rural structures, unburnt brick houses, clay houses may suffer destruction causing gaps in walls, collapse of parts of building, loosening of cohesion of parts of buildings and collapse of inner walls.

The areas subjected to damaging intensities MSK VIII and VII in three earthquakes of Ritcher Mass 6.5 are seen to as follows

Table 28: Areas Affected under Earthquakes of Magnitude 6.5

Earthquake	M	I =VIII (Sq. km)	I = VII (Sq. km)	Total under VII & VIII (Sq. km)
Koyna 1967	6.5	130	430	560
Uttarkashi 1991	6.6	700	1300	2000
Killari 1993	6.3	420	930	1350

Considering the areas affected during past earthquake of M ~ 6.5, it can be expected that such an earthquake occurring in NCR could adversely affect the whole of it with damaging intensities and more than 50% of the Delhi Metropolitan Area depending on the location of the epicentre. Therefore, in terms of probable damage scenario, earthquake would be the worst natural disaster NCR Delhi could have. The whole urban development must be checked for safety against an intensity VIII probability of occurrence, and upgraded for required seismic resistance in buildings and infrastructure as found necessary.

So far as housing is concerned, a preliminary estimate of damages can be obtained by considering the earthquake intensity, the housing types and the population density, using the methodology developed by Prof. A. S. Arya by quantifying the damaging effect based on MSK Intensity Scale.

2. Floods

As per the Flood Atlas of India prepared by Central Water Commission, it is seen that unprotected flood prone area in Delhi is small (about 1.7% or 25 sq.km.) towards the southeast and there is considerable area (about 5% or 74 sq.km.) in the northeastern parts, which is protected by earthen embankments. Almost every year the flood levels in Yamuna cross the danger level. Populations living in low areas behind the 'bunds' (embankments) are evacuated to the top of the bunds or on roadsides at higher elevations. The river flow and the expected stage of Yamuna at Delhi is forecast by the Central Water Commission through hydrological and hydraulic observations on the upstream, particularly taken at Tajewala headworks about 130 km upstream where two canals take off from the river Yamuna, one on its left bank and the other on the right bank. Probable maximum precipitation at Delhi is specified to be 520 m in 24 hours by the India Meteorological Department (IMD). If and when a heavy precipitation happens, local flooding of streets and localities can occur on a large scale.

3. High Winds

So far as wind hazard is concerned, the design wind speed in the whole region is 47 m/s (169 km/h) as per IS 875(Part 3), which could only occasionally be reached in what is called 'Andhi' (wind storm). The wind or infrastructure in this region should be design keeping in view the above wind speed. In such events, weakly built huts of thatch, sheets etc. and those with sloping roofs such as using thatch and tiles and AC sheets and corrugated Galvanized Iron (CGI) sheet roofs which are not fully

anchored and integrated will suffer damage. The damage occurring in 'Andhis' is again of localized nature and does not result in ' disaster' to the region.

Using the houses type data based on 2001 census data, the risk to the housing stock from the wind hazard could be worked out for different regions similar to the vulnerability risk tables prepared using 1991 census data in the Vulnerability Atlases of different states.

This wind scenario, of course, will not cover the risk to a tornado, which is rather a freak case in respect of its occurrence, intensity as well as path and extremely difficult to deal with in generalised hazard risk studies. Also, in any one windstorm, it is not likely that the whole or a large part of Delhi will be affected at once, nor there is a possibility of a disastrous consequence from this hazard.

4. Fire Hazard

Fast growing cities like Delhi located in the NCR are threatened by fire hazards, which may be attributed to following main reasons

1. Non-implementation of fire safety norms as part of building byelaws.
2. Encroachment, over crowding and haphazard growth.
3. Illegal and loose electrical connections.
4. Substandard wiring and over loading of electrical system.
5. Jhuggies and Jhopparies clusters with highly flammable, some very toxic materials like plasters / polythene sheets, bamboo, soft wood etc. without proper access for fire tenders.
6. Illegal storage's and dangerous commercial activities.
7. In addition inadequate pumping facilities hamper fire fighting and control of fire.

Delhi sub-region with multi faceted activities and, large number of multi storeyed buildings, increased population density and mixed occupancy is most vulnerable to fire hazard. Other towns with increasing industrialization and development of multi storeyed buildings such as Ghaziabad, Gurgaon, Noida, Alwar Faridabad and others, are also more vulnerable to fire hazard compared to other towns in the region.

A comprehensive study of the vulnerability due to fire hazards in the region and in different areas of fast growing towns should be taken up and adequate safety provisions be made for future planning of NCR and improvement in the quality of electrical cabling and wiring and distribution systems.

