

- i) This should include all actions required to be taken to complete project preparation and implementation, identifying the agencies responsible for taking these actions. A detailed time table for actions to be taken should be presented. If found necessary and feasible, taking up of works for rehabilitating and/or de-bottlenecking the existing system should be recommended as an immediate action. Such works may be identified and costed so that detailed proposals can be developed for implementation
- ii) It may also be indicated if the project authority can go ahead with taking up detailed investigations, data collection and operational studies, pending undertaking feasibility study formally
- iii) In respect of small and medium size projects, the pre-feasibility report can be considered sufficient for obtaining investment decision for the project if:
 - a) the results of the pre-feasibility study are based on adequate and reliable data/information
 - b) analysis of the data and situation is carried out fairly intensively
 - c) no major environmental and social problems are likely to crop up that might jeopardise project implementation and
 - d) no major technical and engineering problems are envisaged during construction and operation of the facilities
- iv) In that case the pre-feasibility study with suitable concluding report, should be processed for obtaining investment decision for the project. The feasibility study, can then be taken at the beginning of the implementation phase and if results of the study are noticed to be at variance with the earlier ones, suitable modification may be introduced during implementation
- v) In respect of major projects however and particularly those for which assistance from bilateral or international funding agencies is sought for, comprehensive feasibility study may have to be taken up before an investment decision can be taken.

1.9.4 Feasibility Report

Feasibility study examines the project selected in the pre-feasibility study as a short-term project, in much greater details, to see if it is feasible technically, financially, economically, socially, legally, environmentally and institutionally. Enough additional data/information may have to be collected to examine the above mentioned aspects, though the details necessary for construction of project components may be collected during execution of works.

It is a good practice to keep the authority responsible for taking investment decision, informed of the stage and salient features of the project. If there are good prospects of the project being funded immediately after the feasibility study is completed, detailed engineering of priority components may be planned simultaneously.

1.9.4.1 CONTENTS

The feasibility report may have the following sections:

- Background
- The Proposed Project
- Institutional and Financial Aspects
- Conclusions and Recommendations

1.9.4.2 BACKGROUND

This section describes the history of project preparation, how this report is related to other reports and studies carried out earlier, and in particular its setting in the context of a pre-feasibility report. It should also bring out if the data/information and assumptions made in the pre-feasibility report are valid and if not, changes in this respect should be highlighted. References to all previous reports and studies should be made.

In respect of the project area, need for a project and strategic plan for the same, only a brief summary of the information covered in prefeasibility report should be presented, highlighting such additional data/information if any collected for this report. The summary information should include planning period, project objectives, service coverage, service standards considered and selected for long-term planning and for the project, community preferences and affordability, quantification of future demands for services, alternative strategic plans, their screening and ranking, recommended strategic plan and cost of its implementation.

1.9.4.3 THE PROPOSED PROJECT

This section describes details of the project recommended for implementation. Information presented here is based on extensive analysis and preliminary engineering designs of all components of the project. The detailing of this section may be done in the following sub-sections

a) **Objectives**

Project objectives may be described in terms of general development objectives such as health improvements, ease in disposing wastewater, improved environmental conditions, human resources development, institutional improvements and also terms of specific objectives such as coverage of various target groups.

b) **Project Users**

Define number of people by location and institutions who will benefit and/or not benefit from the project area and reasons for the same, users involvement during preparation, implementation and operation of the project.

c) **Rehabilitation and De-bottlenecking of The Existing Wastewater Disposal System**

Rehabilitation, improvements and de-bottlenecking works, if necessary, should be planned for execution prior to that of the proposed project. If so these activities should be mentioned in the feasibility report if however these works are proposed as components of the proposed project, necessity of undertaking the rehabilitation/improvement/de-bottlenecking works should be explained.

d) Project Description

This may cover the following items in brief:

- i) definition of the project in the context of the recommended development alternative (strategic plan) and explanation for the priority of the project
- ii) brief description of each component of the project, with maps and drawings
- iii) functions, location, design criteria and capacity of each component
- iv) technical specification (dimension, material) and performance specifications
- v) stage of preparation of designs and drawings of each component
- vi) constructing in-house facilities
- vii) method of financing.

e) Support Activities

Need for and description of components such as staff training, improving billing and accounting, consumer education, health education, community involvement etc. and timing of undertaking these components and the agencies involved.

f) Integration of the Proposed Project with the Existing and Future Systems

Describe how the various components of the proposed project would be integrated with the existing and future works.

