
UNIT 1 WATER AND SANITATION

Structure

- 1.1 Introduction
- 1.2 Water and Sanitation: Concept and Importance
- 1.3 Water-Sanitation and Development Relationship
- 1.4 Health Effects of Water and Sanitation
- 1.5 Challenges of Water and Sanitation Problems
- 1.6 Water and Sanitation Policy of India
- 1.7 Let Us Sum Up
- 1.8 References and Selected Readings
- 1.9 Check Your Progress-Possible Answers

1.1 INTRODUCTION

The provision of safe drinking water and basic sanitation are critical to sustainable development of any economy. Improvement in safe drinking water supply and sanitation has been seen to have produced significant impact on decrease in diseases and recurring health problems among urban population. However, the problem of urban sanitation and water supply is particularly evident in urban slums both in developed as well as developing countries. Inadequate access to clean water and safe sanitation places slum dwellers at particular risk of several communicable diseases such as diarrheal diseases and helminthic infections. Government of different countries, particularly government of India has formulated water and sanitation policies for ensuring safe drinking water and sanitation to its people. This unit deals with sanitation and drinking water problem in urban areas and its consequences and the policies formulated by the government of India to deal with these two vital basic issues of development.

After reading this unit, you will be able to:

- Explain meaning and importance of water and sanitation
- Spell out relationship between water-sanitation and development
- Discuss the health effect of water and sanitation
- Analyse challenges of water and sanitation problem
- Describe national water policy and national sanitation policy of government of India

1.2 WATER AND SANITATION: CONCEPT AND IMPORTANCE

For the past few decade, the World as a whole, experiencing a wave of urbanization. Rapid urbanization has given rise to a host of problems, water and sanitation are important among them. The Mar Del Plata Conference in 1977 focused exclusively on the drinking water and sanitation needs of the poor and vulnerable. This resulted in the designation of the period from 1981 to 1990 as the International Drinking Water Supply and Sanitation Decade (IDWSSD). The

Global Water Supply and Sanitation 2000 Assessment shows that 1.1 billion people lack access to improved water supply and 2.4 billion to improved sanitation. The report mentioned that, if improved water supply and basic sanitation were extended to the present day “unserved”, it is estimated that the burden of infectious diarrhea would be reduced by some 17 percent and if universal piped water supply and well-regulated water supply is ensured and full sanitation is achieved, this would reduce the burden by some 70 percent.

Water is the most basic, precious and indispensable resources of life and fundamental to the survival of human being. Worldwide, agriculture use 69 percent of the total water available, 23 percent is used by industries and 8 percent is utilized domestically. Water, which is essential for life, growth and health, can also be a source of spread of diseases and cause of ill-health, if contaminated or improperly handled and stored. Safe drinking water plays a major role in the overall well being of people, with a significant bearing on infant mortality rate, death rate, longevity and productivity. It is warned that in India, millions of people suffer the consequences of drinking contaminated water, thereby, seriously affecting the health of future generations who are growing up with bouts of debilitating diarrhoeal diseases. The General Covenant on the Right to Water adopted by the Covenant on Economic Social and Cultural Rights in November, 2002 recognized water as a fundamental human right and stated that everyone has right to access to safe and secure drinking water, equitably without discrimination.

Like water, sanitation is also important for human health. Sanitation is defined as safe management of human excreta, including its treatment, disposal and associated hygiene related practices. The package of environmental sanitation largely include: (i) Solid waste disposal both human and animal; (ii) Liquid waste disposal; and (iii) drainage. Indiscriminate defecation and throwing of garbage are the most uncivilized types of environmental insanitation.

The problem of urban sanitation and water supply is visibly evident in urban slums. Many studies and reviews have noted that the urban slum dwellers have inadequate access to clean water, good sanitation and waste disposal and are vulnerable to risk of several communicable diseases. A World Health Organization Study estimates that the daily fecal output of the urban population in developing countries is greater than 500,000 tons. A study show that in Mumbai, it is estimated that approximately 73 percent of the slum primarily use community toilets provided through the municipal authorities and approximately 25 percent rely primarily on open defecation. Water supply is likewise inadequate, with many slum dwellers required to carry bucket water some distance, thus both increasing their workload and also decreasing the volume available per household.

Why should cities care about safe water and sanitation?

- Vital to human health
- Generate economic and social benefits
- Contribute to social and cultural values
- Helps the environmental sanitation
- Check morbidity and mortality
- Indicators of a health city

1.3 WATER-SANITATION AND DEVELOPMENT RELATIONSHIP

Water and Sanitation are intrinsically interconnected with the Millennium Development Goals, (MDGs) fixed by United Nations. The halve by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation is one of the numerical and time-bound targets defined for the MDGs. The relationships between water-sanitation and various development goals are described below:

- 1) **MDG-1: Eradication of Extreme Poverty & Hunger-** Ensuring safe drinking water and sanitation will have positive impact on poverty and hunger by reducing time spend on fetching drinking water and walking a mile for open defecation and expenses on drinking water and sanitation. A reduction of the distance to the nearest water sources will have a positive impact on the energy required for securing the household water needs. Besides, access to sanitary toilet will reduce the sanitation related problems and make human being hearty and healthy and devote considerable time for income earning activities. With the reduced time, burden from improved water services, more time can be spend on productive activities either on food production or in other income generating activities. Further more, reduction of working days lost to water and sanitation related diseases will also have a positive impact on the household's income situation. The relationship is depicted in Figure 1.

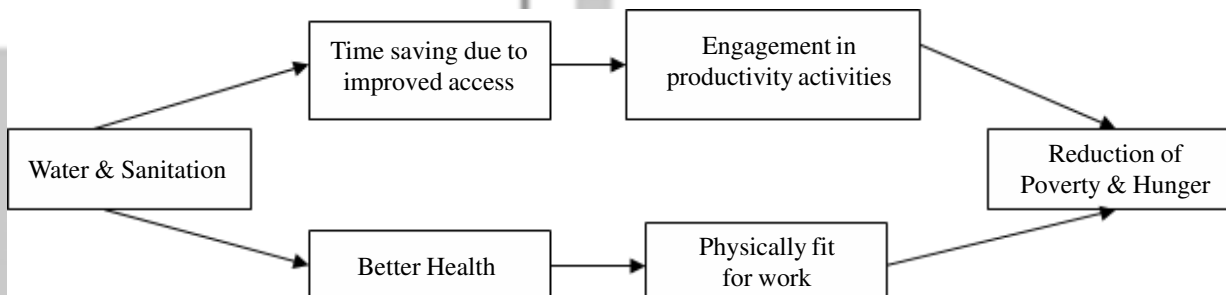


Figure 1: Water and Sanitation vs. Poverty and Hunger

- 2) **MDG-2: Achieve Universal Primary Education-** The improved water supply and sanitary environment in school will enhance enrolment and retention of boys and girls in the schools. Besides, relieving girls from their water fetching duties, it can improve their school attendance rate. It is observed that the girl child attendance rate is higher in schools having separate toilets for girl children. The better health care of children through the provision of safe drinking water and sanitation in the school will keep children physically and mentally sound and thus will have impact on child's learning achievements. It will also motivate parents to send their children particularly girls to the schools. The relationship is depicted in Figure-2.

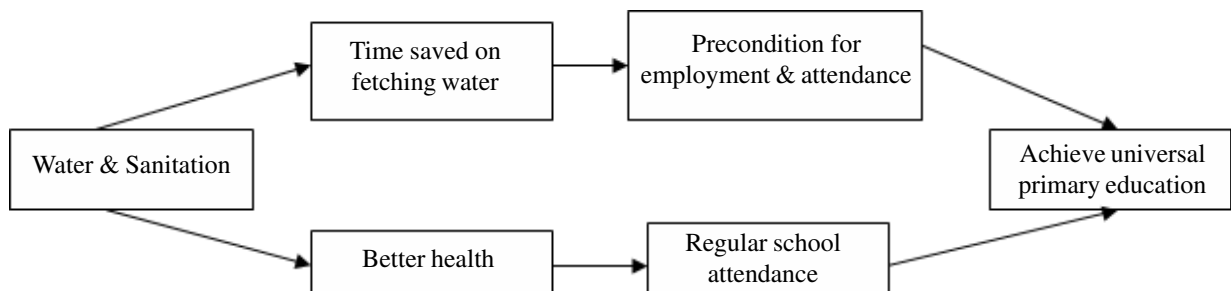


Figure 2: Water and Sanitation vs. Primary Education

- 3) **MDG-3: Gender Equality-** Fetching water and maintenance of sanitation are under the responsibilities of women in most of the societies, particularly in rural societies and those who are staying in urban slum to remain in queue for fetching a bucket of water. Considerable amount of time of women in rural areas is lost on collecting water and caring for members suffering from water and sanitation related morbidities. Improving water supply and sanitation would produce positive impact on women's living conditions by giving them more time for productive activities, caring of children, pursuing adult education, empowerment activities and leisure. Ensuring safe drinking water and sanitation make both male and female equally responsible for its maintenance, thereby promote gender empowerment. Besides, carrying water pots during the advance stage of pregnancy may cause maternal morbidity and miscarriage. The relationship is depicted in Figure-3.

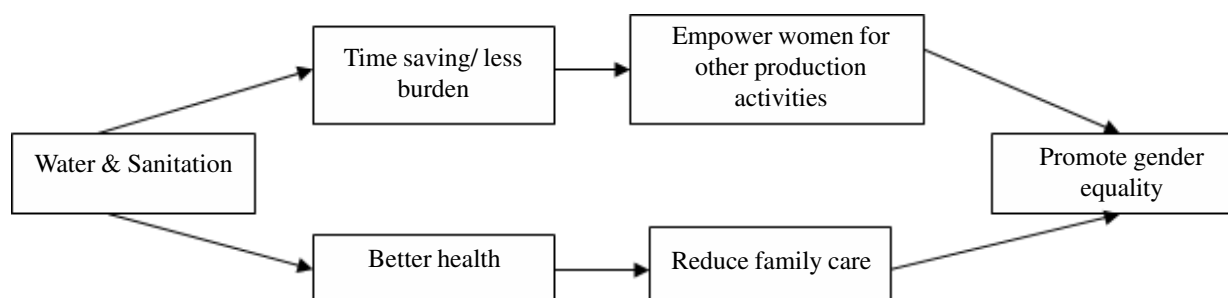


Figure 3: Water and Sanitation vs. Gender Equality

- 4) **MDG-4: Child Mortality-** Water related diseases are the most common cause of illness and mortality especially among children under-5 in developing countries. Children are more vulnerable to unsafe drinking water and healthy sanitary practices. In India, children of the impoverished families and those are residing either at home or in educational centres in urban slums do not have adequate access to safe drinking water and sanitation. The main causes of child morbidity and mortality are water and sanitation related. The diseases associated with drinking water and sanitation is diarrhoea, typhoid, cholera, malaria, worm infection, etc. Provision of safe drinking water and sanitation will reduce the occurrences of these diseases and restrict infant and child mortality. The relationship between water and sanitation and child mortality is given in Figure-4.

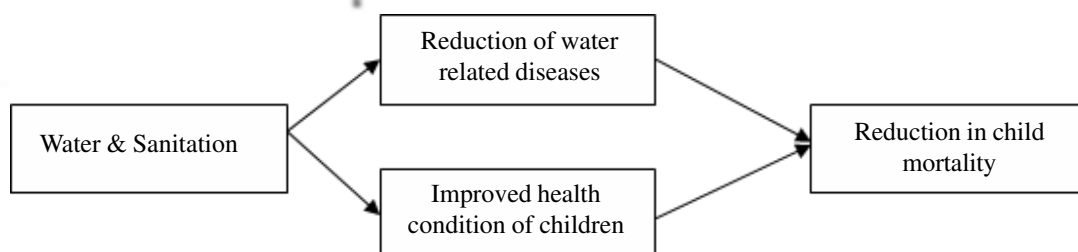


Figure 4: Water and Sanitation vs. Child Mortality

- 5) **MDG-5 & 6: Maternal Mortality and other Diseases-** Like child mortality, the maternal mortality also depends on safe drinking water and sanitation. Contaminated water and poor hygiene is a contributory factor of poor women health, particularly slow postnatal recovery. Besides, carrying water during

advance stage of pregnancy may lead to miscarriage. Provision of protected water, sanitation and hygiene has substantial relation with antenatal, natal and post-natal care of women. The warm infection and water related diarrhoea during pregnancy can cause severe morbidity and even mortality among the pregnant and lactating women. The relationship is shown in Figure-5.

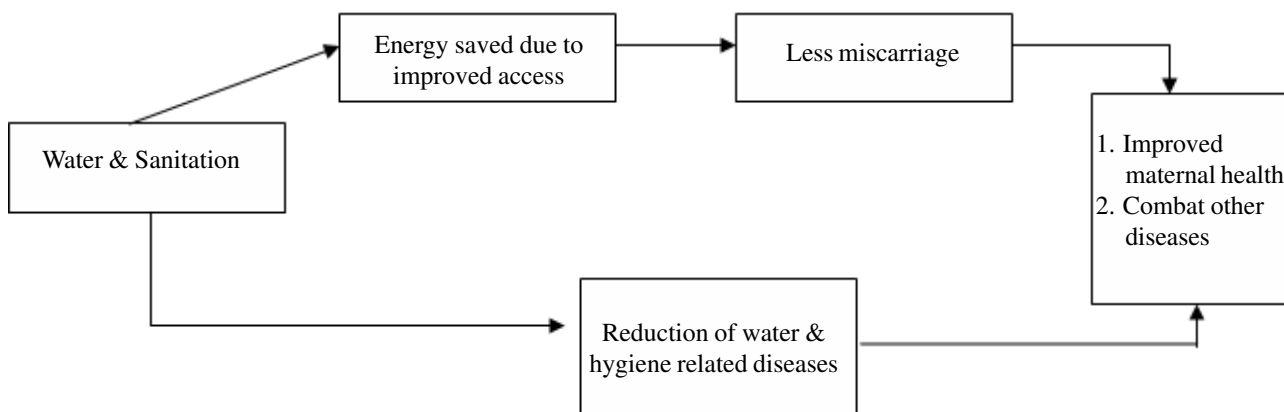


Figure 5: Water and Sanitation vs. Maternal Health and Diseases

- 6) MDG-7: Environmental Sustainability-** Insufficient and inadequate water supply and insanitation are intricately related to sustainable environment. Improved sanitation by safe garbage disposal and disposal of human excreta reduces environmental and health risks. People residing in urban slums are generally the victims of contaminated water supply and filthy environment. Besides, improved water management, including industrial pollution control and water conservation is a key factor for maintaining ecosystem integrity. The relationship between water and sanitation and environmental sustainability is shown in Figure-5.

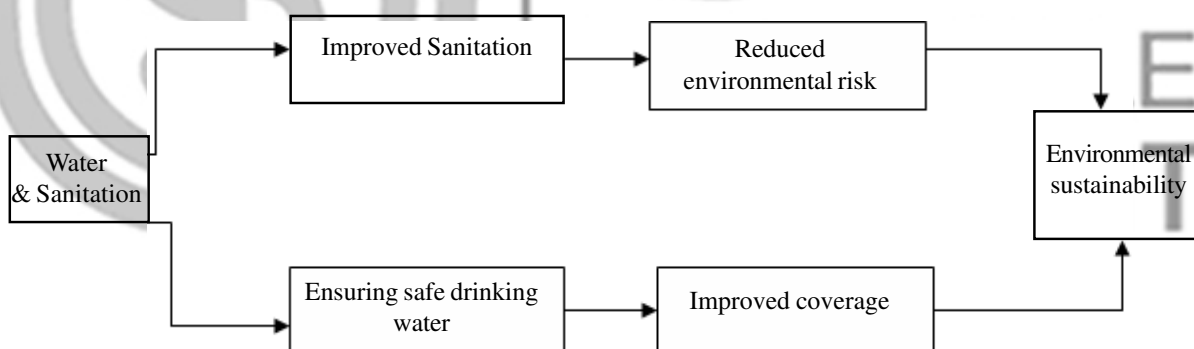


Figure 6: Water and Sanitation vs. Environmental Sustainability

In this session you read about importance of water and sanitation to development. Now answer the questions given in *Check Your Progress 1*.

Check Your Progress 1

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit

- 1) Briefly describe package of environmental sanitation.

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- 6) Explain how water and sanitation is crucial for prevention of child mortality.

1.4 HEALTH EFFECTS OF WATER AND SANITATION

Water and sanitation produces surmountable effect on health in general and health of the children and pregnant women in particular. Some of the health effects of water and sanitation are as follows:

- i) Almost half of the population in the developing world is suffering from one or more infectious diseases associated with contaminated water supply and sanitation. The prominent among them are diarrhea, intestinal helminthes infections, dracunculiasis, schistosomiasis and trachoma.
- ii) More than half of the hospital beds in the world are occupied by people who have water and sanitation related diseases.
- iii) The diarrhea, the second leading cause of infant death is attributed to unsafe drinking water, inadequate sanitation and poor hygiene.
- iv) Intestinal helminthes which affects hundreds of million of people world wide happens largely due to unsafe drinking water and poor sanitation. It is estimated that 133 million have high intensity intenstral helminth infections, which often have severe consequences such as cognitive impairment, massive dysentery or anemia.
- v) Due to lack of availability of basic sanitation, more than 160 million people are infected with schistosomes, causing tens of thousand of deaths every year.
- vi) Improving access to water and better hygiene could reduce the occurrences of trachoma, the leading cause of preventable blindness. More that 150 million people need treatment for these diseases.
- vii) Malaria, typhoid and dengue are largely occurring due to poor sanitation condition in the cities in general and metropolis in particular. The outbreak of dengue in Delhi not only take away several lives but also create a lot of problems for the hospital to accommodate patients suffering from dengue during the outbreak of this epidemic.

See figure 7 for summary on effects of water and sanitation on health.

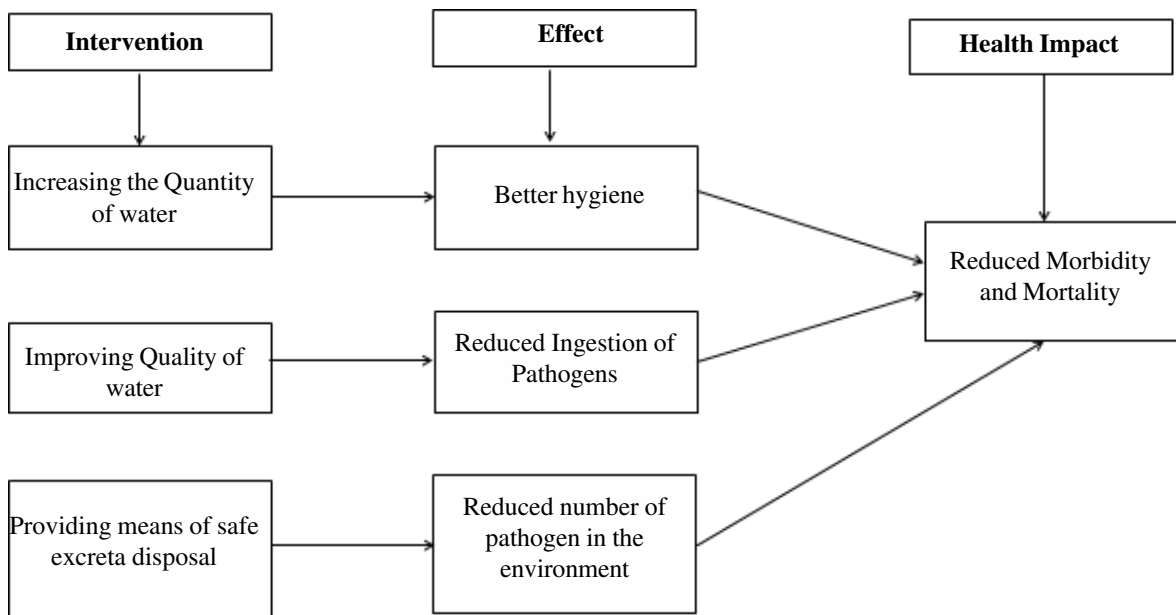


Figure 7: Effect of Water and Sanitation on Health

1.5 CHALLENGES OF WATER AND SANITATION PROBLEMS

Some of challenges associated with water and sanitation problem in urban areas are as follows:

- i) Inadequate investment in water and sanitation infrastructure is a major challenge. Paucity of fund for building of infrastructure by the national and state governments and international investments in water sanitation has been declining.
- ii) There is lack of political will to deal with the problem of water and sanitation. Strong political will is necessary for rebuilding aging water resources and building of garbage disposal tanks and also sewerage system for the safe passage of liquid wastes. Political will necessary to enforce policies which promote water conservation, safe water reuse, safe sanitation and disposal of human excreta, equitable water sharing and sustainable water supply and environmental protection due to insanitation.
- iii) There is a strong requirement of proper solid waste management strategies. Land fill is currently the most preferred alternative for waste disposal by local municipal authorities as it is still the cheapest and easiest method of getting rid of waste away from towns. There is lack of recycling infrastructure with the municipalities which is a cause of concern and it also varies from one municipality to that of the other.
- iv) Operation and maintenance of the urban infrastructure. This is one of the critical areas in almost all municipalities. Because of paucity of funds with municipalities on the one hand and reluctant of beneficiaries to pay for user charges on the other, the operation and maintenance of water and sanitation projects are badly affected. This has also resulted in wastage of investment in these infrastructures.