Specifically a survey of high rise office, commercial and residential buildings in all the important towns in the NCR area should be undertaken.

5. Actions Needed

- The recommendations of the Standing Fire Advisory Committee / Council as contained in their Compendium of Recommendations and as updated should be taken into account while preparing NCR Plan 2021.
- Database and comprehensive evaluation of risks of growing towns to identify areas in each town vulnerable to fires and available equipments and personnel should be under taken on priority.
- Areas in cities and towns in the NCR may be classified as:
    - High Vulnerability
    - Moderate Vulnerability
    - Low Vulnerability

Fire Safety measures for different areas should be worked out based on basic character of cities / towns.

- Part IV of National Building Code and following Indian Standards provide safety regulations. These should be followed as guide for formulating Development Control Rules / byelaws by the participating States' for mitigation of the Fire Hazard.

1. IS 3034:1993	Code of Practice for fire safety of industrial buildings: Electrical generating and distributing station (second revision)
2. IS 3594:199	Code of Practice for fire safety of industrial buildings: General storage and warehousing including cold storage (first revision)
3. IS 9109:1979	Code of Practice for fire safety of industrial building Patent and Varnish factories
4. IS 11457(Pt. 1): 1985	Code of Practice for fire safety of chemical industries Part 1 Rubber and Plastic
5. IS 11460:1985	Code of Practice for fire safety of libraries and archives buildings
5. IS 12456:1998	Code of Practice for fire protection of electronic data processing installation
7. IS 13694:1993	Code of Practice for fire safety in iron and steel industries
8. IS 13716:1993	Code of Practice for fire safety of hotels
9.IS 14435:1997	Code of Practice for fire safety in educational institutions

7.4 Guidelines for Disaster Resistant Construction

Disaster mitigation and management require to place reliance on heavy data banks, proper planning and design of the environment, development of an area and at the micro level planning, design, construction and maintenance of structures, buildings, flood containing structures, prevention and so on. Indian Standards play a major role in the entire gamut of these activities.

NCR falls under the following zones

- **Earthquake (IS 1893)** **Zone IV**
- **Design Wind Speed [IS 875(Part 3)]** **47 m/sec**

Besides the above there are several Indian Standards on foundations, design of steel, RCC structures of various types and construction codes and particularly the National Building Code of India, which are to be generally followed in conjunction with the basic codes, mentioned above.

In case of floods collection of data on normal water and flood flows, design and provision of flood containing structures and above all planning the drainage network to carry away precipitation are important. There are several Indian Standards, which provide guidelines on these aspects.

7.5 Micro-zonation with Respect to Earthquakes and Floods

General physiological and geological features in NCR regions, as explained in the Para 2, clearly brings out the fact that the region is situated on some geological faults and site condition in the entire area is also different at many places. The area has some flood plains and riverbanks. The soil in most of the region is alluvial. Although the entire area falls under seismic zone IV causing earthquake of intensity VIII on MSK scale, the uniform shaking intensity for the entire region is most unlikely because individual sites will respond differently to seismic events on various faults and lineaments in the region due to probable differences in some mechanism, travel path, etc. and local soil deposits. Further seismic waves propagation from bed rock to earth surface are significantly modified (usually amplified) by the underlying alluvial (local soil effects) and ground features (topography i.e. valleys, slopes, basin edges and their focussing effects. Clearly, a micro-zonation of NCR and / or its constituent urban centres is very much needed. From the growth pattern of the region and taking into consideration other aspects such as site condition, specific location, seismotectonic features commercialization, vulnerability to natural and man made hazards, it is evident that following townships would require priority attention for micro-zonation i.e., NCT Delhi, Noida, Rohtak, Ghaziabad, Faridabad, Meerut, Gurgaon, Alwar. Subsequently other towns could be taken up depending upon the possible growth of the other towns.

Micro-zonation requirement is similar to macro level hazard evaluation but requires more rigorous inputs about the site specific geological condition, ground responses to earthquake motions and their effects on the safety of the constructions taking into account the design aspects of the buildings,

ground conditions which would enhance the earthquake effects like the liquefaction of soils, the ground water conditions and the static and dynamic characteristics of foundations. The variable factors are

a) The earthquake ground motion characterized by the earthquake source parameters e.g. the magnitude, the fault type, the displacement or stress drop, the hypo-central distance to the site, the velocity structure etc.
b) The local soil profile characterized by the soil layering to the base rock, its age and sequence, depth and shear wave velocity of the strata, the depth of water table etc. and
c) The topographic structures such as ridges and valleys, width and depth of valleys and locations of the site in the valley etc.