g) Agencies Involved in Project Implementation and Relevant Aspects

- i) designate the lead agency
- ii) identify other agencies including government agencies, who would be involved in project implementation, describing their role, such as granting administrative approval, technical sanction, approval to annual budget provision, sanction of loans, construction of facilities, procurement of materials and equipment etc.
- iii) outline arrangements to coordinate the working of all agencies
- iv) designate the operating agency and its role during implementation stage
- v) role of consultants if necessary, scope of their work, and terms of reference
- vi) regulations and procedures for procuring key materials and equipment, power, and transport problems if any
- vii) estimate number and type of workers and their availability
- viii) procedures for fixing agencies for works and supplies and the normal time it takes to award contracts
- ix) list of imported materials, if required, procedure to be followed for importing them and estimation of delivery period

- x) outline any legislative and administrative approvals required to implement the project, such as those pertaining to environmental clearance, prescribed effluent standards, acquisition of lands, permission to construct across, along roads and railways, high-tension power lines, in forest area and defence or other such restricted areas
- xi) comment on the capabilities of contractors and quality of material and equipment available indigenously.

h) Cost Estimates

- i) Outline basic assumptions made for unit prices, physical contingencies, price contingencies and escalation
- ii) summary of estimated cost of each component for each year till its completion and work out total annual costs to know annual cash flow requirements
- iii) estimate foreign exchange cost if required to be incurred
- iv) work out per capita cost of the project on the basis of design population, cost per unit of wastewater disposed and compare these with norms, if any, laid down by government or with those for similar projects.

i) Implementation Schedule

Prepare a detailed and realistic implementation schedule for all project components, taking into consideration stage of preparation of detailed design and drawings, additional field investigations required if any, time required for preparing tender documents, notice period, processing of tenders, award of works/supply contract, actual construction period, period required for procurement of material and equipment, testing, trials of individual components and system and commissioning of the facilities etc.

If consultant's services are required, the period required for completion of their work should also be estimated.

A detailed PERT/CPM network showing implementation schedule for the whole project, as well as those for each component should be prepared, showing linkages and inter-dependence of various activities.

Implementation schedule should also be prepared for support-activities such as training, consumers' education etc., and their linkages with completion of physical components and commissioning of the project should be established.

j) Operation and Maintenance of the Project

Estimate annual operating costs considering staff, chemicals, energy, transport, routine maintenance of civil works, maintenance of electrical/ mechanical equipment, including normal cost of replacement of parts and supervision charges. Annual cost estimates should be prepared for a period of 10 years from the probable year of commissioning the project, taking into consideration expected coverage and escalation.

Procedure for monitoring and evaluating the project performance with reference to project objectives should be indicated.

1.9.4.4 INSTITUTIONAL AND FINANCIAL ASPECTS

a) Institutional Aspects

It is necessary to examine capabilities of the organisations who would be entrusted with the responsibility of implementing the project and of operating the same after it is commissioned. The designated organisation(s) must fulfil the requirements in respect of organisational structure, personnel, financial, health and management procedures, so that effective and efficient performance is expected. This can be done by describing the following aspects:

- i) history of the organisation, its functions, duties and powers, legal basis, organisational chart, (present and proposed), relationship between different functional groups of the organisation and with its regional offices, its relation with government agencies and other organisations involved in sector development
- ii) public relations in general and consumer relations in particular, extension services available to sell new services, facilities for conducting consumer education programme and settling complaints
- iii) systems for budgeting for capital and recurring expenditure and revenue, accounting of expenditure and revenue, internal and external audit arrangements, inventory management
- iv) present positions and actual staff, comments on number and quality of staff in each category, ratio of staff proposed for maintenance and operation of the project to the population served, salary ranges of the staff and their comparison with those of other public sector employees
- v) staff requirement (category wise) for operating the project immediately after commissioning, future requirements, policies regarding staff training, facilities available for training
- vi) actual tariffs for the last 5 years, present tariff, tariff proposed after the project is commissioned, its structures, internal and external subsidies, procedure required to be followed to adopt new tariff, expected tariff and revenues in future years, proposal to meet shortage in revenue accruals
- vii) prepare annual financial statements (income statements, balance sheets and cash flows) for the project operating agency for five years after the project is commissioned, explain all basic assumptions for the financial forecast and the terms and conditions of tapping financial sources, demonstrate ability to cover all operating and maintenance expenditure and loan repayment, workout rate of return on net fixed assets and the internal financial rate of return of the project.

b) Financing Plan

Identify all sources of funds for implementation of the project, indicating year-by-year requirements from these sources, to meet expenditure as planned for completing the project as per schedule, state how interest during construction will be paid, or whether it will be capitalised and provided for in the loan, explain the procedures involved in obtaining funds from the various sources.

1.9.4.5 CONCLUSIONS AND RECOMMENDATIONS

This section should discuss justification of the project, in terms of its objectives, cost-effectiveness, affordability, willingness of the beneficiaries to accept the services and effect of not proceeding with the project.

Issues which are likely to adversely affect project implementation and operation should be outlined and ways of tackling the same should be suggested. Effect of changes in the assumptions made for developing the project on project implementation period, benefits, tariff, costs and demand etc. should be mentioned.