- v) Public private partnership in urban water and sanitation is another important area to be taken into consideration for the effective handling of water and sanitation problem in urban areas. It has been urged upon developing countries by international lending agencies as an essential component of water sector reform. The Government of India (2002) has urged upon “private sector participation in planning, development and management of water resources projects for diverse uses wherever feasible”.

PPP in Water Supply-A Case Study

The Government of Maharashtra had issued guideline to the Municipal Corporations and Municipal Councils Class ‘A’ for encouraging PPP to increase efficiency and investments in water supply and sewerage projects vide Govt. Circular dated 12th June, 2001. According to the Govt. Circular, the following options for PPP were suggested:

- i) Management agreement/contract
- ii) Tax agreement
- iii) Concession agreement

As the water supply scheme of Municipal Council Chandrapur City was in loss, this case was put in the General Meeting of the Council held on 26/02/2002 to explore PPP.

In the General Body meeting resolution was passed and decided to collect the required information regarding privatization of the scheme. So rules and conditions were prepared/framed to privatize the scheme as per the guidelines of Government.

Through tendering route, the water supply scheme of Chandrapur was privatized on 23/04/2004. The scheme was handed over the M/s Gurukrupa Association & Pvt. Ltd. for 10 years.

As the scheme has been privatized, the council is not required to spend any amount on the scheme. On the contrary, in 10 years, during /period the Council will get income of Rs. 1.59 crore from the private agency.

Key Features and Findings of PPP

- There will be no financial burden on the Council.
- In the next 10 years, the council will get an income of Rs. 1.59 crore from the contractors.
- From the date of privatization in the last 4 years there is no serious complaint received regarding to the water supply except some casual ones.
- During scarcity, the contractor supplies water through tankers without taking any extra charges from the Council.
- It is in the agreement that the contractors should lay at least 1 KM pipe line every year.
- It is also mentioned in the agreement/contract that the number of the public stand posts shall be kept intact.

- The minimum water rate notified by the State Government (Rs. 806/- per year from ½ inch connections) will be continued for 3 year and afterwards 10% additional charges will be levied for 3 years. Finally after 10 years the rate will grow from Rs. 806/- to Rs. 1072/-.
- Municipal workers collect the water samples and sent it for checking to the District Health Centre.
- Rs. 75/- Lakhs bank guarantee is located from private contractor as security.
- The contractor will be responsible to maintain machineries, pipelines, etc. with any additional cost.
- In case of default by contractor, there is a proper penal action prescribed by Municipal Council as per the agreement.
- The contractor is also responsible for repairing all bore wells and hand pumps in the City.
- Regarding to the regular water supply by the contractors, there are some special clauses in agreements.

Source: Compendium on Public Private Partnership in Urban Infrastructure case study, <https://doc-o4-94-docswieer.googleusercontent.co>

- vi) Water pricing is another important and challenging area of urban services management. According to Mathur and Thakur (2003) the main objectives of water pricing are to be: (1) **revenue efficiency**: the revenue from the water users should be sufficient to pay the operation and maintenance cost of water utility's operations, to pay loans undertaken to replace and expand the capital stock and to provide a return to capital at risk ; (2) **economic efficiency**: it requires that prices be set to ensure that consumer face the avoidable costs of their decisions; (3) **equity**: means that water tariff treats similar customer equally and that customers in different situations are not treated the same; and (4) **poverty alleviation**: water services are often seen as a "basic right" and their access as necessary regardless of whether or not people can pay. Effective pricing mechanism needs to be evolved by the municipalities which will not be very taxing.
- vii) Community based management of water supply and sanitation through decentralization is now days proved to be better solution for water and sanitation problems. The urban local bodies can play vital role in the management of water problems and collection and disposal of garbage in their respective municipalities. The community and community based organizations can become indomitable source of sustainable water and environmental development in their respective areas.

1.6 WATER AND SANITATION POLICY OF INDIA

Water supply and sanitation is sole responsibility of state government, however, with the passing of 73rd and 74th constitutional amendments, the state can assign these responsibility and power to Panchayati Raj Institutions (PRIs) and Urban Local Bodies (ULBs). Government of India has formulated National Water Policy and National Sanitation Policy at different points of time to deal with water and sanitation issues effectively. Let us discuss them one by one.

1.6.1 National Water Policy

National Water Policy was adopted in September, 1987. It has enabled the government to gather, a number of issues and challenges emerged in the development and management of the water resources. The National Water Policy (1987) was reviewed and updated in 2002 with the issue of National Water Policy 2002 (NPW 2002). The salient features of the NPW 2002 are:

- **The NWP Defines Water as a Prime Natural Resource:** Water is a basic human need and a precious national asset, to be planned, developed, conserved and managed in an integrated and environmentally sound basis, keeping in view the socio-economic aspects and the needs of the states. It recognizes water as a crucial element in developmental planning, to be managed in a sustainable manner and guided by the national perspective. Water as a resource is one and indivisible: rainfall, river waters, surface ponds and lakes and ground water are all part of one system.
- **Private Sector Participation:** It encourages participation of private sector in planning, development and management of water resources projects with a view to introduce innovative ideas, generate financial resources, and bring in better management practices. All models of private sector participation, viz. build, own, operate and transfer, are acceptable.
- **Emphasis of Asset Utilization:** It stipulates that there is an urgent need for paradigm shift from creation of new projects to improvement of the performance of existing projects.
- **Practices for Water Conservation:** It acknowledges the importance of all types of practices, the traditional practices like rainwater harvesting, preservation of forests; the modern conventional practices like water shed management, soil conservation; and the modern non-conventional methods like inter-basin sharing of water, artificial recharge of ground water and desalination of sea water.
- **Multi-Pronged Approach:** It emphasizes multi-sect- oral, multi-disciplinary planning with participatory approach, for the entire river basin. The water allocation priorities and drinking water, irrigation, hydro-power, ecology, industrial use and navigation, in that order. It specifically stipulates that drinking water requirement shall be first charge on any available water.

The NWP 2002 is aimed at improving existing strategies to improve water quality and reduce ground water and surface water pollution. Use and application of scientific tools and techniques to improve water resources development has also been emphasized. Further the policy encourages those projects development and proposals, which account for the sustainable use of surface and ground water, incorporating quantity and quality as well as environmental considerations.

There are 24 goals of the National Water Policy 2002 among which key areas related to water supply and sanitation being: Water Resource Planning, Project Planning, Groundwater Development, Drinking Water, Private Sector Participation, Water Quality, Water Zoning, Conservation of Water, Project Monitoring.

1.6.2 The National Urban Sanitation Policy 2008

The National Urban Sanitation Policy 2008 aims to achieve 100 per cent sanitation coverage under the 11th plan. The Policy focuses on generating awareness about sanitation and its linkages with public and environmental health among communities, encourages behavioral changes to adopt healthy sanitation practices. The policy hopes to achieve sanitized towns and cities ensuring affordable hygiene and sanitation facilities for urban poor and women.

1.6.2.1 Policy Goals

The overall goal of this policy is to transform Urban India into community-driven, totally sanitized, healthy and livable cities and towns.

The specific goals are:

- a) Awareness Generation and Behaviour Change
- b) Open Defecation Free Cities
- c) Integrated City-wide Sanitation
- d) Sanitary and Safe Disposal
- e) Proper Operation & Maintenance of all Sanitary Installations.

a) Awareness Generation and Behaviour Change

- i) Generating awareness about sanitation and its linkages with public and environmental health amongst communities and institutions.
- ii) Promoting mechanisms to bring about and sustain behavioral changes aimed at adoption of healthy sanitation practices.

b) Open Defecation Free Cities

All urban dwellers will have access to and use safe and hygienic sanitation facilities and arrangements so that no one defecates in the open. In order to achieve this goal, the following activities shall be undertaken:

- i) Promoting access to households with safe sanitation facilities (including proper disposal arrangements).
- ii) Promoting community-planned and managed toilets wherever necessary, of groups, of households who have constraints of space, tenure or economic constraints in gaining access to individual facilities.
- iii) Adequate availability and 100% upkeep and management of public sanitation facilities in all urban areas, to rid them of open defecation and environmental hazards.

c) Integrated City Wide Sanitation

- i) Mainstream thinking, planning and implementing measures related to sanitation in all sectors and departmental domains as a cross cutting issue, especially in all urban management endeavours.
- ii) Strengthening national, state, city and local institutions (public, private and community) to accord priority to sanitation provision, including planning, implementation and O&M(operation and maintenance).
- iii) Extending access to proper sanitation facilities for poor communities and other unserved settlements.

d) Sanitation and Safe Disposal

100% of human excreta and liquid wastes from all sanitation facilities including toilets must be disposed of safely. In order to achieve this goal, the following activities shall be undertaken.

- i) Promoting proper functioning of network based sewerage systems and ensuring connections of household to them wherever possible.
- ii) Promoting recycle and reuse of treated waste water for non potable applications wherever possible will be encouraged.
- iii) Promoting proper disposal and treatment of sludge from on site installations (septic tanks, pit latrines, etc.).
- iv) Ensuring that all the human wastes are collected safely confined and disposed of after treatment so as not to cause any hazard to public health or the environment.

e) Proper Operation & Maintenance of all Sanitary Installations

- i) Promoting proper usage, regular upkeep and maintenance of household, community and public sanitation facilities.
- ii) Strengthening ULBs to provide sustainable sanitation services delivery.

1.6.2.2 Components of National Urban Sanitation Policy

Government of India shall support the following components:

a) Awareness Generation

A country wide Information, Education and Communication (IEC) Strategy will be designed and implemented for raising awareness on the public health and environmental importance and sanitation. The socio cultural basis against sanitation and sanitary work need to be targeted, and dignity and humane approach promoted in the elevation of priority to sanitation in public affairs. Further, the public good nature of urban sanitation necessitating collective action needs to be highlighted in the minds of all stakeholders.

b) Institutional Roles

The Government of India will support clear assignment of roles and responsibilities, resources and capacities and institutional incentives in relation to setting standards, planning and financing, implementation, knowledge development, capacity building and training, Monitoring & Evaluation (M&E), and regulatory arrangements. The government will help states and cities in ensuring sanitation as a core responsibility of Urban Local Bodies as envisaged in the Constitutional (Seventy fourth) Amendment Act, 1993. The special roles of NGOs and Community Based Organizations (CBOs) will be recognized in mobilizing communities, raising awareness and in working with poor communities to assist them in finding affordable, community-managed solutions to sanitation.

c) Reaching the Un-Served and Poor Households

The national policy will help urban areas adopt a city-wide, demand based participatory approach to individual (resolving tenure, space and affordability constraints), and community sanitation where individual sanitation facilities

are not feasible. Towards this, special slum and community sanitation plans will be formulated as a part of the City Sanitation Plan. Provision of public sanitation facilities will also be supported.

d) Knowledge Development

The policy recognizes the importance of developing and disseminating knowledge on institutional development, technology choices and management regimes, planning new developments and up gradation, and sustainability issues.

e) Capacity Building

Government of India will help to formulate and implement a National level strategy on capacity building and training to support states and cities to build their personnel capacities and organizational systems for delivery of sanitation services.

f) Financing

The Govt. of India, wherever possible, will explore possibilities of providing assistance for funding projects proposed as part of city sanitation plans through its schemes like JNNURM, UIDSSMT and 10% lump sum for North Eastern States, Satellite Township Scheme, etc. However, the emphasis will be on improving the efficiency of existing sanitation infrastructure and service delivery.

g) National Monitoring & Evaluation

At the national level, the Govt. of India will support periodic rating of cities by independent agencies. A National Annual Award will be instituted on the basis of this rating.

h) Coordinator at the National Level

National Investments in urban infrastructure and housing shall accord high priority to sanitation. Towards this, sanitation will be mainstreamed into all relevant programmes of all the relevant sectoral ministries.

In this session you read about water and sanitation policy of government of India. Now answer the questions given in *Check Your Progress 2*.

Check Your Progress 2

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit

- 1) Briefly describe, the multipronged approach as emphasized in National Water Policy.

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- 2) Explain objectives of National Sanitation Policy.

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1.7 LET US SUM UP

The provision of safe drinking water and basic sanitation are critical to sustainable development of any economy. Improvement in safe drinking water supply and sanitation has been seen to have produced significant impact on diseases and recurring health problems among urban population. This unit has covered the importance of water and sanitation to Millennium Development Goals. Further it also describes the importance of water and sanitation to health. Finally the unit has narrated the National Water and National Sanitation Policy of Government of India.

1.8 REFERENCES AND SELECTED READINGS

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1.9 CHECK YOUR PROGRESS POSSIBLE ANSWERS

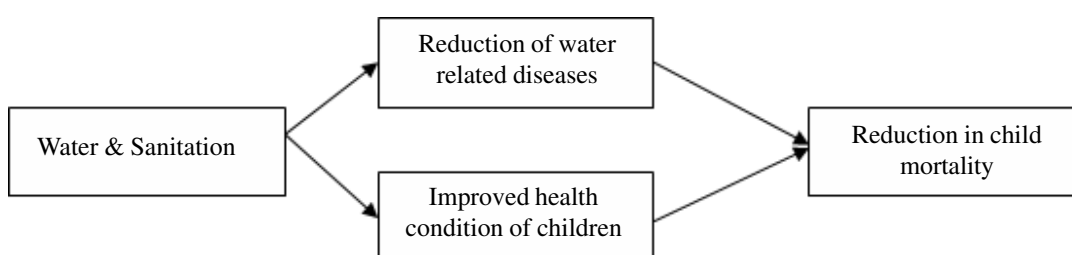
Check Your Progress 1

- 1) Briefly describe package of environmental sanitation.

The package of environmental sanitation largely include: (i) Solid waste disposal both human and animal; (ii) Liquid waste disposal; and (iii) drainage. Indiscriminate defecation and throwing of garbages are the most uncivilized types of environmental insanitation.

2) Explain how water and sanitation is crucial for prevention of child mortality

Water related diseases are the most common cause of illness and mortality especially among children under-5 in developing countries. Children are more vulnerable to unsafe drinking water and healthy sanitary practices. In India children of the impoverished families and those are residing either at home or in educational centres in urban slums do not have adequate access to safe drinking water and sanitation. The main causes of child morbidity and mortality are water and sanitation related. The diseases associated with drinking water and sanitation are diarrhoea, typhoid, cholera, malaria, worm infection, etc. Provision of safe drinking water and sanitation will reduce the occurrences of these diseases and restrict infant and child mortality.



Check Your Progress 2

1) Briefly describe the multipronged approach as emphasized in National Water Policy.

The National Water Policy emphasizes on multi-sect- oral, multi-disciplinary planning with participatory approach, for the entire river basin. The water allocation priority goes like drinking water, irrigation, hydro-power, ecology, industrial use and navigation, in that order. It specifically stipulates that drinking water requirement shall be first charge on any available water.

2) Explain objectives of National Sanitation Policy.

The overall objective of this policy is to transform Urban India into community-driven, totally sanitized, healthy and liveable cities and towns.

The specific objectives are:

- a) Awareness Generation and Behaviour Change
- b) Open Defecation Free Cities
- c) Integrated City-wide Sanitation
- d) Sanitary and Safe Disposal
- e) Proper Operation & Maintenance of all Sanitary Installations.

UNIT 2 WASTE MANAGEMENT

Structure

- 2.1 Introduction
- 2.2 Waste Management: Concept and Elements
- 2.3 Types and Characteristics of Urban Waste
- 2.4 The Waste Management Hierarchy and the 3R Concept
- 2.5 Governmental Measures for Waste Management
- 2.6 Role of Private Sector, NGOs and Community in Waste Management
- 2.7 Deficiencies and Challenges in the SWM System in India
- 2.8 Let Us Sum Up
- 2.9 References and Selected Readings
- 2.10 Check Your Progress Possible Answers

2.1 INTRODUCTION

You are aware about the wastes and have seen the indiscriminate waste disposal in and around your locality. Waste management is one of the hot topics of urban planning and development. The collection, transportation and disposal of garbage, sewage and other waste products are critical to city government. Waste management encompasses management of all processes and resources for proper handling of waste materials from maintenance of waste transport trucks and dumping facilities to compliance with health hazards. In this unit a detailed analysis of waste management has been done. After reading this unit you will be able to:

- Define the concept and elements of waste management
- Discuss the types and characteristics of urban waste
- Analyze the waste management hierarchy and 3R concept
- Describe governmental measures for waste management
- Narrate the role of private sector, NGOs and community in waste management
- Advocate deficiencies and challenges of waste management in India.

2.2 WASTE MANAGEMENT: CONCEPT AND ELEMENTS

Waste management is the collection, transport, processing or disposal, managing and monitoring of waste materials. The term usually relates to materials produced by human activity, and the process is generally undertaken to reduce their effect on health, the environment or aesthetics. Waste management is a distinct practice from resource recovery which focuses on delaying the rate of consumption of natural resources. All wastes materials, whether they are solid, liquid, gaseous or radioactive fall within the remit of waste management.

Solid waste can be defined as non liquid material that no longer has any value to the person who is responsible for it. The words *rubbish, garbage, trash, or refuse*

are often used as synonyms when talking about solid waste. In urban areas, solid waste is generated by domestic households, commercial and industrial enterprises, and health care and institutional activities, as well as on the streets. Street refuse contains a mixture of refuse from many sources, because streets are used as dumping grounds by all generators of waste. Where sanitation facilities are lacking and a large animal population roams the streets, street refuse contains a lot of human fecal matter and manure. Streets are also often used for extensive dumping of construction and demolition debris—attracting further dumping of solid waste.

The term *municipal solid waste* refers to solid waste from houses, streets and public places, shops, offices, and hospitals. Management of these types of waste is most often the responsibility of municipal or other governmental authorities. Although solid waste from industrial processes is generally not considered municipal waste, it nevertheless needs to be taken into account when dealing with solid waste because it often ends up in the MSW stream.

Waste management practices can differ for developed and developing nations, for urban and rural areas, and for residential and industrial producers. Management of non-hazardous waste, residential and institutional waste in metropolitan areas is usually the responsibility of local government authorities, while management of non-hazardous commercial and industrial waste is usually the responsibility of the generator subject to local, national or international controls.

The waste generation rates in India are lower than the low-income countries in other parts of the world and much lower compared to developed countries. However, lifestyle changes, especially in the larger cities, are leading to the use of more packaging material and per capita waste generation is increasing by about 1.3 per cent per year. With the urban population growing at 2.7 per cent to 3.5 per cent per annum, the yearly increase in the overall quantity of solid waste in the cities will be more than 5 per cent. The Energy and Resources Institute (TERI) has estimated that waste generation will exceed 260 million tonnes per year by 2047—more than five times the present level. Cities with 100,000 plus population contribute 72.5 per cent of the waste generated in the country as compared to other urban centres that produce only 17.5 per cent of the total waste.

There has been a significant increase in the generation of Municipal Solid Waste (MSW) in India over the last few decades. This is largely a result of rapid population growth in the country. The daily per capita generation of municipal solid waste in India ranges from about 100 gm. in small towns to 500 gm. in large towns. The growth in municipal waste generation in our urban centers has outpaced the growth in population in recent years. The reasons for this trend could be our changing lifestyles, food habits and changes in the standard of living. Municipal solid waste in cities is collected by the municipalities and transported to designated disposal sites normally a low lying area on the outskirts of the city for disposal. The choice of a disposal site is more a matter of what is available than what is suitable. Hence, it has become apparent to harness the energy towards improving the legislative framework, institutional set-up as well as technological practices for MSW management in a coordinated and cohesive manner.