In order to attempt micro-zonation of an area following information is important

- Earthquake data (specially micro)
- Seismotectonics of the region
- Local geology
- Soil profile
- Material properties of the layers
- Ground water table
- Topographic maps
- Large scale maps

45.

46. The development of such micro-zonation undergoes a very complex process, and is time consuming and expensive undertaking. It has been observed that uneven distribution of structural damage among similar construction types is largely due to local site effects such as depth of soil cover, topographical features. Many design codes, in absence of detailed micro-zonation hazard maps, consider this effect of local soil cover in a very simplistic fashion by site factor which modifies the base design response spectrum of rock site. For example, the proposed IS: 1893 will have different design response spectra for rock and soil sites. The site soils can be classified using SPT-*N*-values or shear wave velocity of sub-soils. For the NCR, until such time when detailed micro-zonation hazard maps are available, it is essential that a rigorous site soil classification along the lines of International Building Code 2000 is introduced with the current seismic hazard map of IS: 1893. It will help to avoid poor and liquefiable soil sites for construction activities and to modify the earthquake design forces suitably for otherwise competent soils. Similar provisions can be drafted for adverse topographic features, which can be either avoided or suitably modified to lessen the severity of damage.

General zonation could be improved considerably by value addition, by weeding out of unreliable information and by generating new data to fill in the knowledge gaps. New and additional investigations may also become necessary to map out the hydrogeology and geological units and geological features pertinent to local ground amplifications, liquefaction susceptibility and slope failures. By making effective use of the available information and new data, fairly reliable subsurface profiles could be constituted, eventually leading to three dimensional geotechnical profiles of micro-seismic tremors should help understand the ground response better.

A rigorous zoning would require reliable knowledge even of minor geological details which fashion ground behaviour during an earthquake. This level of mapping will also require a systematic and detailed study of buildings and other structure in order to assess their respective degrees of vulnerability. The locations of vital installations such as police stations, hospitals, fire depots, local government offices should be carefully mapped.

7.6 Land Use Planning

The basic objective of land use zoning is to regulate land use in hazard prone areas to minimise the damage caused to the habitat, as a result of natural hazards viz. earthquakes, floods, which occur from time to time in the region. The expert group responsible for the preparation of vulnerable Atlas has

given guidelines in their Report. While planning, shelter areas to be earmarked in case of floods and earthquakes in the regional and sub regional plans

7.7 Suggested Actions

- Earthquake Related

1. Seismic micro-zonation for selected areas/towns, having high growth rates should be taken up on priority. Such identified areas/towns are NCT Delhi, Noida, Rohtak, Ghaziabad, Faridabad, Meerut, Gurgaon, and Alwar. Subsequently other towns should be taken up for similar exercise deciding the priority based on the growth rates. Seismic micro-zonation, however, on a scale of 1:1,00,000 to 1:50,000 is required for the whole NCR region based on the already available data/indicators.
2. It was noted that India Meteorological Department (IMD) installed an array of telemetric instruments for continuous monitoring of earthquake activities including the occurrence of small magnitude earthquakes in the NCR region. It is suggested that data available be utilized for micro-zonation and for carrying out detailed risk assessment studies for formulating appropriate risk reduction policies and strategies.

- Floods Related

3. Detailed contour maps in the NCR region liable to flood should be prepared on a scale in 1 in 15000 showing contours an interval of 0.3 to 0.5 metre.
4. Different areas on NCR map need to be identified which are liable to flooding in rivers of return period of 5,10, 25, 50 and 100 years or may be due to excessive rainfall of return period of 5,10, 25, 50 years for identifying and deciding areas to be used for different land use categories at regional and sub-regional levels.
5. Keeping in view the geotectonic features of the region, it is observed that rocky ridges, although form small part of the region (as indicated in Fig.2), yet these act as water divides for recharging the aquifer of the surrounding areas and therefore should be kept preserved.
6. There are certain areas like Rohtak, which are topographically low, and flood prone, as such any development in such areas should be taken up keeping in view that these are also seismically intense zones.
7. It is also observed that in southern part of the NCR, desert is extending eastward, it is suggested that suitable measures should be adopted to arrest the tendency of desert's extension in this part of the region.
8. There should be marking on ground, information on flood levels in areas liable to significant floods on pillars / permanent structures.

1.