2.2.1 Elements of Urban Waste Management

A typical waste management system in a low- or middle-income country includes the following elements:

- Waste generation and storage
- Segregation, reuse, and recycling at the household level
- Primary waste collection and transport to a transfer station or community bin
- Street sweeping and cleansing of public places
- Management of the transfer station or community bin
- Secondary collection and transport to the waste disposal site
- Waste disposal in landfills
- Collection, transport, and treatment of recyclables at all points on the solid waste pathway (collection, storage, transport, and disposal).

In the past, these important elements of waste management were often regarded only from an engineering and technical viewpoint. It is essential to realize that these elements are embedded in the local institutional, socio cultural, and economic context, which is further influenced by national politics, policies, and legislation as well as national and global and economic factors.

In this session you read about meaning and elements of urban waste and now answer the questions given in *Check Your Progress 1*.

Check Your Progress 1

Note: a) Write your answer in about 50 words

b) Check your answer with possible answers given at the end of the unit.

1) What is Municipal Solid Waste and what are its sources of generation?

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2) What are important elements of urban waste?

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2.3 TYPES AND CHARACTERISTICS OF URBAN WASTE

Urban waste can be broadly categorized into three types.

i) Construction and Demolition Waste

Construction and demolition waste is that waste which is generated during the course of repair, maintenance, and construction activities comprises bricks, stones, tiles, cement concrete, wood, and so forth. Such waste is generally not stored by the waste generator within its premises until disposal. By and large, these wastes are deposited just outside the premises on the streets or in open spaces and may hinder traffic and adversely affect the aesthetics of the city.

ii) Industrial Waste

Many cities and towns have small and large industries within the city limits. Those industries produce hazardous and nonhazardous industrial waste, which the industries must dispose of following the standards laid down under hazardous waste management rules framed by the government of India and following directions given by CPCB and by state pollution control boards. In practice, however, very few sites are authorized for the disposal of industrial waste in the country; hence, compliance is weak. Some states do not have even a single facility for disposal of industrial waste. Industrial solid waste is, therefore, disposed of in an unscientific manner, often surreptitiously on open plots or on the roadside, thereby creating environmental pollution and subsoil contamination.

iii) Biomedical Waste(BMW)

Mainly comprises of solids, liquids, sharps and laboratory waste that are potentially infectious or dangerous and are considered bio waste. According to WHO, BMW is solid waste generated during the diagnosis, testing, treatment, research or production of biological products for humans or animals. WHO estimates that 85 percent of hospital waste is non-hazardous, 10 percent is infectious and 5 percent is non-infectious but consists of hazardous chemicals like Methylchloride and formaldehyde.

2.3.1 Characteristics of Urban Waste

The characteristics of some of the important wastes generated in urban areas are narrated below.

i) Waste from hotels and restaurants

The following characteristics are usually observed in waste from hotels and restaurants:

- Hotel and restaurant waste has a similar composition to that of household waste but may contain more organic waste.
- In general, hotels and restaurants either receive municipal collection service or must make their own arrangements for waste disposal. Their association may organize collection and transport of waste to the municipal treatment and disposal site.

- If waste is segregated, the recyclable material has a high value and might be collected by a specialized waste collector.
- Reuse and treatment options for the restaurant and kitchen waste should be assessed (such as animal feeding, composting).

ii) Waste from fruit and vegetable markets

The important characteristics of fruit and vegetable market wastes are as follow:

- Market waste contains a high fraction of biodegradable waste. Therefore, the waste might be of value for specialized waste treatment plants such as composting sites.
- Waste from meat and fish markets requires closed containers and frequent collection services to avoid odor and attraction of vermin.

iii) Waste from parks and gardens

The characteristics of waste from parks and gardens are as follow:

- Park and garden waste mainly consists of biodegradable waste and litter.
- The organic fraction might be treated directly in the park or garden and converted into compost.
- Litter must be collected in litter bins in the park or garden. This waste could be collected on a daily basis.

iv) Construction and demolition debris

The wastes generated through the construction and demolition of debris generally has following issues:

- Demolition debris is a big issue in Indian cities. Many vacant plots are misused and spoiled with illegal disposal of debris, causing considerable costs for the municipality and for private owners.
- Because such debris is rather inert, it does not cause direct harm to people and the environment. Therefore, such waste could be collected separately and taken to landfill sites to be used as inert cover material.

2.4 THE WASTE MANAGEMENT HIERARCHY AND THE 3R CONCEPT

The 3R concept refers to “reduce, reuse, and recycle”. The concept is based on the waste management hierarchy. This hierarchy classifies waste management strategies according to their potential to minimize waste. Waste reduction, reuse, and recycling are the main categories that we need to focus on regarding the 3R concept. The main objective is to reduce the amount of waste that is disposed of in landfills. The 3R concept fosters cooperation among waste generators, waste collectors, processors, and manufacturers. It aims at reducing waste to be disposed of in landfills, thereby, reducing the deterioration of the environment, reducing the emissions that landfills produce, and saving energy and natural resources.

The essential steps in waste management are narrated below:

a) Waste Prevention, Reduction or Minimization

Ideally, waste should be avoided. Waste that can be avoided stops being a burden for the municipality. Waste prevention is most effective if it is

considered in the product design and production processes. By optimizing production processes, manufacturers can reduce waste or even allow it to be reused by another manufacturer. Valuable natural resources can therefore be saved.

b) Reuse

Reuse happens when something that already fulfills its original function is used for another purpose. However, reuse does not involve reprocessing or transforming the item. For example, typical reuse strategies are the deposit refund system for glass bottles or polyethylene terephthalate (PET) water bottles, old tires that are used in fences or as boat fenders, steel drums that are reused as compost bins, or plastic bags that are reused as liners for household waste bins.

c) Recycling

Recycling means the reprocessing of used materials that would otherwise become waste. It breaks material down to its main component and produces new products. Recycling is most common for valuable materials or materials that are costlier if produced from virgin raw materials (such as metal, plastic, glass, and electronic waste). Recycling of organic matter produces compost, which can be used as a soil enricher in gardens and horticulture and which contributes to improved agricultural production.

d) Recovery

Recovery relates mainly to energy recovered from waste. Waste that cannot be reused or recycled can be, for example, incinerated to generate heat or electricity. Another option—for organic waste—is anaerobic digestion to produce biogas. The appropriateness of such recovery strategies depends on the composition and calorific value of the waste.

e) Disposal

At the lowest level of the waste management hierarchy is final disposal. All remaining waste or residues from previous waste management processes must be stored in a final disposal site. The disposal site must be designed and operated as a sanitary landfill to protect people and the environment from the negative impact of waste. Even at this stage, some recovery options are still feasible. Landfills emit methane gas caused by the anaerobic biological degradation of organic waste within the landfill. If the landfill is set up and managed appropriately, this landfill gas can be recovered for several years. However, in India, the Municipal Solid Waste (Management and Handling) 2000 Rules mandate that municipal authorities treat the organic fraction of waste before disposal.

f) Composting

Composting has been practiced in rural India for centuries by farmers treating their own domestic and agricultural waste and returning it as compost to their fields. Urbanization in India has created a new problem. Domestic urban waste still contains up to 55 percent biodegradable waste but is cut off from rural reuse and therefore is disposed of in drains or landfills. The uncontrolled degradation of organic matter is causing hygienic and environmental problems in many urban areas.

Composting, in contrast, is a controlled biological treatment process in which microbes degrade organic waste under aerobic conditions to a humus substance called *compost*. Compost is a stable, dark-brown, soil-like material. Contrary to popular belief, mature compost does not smell bad—it can smell as fresh as a forest flower. Compost contains important plant nutrients (such as nitrogen, potassium, and phosphorus), though usually not as much as animal manure or chemical fertilizers. It can also contain a range of beneficial minerals and is rich in humus and micro-organisms beneficial to plant growth.

Composting is beneficial in a SWM system because it reduces organic waste to 25 to 30 percent of its initial weight. If waste is composted close to its source of generation (for example, at the household level or neighborhood level) significantly less waste must be transported and disposed of.

Currently, composting plants operate in about 50 cities in India. They cover a large variety of capacity and technology. Large-scale plants treating between 100 and 700 tons of mixed waste per day are capital intensive because of their high grade of mechanization. Composting of mixed waste should be avoided; research results show that compost from mixed waste barely meets national quality requirements for compost, owing to contamination with heavy metals and other pollutants. In contrast, cities such as Bangalore, Chennai, Mumbai, and Pune have very active community-based and decentralized composting schemes, by which sorted waste is turned into high-quality compost. These schemes have capacities of up to one ton per day.

2.5 GOVERNMENTAL MEASURES FOR WASTE MANAGEMENT

2.5.1 Legislative Response

The Ministry of Environment and Forest, (MOEF), Government of India, issued the Municipal Solid Wastes (Management and Handling) Rules in the year 2000. These rules identify the Central Pollution Control Board (CPCB)/State Pollution Control Board (SPCB) as the agency that will monitor the implementation rules. This law details the practices to be followed by various municipalities for managing urban waste and the rules specify compliance criterion for collection, recycling, storage, transportation, processing and disposal of municipal solid waste. Apart from notification of rules by MOEF, some of the initiatives taken at the national level are as follows:

- National Waste Management Council (NWMC) was constituted in 1990 and one of its objectives was municipal waste management. NWMC in 1993 constituted a National Plastic Waste Management Task Force to suggest measures to minimize adverse environmental and health impacts arising out of plastic recycling. Based on the recommendation of this Task Force, MOEF framed Recycled Plastic Usage Rules, 1998, which bans storing, carrying and packing of food items in recycled plastic bags.
- National Environmental Engineering Research Institute (NEERI) formulated strategy paper and prepared manual on municipal solid waste management documenting critical issues relating to management of solid waste and suggestion for improvement.

- The Central Public Health Environmental Engineering Organization (CPHEEO) prepared policy paper on promoting the integrated provision of water, sanitation, solid waste management and drainage utilities in India.
- CPCB formulated guidelines for safe disposal of hospital waste.
- Ministry of Non Conventional Energy Sources (MNES) launched a National Programme on Energy Recovery from urban – municipal and industrial waste. Various fiscal and financial incentives are offered under this programme for energy recovery from waste.
- High Powered Committee was constituted in 1995, which came out with number of recommendations covering issues like segregation, door-to-door collection, proper handling and transportation, waste composting treatment and use of appropriate technologies for waste treatment and disposal.

There have been a variety of policy responses to the problems of municipal solid waste in India, especially over the past few years, yet fragmented interventions have eluded the sustainable solutions. It has been recognized that the municipal authorities will not be able to implement effective management of wastes without active involvement and partnership of public and private agencies as well as civil societies.

2.5.2 Role of Centre and State in Waste Management

Solid waste management is a state function, however, the central government has powers to enact laws and frame rules for environmental protection. Accordingly, the government of India has enacted Environment Protection Act 1986 (EPA) and under the provisions of this act has framed rules for managing and handling municipal solid waste, biomedical waste, hazardous waste, and so on.

i) Central Government Level

Because the subject of SWM is left to the states and passed on to the ULBs by state governments, the central government has a very limited role. The role of central government is principally to frame laws and rules, which it does through the Ministry of Environment and Forests, and to provide guidelines, technical assistance, financial support, and so forth, which it accomplishes through other ministries such as the Ministry of Urban Development and Ministry of Housing and Poverty Alleviation.

The Central Pollution Control Board (CPCB) is the apex regulatory body in environmental matters. Its principal role is to monitor the implementation of the rules. However, the CPCB has taken several proactive measures by issuing guidelines and manuals and has also supported several training programs and pilot projects. The Ministry of Agriculture and the Ministry of New and Renewable Energy are also playing an active role in promoting and providing financial support for composting of municipal solid waste and waste-to-energy projects, respectively.

ii) State Government Level

The state governments are primarily responsible for appropriate SWM in the state. The state urban development department, which is responsible for looking after urban affairs through municipal corporations and state

municipalities, plays a decisive role in directing the municipal authorities in implementing the rules and in giving them financial and technical support to facilitate implementation. The state environment department usually plays a role in monitoring the implementation through the urban development department and the state pollution control board. State pollution control boards (PCBs) are primarily responsible for monitoring the implementation of the Municipal Solid Waste (Management and Handling) Rules 2000 and for taking actions against defaulters. The state PCBs are also responsible for authorizing the municipal authorities or operators of the facilities to set up treatment and disposal facilities in the respective states. In addition to regulating local authorities, some state PCBs take a proactive role in guiding the local authorities in implementation of the rules.

2.5.3 The Municipal Solid Waste (Management and Handling) Rules 2000

The Municipal Solid Waste (Management and Handling) Rules lay down the steps to be taken by all municipal authorities to ensure management of solid waste according to best practice. The municipal authorities are responsible for implementing provisions of the 2000 rules. They must provide the infrastructure and services with regard to collection, storage, segregation, transport, treatment, and disposal of MSW.

i) Collection of Solid Waste

To prohibit littering and to facilitate compliance, municipal authorities must take the following steps:

- Organize collection of MSW at household level by using methods such as door-to-door, house-to-house, or community bin service. Collection must be on a regular pre informed schedule or by acoustic announcement (without exceeding permissible noise levels).
- Give special consideration to devising waste collection in slums and squatter areas, as well as to commercial areas such as areas with hotels, restaurants, and office complexes.
- Segregate at the source all recyclable waste, as well as biomedical waste and industrial waste, to prevent special waste from being mixed with ordinary municipal solid waste.
- Collect separately all horticultural waste and construction or demolition waste or debris, and dispose of it following proper norms. Similarly, waste generated at dairies will be regulated in accordance with the state laws.
- Prohibit burning of waste.
- Do not permit stray animals at waste storage facilities.

ii) Secondary Storage of Waste

With respect to secondary storage of waste, municipal authorities must do the following:

- Make available sufficient storage facilities in accordance to the quantities of waste generated.
- Provide covered storage facility so that waste is not exposed to open atmosphere.

- Ensure that storage facilities are attended daily and are emptied and cleaned regularly.
- Ensure that storage facilities or bins are of an appropriate design for ease in handling, transfer, and transport.
- Ensure that manual handling and multiple handling of waste are avoided or are done with proper safety and care.

iii) Transport of Waste

The following rules apply to transport of waste:

- Ensure that vehicles used for transport of waste are covered.
- Ensure that waste is not visible to public or exposed to the open environment, thus preventing the scattering of waste.
- Attend to storage facilities daily for clearing of waste.
- Empty bins or containers before they start overflowing.
- Ensure that transport vehicles are so designed that multiple handling of waste is avoided before final disposal.

iv) Waste Treatment

Waste treatment rules are as follows:

- Ensure that biodegradable waste is processed by composting, vermin-composting, anaerobic digestion, or any other appropriate biological process for stabilizing waste. Compost or any other end product must comply with specified standards.
- Ensure that mixed waste containing recoverable resources follows the route of recycling. Incineration with or without energy recovery may be used in special cases.

v) Waste Disposal

These rules apply to waste disposal:

- Restrict land-filling to non biodegradable and non recyclable waste.
- Ensure that land-filling meets the specifications.

In these sessions you read about types and characteristics of urban waste and governmental measures to manage urban waste, now answer the questions given in *Check Your Progress 2*.

Check Your Progress 2

Note: a) Write your answer in about 50 words

b) Check your answer with possible answers given at the end of the unit.

- 1) Name the rule handling solid waste management in municipal areas and the responsibilities of municipal authorities in solid waste management in urban areas.

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2.6 ROLE OF PRIVATE SECTOR, NGOS AND COMMUNITY IN WASTE MANAGEMENT

2.6.1 Private Sector Participation in SWM(Solid Waste Management) in India

In recent years private sector plays a vital role in waste management in urban areas. More than 50 Urban Local Bodies (ULB's) have contracted with/private firms for waste collection and transportation in selected zones. About 35 per cent of municipal area in Chennai and 50% of municipal area in Hyderabad is contracted out to private sector enterprise for sweeping, collecting, storing, and transporting waste (garbage, construction and garden waste) and for creating public awareness. Approximately 35 composting projects have been set up in India with private sector partnerships in the last 8 years, mostly in states of Maharashtra, Tamil Nadu, Andhra Pradesh & Kerala. The private firm recoups its investment by selling compost derived from waste processing. Kolhapur Municipal Corporation signed a 30-year, Build-Own-Operate-Transfer (BOOT) contract with private enterprise that will design, build, operate and maintain the waste treatment for this period and mobilize its financing and will retain income from sales of organic fertilizer produced from composting of waste. Puri municipality of Orissa formed a contract with private firm for bio- composting of the bio-degradable municipal waste and became the first city in the state of Orissa to have arrangements for disposal of waste in scientific manner and able to recover a portion of expenditure incurred on solid waste management from the royalty that its gets on the sale of compost. Rudrapur Municipality in Uttaranchal efficiently privatized 11 sectors of the city on contract basis. The contract is for sweeping streets, cleaning nala (drains) and transporting/collecting garbage on a dumping yard. The garbage disposal has increased from 6 to 10 tons per day to 45 to 50 tons per day. Being a contract system, the local body is saving Rs. 1.2 lakhs per month. Numakkal municipality in Tamil Nadu involved citizens and other stakeholders in "Zero Garbage Drive", scheme privatizing door-to-door collection of waste, manufacturing of compost by vermi-composting, sale of recyclable waste and transportation & disposal of inorganic waste.

Surat Privatization SWM Model

- The city introduced several measures of privatization in solid waste management after the plague in 1994, which transformed it to one among the cleanest.
- Surat practices night brushing and scraping of roads. Forty-seven major roads have been identified for night cleaning by 1183 persons and 99 vehicles deployed through 31 agencies.
- Privately managed primary waste collection has been introduced in some parts of the city. Four hundred residential societies have been given grant in aid for cleaning their own area.
- Transportation of waste from the primary collection points to transfer stations has been contracted to two agencies that deploy 22 vehicles to make a total 221 trips per day.
- Contracts for secondary transportation of waste for removing MSW from transfer station to final disposal site have been awarded to four private

agencies. Five transfer stations have been set up and the entire quantity of 1000 MT of MSW is transported by the private agencies. The contractors deploy 42 close body vehicles.

- Final waste disposal Surat has constructed the first large size engineered landfill in the country with a cell capacity of 12,5000 cmt through a private agency.
- For disposal of biomedical waste, a seven-year contract has been awarded to a private operator on BOOT basis. A plant with the capacity to dispose 200 kg of waste per day has been constructed, equipped with an incinerator, autoclave, and shredder.

2.6.2 NGO/CBO Initiatives

Cities are increasingly accepting the role of non-government and community based organization in urban waste management. Some cities are experimenting with community contracting to complement service provision by the ULBs. Municipal Corporation of Hyderabad (MCH) decided to experiment citizen's participation by involving Resident Welfare Associations (RWA's) in motivating the citizens to store compostable and non-compostable waste in two separate plastic containers.

Municipal Corporation in Greater Mumbai (MCGM) adopted an "Advanced Locality Management (ALM)" scheme in 700 localities wherein citizens and the Municipal Corporation employees work hand-in-hand for the improvement of solid waste management in terms of segregation of waste, awareness campaign, tree plantation, prevention of encroachments on pavements and beautification of streets. Municipal Corporation of Bhubaneswar, Orissa formed an association with citizens and introduced "Express Cleaning Services" to collect waste from hospitals, nursing homes, hotels & restaurants and apartments in 1999. Citizen's involvement in monitoring the process has considerably improved the level of service. Various other NGO's in association with RWA's and the citizens in Delhi (Vatavaran and Asian Centre for Organization Research and Development (ACCORD), (Sristi and Center for Environmental Education), and Exhora in Chennai etc. have taken the initiatives at local level for segregation, collection and utilization of municipal solid waste.

2.6.3 Community Participation in SWM

SWM requires the involvement not only of a technical staff with knowledge of the SWM system but also of the whole of civil society. Citizens, businesses, and industries are producers of waste, and the impacts of this waste directly affect their health, environment, and quality of life. Uncollected waste can be a factor in the spread of diseases such as typhoid, cholera, hepatitis A, leptospirosis, filariasis, malaria, dengue, and chickengunya. Moreover, waste that is not properly disposed of causes serious environmental problems.

Despite all its negative impacts, SWM has seldom been a priority issue in India. In urban areas such as Mumbai, where 60 percent of the population lives in slums, the daily needs of water, electricity, transportation, drainage, and other supplies become the major issues to consider, leaving waste management as a low-priority issue. Therefore, citizens keep suffering, and governments are slow

to react because of a lack of proper strategies and concrete and permanent action plans.