- Fire Related

9. The recommendations of the Standing Fire Advisory Committee / Council as contained in their Compendium of Recommendations and as updated should be taken into account while preparing NCR Plan 2021.
10. Database and comprehensive evaluation of risks of growing towns to identify areas in each town vulnerable to fires and available equipments and personnel should be under taken on priority.
11. Areas in cities and towns in the NCR may be classified as

- High Vulnerability, Moderate Vulnerability, Low Vulnerability from fire hazard point of view
- Fire Safety measures for different areas should be worked out based on basic character of cities / towns.

10. Part IV of National Building Code and other related Indian Standards provide safety regulations. These should be followed as guide for formulating Development Control Rules / byelaws by the participating States' for mitigation of the Fire Hazard.
11. Fire Department authorities should be involved in Planning for NCR right from the beginning so that there is a coordinated effort amongst the different participating states.

- General for all hazards

12. Risk table should be upgraded based on 2001 census data and subsequently using that data extrapolation for the years 2011 and 2021 should be worked out.
13. It is also suggested that proper Post-Disaster Management Plan should form part of the sub-regional plan. The contents and guidelines for this purpose, required to be followed by the participating States and NCT Delhi should be clearly defined.
14. Keeping in view the hazard risk of NCR, it is recommended that an exercise should be undertaken by participating States for vulnerability and risk assessment of important buildings, infrastructure etc. and suitable action be taken for retrofitting and strengthening.
15. Priority should be accorded to public buildings such as hospitals, educational buildings, power stations, and life line structures and those which are likely to attract large congregation care should also be taken for monuments / heritage buildings.

- R&D Effort

16. Innovative and emerging construction technologies should be studied and carried out for buildings and structures for implementation as a pilot project.
17. Detailed data base on the occurrence of hazards, damage caused to buildings and infrastructure and the economic losses suffered by various govt. departments, public and private enterprises, agriculture and horticulture and the related infrastructure in the area, should be complied.
18. Proper mechanism should be worked out to collate disasters and mitigation related data available with different sources and to ensure the accessibility and retrieval of the data by R&D institutions, disaster managers and voluntary agencies involved in disaster preparedness, mitigation and management (on cost basis if found necessary).
19. Research studies for buildings and infrastructure through analysis of damage data and model studies should be undertaken and suitable methods of risk assessment for earthquake and flood hazards should be evolved.

- Amendments to statutory Acts, Regulations

20. Necessary amendments to the existing NCR Planning Board Acts/Rules 1985 relating to natural hazards.
21. It is also suggested that the Development Control Rules and Building Bye-laws applicable in the sub-region (participating States) should be appropriately modified, having provisions on safety aspects relating to natural hazards and fire safety.
22. The relevant Town and Country Planning, Development and Municipal Acts of the participating States should be carefully examined and amendments be carried out to incorporate necessary provisions on safety aspects relating to natural hazards.

8.0 Environmentally Sensitive/Fragile Areas Needing Protection

The areas/zones as below located in NCR should be protected from land use conversion

1) Reserved Forests
2) Protected Forests
3) Forests other than reserved and protected forests
4) National Parks
5) Sanctuaries
6) Areas with endangered species - Flora and Fauna
7) Biosphere Reserves
8) Wetlands
9) Monuments - National, State, Local
10) Heritage/cultural sites
11) Protected Tribal Settlements
12) Scenic areas
13) Resorts/Areas of tourist interest
14) Water bodies
15) Springs/Water recharge areas
16) Other environmental resource areas

The areas falling in the above categories should be identified and they be shown as such in the regional plan. The need for extending the existing area may also be looked into. Some of the areas, from the list above, falling in NCR are given below (source: NEERI Report on Carrying Capacity)

Delhi Sub- region

1. Delhi Ridge- northern, central and southern
2. Asola Wildlife Sanctuary
3. Riparian ecosystem along with riverine track of Yamuna
4. Najafgarh Lake and its neighbouring areas
5. Bhalaswa lake near Burari village

Haryana Sub- region

1. Bhindawas bird sanctuary and Nahar wildlife sanctuary in Rohtak District
2. Catchment areas of Badkhal, Sultanpur, Sohna and Damdama lakes - Aravalli ranges
3. Sultanpur bird sanctuary
4. Riverine track and marshy habitats of Chotti Yamuna in Panipat District
5. Kotla Dahar and its catchment in a water body Nuh and Ferozpur Jhirka Tehsils
6. Highly degraded agricultural lands, due to salinity in Rewari District

Rajasthan Sub-region

1. Sariska National park/Tiger Reserve
2. Anogessus pendula forests in Alwar, Tijara and Behror Tehsils
3. Riverine tracts of Rurarel and Sahibi rivers
4. Jaisamand, Thekra, Siliserh, Kaduki lakes and their neighbouring catchments
5. Degraded lands due to mining operations near Sariska Tiger reserve