In the past few years, owing to increased concerns for health and the environment, citizens have become highly sensitized and are willing to give some of their time for appropriate SWM. Municipal administrations often lack the financial and technical abilities to provide proper SWM services, and the introduction of community-based schemes involving communities in collecting, sorting and recycling activities has proved a viable alternative.

These community initiatives have proven the importance of involving the community in SWM, not only in the decision making but also in the day-to-day operation. Therefore, municipal authorities need to change their mindsets and improve their approach to and methods of involving citizens in the day-to-day governance of cities—especially with respect to SWM. Municipal bodies should allow innovation and entrepreneurship from the public, providing space and power within a governance structure where rag pickers, waste workers, slum dwellers, and small and medium entrepreneurs can work alongside health officers, engineers, commissioners, and the rest of the citizenry.

Unlike other highly centralized services, SWM requires a decentralized approach that needs active citizen participation rather than mere democratic representation.

Why Community Participation Is Important in SWM?

The community participation is important in SWM for the following reasons:

- It achieves the principles of reducing, reusing, and recycling waste.
- It reduces littering of waste on streets and into drains, open spaces, water bodies, and the like.
- It promotes storage of waste at source, segregated as biodegradable and non biodegradable (so that hazardous waste and infected waste are kept separate).
- It results in arrangements for primary collection of waste through Resident Welfare Associations (RWAs), self-help groups, NGOs, or individual waste collectors by paying for the services provided.
- It encourages and assists in local composting and recycling initiatives.
- It provides SWM services for low-income populations.

2.7 DEFICIENCIES AND CHALLENGES IN THE SWM SYSTEM IN INDIA

An expert committee appointed by the Supreme Court identified the following deficiencies in the SWM system in India.

- No system of primary collection of waste at the doorstep
- Irregular street sweeping
- Inappropriate system of secondary storage of waste
- Irregular transport of waste in open vehicles
- No treatment of waste

- Inappropriate disposal of waste at open dumping grounds
- Lack of civic sense and bad habits of people to litter
- Lack of cooperation from households, trade, and commerce
- Lack of stringent panel provision
- Lack of powers to levy spot fines
- Lack of litter bins in the city
- Long distance between community bins
- Resistance to change in attitude
- Lack of wide publicity through electronic and print media
- Lack of public awareness and motivation, resulting in poor response from citizens
- Lack of citizens' understanding how to use separate bins for storage of recyclables
- Lack of sufficient knowledge of benefits of segregation
- Lack of cooperation and negative attitude of people
- Lack of finances to create awareness
- Difficulty of educating slum dwellers
- Lack of awareness and motivation
- Unavailability of primary collection vehicles and equipment
- Insufficient response from citizens
- Lack of personnel for door-to-door collection
- Excessive leave and absenteeism of sanitary workers
- Unavailability of workers on Sundays and public holidays
- Shortage of containers
- Lack of planning for waste storage depots
- Inaccessible areas and narrow lanes that do not allow sufficient space for containers
- Old vehicles those are difficult to replace
- Lack of technical know-how
- Lack of skilled personnel
- Unavailability of appropriate land
- Lack of basic facilities to set up treatment plants
- Lack of institutional capacity

In this session you read role of private, NGOs and community in waste management and now answer the questions given in *Check Your Progress 3*.

Check Your Progress 3

Note: a) Write your answer in about 50 words

b) Check your answer with possible answers given at the end of the unit.

- 1) Explain briefly the private sector participation and role of NGO's and CBO's in management of solid waste in India.

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- 2) Briefly give the deficiencies in the management of solid waste.

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2.8 LET US SUMUP

This unit on waste management, at the out set dealt with the concept and elements of waste management. This unit also describes the process and government measures for waste management. It has also described the role of government, private, NGOs and community in waste management. In the end this unit has jotted out the points relating to deficiencies and challenges of solid waste management in India.

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2.10 CHECK YOUR PROGRESS POSSIBLE ANSWERS

Check Your Progress 1

- 1) What is Municipal Solid Waste and what are its sources of generation?

A. The term *municipal solid waste* refers to solid waste from houses, streets and public places, shops, offices, and hospitals. Management of these types of waste is most often the responsibility of municipal or other governmental authorities. In urban areas, solid waste is generated by domestic households, commercial and industrial enterprises, and health care and institutional activities, as well as on the streets. Street refuse contains a mixture of refuse from many sources, because streets are used as dumping grounds by all generators of waste.
- 2) What are important elements of urban waste?

A. A typical waste management system in a low- or middle-income country includes the following elements:

 - Waste generation and storage
 - Segregation, reuse, and recycling at the household level
 - Primary waste collection and transport to a transfer station or community bin
 - Street sweeping and cleansing of public places
 - Management of the transfer station or community bin
 - Secondary collection and transport to the waste disposal site

- Waste disposal in landfills
- Collection, transport, and treatment of recyclables at all points on the solid waste pathway (collection, storage, transport, and disposal)

Check Your Progress 2

- 1) Name the rule handling solid waste management in municipal areas and the responsibilities of municipal authorities in solid waste management in urban areas.

Under the Municipal Solid Waste (Management and Handling) Rules 2000, Municipal authorities are responsible for implementing provisions of the 2000 rules. They must provide the infrastructure and services with regard to collection, storage, segregation, transport, treatment, and disposal of MSW. Municipal authorities are requested to obtain authorization (that is, permission or technical clearance) from the state pollution control board or committee to set up waste processing and disposal facilities, and they must deliver annual reports of compliance.

Check Your Progress 3

- 1) Explain briefly the private sector participation and role of NGO's and CBO's in management of solid waste in India.

Approximately 35 composting projects have been set up in India with private sector partnerships, mostly in states of Maharashtra, Tamil Nadu, Andhra Pradesh & Kerala. The private firm recoups its investment by selling compost derived from waste processing. Kolhapur Municipal Corporation signed a 30-year, Build-Own-Operate-transfer (BOOT) contract with private enterprise that will design, build, operate and maintain the waste treatment for this period and mobilize its financing and will retain income from sales of organic fertilizer produced from composting of waste.

Cities are increasingly accepting the role of non-government and community based organization in urban waste management. Some cities are experimenting with community contracting to complement service provision by the ULB's. Municipal Corporation of Hyderabad (MCH) decided to experiment citizen's participation by involving Resident Welfare Associations (RWA's) in motivating the citizens to store compostible and non-compostable waste in two separate plastic containers.

- 2) Briefly, give the deficiencies in the management of solid waste.

An expert committee appointed by the Supreme Court identified the following deficiencies in the SWM system in India.

- No storage of waste at source
- Partial segregation of recyclable waste
- No system of primary collection of waste at the doorstep
- Irregular street sweeping
- Inappropriate system of secondary storage of waste
- Irregular transport of waste in open vehicles
- No treatment of waste
- Inappropriate disposal of waste at open dumping grounds
- Lack of civic sense and bad habits of people to litter
- Lack of cooperation from households, trade, and commerce

UNIT 3 TRANSPORT SYSTEM MANAGEMENT

Structure

- 3.1 Introduction
- 3.2 Classification of Transport System
- 3.3 Transport System Indicators
- 3.4 Characteristics of Urban Mass Transit System
- 3.5 Transport Systems as per Modes
- 3.6 Transport System Management
- 3.7 Resources Component of Urban Transport
- 3.8 Let Us Sum Up
- 3.9 Abbreviations
- 3.10 References and Selected Readings
- 3.11 Check Your Progress-Possible Answer

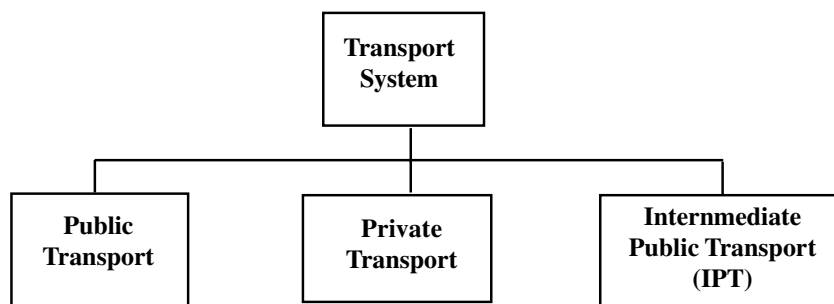
3.1 INTRODUCTION

You are well aware that transport is very important element of urban infrastructure. The transport system and management can be broadly categorized into three aspects: (i) Transportation system- A facility consisting of the means and equipment necessary for the movement of passengers or goods; (ii) The Transportation Systems Sector- a sector that comprises all modes of transportation (Aviation, Air, Mass Transit, Highway, Freight, Rail, and Pipeline), is a vast, open, interdependent Network system that moves millions of passengers and millions of tons of goods; and (iii) The Transportation network- is critical to the Nation's economic progress. Every day, the transportation network connects cities, provided mobility requirement at a desired accessibility levels and particular level of service. This unit discusses urban transport system and its management. After reading this unit, you will be able to:

- Classify transport system
- Identify indicators of transport system
- Narrate the characteristics of urban transport system
- Describe transport system as per mode used
- Analyse the best practices in transport system
- Describe transport system management
- Discuss human resource component of urban transport
- Record best practices of traffic management

3.2 CLASSIFICATION OF TRANSPORT SYSTEM

The Transport system is broadly divided into three major divisions as shown in the figure below.



These Transport Systems can be classified as follows according to flexibility and time:

		Time	
		Fixed	Variable
Space/Route/Fare	Fixed	Rail Rapid Transit Light Rail Fixed Route Bus	Jitney / RTV
	Variable	Van Pool Subscription Bus Car Pool	Taxi Auto rickshaws Cycle Rickshaw Dial-a-ride Auto Rental

Private Transport

Private transport has flexible route, space, timings. Road based private transport can further be classified as Fast, Slow. Fast is the mechanised mode that includes Car, 2 Wheeler, etc. Slow mode is also called as non-mechanised modes such as cycles, animal drawn private vehicles.

Public Transport

Public Transportation includes all multiple occupancy vehicle services designed to transport customers on local and regional routes. It is transportation by van, bus, or rail or other conveyance, either privately or publicly owned, providing to the public general or special service. Any form of transportation that charge set fares, run fixed routes, and are available to the public. For Example: Bus, Metro, Commuter Rail, Trams, etc.

Intermediate public transport/para transit

Para-Transit can be further be classified as (i) IPT (Para Transit) Fast; and (ii) IPT (Para Transit) Slow.

- i) **IPT Fast:** It is mechanised mode that can be hired and used on any flexible route, with flexible timings. IPT in certain part of the city or in some of the cities also run on fixed route. In that case IPT become the substitute of Public Transport System. Some of the examples of IPT-fast are auto rickshaw, Jugad (Modified form of large size auto which is used in Northern part of India), Taxis, Cabs, e-Rickshaw, etc.
- ii) **IPT Slow:** It is non-mechanised mode that can be hired and used on any flexible route, flexible timings. i.e. Cycle Rickshaw, Hand-pull Rickshaw, Camel Cart, etc.

IPT plays a greater role in small and medium size cities. It meets the mobility requirements even on network where Bus cannot run due to non-availability of required Road Space or transport demand may not justify bus transport.

3.3 TRANSPORT SYSTEM INDICATORS

The following indicators are used to evaluate or asses performance of transport systems in a city.

1. Average Speed	
2. Public Transit Share	
3. Walkability	
4. Cycle- ability	
5. Fatality Index	
6. On Street parking Index	
7. Non-Motorized Travel Index	
8. Emission/hr.	

3.4 CHARACTERISTICS OF URBAN MASS TRANSIT SYSTEM

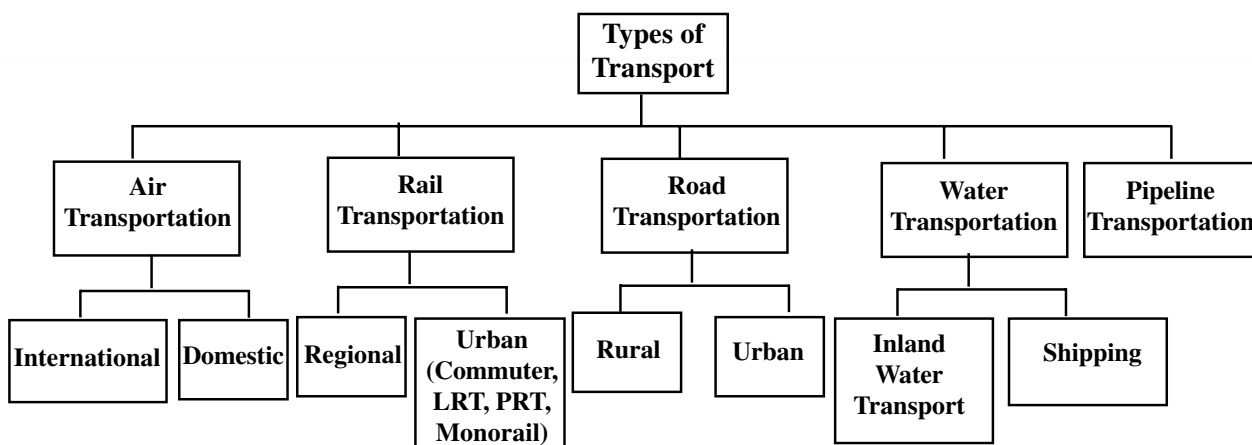
The Characteristics of different urban mass transport system are given in the Table below. The various types of urban transit modes used in Metropolis and Cities are broadly commuter rail, metro, monorail, light rail, and bus rapid transits.

Transit Mode	Commuter Rail	Metro	Monorail	Light Rail	Bus rapid Transit
ROW Options	Exclusive ROW General Railroad mixed Traffic	Exclusive ROW Grade Separated	Exclusive ROW Grade Separated	Exclusive ROW Semi Exclusive Mixed traffic Lanes	Exclusive ROW Semi Exclusive Mixed traffic Lanes
Station Spacing (Km)	3 to 15	1.5	0.75 to 1.5	0.75 to 1.5	0.4 to 1.5
Vehicles	Locomotive with set of Passenger coaches	High Platform Cars operating in multiple car trains set	High Platform Cars operating in multiple car trains set, electric propulsion	Articulated double articulated low floor, can operate in multiple car sets , electric propulsion 65- 85 per car	Standard articulated or double articulated, low floor or high platform, diesel, hybrid Propulsion of ETB

Seated Capacity	90-185 per car	60-80per car	30- 75 per car		40 standard 65 articulated 85 double articulated
Average speed	40 -70 kmph	25-55 kmph	25-40 kmph	25-50 kmph	25-40 kmph
Passenger Throughput	>40,000 PPHPD	Up to 40000 PPHPD	Up to 20000 PPHPD	Up to 20000 PPHPD	Up to 8000 PPHPD
Min. Curve Radius	50 m	40m	75m	25m	13m
Approx. Operation and management cost	40-60 lakh	100-200 Lakh	40-60 Lakh	50-60 Lakh	–
Approx. Capital Cost Per Km (2008 Km)	100-120 crores	200 crore	80-130 crore	100 crore	15 crore
Implemented Cities- India	Mumbai, Chennai,Kolkata Hyderabad	Delhi, Kolkata			Indore, Rajkot, Pune , New Delhi , Ahemdabad,
Implemented Cities- International	Moscow, Jakarta, Johannesburg	Bangkok, Kuala Lumpur, Mexicocity, Cairo	Tokyo, Sydney, Kuala Lumpur, Seattle	Hong Kong, Shanghai, Kuala Lumpur	Instanbul, Taipie, Bagota

3.5 TRANSPORT SYSTEM AS PER MODES

There are broadly five types of transportation modes. The user select the various modes based on (i) various level of price and (ii) various levels of service such as convenience, speed, safety and availability. Broadly, the various types of the transport system are used for Freight and Passenger movement from one place to another. Now a days, various new modes of transportation are also used for the transportation such as ropeway, etc.



Let us describe these transport system one by one.

3.5.1 Air Based Transport

Air based transport involves the Air Plane. Air transport by nature provides the speediest mode of transport service. This mode of transport does not encounter the geographical barriers of earth's surface like mountains, hills, deserts, rivers, etc. and this allows the air transport to provide gradually faster services. It has also the advantages of linking remote and inaccessible areas across the mountains, oceans, deserts and dense forests.

There are three elements in air transport i.e.

- i) Airway
- ii) Aircraft service
- iii) Airport.

3.5.2 Rail Based Transport

Railways are composed of a traced path on which vehicles are bound. They have an average level of physical constraints linked to the types of locomotives and a low gradient is required, particularly for freight. Heavy industries are traditionally linked with rail transport systems, although, containerization has improved the flexibility of rail transportation by linking it with road and maritime modes. Rail is by far the land transportation mode offering the highest capacity

Rail Based Transportation is of two types

- i) Regional Rail Transportation
- ii) Urban rail Transport

The urban rail transportation is broadly of following categories:

- a) Commuter Rail
- b) Metro Rail
- c) LRT (Light Rail Transit)
- d) Mono Rail
- e) PRT (Personalised rapid Transit)



Commuter Rail



Metro Rail



LRT



Monorail



PRT Pod Cars

3.5.3 Road Based Transportation

India has a network of National Highways connecting all the major cities and state capitals, forming the economic backbone of the country. As of 2010, India has a total of 70,934 km of National Highways, of which 200 km are classified as expressways. Under National Highways Development Project (NHDP), work is under progress to equip some of the important national highways with four lanes; also there is a plan to convert some stretches of these roads to six lanes.

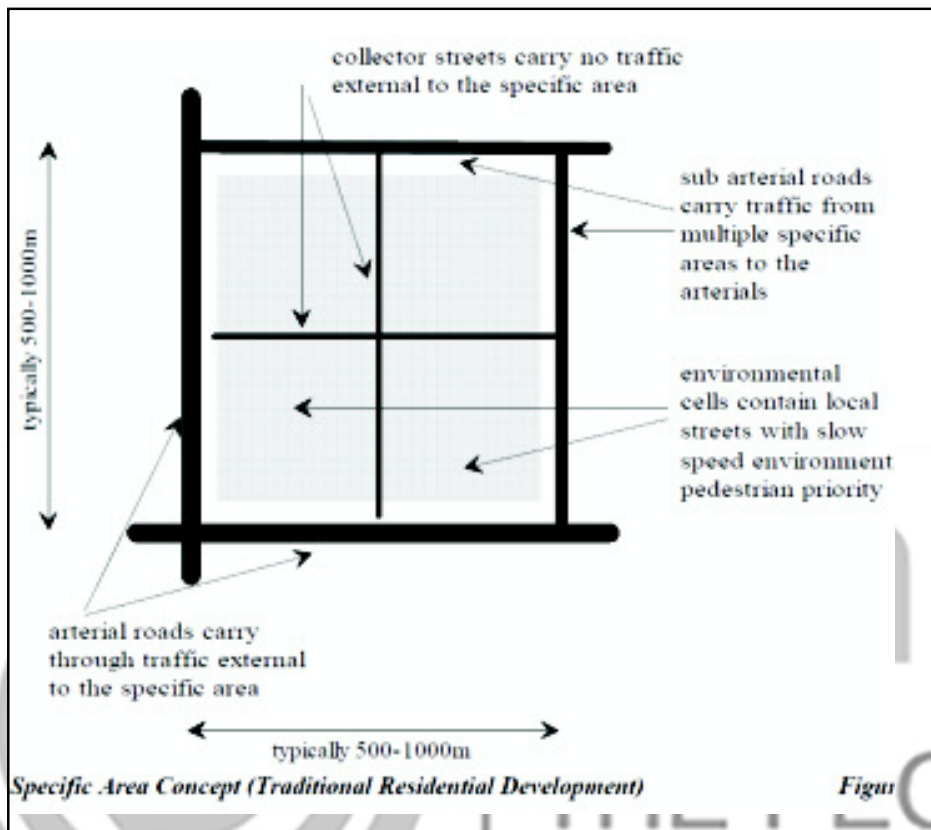
As per the National Highways Authority of India (NHAI), about 65% of freight and 80% passenger traffic is carried by the roads. The National Highways carry about 40% of total road traffic, though only about 2% of the road network is covered by these roads. Average growth of the number of vehicles has been around 10.16% per annum over recent years.



The road based transportation can be broadly classified as (i) Urban road hierarchy;
(ii) Urban road intersection.

i) Road Hierarchy

An efficient urban road network follows a hierarchy. The hierarchy is based on the function that the road is expected to perform, and the type of traffic and the road users present on the road. The design, speeds, road widths and other geometric features are adapted to suit the road function. These guidelines are based on the following classification of urban road:



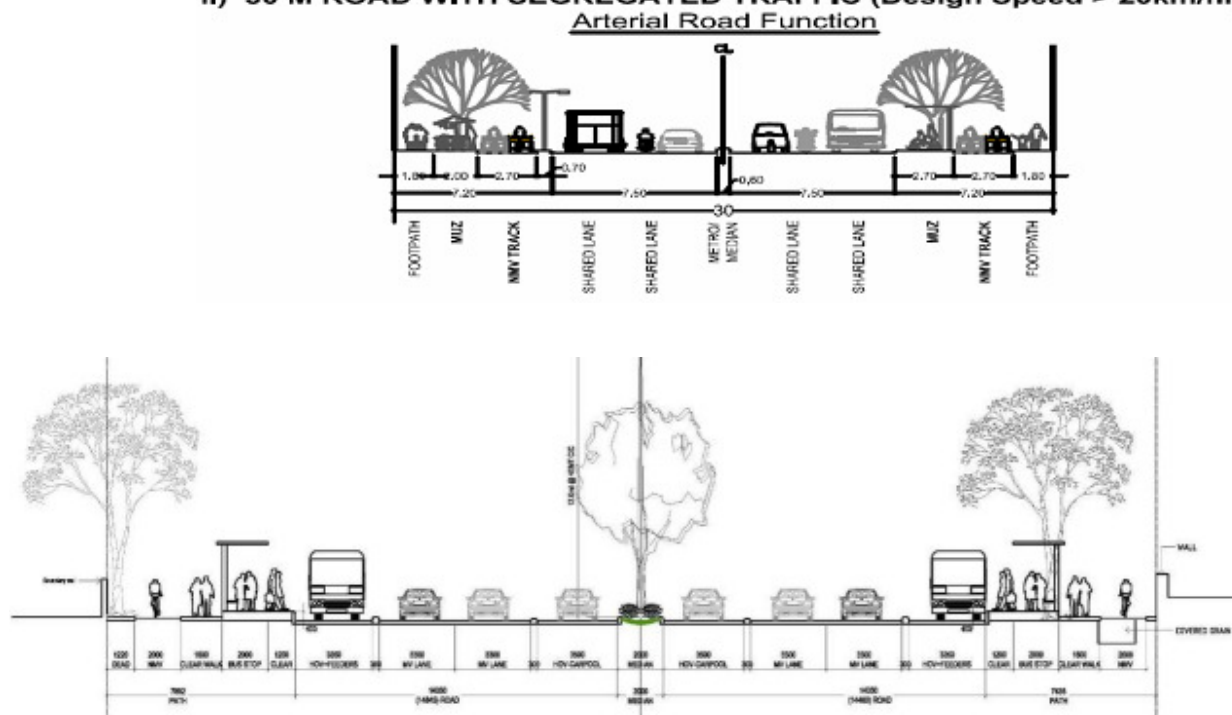
- Arterial Road
- Sub-Arterial Road
- Collector Road
- Access streets/Local streets

Let us explain these types one by one.

a) Arterial Roads

They are the primary roads for ensuring mobility function. They carry the largest volumes of traffic and longest trips in a city. These roads are characterized by mobility and cater through traffic with restricted access from carriageway to the side. In such cases, special provisions should be introduced to reduce conflict with the through traffic. These roads also have the maximum right of way (ROW) amongst all categories. However, roads of lower width also function as arterial roads. Functional classification supersedes the geometric classification.

ii) 30 M ROAD WITH SEGREGATED TRAFFIC (Design Speed > 20km/hr)



Measured Section: Urban Arterial Road: Vikas Marg, opposite to SPA, New Delhi

b) Sub Arterials Roads

Their basic functions are similar to that of Arterial. It is a street primarily through traffic usually on a continuous route but offering somewhat lower level of traffic mobility than the arterial.

c) Collector Roads

As the name suggests, these are connector roads which collect and distribute the traffic from and to the local streets. They are characterized by mobility and access equally. It carries moderate traffic volumes compared to the arterial roads..



Cross section of (a) 24m ROW and (b) 18m ROW.

- d) **Access Streets or Local Street:** This is a street primarily aimed for access to residents, business or other abutting properties. Majority of trips in urban areas usually originate or terminate on these streets. They carry relatively lower volumes of traffic at low speeds. They are characterized by high accessibility among all the categories of roads.

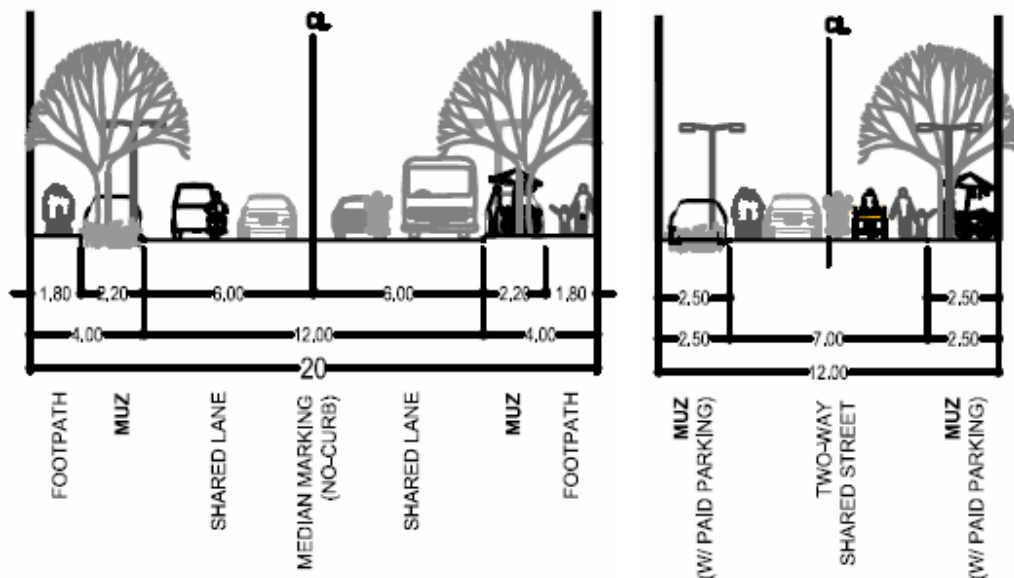


Figure 0-4 Cross section of (a) 20m ROW and (b) 12 m ROW Road

Based on the standard cross sections as per the guidelines, all the roads should be designed in a particular manner with given ROW. The types are as follows:

- Pedestrian Paths (accessible footpaths)
- Infrastructure of non-motorized vehicles Bus lanes
- Bus lanes
- Carriageway (Motorized vehicles)
- Median
- Unpaved- Curbs and segregators
- Service Roads
- Parking
- Tree belts/ Green belts /Landscaped area
- Bus shelters
- Other facilities – Street furniture and other facilities
- Grade separator facilities

ii) Urban Road Intersection

The Road Intersections are the critical elements of the road sections and the function of a designed intersection is to control conflicting and merging streams of traffic, to minimize the delay including pedestrian and bicycle traffic.

Intersection design influences the capacity of the corridor and the safe movement of conflicting directions. The pattern of the traffic movements at the intersection and the volume of traffic on each approach, during one peak period of the day determine the lane widths required including the auxiliary lanes, traffic control devices and channelization, wherever necessary. The arrangement of the islands and shape, length of the auxiliary lanes also differs based upon the type of intersection.

Different combinations of the intersection type is determined primarily by the number of intersecting legs, the topography, the character of the intersecting roads, the traffic volumes, patterns, and speeds, and the desired type of operation.

Intersection has merging, diverging, cross conflict points. Four Arm Intersection of Two Way Roads has 16 cross ,8 merging ,8 diverging conflict points. In total, there are 32 conflict points.

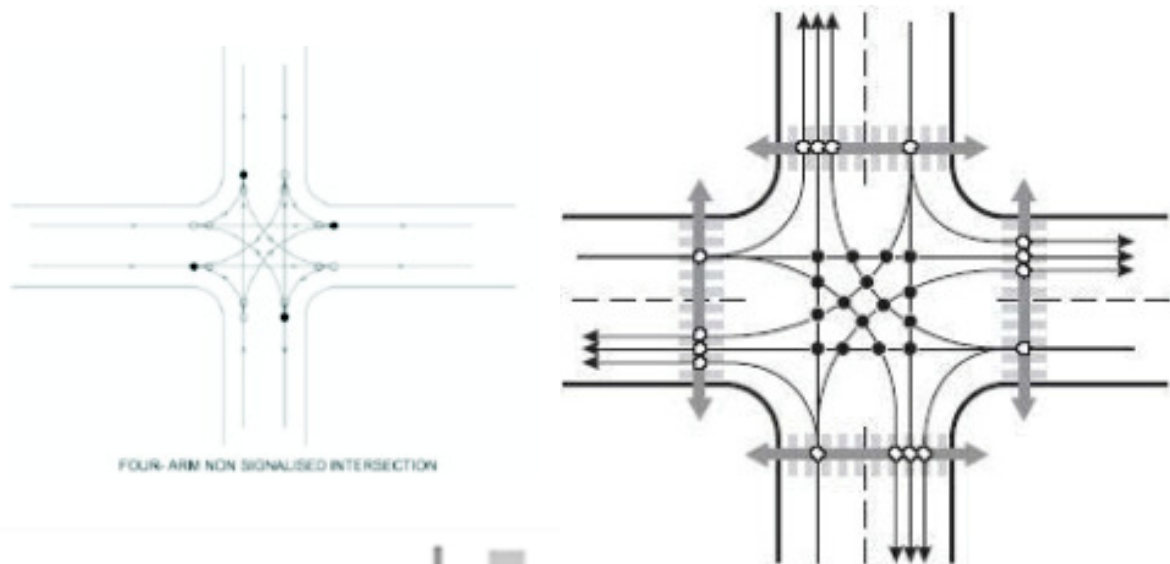


Figure 0-5 Conflict Points in 4 arm Unchannelized intersection and 4 arm Channelized intersection

Types of intersection depending on the geometric forms are as follows

- 1) 3- Leg Junction
- 2) 4- Leg Junction
- 3) Multi-Leg Junction

The function of an intersection is to enable safe interchange between two directions or two modes.

The design of an intersection must be comprehensible to road users. This aim is best achieved with a well-organized situation with a minimum number of conflict points. The basic principle is to limit the number of conflict points.

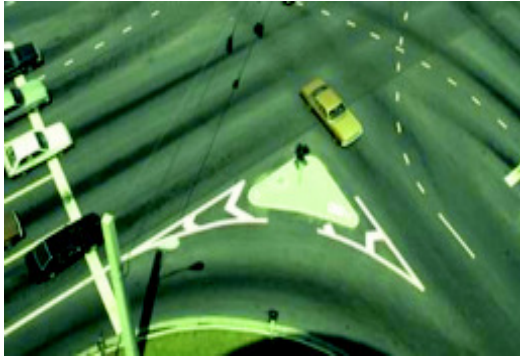
Different types of intersections are as follows:

- 1) Channelized intersection
- 2) Roundabout
- 3) Signalized Intersection
- 4) Grade Separated Intersection (Flyover)
- 5) Grade Separated Interchange

1) **Channelized Intersections**

Channelized intersections use pavement markings or raised islands to designate the intended vehicle paths. The most frequent use is for left-turns,

particularly when accompanied by an auxiliary left-turn lane. At skewed intersections, channelization islands are often used to delineate left turns. At large intersections, short median islands can be used effectively for pedestrian refuge. The design of channelized intersections needs to ensure that the needs of pedestrians are considered. In this type of Intersection, Merging and Diverging type conflict points are reduced.



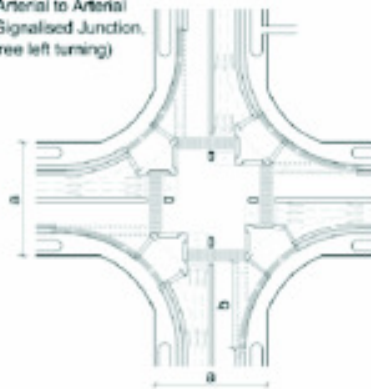
2) Roundabouts

A Roundabout is a type of Circular intersection with a specific design and traffic control features. Roundabouts can be tailor designed to suit most site conditions, traffic volumes, speeds, and all road users' requirements. This is one versatile solution, which combines the benefits of safety and efficiency in an attractive package. Safety is achieved by reduced speed (less than 40 km/hr.) within the roundabout and efficiency by high directness in time and distance or minimal delays for all users.



Roundabouts, on higher traffic intensity junctions, requiring complex crossing decisions by cyclists would require segregated bicycle infrastructure along with safer crossing provisions for pedestrians, whereas lower intensity junctions may rely more on mixed conditions and traffic calming techniques.

Junction Type : Arterial to Arterial
(Signalised Junction, free left turning)



In Roundabout, cross conflict points are converted to angular type conflict points which are less dangerous. Roundabout can carry around 3000 pcu/hr. However Capacity can be increased by changing Geometrics.

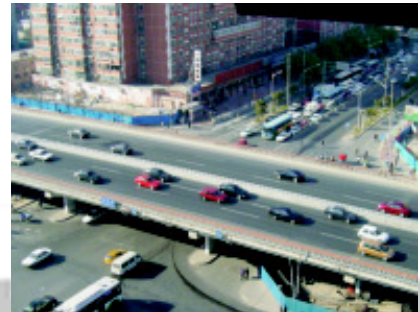
3) Signalized Intersection

A signalized intersection is the junction of road which is controlled by traffic signals. Signalised Intersection generally comes after Roundabout, however, sometimes Signalised Intersection is preferred over Roundabout due to space consideration or Roundabout is not able to handle the required traffic. It encourages:

- a) Orderly movement
- b) Reduce right angle accidents
- c) Increase capacity
- d) Allow crossing
- e) Coordination
- f) Driver's confidence
- g) Cost effective

4) Grade Separated Intersection (Flyover)

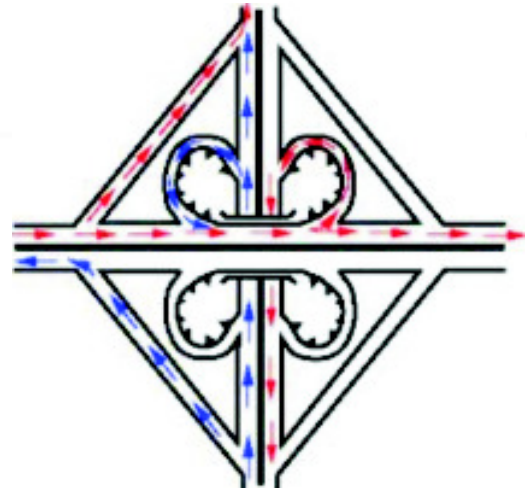
It is a road junction in which the direct flow of traffic on one or more of the roads is not disrupted. Instead of a direct connection, traffic must use on and off ramps (United States, Australia, New Zealand) or slip roads (United Kingdom, Ireland) to access the other roads at the junction.



Grade Separated Intersection is planned and designed when average delay to vehicle increase at the intersection as per IRC, when total approaching traffic in peak hour increases 10,000 pcu/hr, we generally go for flyover.

5) Grade Separated Interchange

In the field of road transport, an interchange is a road junction that typically uses grade separation, and one or more ramps, to permit traffic on at least one highway to pass through the junction without directly crossing any other traffic stream. It differs from a standard intersection, at which roads cross at grade.



Trumpet Interchange at 3 arm Road and (b) Clover leaf Interchange at 4 arm road.

In these sessions you read about the various transport system and also best practices in transport system, now you would be able to answer the questions given in *Check Your Progress 1*

Check Your Progress 1

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit

1) What do you mean by Transport Systems?

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2) Explain Briefly Road Transportation with Example.

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3.6 TRANSPORT SYSTEM MANAGEMENT

Transport System Management is the planning, monitoring, and controlling or influencing of traffic modes. It aims to:

- Maximise the effectiveness of the use of existing infrastructure;
- Ensure reliable and safe operation of transport;
- Address environmental goals; and
- Ensure fair allocation of infrastructure space (road space, rail slots, etc.) among competing users.

Transport System Management (TSM) maximises the capacity of the street system and reduces the demand on it. Although some of them may be expensive to implement, TSM measures are typically low cost localized improvements that attempt to take full advantage of the existing street infrastructure thereby increasing the efficiency of the street system.

The spectrum of TSM measures is wide; the measures that are applicable will generally fall into one of six categories listed below:

- 1) Regulatory Techniques
- 2) Traffic Control Devices
- 3) Traffic Segregation Techniques

- 4) Demand Management Techniques
- 5) Bus Priority Techniques
- 6) Self-Enforcing Techniques

3.6.1 Regulatory Techniques

The regulatory techniques are further divided into 5 management techniques listed below:

- a) One way Street
- b) Reversible Streets
- c) Reversible lanes
- d) Turning Moment Restrictions
- e) Closing Streets

a) One Way Street

This is a technique where vehicle movements are possible only in one direction. It optimizes the road capacity and minimizes the conflict. It is best suited if the network is Grid Pattern.

Reasons for being one-way:

- The street is too narrow for movement in both directions and the road users unable to co-operate.
- To prevent drivers from cutting through residential streets (rat runs) to bypass traffic lights or other requirements to stop.
- Part of a one-way pair of two parallel one-way streets in opposite directions (a divided highway).
- For a proper functioning of a system of paid parking or other paid access.
- To increase traffic flow and potentially reduce traffic congestion.

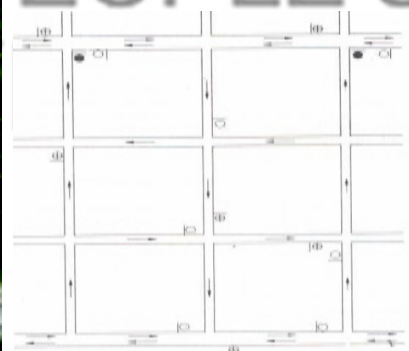


Image showing one-way section and Typical Layout for one way section

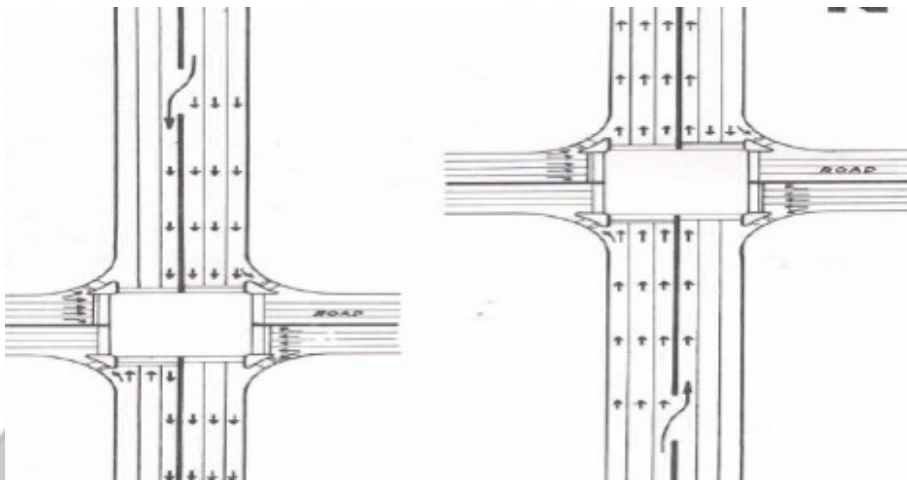
b) Reversible Streets

It is a technique adopted on the way where one direction traffic is about twice the other direction. To adopt this technique, another parallel street should be available to accommodate those traffic.

c) Reversible Lanes

It is a lane in which traffic may travel in either direction, depending on certain conditions. Additional lane should be provided to the peak flow direction by squeezing the carriage way width of opposite traffic flow. Typically, it is meant to improve traffic flow during rush hours, by having overhead traffic lights and lighted street signs, notify drivers which lanes are open or closed to driving or turning. The presence of lane controls allows authorities to close or reverse lanes when unusual circumstances (such as construction or a traffic mishap) require use of fewer or more lanes to maintain orderly flow of traffic.

- This technique is normally implemented if road is more than 4-lane.
- Traffic cones are generally used to delineate boundary of additional area taken away from opposite carriage way.