Uttar Pradesh Sub- region

1. Hastinapur Wildlife Sanctuary
2. Forest areas of Sardana Tehsil
3. Forest areas of Anupshahr, Khurja, Bulandshahr and Dadri Tehsils
4. Hindon river ecosystem near Ghaziabad and Dadri Tehsils
5. Water bodies around Hindon river in Ghaziabad Tehsil
4. Agricultural lands in Mawana, Baghpat and Sardana Tehsils degraded due to affluent discharge from sugar factories and distilleries

9.0 Areas Needing Care while Planning Activities/Land Uses

1) Polluted area (areas where environmental quality is exceeding standards)
2) Double cropped areas
3) Organised bathing places
4) Areas with specialized skills (handicrafts, weaving etc)
5) Orchards, plantations
6) Seismic zones
7) Flood prone areas
8) Flood plains

The polluted areas can be identified using the following procedure

Step I: Inventorise the sources of pollution (industry, domestic fuels, vehicular, brick kilns, mining, domestic sewage/garbage, etc.) and using their pollution loads, estimate the impact zones.
Step II: Identify the areas with public complaints against pollution
Step III: Identify polluted areas from field surveys and observations
Step IV: Use the existing air/water quality data and identify the additional data requirements
Step V: Undertake additional monitoring
Step VI: Using all the above information, draw air/water quality maps and demarcate polluted zones.

Planning for Environmentally Relevant Land Uses Including Sites for Industries and Other Developmental Projects

The environmentally relevant land uses include

- Trade and industry
- Housing
- Agriculture
- Mining
- Tourism
- Transportation
- Water supply, waste treatment and disposal installations
- Forests

Some of the activities have interdependencies such as the industry requiring transportation, housing, waste treatment installation etc. The planning of above land uses requires incorporation of environmental considerations and integrating them in an environmentally compatible manner.

The transportation network forms the basis for future development and hence proper environmental assessment should be carried out before deciding on the network.

The sources of water supply need regulation of activities having pollution potential in its vicinity. The protection and sustainable use of natural resources must be ensured.

The NCR Plan should specify the areas where siting of certain types of industries or development projects are prohibited. The factors to be considered while identifying such are given in Annexure. Such restrictions may include restriction of certain types of industries in the entire region.

Environmental Standards

The minimal national standards as are applicable for the entire country may be referred from the CPCB document on “Environmental Standards for Ambient Air, Automobiles, Fuels, Industries and Noise”, “Pollution Control Acts, Rules and Notifications Issued There under” and “Standards for Liquid, Solid, gaseous Emissions”.

The minimal national standards are to be made stringent for a region/place depending on the local requirements, however the standards cannot be relaxed. The standards as applicable presently for NCR may be obtained from the concerned state pollution control boards.

The NCR Plan should specify the standards that would made applicable so that the permission for new industries and other developmental projects can be issued accordingly. While deciding on the standards applicable for NCR, the following factors should be considered

- Minimal national standards
- The environmental sensitivity of the region
- The carrying capacity of the receiving water bodies and environment
- The existing quality of environment
- The health requirements in the area

10.0 Conclusion

The NCR Plan – 2021 has to be environmentally sustainable. In order to achieve this objective, it is necessary to follow the following steps

Step 1 Formulate an index of environmental quality taking into consideration the aspect of natural environmental endowments, built and natural heritage, hazard prone areas, level of social infrastructure, economic development, etc.

Step 2 To classify various parts of NCR, particularly the urban areas in terms of the index.

Step 3 Formulate development perspective and mitigation measures to create environmentally satisfactory development.

Step 4 Assess the impact of the perspective development on the environmental resources.

Step 5 Formulate a mechanism to continuously monitor the environment and development and in-built facility into the planning process to respond to changing situation.

The report on Environment and Ecology, made under the leadership of Prof. A. K. Maitra, had classified some of the towns of NCR in terms of environmental criticality. Similarly the report by NEERI on the Environmental Carrying Capacity of NCR had identified several hot spots as well as environmentally critical area. Both the studies are now almost a decade old and cannot be depended on to provide accurate guidelines for future developments. Also both the studies had limited their views to certain aspects of the environment, according to the terms of reference, which was restrictive since several other studied were also commissioned by NCRPB at the same time.

Environment is to be viewed holistically and in order that the Plan may be environmentally sustainable, it is imperative that the indicators are comprehensively formulated and evaluation of areas are done on that basis. NCRPB may assign this task to a group of experts.