Reversible lane during (a) Morning and (b) Evening Peak hours.

d) Turning Movement Restrictions

It is a technique used where the turning movement of the vehicles is restricted or banned to minimise the conflict points. It also helps to minimise the traffic signal phases at crowded intersection.

e) Closing Streets

It is a technique adopted to improve the flow on the main street by minimising conflicts. The side street may be used for the parking purposes or the pedestrian purposes according to the requirements.

3.6.2 Traffic Control Devices

The various traffic control devices used for the traffic management are:

- Traffic Signs
- Traffic Signals
- Road Markings
- Computerised Signal Control device
- Traffic Cone and Drums
- Speed Breakers

a) Traffic Signs

Traffic signs or road signs are signs erected at the side of or above roads to provide information to road users. As per IRC specifications, the road signs can be broadly classified into:

- Informatory Signs (They are Shown in Rectangle)
- Cautionary Signs (Also known as warning Sign, shown in triangle)
- Mandatory Signs



Examples of (a) Informatory Signs (b) Cautionary Signs (c) Mandatory Signs

b) Traffic Signals

These are important for orderly traffic movement and it also helps the pedestrians to cross in heavy traffic stream.

c) Road Surface Markings

Road surface marking is any kind of device or material that is used on a road surface in order to convey official information. They can also be applied in other facilities used by vehicles to mark parking spaces or designate areas for other uses. Road surface markings are used on paved roadways to provide guidance and information to drivers and pedestrians. Uniformity of the markings is an important factor in minimizing confusion and uncertainty.



Road surface markings to differentiate right and Straight Traffic Movements.

d) Computerised Signal Control Device

ITS technology is used to regulate the traffic flow. Cycle time is optimized according to the cycle volume at morning, evening and non-peak hours. A computerised signal control device is placed at intersection whereby the information is transferred to the control room and signal operation is controlled to minimise the delay.

e) **Traffic Cone and Drums**

These are portable temporary devices used to delineate the diverted path.



Traffic cone and Traffic Drums used to segregate the flow

f) **Speed Breakers**

This is a traffic control device which alerts the driver of the change in condition and to break the speed of the vehicle. Now a days rumble strips and sleeping police mans are also used.



Speed Breaker

3.6.3 Traffic Segregation Techniques

The various traffic segregation techniques used are:

- a) Vehicle-Vehicle Segregation
- b) Pedestrian-Vehicle Segregation
- c) Time Segregation

a) **Vehicle-vehicle Segregation**

It is a technique used to separate slow moving vehicle from the fast moving. Basically it is observed in CBD area ,where slow moving vehicle are confined to outer area.

b) **Pedestrian-vehicle Segregation**

It is a technique used to separate the pedestrians from the moving vehicles. The various techniques used under this are:

i) Longitudinal Segregation

It includes the separate footpath provided to the pedestrians. It prevents the conflicts between the pedestrians and the vehicles.

ii) Lateral Segregation

These are done for safe crossing of pedestrians across the road ,which includes zebra crossing, pedestrian traffic signal, foot over bridge, pedestrian sub way etc.

iii) Total Segregation

If the pedestrian movement is large, then the street is made exclusively for pedestrians only i,e pedestrian mall.

iv) Special Segregation Technique

These are the techniques which are meant for cyclist or bushes

c) Time Segregation

It is a technique meant to regulate the specific traffics at different times of the day. For example heavy vehicle are not allowed in peak hours in busy area.

3.6.4 Demand Management Techniques

The various demand management techniques used are:

- 1) Parking Restriction
- 2) Parking Pricing
- 3) Off Street Parking and Pay Area
- 4) On street parking meters
- 5) Park and ride systems

i) Parking Restriction

It is a technique where parking may be restricted in the CBD area or the core areas where there is limitation of space for parking. On street parking avoided if traffic flow is more on the corridor.

ii) Parking Pricing

It is a tool used for enforcing on-street parking policy, usually related to the traffic and mobility management policies in order to reduce the demand for parking in the core areas. Pricing methods are being improved to make pricing more cost effective, convenient and fair.

For example, use of electronic pricing systems that accommodate various payment methods and rates, and allow motorists to pay for just the amount of time they will be parked. For short-term parking, it is charged by the minute rather than by the hour, and for long-term parking it is charged by the hour rather than by the day or month.

iii) Off street Parking and Pay Area

According to land availability and the demand for parking, off street parking is created with a specific parking tariff.

iv) On street Parking Meters

In this case, a meter may be installed on the on-street parking such that the demand reduces and the traffic flow is not hampered.

v) Park and Ride Systems

Large off street parking is created to enable motorist to park their vehicle and switch to public transport to reach work place ,CBD etc.

3.6.5 Bus Priority Techniques

The various bus priority techniques used are:

- Bus Priority Manoeuvres
- Bus Lanes
- Bus Priority Signal system

a) Bus Priority Maneuvers

It is a technique to give priority to buses by permitting them turning movements which are prohibited to other vehicles.

b) Bus Lanes

A bus lane or bus only lane is lane restricted to buses on certain days and times, and generally used to speed up public transport.

- Such lane is either with-flow bus lane and contra-flow bus lane.
- The with flow bus lane should be proposed if frequency of the buses is 60 per hour in number or the 1.5 times the passenger moved by other vehicles.

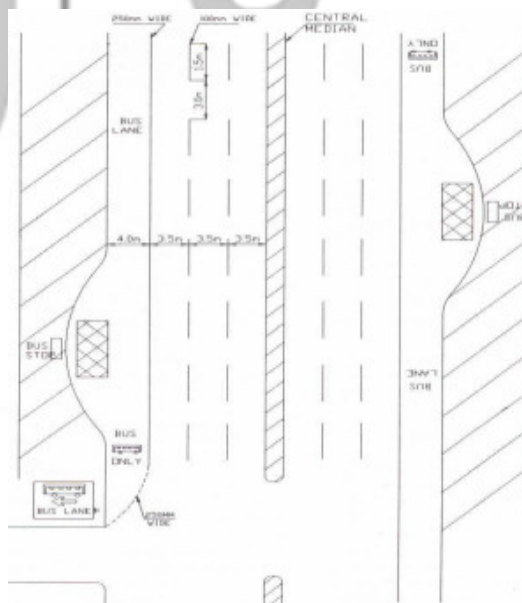


Image and Plan showing Bus lanes

Contraflow: These techniques are generally adopted in one way road; (ii) Minimum no of bus per hour 30; and (iii) here some emergency vehicle and school bus may be allowed.

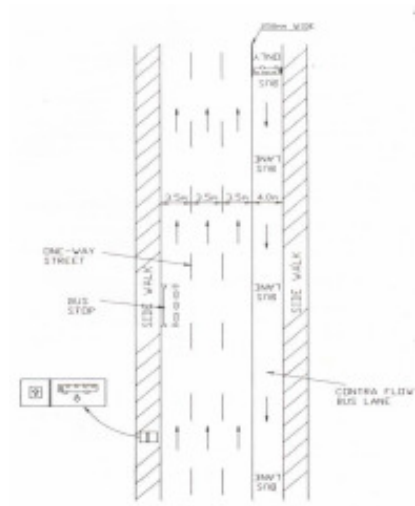
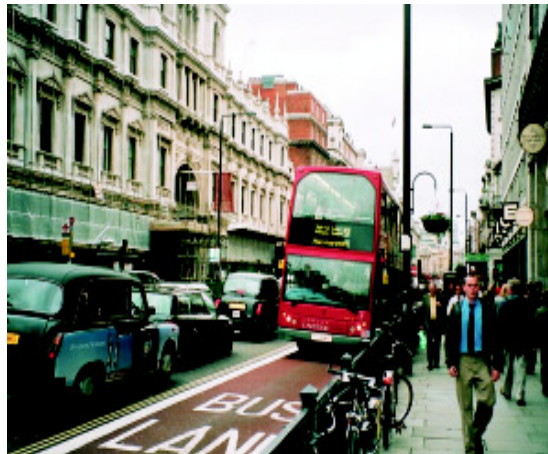


Image and Plan showing Contra-flow lanes.

c) Bus Priority Signal System

By providing Bus priority signal, public transport may be promoted.

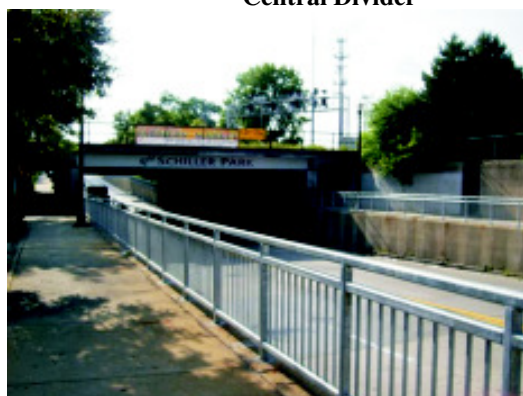
3.6.6 Self-enforcing Techniques

These are the some techniques which ensure traffic discipline automatically. The various techniques used are:

- 1) Central Divider
- 2) Railing
- 3) Parabolic Dividers
- 4) Channelisers
- 5) Parking Notches
- 6) Sleeping Policeman



Central Divider



Railing



Parabolic Divider



Channelizers



Concrete Divider



Sleeping Policeman

3.7 RESOURCES COMPONENT OF URBAN TRANSPORT

Delhi Traffic Police established a **Road Safety Cell** in 1972 to generate awareness among road user. It is an educational wing of the Delhi Traffic Police and its main function is to educate the road users as regards the proper and safe use of roads as well as to develop the human resources who are responsive to public and are technically competent. The training programmer is meant to encompass the whole range of road using citizens, from a common pedestrian to a vehicle driver.

3.7.1 Human Resource Requirement

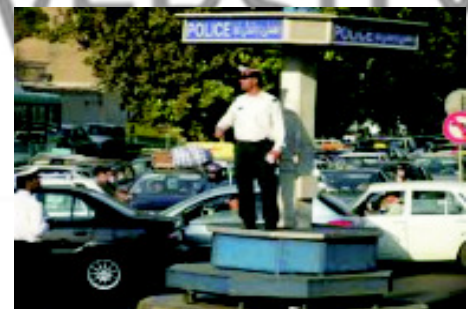
The ideal number of human resources required for urban transport management is follows:

- Minimum 1600 Police Personals per traffic Police range.
- One Traffic Training park for 10 lakh population. Hence New Delhi requires 19 Traffic training parks.
- Number of Traffic police personnel on every intersection installed with CC TV Cameras should be two.
- Min 6 Traffic Police Personnel should be deployed in each intersection without use of CCTV Camera.
- 100 Traffic police Personnel required per Lakh Population.
- For every 10 Km length of ARTERIAL road 4 Traffic Police personals should be deployed.
- One TRAFFIC MANGEMENT CONTROL CENTER(TMCC) for the whole city and One small traffic control center for each planning zone.

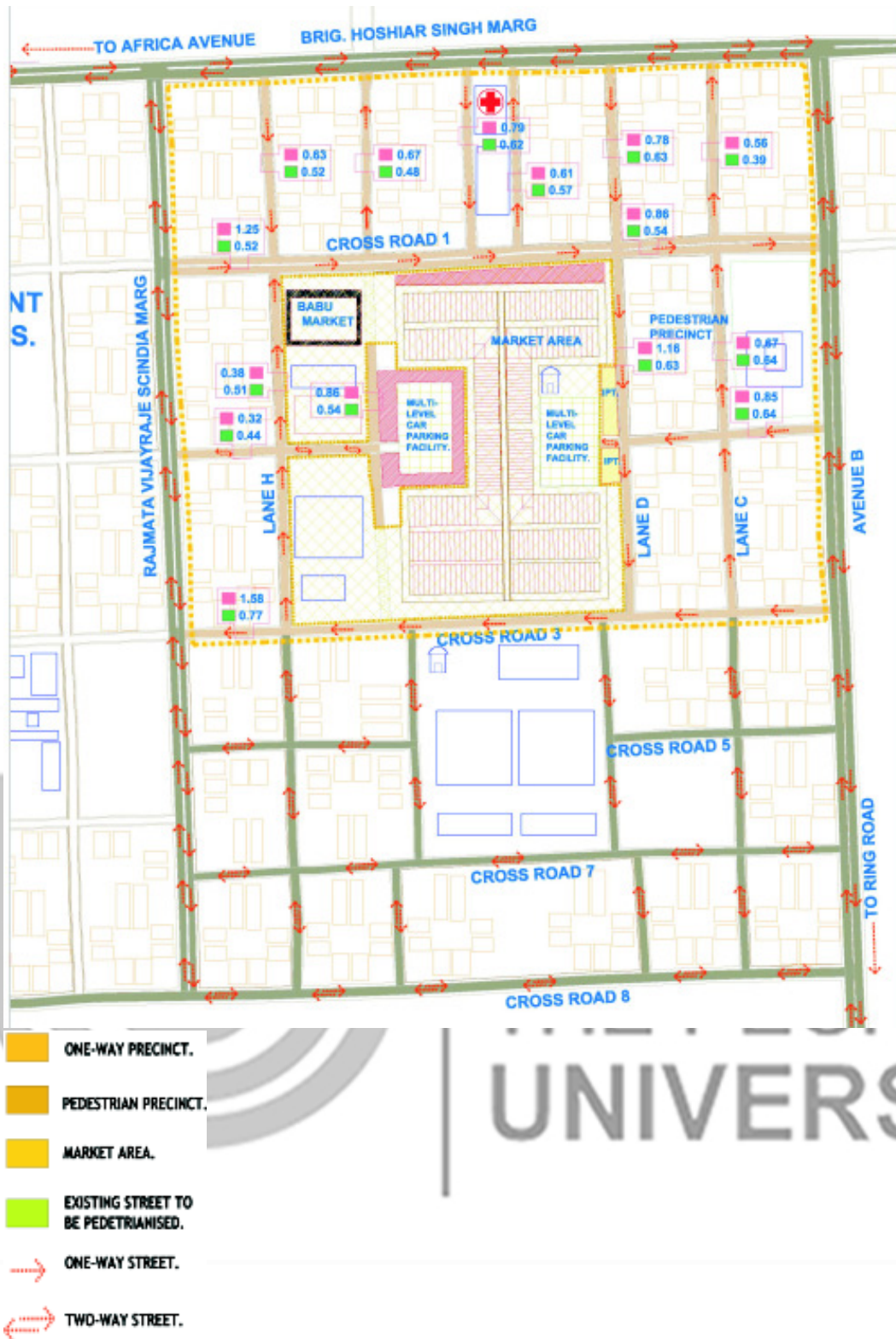
3.7.2 Infrastructure and Vehicle Requirements

The deal quantum of infrastructure and vehicle requirements for traffic management is as follows:

- At least 2 CCTV Cameras for one Arterial interaction
- 1 CCTV camera on 3 legged intersection where Traffic flow is more than 5000 PCUs per hour
- One Motorcycle for HC , ASI rank
- 1 Gypsy each for Senior Inspector rank
- 2 Interceptors per Police districts
- 2 Light cranes per Field inspector
- 3 Heavy Cranes per district
- 1 super heavy crane per Police Range
- 4 Ambulance per district
- 3 Recovery Vans per Police District
- One Toying Van per Field inspector

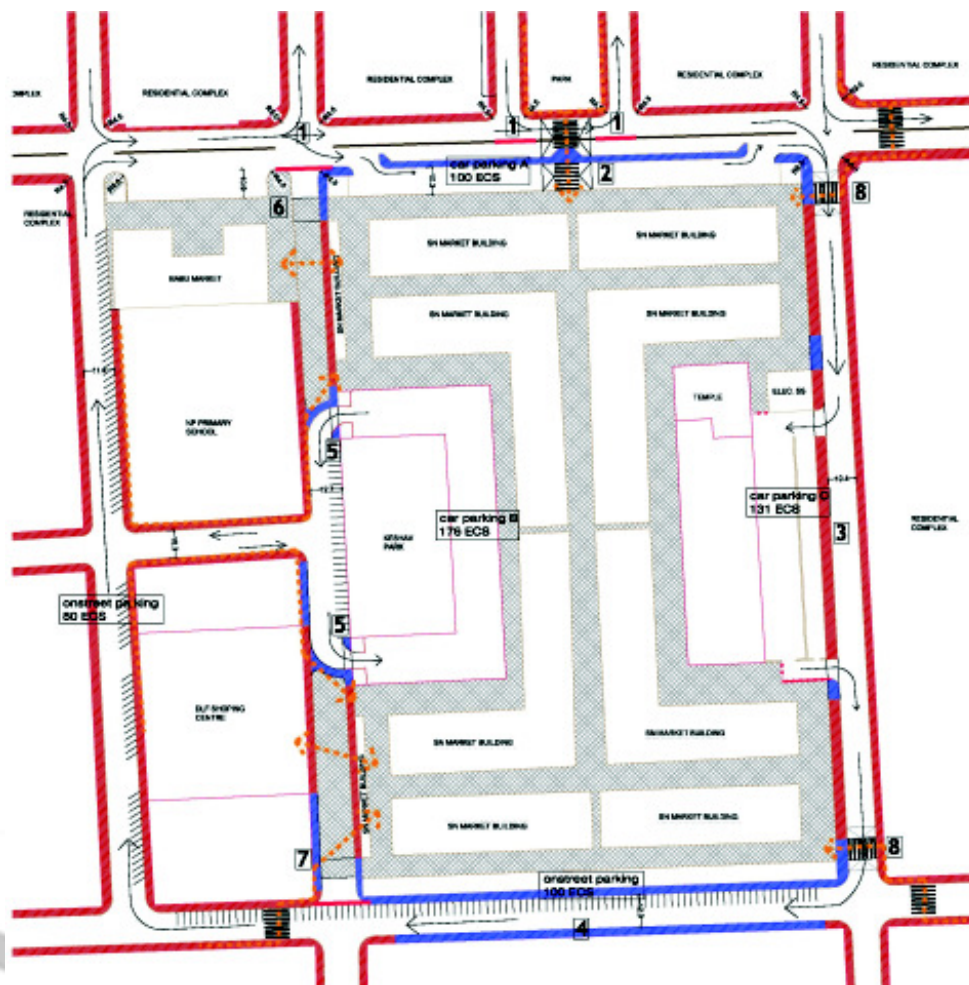


(a) Training Centre (b) Traffic Police Kiosk (c) Recovery Van (d) Traffic Control Room



Suggested Movement of Traffic System Management around the Sarojani Nagar Market

Projected peak demand	: 1800 ECS
Parking at Multi-storeyed parking lot by DLF	: 800
Total parking supply in adjoining areas	: 580 ECS
Shortage	: 420 ECS



Plan of Future Pedestrian Movement

In these sessions you read about the transport management, human resources requirement of transport system and also best practices in transport management, now you would be able to answer the questions given in *Check Your Progress 2*.

Check Your Progress 2

Note: a) Write your answer in about 50 words.

b) Check your answer with possible answers given at the end of the unit

1) Name various traffic control devices.

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2) What are various techniques used for automatic traffic discipline?

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3.8 LET US SUM UP

Transport system is an important arm of the urban development. In this unit on transport system and management, several of types of transport, transport and traffic management and manpower requirement of the urban transport has been described. This unit also gives a pictorial description of case studies on best practices in traffic management.

3.9 ABBREVIATIONS

AADT	- Annual Average Daily Traffic
BRT	- Bus Rapid Transit
CPCB	- Central Pollution Control Board
ECS	- Equivalent Car Space
DIMTS	- Delhi Integrated Multimodal Company
DTC	- Delhi Transport Corporation
HCM	- Highway Capacity Manual
IDFC	- Infrastructure Development Finance Company
IPT	- Intermediate Public Transport
IRC	- Indian Road Congress
IUT	- Institute of Urban Transport
JNNURM	- Jawaharlal Nehru National Urban Renewal Mission
LOS	- Level of Service
LRT	- Light Rail Transit
MoUD	- Ministry of Urban Development
MRTS	- Mass Rapid Transit System
MUZ	- Multi Utility Zone
NHAI	- National Highway Authority of India
NHDP	- National Highways Development Project
NUTP	- National Urban Transport Policy
PCU	- Passenger car Unit
PMGSY	- Pradhan Mantri Gramin Sadak Yojana
pphpd	- Persons Peak Hour per Direction
PRT	- Personal Rapid Transit
ROW	- Right of Way
TSM	- Traffic System Management

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3.11 CHECK YOUR PROGRESS: POSSIBLE ANSWERS

Check Your Progress 1

- 1) What do you mean by Transport Systems?

The transport system and management can be broadly categorised into three aspects: (i) Transportation system: A facility consisting of the means and equipment necessary for the movement of passengers or goods; (ii) The Transportation Systems Sector—a sector that comprises all modes of transportation (Aviation, Air, Mass Transit, Highway, Freight, Rail, and Pipeline), is a vast, open, interdependent Network system that moves millions of passengers and millions of tons of goods; and (iii) The Transportation network is critical to the Nation's economic progress. Every day, the transportation network connects cities, provided mobility requirement at a desired accessibility levels and particular level of service.

2) Explain Briefly Road Transportation. with Example.

India has a network of National Highways connecting all the major cities and state capitals, forming the economic backbone of the country. As of 2010, India has a total of 70,934 km of National Highways, of which 200 km are classified as expressways. Under National Highways Development Project (NHDP), work is under progress to equip some of the important national highways with four lanes; also there is a plan to convert some stretches of these roads to six lanes. As per the National Highways Authority of India (NHAI), about 65% of freight and 80% passenger traffic is carried by the roads. The National Highways carry about 40% of total road traffic, though only about 2% of the road network is covered by these roads. Average growth of the number of vehicles has been around 10.16% per annum over recent years.

Check Your Progress 2

1) Name various traffic control devices.

The various traffic control devices used for the traffic management are:

- g) Traffic Signs
- h) Traffic Signals
- i) Road Markings
- j) Computerised Signal Control device
- k) Traffic Cone and Drums
- l) Speed Breakers

2) What are various techniques used for automatic traffic discipline?

There are some techniques which ensure traffic discipline automatically. The various techniques used are:

- Central Divider
- Railing
- Parabolic Dividers
- Channelisers
- Parking Notches
- Sleeping Policeman

UNIT 4 ENERGY MANAGEMENT

Structure

- 4.1 Introduction
- 4.2 Energy Concepts and Types
- 4.3 Sustainable Urban Energy Planning
- 4.4 Local Governments and Sustainable Energy Management
- 4.5 Role of Information Technology
- 4.6 Energy Audit
- 4.7 Government Response – Municipal Demand Side Management
- 4.8 Government Response – Green Buildings
- 4.9 Let Us Sum Up
- 4.10 References and Selected Reading
- 4.11 Check Your Progress – Possible Answers

4.1 INTRODUCTION

Energy is a vital component of urban infrastructure. Be it water supply, sewerage network, transportation, construction, manufacturing, information and communication technology (ICT) or provision of social infrastructure to enhance quality of life, energy in the form of electricity, oil and gas is an inescapable necessity to enable infrastructure development. An integrated approach for: (i) providing uninterrupted supply of energy, (ii) promoting energy conservation and (iii) minimizing total energy costs is critical, and will be the focus of this Unit. The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect. The term energy management can be understood by “*The strategy of adjusting and optimizing energy, using systems and procedures so as to reduce energy requirements per unit of output while holding constant or reducing total costs of producing the output from these systems*”. The objective of Energy Management is to achieve and maintain optimum energy procurement and utilization, throughout the organization and to minimize energy costs/ waste without affecting production and quality; and minimize environmental effects.

After reading this unit you will be able to:

- Define energy and establish relationship between energy management and development
- Explain various components of energy management
- Analyse urban energy status and energy issues
- Discuss the necessity of urban sustainable energy planning
- Discuss the challenges of urban energy management system

4.2 ENERGY CONCEPTS AND TYPES

Energy is the ability to do work. Energy is the capacity of a physical system to perform work. Energy exists in several forms such as heat, kinetic or mechanical

energy, light, potential energy, electrical, or other forms. So energy is power, without which nothing can survive on Earth. The term, energy, used here, has a slightly different meaning. Energy actually means, useful energy, or, the energy that we can use; for cooking, operating machines, to run vehicles, and so on. And we get this useful energy only from specific sources, which we call, sources of energy. A good source of energy should have the following characteristics.

- It should do a large amount of work per unit mass or volume. This means that the output energy must be more than the input energy. It should have high calorific value.
- It should be easily accessible. The energy source should be able to provide energy over a long period of time. Examples: coal and petroleum.
- It should be easy to store and transport. The most common sources of energy such as coal, petrol, and LPG need to be transported to users from their points of production. They also need safe and economical storage and transportability. Safe and convenient to use. Energy sources should be safe as they are used by a large number of people, and they should be convenient. Example: nuclear energy from a nuclear power plant is too hazardous to be used at homes.

Types of Energy

Broadly, there are two types of energy: i) conventional energy ii) non conventional energy.

i) Conventional sources of energy:

Conventional sources of energy include fossil fuels, thermal energy and hydroelectric energy. Fossil fuels include fuels that are most commonly used, such as wood, coal, and petroleum. These fossil fuels are non renewable sources of energy and we need to conserve them.

Wood

Wood is a major source of energy for man; it is widely used for cooking and heating. It is a primary fuel which can be used directly to produce heat. A major portion of heat produced by burning wood is lost to the surroundings and only 8 per cent of the total heat is actually used for cooking food, leading to significant wastage of fuel. It produces a lot of smoke due to incomplete combustion, which leads to pollution and health hazards.

Coal

Coal varies in quality according to the amount of pressure and heat to which it is subjected to during its formation. It consists largely of carbon, hydrogen, oxygen, and small amounts of sulphur and nitrogen. Coal is formed in layers called seams and takes millions of years to be formed. The oxides of carbon, nitrogen and sulphur are acidic oxides, and are released when coal and petroleum are burned. This leads to acid rain which affects our water and soil resources.

Non renewable resources of energy in India are the natural resources of energy that cannot be produced, regenerated, re-grown, or reused on a large scale. These non renewable resources exist in a fixed amount and are consumed much faster than nature can recreate them. Fossil fuels including

coal, petroleum, and natural gas are some examples of non renewable resources of energy in India. On the other hand, resources such as timber, which can be recycled, are known as the renewable resources of energy in India. A non renewable resource is always strained down with anabolic procedures that use up energy.

Non renewable resources of energy in India such as coal, petroleum, oil and natural gas require millions of years to form naturally and cannot be replaced as quickly as they can be consumed. Eventually natural resources will become too costly to reap, and mankind will have to find other sources of energy. At present, the main sources of energy used in India are non renewable sources of energy.

ii) **Non-conventional sources energy**

Non conventional sources of energy include wind, tides, solar geo-thermal heat, and biomass including farm and animal waste, as well as human excreta. All of these sources are renewable or inexhaustible. They are inexpensive in nature.

Wind Energy

It can be used for pumping water, a prime need in irrigating farms in the countryside. Also, it can be used for generating electricity. The states of Gujarat, Tamil Nadu, Maharashtra, and Orissa are better places in regard to this energy. Areas with constant and high speed winds are suitable for the purpose. Besides windmills, there are also wind farms.

Tidal Energy

This is another unlimited and inexhaustible source of energy. The Gulfs of Kutch and Cambay are ideally suited to develop electricity from the energy produced by high tides entering into narrow creeks.

Solar Energy

The most abundant and inexhaustible source of energy is the sun. It is a universal source and has huge potential. A notable achievement has been the invention of solar cookers. They help in cooking food almost without any cost. Small and medium sized solar power stations are being planned for deployment in rural areas. The successful applications of the solar energy, so far, have been for cooking, heating water, water desalination, space heating, and crop drying. It is going to be the energy of the future when fossil fuels, namely coal and oil, are totally exhausted.

Thermal Energy

India is not rich in this source. However, efforts are on to utilize natural energy from the hot springs at Manikaran in Himachal Pradesh. Energy so produced can be used for running cold storage plants.

Biomass

The efforts are being made in India to make use of biomass in an efficient and scientific manner. The two main components of the biomass programme are production and utilization of biomass.

Waste and denuded lands are being used for plantation of fast growing shrubs and trees with high calorific value. These, in turn, provide fuel wood, charcoal, fodder, power, and also scope for rural employment. Through the gasification system, these energy plantations over 8,000 hectares were producing nearly 1.5 MW of power, annually.

Energy from Urban Waste

A pilot plant for demonstration purposes has already been set up in Delhi to treat solid municipal waste for conversion into energy. It produces nearly 4 MW of energy every year. Sewage in cities is used for generating gas and electricity.

Biogas Based Power Plants

It is estimated that sugar mills in India can generate 2,000 MW of surplus electricity during crushing season. Out of every 10 MW of energy produced by a mill of a given size, 4 mw would meet its own power requirements and the rest, 6 MW of energy, can be utilized to irrigate fields by feeding it into the local grid. Like biogas, several other farm wastes such as rice husks are also being used to produce electricity.

Farm, Animal, and Human Wastes

By using farm and animal wastes as well as human excreta, *gobar gas* plants are being set up in villages to make them self sufficient in their power requirements. The power so produced, is used for cooking, lighting homes and streets, and meeting the irrigation needs of villages. The plants are being set up both at individual, community, and village levels. Sewage from large cities can be used for generating biogas.

4.3 SUSTAINABLE URBAN ENERGY PLANNING

Sustainable urban energy planning integrates sustainable energy, clean energy technologies and responsible resources management strategies for the development of economically, socially and environmentally healthy communities. The ultimate aim is to bring about a paradigm shift with respect to energy and resource use within all of the functions of a community and to change infrastructure parameters and development patterns by affecting 'how and where we build' and 'how we generate, deliver and use energy'.

Sustainable energy planning seeks to strike a new balance in the dynamics between energy and resource supply and demand, by fusing energy and resource efficiency with smart growth, smart grid, intelligent transportation system management and similar urban strategies within the following framework of community planning and design principles:

4.3.1 Sustainable Use of Energy Resources

Planning and design should maximize the efficient use of energy resources across all end uses, while minimizing direct and indirect adverse impacts on the environment.

4.3.2 Ecological Community Form and Function

Planning and design should emulate nature to maximize the benefit of natural systems and preserve and restore the natural environment. Urban functions should be managed to reinforce natural flows and characteristics, creating a balance and mutually supportive cycle of interaction between built and natural environments.

4.3.3 Environmentally Sound and Energy Efficient Land Use Optimization

Planning and design should seek to minimize the consumption of energy, material and natural resources by restructuring and more efficiently utilizing the existing urban footprint. In addition, compact, mixed-use development, along with the co-location of compatible uses and increasing proximate loads, can enable cost-effective distributed energy resource applications and urban mass transit systems.

Potential for Low Carbon Urban Growth in India

McKinsey (2010) reports that over 75% of urban India is still to be built/re-built. The same report also suggests that if India's cities systematically plan for higher densities around business districts, together with transit corridors and other supporting infrastructure, India can save up to 6.2 million hectares of land, which in itself is a critical component of low carbon development.

4.3.4 Energy and Environmental Technology Integration

Planning and design should integrate cleaner energy systems into development projects, using 'whole building' and 'community-scale' approaches to maximize energy performance and economic value, while minimizing adverse environmental impacts. Efforts should capitalize upon technology advancements, but promote integrated technical systems needed to expand the use of local renewable and recyclable energy resources, build sustainable local and regional energy networks, secure underground distribution systems for critical urban facilities, develop supply and demand network control systems, and establish more technology-ready infrastructure.

4.3.5 Community Resources Management

Wherever possible, planning and design should engage community residents in the efficient use of energy and material resources by decentralizing resource management systems to the neighbourhood level. Neighbourhood-based systems should be designed to provide ongoing systemic management of community resources and promote shared energy resources and material and process efficiencies, based on town energy management plans.

4.3.6 Social Equity and Economic Vitality

Energy-efficient planning and design should increase access to affordable housing, public services and employment for lower-income populations and stimulate local economic opportunities.

There is a fundamental linkage between energy and community form. The value proposition for integrating energy planning into urban land-use and design and for taking a systems approach to community development lies in the fact that

70% of a community's energy consumption is influenced by land use allocations, site design, development practices and transportation and utility infrastructure. Indeed, realizing the fuller potential of energy efficiency and renewable energy is dependent to a large extent on the form and parameters of a community's infrastructure and built environment. Therefore, to maximize GHG emissions reductions and energy savings, the effects of land use decisions and urbanization need to be addressed and mitigated. Moreover, the opportunity to influence significantly local energy end-use through 'how and where' construction and renovation takes place is quite promising, manifest

By taking a 'total energy and environmental systems' approach to land-use development and urban design, sustainable urban energy planning seeks to reconcile environmentally sound energy and resource use with exponential urban growth. Sustainable energy planning integrates energy and environmental planning into land-use, transportation and economic development planning to support community sustainability. Through these linkages, sustainable energy planning seeks to promote the efficient production, delivery and use of energy resources in the development of economically, socially and environmentally healthy communities.

This planning, therefore, takes an holistic approach to sectors such as transport, waste, water and energy, that have traditionally been addressed in a disparate manner, in order to better characterize future energy demand, optimize energy use and influence supply strategies. This systems methodology enhances individual technology, facility and sector approaches. Moreover, sustainable energy planning can guide the development and use of distributed energy resources within communities to assure responsible resources management "that meets present needs without compromising the ability of future generations to meet their needs. (Brundtland Commission, 1987)"

Generally, sustainable development organizations have focused on improving the natural and built environment by reducing sprawl, enhancing livability, improving environmental quality and reintroducing traditional neighbourhood development patterns (smart growth). For their part, globally, sustainable energy organizations have focused upon achieving environmental and other benefits through distributed energy projects (combined cooling, heat and power; demand side management, distributed generation, district energy) that introduce renewable energy and energy efficiency in buildings, transportation systems, industrial and commercial processes and municipal infrastructure. Sustainable energy planning expands upon and integrates these areas of focus to create commercially viable and transferable models of development that integrate energy resources and technologies with community design for long-term community sustainability.

However, there also are significant obstacles to sustainable energy planning by local governments. Primary among these are significant financial constraints, competing priorities, lack of knowledge and technical expertise, little incentive to undertake energy-related activities outside of managing their own consumption; lack of control of the resources required to engage in comprehensive energy sustainability planning and regulatory obstacles. It is also a daunting challenge to integrate energy systems planning into local land use planning and development processes that have been structured to address other matters such as growth management, public infrastructure development (transportation, water supply and wastewater treatment, and solid waste management), affordable housing, etc.

Zero net energy (ZNE) refers to a building or development with a net energy consumption of zero over a typical year. To cope with fluctuations in demand, zero energy buildings or developments are typically envisioned as connected to the grid, exporting electricity to the grid when there is a surplus, and drawing electricity when not enough electricity is being produced. The amount of energy provided by on-site renewable energy sources is equal to the amount of energy used by the building or development. A ZNE building or development may also consider embodied energy – the quantity of energy required to manufacture and supply to the point of use the materials utilized for its building.

4.4 LOCAL GOVERNMENTS AND SUSTAINABLE ENERGY MANAGEMENT

There are compelling reasons for local governments to become involved in sustainable urban energy planning. Smarter energy use can reduce energy costs, improve public health and safety, enhance economic development and environmental quality, increase social equity and environmental justice, and raise living standards and the overall quality of life. With the increasing availability of energy supply and end-use technologies, local governments also are seeking to achieve a higher level of control and self-sufficiency with respect to their access to energy resources. To date, local governments have engaged in sustainable energy planning in three principal ways:

- Reducing energy consumption within their own facilities and operations;
- Promoting efficient energy use and alternative resources in the private sector through judicious use of incentives, regulations and demonstration projects; and
- Shaping local land use and development patterns to reduce per capita energy use and improve environmental quality.

Such efforts have largely been undertaken separately rather than in an interrelated and systemic manner. Furthermore, the efforts have been predominantly project-oriented, aimed at addressing the environmental impacts of energy use in stationary and mobile sources by increasing efficiencies within buildings, installing alternative energy in municipal facilities and fleets, and promoting mass transit and alternative mobility options. But these efforts have not been guided or prioritized by strategic energy planning that seeks to address future growth and uncertainties and to assess a broad range of options based upon systemic community evaluations.

To contribute to a future of both population growth and urban sustainability, local and regional governmental officials must better understand:

- How different development patterns, building and infrastructure design and materials, and clean energy technologies can increase energy and resource efficiency without compromising the quality of life;
- How decisions regarding private development projects affect long-term energy demand;
- How energy smart planning carried out as part of land use development and growth management processes can bring into better balance energy supply with demand, including by facilitating the orderly, capital efficient and

environmentally sound application of distributed energy resources. Developing the capacity for sustainable energy planning would enable local and regional governments to;

- Shape energy and resource-efficient community development patterns and land-use practices under the discipline of a sustainable urban form, significantly reducing energy consumption and greenhouse gas emissions, while also enhancing energy reliability and security and economic growth and development;
- Advance a 'systems' approach for integrating and optimizing clean energy technologies within development projects to accelerate the combined use of renewable energy and advanced end-use and smart grid enabling technologies within a community's built-environment and infrastructure; and
- Help design market-changing public-private partnerships, policies, and business and financial models to overcome technical, market and institutional barriers to clean energy products, services and infrastructure.

Not many urban local bodies (ULBs) in India are oriented towards sustainable energy planning; a few ULBs have undertaken initiatives as illustration in case studies below.

Energy Efficiency Cell – Surat Municipal Corporation

Mission:

- To optimise the specific energy consumption required to provide various services without affecting quantity and quality.

Functions:

- To conduct in house Energy Audit
- To conduct External Energy Audit
- To identify energy conservation projects and its feasibility
- To find out sources for procuring power at lowest possible price
- Feasibility study for own power generation from conventional & renewable energy sources
- To do scrutiny of file having more than equal to 30 kW power loading.
- To monitor the usages of electricity of entire corporation

Reducing Theft by Improving Access: Demand Side Management – Case of Ahmadabad

In analysing the problem of electric power theft, it is important to note that in India (where electric service is often denied in unrecognized slums) people purchase stolen electricity not so much with the hope of getting it at a lower price but simply because this is often the only way in which they can obtain such services. In fact, once the various bribes are included, people in these slum communities typically pay twice as much for stolen electricity as other residents pay for legal electricity.

Fortunately, the Ahmadabad Slum Electrification project clearly demonstrates that one of the most effective means of reducing electricity theft is not through increasing police powers but rather through reducing the demand for stolen electricity by making legal electricity a practical alternative.

In 2003 USAID initiated a catalytic effort to bring together the Ahmadabad Electric Corporation (AEC), the Ahmadabad Municipal Corporation (AMC), and several NGOs and slum communities. Following an agreement by the AMC to grant a moratorium on evictions and issue 'No Objection Certificates', the AEC, with the help of the NGOs, persuaded the residents to pay for legal connections and metres and to begin purchasing legal electricity instead of the stolen electricity that they had previously been paying for. SEWA and other NGOs played an important role in helping to win the confidence of slum residents and in some cases providing loans to pay for installation. As a consequence, not only were the slum residents able to obtain safer and more reliable electricity at approximately half of the earlier costs but the AEC saw an immediate drop in stolen electricity.

What began as a pilot project for 800 homes quickly spread city-wide and now more than 60,000 slum homes have been converted to safe legal electricity. Furthermore, as the residents are paying full cost with no subsidy from the city or the power company, AEC is rapidly extending this programme city-wide with no cost to the government.

This project is especially noteworthy for at least three reasons (i) it significantly improves the quality of life and productivity of the poor while demonstrating their 'willingness to pay' for good services; (ii) it provides a practical and efficient means for reducing theft of electric power; and (iii) it can be rapidly scaled up and is imminently sustainable because of the cost recovery and built in incentives for the major participants.

Source: India Infrastructure Report, 2006

4.5 ROLE OF INFORMATION TECHNOLOGY

Integral to this planning is the development and application of modelling and analytical tools that can assess what changes are needed to foster energy and resource efficient community development, as well as to inform the structuring of public-private partnership arrangements to evaluate and implement cost-effective options. Effective decision support tools and methods are needed to:

- Assess systematically the costs and benefits of alternative urban design and site planning scenarios;
- Enable city officials, development authorities and planners to formulate municipality-wide energy management plans that consider all energy sources and all end-uses; and
- Structure and fund effective energy and environment-related programs, measures and partnerships to overcome technical, institutional, financial and other barriers to sustainable development.

In this section , you have read about sustainable urban energy planning local governments and sustainable energy management and role of information technology . Now, answer the questions given in *Check Your Progress 1*.

Check Your Progress 1

Note: a) Write your answer in the space given below

b) Compare your answer with those given at the end of the unit.

1) What are the key principles of Sustainable Urban Energy Planning?

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2) What do you understand by 'Zero Net Energy'?

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4.6 ENERGY AUDIT

4.6.1 Types and Methodology

Energy Audit is the key to a systematic approach for decision-making in the area of energy management. It attempts to balance the total energy inputs with its use, and serves to identify all the energy streams in a facility. It quantifies energy usage according to its discrete functions. Industrial energy audit is an effective tool in defining and pursuing comprehensive energy management programme.

As per the Energy Conservation Act, 2001, Energy Audit is defined as “the verification, monitoring and analysis of use of energy including submission of technical report containing recommendations for improving energy efficiency with cost benefit analysis and an action plan to reduce energy consumption”.

4.6.2 Need

Energy audit helps understand more about the ways energy and fuel are used in ULB functioning, and helps in identifying the areas where waste can occur and where scope for improvements exist.

Energy audit gives a positive orientation to the energy cost reduction, preventive maintenance and quality control programmes which are vital in ULB functioning. It helps keep focus on variations which occur in the energy costs, availability and reliability of supply of energy, decide on appropriate energy mix, identify energy conservation technologies, retrofit for energy conservation equipment etc.

In general, energy audit is the translation of conservation ideas into realities, by lending technically feasible solutions with economic and other organizational considerations within a specified time frame.

The primary objective of Energy Audit is to determine ways to reduce energy consumption per unit of product output or to lower operating costs. Energy Audit provides a benchmark for managing energy in the organization and also provides the basis for planning a more effective use of energy throughout the ULB's jurisdiction.

4.6.3 Types of Energy Audit

The type of Energy Audit to be performed depends on:

- Function and type of industry;
- Depth to which final audit is needed; and
- Potential and magnitude of cost reduction desired.

Thus Energy Audit can be classified into the following two types.

- i) Preliminary audit.
- ii) Detailed audit.

4.6.4 Preliminary Energy Audit Methodology

Preliminary energy audit is a relatively quick exercise to achieve the following and uses existing, or easily obtainable data.

- Establish energy consumption in all ULB assets (buildings, water supply, sanitation, solid waste management, streetlighting, etc.);
- Estimate the scope for saving;
- Identify the most likely (and the easiest areas) for attention;
- Identify immediate (especially no-/low-cost) improvements/savings;
- Set a reference point that the ULB may want to achieve; and
- Identify areas for more detailed study/measurement.

4.6.5 Detailed Energy Audit Methodology

A comprehensive audit provides a detailed energy project implementation plan for a facility, since it evaluates all major energy using systems. This type of audit offers the most accurate estimate of energy savings and cost. It considers the

interactive effects of all projects, accounts for the energy use of all major equipment, and includes detailed energy cost saving calculations and project cost.

In a comprehensive audit, one of the key elements is the energy balance. This is based on an inventory of energy using systems, assumptions of current operating conditions and calculations of energy use. This estimated use is then compared to utility bill charges.

Detailed energy auditing is carried out in three phases:

- Phase I - Pre Audit Phase
- Phase II - Audit Phase
- Phase III - Post Audit Phase

Phase I -Pre Audit Phase Activities

A structured methodology to carry out an energy audit is necessary for efficient working. An initial study of ULB assets targeted should always be carried out, as the planning of the procedures necessary for an audit is most important.

i) Initial Site Visit and Preparation Required for Detailed Auditing

An initial site visit may take one day and gives the Energy Auditor/Engineer an opportunity to meet the personnel concerned, to familiarize him with the site and to assess the procedures necessary to carry out the energy audit.

During the initial site visit the Energy Auditor/Engineer should (i) discuss with the site's senior management the aims of the energy audit; (ii) discuss economic guidelines associated with the recommendations of the audit; (iii) analyse the major energy consumption data with the relevant personnel; (iv) obtain site drawings where available - building layout, steam distribution, compressed air distribution, electricity distribution etc.; and (v) tour the site accompanied by team members and concerned engineers.

The main aims of this visit will be to (i) finalise Energy Audit team; (ii) identify the main energy consuming areas/plant items to be surveyed during the audit; (iii) identify any existing instrumentation/ additional metering required; (iv) decide whether any meters will have to be installed prior to the audit eg. kWh, steam, oil or gas meters; (v) identify the instrumentation required for carrying out the audit; (vi) plan with time frame, (vii) collect macro data on plant energy resources, major energy consuming centres; and (viii) create awareness among stakeholders.

Phase-II: Detailed Energy Audit Activities

Depending on the nature and complexity of the site, a comprehensive audit can take from several weeks to several months to complete. Detailed studies to establish, and investigate, energy and material balances for specific plant departments or items of process equipment are carried out. Whenever possible, checks of plant operations are carried out over extended periods of time, at nights and at weekends as well as during normal daytime working hours, to ensure that nothing is overlooked.

The audit report should include a description of energy inputs and product outputs by major department or by major processing function, and evaluates the efficiency

of each process. Means of improving these efficiencies need to be listed, and at least a preliminary assessment of the cost of the improvements will be made to indicate the expected payback on any capital investment needed. The audit report should conclude with specific recommendations for detailed engineering studies and feasibility analyses, which must then be performed to justify the implementation of those conservation measures that require investments.

The information to be collected during the detailed audit includes (i) energy consumption by type of energy, by department, by major items of process equipment, by end-use; (ii) material balance data (raw materials, intermediate and final products, recycled materials, use of scrap or waste products, production of by-products for re-use, etc.); (iii) energy cost and tariff data; (iv) process and material flow diagrams; (v) generation and distribution of site services; (vi) sources of energy supply (e.g. electricity from the grid or self-generation); (vii) potential for fuel substitution, process modifications, and the use of co-generation systems; and (viii) energy Management procedures and energy awareness training programs within the ULB.

Existing baseline information and reports are useful to get consumption pattern, production cost and productivity levels. The audit team should collect data concerning (i) technology, processes used and equipment details, (ii) capacity utilisation, (iii) amount & type of input materials used, (iv) water consumption, (v) fuel consumption, (vi) electrical energy consumption, etc., (vii) quantity and type of wastes generated, (viii) efficiencies/yield, among others.

Based on the above, a series of energy conservation opportunities are identified. Based on a financial and economic viability (internal rate of return, net present value, economic rate of return are common tools), these opportunities are listed under low cost-high return, medium cost-medium return, and high cost-high return matrix based on which these are in turn graded into short term, medium term, and long term activities. The report is then presented to the senior decision makers from the ULB for approval.

Phase-III: Post-Audit Activities

This phase primarily includes implementation and follow-up of the approved activities.

4.7 GOVERNMENT RESPONSE – MUNICIPAL DEMAND SIDE MANAGEMENT

BEE has developed a module for determining municipal demand side management, as well as a manual for development of municipal energy efficiency projects. Both are accessible on the BEE website. The Manual indicates that all ULBs should undertake self-assessment (preliminary audit) based on whose findings the detailed audit can be contracted out or structured on a public-private partnership (PPP) modality.

4.7.1 Guidelines for Self-Assessment

The BEE Manual indicates that a ULB should do a self-assessment in order to evaluate the importance of the project. This assessment includes the reasons and goals for the project, a feasibility study, analysis of the project financing and

contractor selection options. Thereafter, an energy efficiency (EE) project plan needs to be prepared by the ULB. The commitment of the municipality and a well-defined EE project plan can highly impact the success of the EE project.

4.7.2 Energy Service Company (ESCO)

ESCO is a company with technical expertise that enters into a performance contract with the ULB to implement energy efficiency measures that optimize energy usage and reduce energy expenditure in a technically and commercially viable manner. ESCO contracts differ from typical service or supply of equipment contract that the municipality is familiar and accustomed to. Around the world, ESCO contracts are considered as viable business model for financing and implementing energy efficiency projects.

The ULB can enter into an Energy Performance Contract (EPC) to initiate investment grade energy audit and implementation of commercially feasible energy efficiency measures that offer attractive returns in the form of reduced operating costs due to optimized energy usage and reduced energy expenditure and improved delivery of services. The project can be financed by the Municipality or the ESCO. The contract may have rewards and penalties built into it in the form of explicit or implicit guarantees. The Municipality may engage the service of an ESCO in a single step or a two step process. In the single step process the ESCO does the IGA and effect energy savings by implementing recommended measures. In the two steps process the municipality first contracts with an ESCO to do an IGA and based on the audit report prioritize measures by calculating the time, capital investment and payback period and proceed with implementation.

4.7.3 Guidelines for Procuring Services for Undertaking a Detailed Audit

BEE prescribes that preferably a ULB should outsource the work of carrying out of the detailed energy audit after undertaking a preliminary audit based on which EE options are prioritised. As indicated earlier, the ULB has a range of options on engaging the private sector on delivery of the EE options.

A) Steering Committee

The municipality should establish a steering committee to assist in monitoring the work of the ESCO/consultant and render guidance for the entire project work. The team leader from the ESCO can then meet with the committee on a weekly or biweekly basis to review progress to facilitate the completion of the project in a timely manner and eliminate discrepancies at later stages.

B) List proposed efficiency measures

The detailed energy audit carried out at the various facilities will help identify energy efficiency measures. The measures that have the best technical and economic potential will be further developed into saving projects that should be listed in the report.

C) Develop a set of potential energy efficiency (EE) projects

The ESCO develops a set of potential efficiency projects for consideration, in consultation with the steering committee. An investment grade evaluation conducted on each that includes the following:

- Description of the baseline situation (e.g., losses from a water supply system)
- Project design, including basic engineering
- Technical constraint analysis
- Project financials
- Baseline calculation
- Options for monitoring and verification
- Assessment of potential technical and financial risk and a risk mitigation plan

The baseline of energy use (and water as appropriate) is calculated from all relevant information, such as operating conditions, measurements of various system equipment, log book trends, historical data, and any previous test reports on the existing operating conditions. The project financials (cost benefit and financial analysis) are calculated by the ESCO using the detailed cost estimates obtained for all equipment and the projected saving rates. This allows the potential projects to be classified according to their cost-effectiveness. Cash flow considerations should also be taken into account since this will determine the amount that needs to be financed by a commercial bank or other local/international financial institutions. From the financial analysis, the ESCO develops an action plan by prioritizing the projects based on so called “ABC-analysis” where activities are classified according to specific performance criteria, both technical and financial. “A” corresponds to priority projects; “B” corresponds to less important projects; and “C” classifies relatively unimportant ones.

D) Monitoring and Verification

Monitoring and verification involves the measurement of parameters in accordance with standard engineering protocols, codes & practices, at a predefined periodicity and term. M&V on efficiency projects are to be conducted in accordance with the norms of the international performance measurement and verification protocol, and considering operating conditions specific to the country. Various M&V plans consistent with IPMVP should be analyzed to select the best option for tracking savings. Since savings are calculated relative to the baseline, the choice of M&V protocol needs to be consistent with the calculation of the baseline. As needed, different M&V protocols may be chosen for different individual projects.

E) Preparing the Audit Report

The audit report will include the following:

- Executive summary - provides brief description of the systems and facilities covered overview of the existing conditions, measures evaluated analysis methodology, results and a summary table presenting the cost and savings estimates for each recommended measure. It also includes a summary of the recommended measures and costs as well as the financial indicators of the project.
- Background - extensive background about the municipality and project should be provided.

- Facility description - Details of the existing facilities targeted, such as water treatment, supply and distribution systems, street lighting and electrical distribution systems, sewage treatment and handling systems and municipal buildings including municipal hospitals.
- Energy scenario - energy consumption details of all facilities included in the audit and their energy sources.
- Inventories - inventories of all relevant systems, including pumping, lighting, water treatment, supply and distribution systems.
- Baseline parameters and adjustments - methodology followed in establishing the baseline parameters and the criteria to be followed in adjusting it. Provide all the baseline parameters and the calculation procedure in an annex.
- Data collection - list the various types of data collected and their sources. Include the data in the annex.
- System mapping - describe the methodology followed for system mapping and include the maps in the annex.
- List of potential projects - a list of all identified measures with estimates of the savings and payback periods on investments, and a summary of the steering committee meeting decision selecting those projects chosen for further development.
- Review of current operation & maintenance practices - provide detailed description of current operation and maintenance (O&M) practices within the Municipal facility. This will include discussion with operators, engineers and other staff, observing the day to day O&M and reviewing the log sheet during the field study. The consultant has to identify areas for improvement and suggest the strategy and methodology for implementing it.
- Details of approved projects.
- Training of municipal staff - based on discussions with engineers and other relevant staff the report should include a proposal for short- and-long term training that the ESCO will conduct for facility personnel. Training will typically cover mapping, methods for identifying the opportunities for energy efficiency, and implementation of efficiency measures.

A number of success stories from across the world, but especially from emerging economies, are presented below for your benefit across a range of sectors. These demonstrate that a well-prepared energy audit study could lead to substantial savings for ULBs.

4.8 GOVERNMENT RESPONSE – GREEN BUILDINGS

Today, programmes for increasing market penetration of energy efficient products and processes exist in myriad forms - voluntary programmes, voluntary industrial agreements, building and appliance efficiency standards and labels, information programmes, best practices and benchmarking programmes, state market transformation programmes, financing and procurement. These programmes are being designed and implemented by government, industries and industry

associations, public private partnerships (PPPs) and non governmental organisations (NGOs). Though so far the central government and industry associations have played a stronger role in this arena; but utility companies, regulatory commissions, and energy service companies are now beginning to assert their role. India has many central and local authorities and bodies that help compile building codes and standards that are applicable at the local and national levels. There are three significant codes/regulations that have been developed by national bodies:

- The Bureau of Indian Standards (BIS), National Building Code (NBC), which covers all aspects of building design and construction;
- The Bureau of Energy Efficiency (BEE), Energy Conservation Building Codes (ECBC), which target building energy efficiency; and
- The Ministry of Environment and Forests (MoEF), Environmental Impact Assessment (EIA) and clearance.

Among these codes/regulations, the ECBC is expected to have the most significant impact on a buildings energy performance.

4.8.1 National Building Code

Building bye laws in India fall under the purview of state governments and vary in administrative regions within the states. BIS developed the NBC in the early 1980s as a guiding code for municipalities and development authorities to follow in formulating and adopting building bye laws. Today, NBC is the reference standard for most construction designs in the country. In its initial form the voluntary code covered most aspects of building design and construction, with only a small part dedicated to energy efficiency. However, the revised the NBC 2005, in its latest version provides guidance on aspects of energy conservation as well as aspects of sustainable development.

The NBC provides general guidance on potential energy efficiency aspects of factors like daylight integration, artificial lighting requirements and heating, ventilating, and air conditioning (HVAC) design standards. A new chapter on sustainability is being added to the NBC to provide a holistic approach to designing and constructing sustainable buildings. The chapter focuses on the integrated nature of design and adopts a cradle to grave approach for buildings.

4.8.2 Energy Conservation Building Codes

ECBC was formally launched in May 2005 as a provision of the Energy Conservation Act of 2001. As per the Act, ECBC will be mandatory for buildings with a connected load of 100 kW or a contract demand of 120 kVA or more. ECBC focuses only on the operation energy use impact of a building and specific maximum and minimum limitations on a number of key building features to reduce a buildings energy use.

ECBC has both prescriptive and performance based compliance paths. The prescriptive path specifies the minimum requirements for the building envelope and energy systems (lighting, HVAC, service water, heating and electrical) that should be adopted. While the performance based compliance path requires the application of whole building simulation approach to prove efficiency over base building as defined by the code. ECBC takes into account location and occupancy

of the buildings and provides minimum standards for reducing energy demand of the buildings through design and construction practices while enhancing the occupants' comfort.

BEE is facilitating the adoption of the policy at the state level as well as providing technical support for the development of the codes and standards. A number of software, tools, tip sheets, case studies and a comprehensive user manual are now ready and available to the building professionals. The ECBC document is complementary to the NBC 2005. Several references to natural ventilation, day lighting, lighting, comfort, and other standards in the document are also detailed out in the NBC. The sustainability chapter of NBC refers to the ECBC document for specific energy efficiency standards for buildings and components. The EC Act and ECBC do not directly address the small commercial and residential building segment. The heaviest energy end use in these smaller buildings is in the form of appliances and equipment. This appliance energy use is being targeted through BEE's energy efficiency standards.

4.8.3 Environmental Impact Assessment

The MoEF's EIA is an important measure for ensuring optimal use of natural resources for sustainable development. EIA was made mandatory in India under the Environmental Protection Act (1986) for 29 categories of large scale developmental activities. The requirement for building energy performance in the EIA is a combination of related terms in NBC and ECBC. The EIA requirements are extremely pertinent and relevant, and if properly implemented, will result in a significant reduction in the environmental impact of buildings. In fact, buildings complying with the requirements of the MoEF's EIA will fulfil most of the requirements of popular green building rating systems.

4.8.4 Green building rating systems

There are two major green building rating systems currently operating in India: LEED India and GRIHA. Industry associations and the private industry have played an important role in promoting the green building movement in India. The Indian Green Building Council (IGBC) is facilitating the Leadership in Energy and Environmental Design (LEED) rating of the United States Green Building Council (USGBC) in India. It has developed several India specific ratings, namely LEED-India, Green-Homes and Green-Factories. The IGBC also offers training, technical assistance, and other capacity building programmes to industry associations and industries. The Energy and Resources Institute (TERI) jointly with the Ministry of New and Renewable Energy (MNRE) has developed the Green Rating for Integrated Habitat Assessment (GRIHA) for the emerging energy consuming segment - the commercial, institutional and residential buildings. GRIHA has now been adopted as the national green building rating system and MNRE has developed incentives to promote it among architects and building owners. Additionally, MNRE has initiated several programmes for the integration of renewable energy in buildings.

In this section you have read about energy audit, government response – municipal demand side management and government response – green buildings. Now, answer the questions given in *Check Your Progress 2*.

Check Your Progress 2

Note: a) Write your answer in the space given below

b) Compare your answer with those given at the end of the unit.

- 1) What are the key requirements for an Urban Local Body to develop capacity for sustainable urban energy planning?

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- 2) Describe key elements of undertaking a preliminary energy audit.

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4.9 LET US SUM UP

Energy is a vital component of urban infrastructure. Be it water supply, sewerage network, transportation, construction, manufacturing, information and communication technology (ICT) or provision of social infrastructure to enhance quality of life, energy in the form of electricity, oil and gas is an inescapable necessity to enable infrastructure development. An integrated approach for (i) providing uninterrupted supply of energy, (ii) promoting energy conservation and (iii) minimizing total energy costs is critical, and will be the focus of this Unit. The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect. The fundamental goal of energy management is to produce goods and provide services with the least cost and least environmental effect.

Energy management includes planning and operation of energy-related production and consumption units. Objectives are resource conservation, climate protection and cost savings, while the users have permanent access to the energy they need. It is connected closely to environmental management, production management, logistics and other established business functions.

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4.11 CHECK YOUR PROGRESS-POSSIBLE ANSWERS

Check Your Progress 1

1) What are the key principles of Sustainable Urban Energy Planning?

Ans: The key principles of Sustainable Urban Energy Planning are

- 1) Sustainable Use of Energy Resources
- 2) Ecological Community Form and Function
- 3) Environmentally Sound and Energy Efficient Land Use Optimization
- 4) Energy and Environmental Technology Integration
- 5) Community Resources Management
- 6) Social Equity and Economic Vitality

2) What do you understand by 'Zero Net Energy'?

Ans Zero net energy (ZNE) refers to a building or development with a net energy consumption of zero over a typical year. To cope with fluctuations in demand, zero energy buildings or developments are typically envisioned as connected to the grid, exporting electricity to the grid when there is a surplus, and drawing electricity when not enough electricity is being produced. The amount of energy provided by on-site renewable energy sources is equal to the amount of energy used by the building or development. A ZNE building or development may also consider embodied energy – the quantity of energy required to manufacture and supply to the point of use the materials utilized for its building.

Check Your Progress 2

1) What are the key requirements for an Urban Local Body to develop capacity for sustainable urban energy planning?

Ans : Local governments have engaged in sustainable energy planning in three principal ways:

- Reducing energy consumption within their own facilities and operations;
- Promoting efficient energy use and alternative resources in the private sector through judicious use of incentives, regulations and demonstration projects; and
- Shaping local land use and development patterns to reduce per capita energy use and improve environmental quality.

2) Describe key elements of undertaking a preliminary energy audit

Ans: Preliminary energy audit is a relatively quick exercise to achieve the following and uses existing, or easily obtainable data.

- Establish energy consumption in all ULB assets (buildings, water supply, sanitation, solid waste management, streetlighting, etc.);
- Estimate the scope for saving;
- Identify the most likely (and the easiest areas) for attention;
- Identify immediate (especially no-/low-cost) improvements/savings;
- Set a reference point that the ULB may want to achieve; and
- Identify areas for more detailed study/measurement.