Definite recommendations should be made regarding time-bound actions to be taken by the various agencies, including advance action which may be taken by the lead agency pending approval and financing of the project.

CHAPTER 2

MANAGEMENT, ADMINISTRATION, LEGAL AND FINANCIAL ASPECTS

2.1 MANAGEMENT

In India, wastewater disposal systems are usually managed by local bodies. In a few specific cases these are managed by State Government Departments/Statutory Boards set up by State Governments. This service facility falls under the water supply and sanitation sector. The development of the sector is assisted at three levels.

2.1.1 Government of India (G.O.I) Level

Broad policies on sector development of Water Supply and Sanitation in urban and rural areas are formulated and circulated to State Governments and Union Territories as guide lines. Technical manuals are drafted and published for use by the Water and Wastewater authorities. General progress in providing these services in the urban and rural areas is monitored. External aid is also procured through the G.O.I. for major projects fulfilling certain norms. Apart from offering specific inservice training programmes for the employees of wastewater authorities in the States, financial assistance for specific inservice training programmes of the States is also offered. Assistance from financial institutions and other bodies like HUDCO, LIC etc., are available.

2.1.2 State Government Level

The State Governments offer to assist the local bodies in planning and implementation of wastewater disposal schemes of individual or a group of local bodies. Financial assistance is also given for these schemes in the form of Grant-In-Aid and loan etc. for capital investment. In special circumstances the State Governments assist the local bodies in operating and maintaining their wastewater disposal schemes through their own departments or through the statutory boards. Trained Engineers and skilled workmen are sometimes deputed to local bodies on request, to plan, implement and operate the systems. The State Governments monitor general progress of schemes of local bodies in respect of planning, implementation, operation and maintenance.

2.1.3 Local Body Level

It is obligatory responsibility of every local body (Municipality, village panchayat etc.) to collect, transport and properly dispose wastewater produced in the area under their respective jurisdictions. Depending upon financial status of each local body, the State/Central Governments come to the help of these local bodies to meet a part/whole of their capital investment cost on schemes in the form of Grant-In-Aid and/or loan. The expenditure on annual operation and maintenance of these schemes has however to be met by the local body out of its own revenue to be generated from taxes. As per the respective acts of local bodies, they have been empowered to levy and recover tax from the community to whom wastewater disposal facility is provided by the local body.

2.2 COMMON ASPECTS OF MANAGEMENT

The aspects considered in this chapter refer to management of wastewater disposal systems. There are five important aspects of management that could be considered namely (i) General Administration (ii) Personnel Administration, (iii) Inventory Control, (iv) Financial Control and (v) Public Relation. For proper maintenance of data, review, follow up and decision making, software programmes developed by the Central Public Health Engineering Organisation (CPHEEO) under Management Information System as well as by other agencies can be profitably used.

The system has to work as a unit management organisation.

The management in general should aim at the following achievement:

- a) Proper collection of wastewater discharged by the community
- b) Adequate treatment of wastewater to achieve the desired (prescribed) effluent standards
- c) Safe & efficient operations and as far as possible self supporting
- d) Sound financial management.

An efficient and effective management of wastewater disposal systems is most essential for their proper functioning.

2.2.1 General Administration

This could be sub-divided into two categories viz. (a) Supervisory and (b) Operational. The operational level is to be subordinate to supervisory level.

The supervisory administration is expected to control all the functions of management. Wastewater disposal works is an Engineering service. Hence it is a general practice to set up an Engineering Supervisory Organisation on the considerations of annual work load and expenditure to be handled by the organisation. These units are an Engineering Division Unit and an Engineering Sub-Division Unit. These Engineering Units would be administratively controlled by the local bodies of the town or village and their Committees.

2.2.1.1 SUPERVISORY STAFF

The duties and responsibilities of the supervisory units could be listed as under.

- a) To supervise and manage the wastewater disposal systems
- b) To develop annual operation and maintenance (A.O.M.) programme and the budget
- c) To implement A.O.M. programme using appropriate planning and scheduling techniques
- d) To keep accounts, records of the materials and tools, work performance and money spent on work establishment
- e) Periodically (say monthly/quarterly) inform the owner about the status of O. & M. programme and budget
- f) Prepare special reports as required to ensure economical and efficient use of resources
- g) Schedule, assign and monitor work being done by personnel in the organisation
- h) Purchase equipment, tools and supplies required to carry out the programme of the system
- i) Provide inservice training.

In addition to the above they should also look into the following aspects:

- a) That there are adequate maintenance facilities
- b) That the operations are smooth
- c) That the maintenance is efficient and economical
- d) That the administration is efficient and responsive (task assigned to the manager)
- e) That the equipment and supplies are controlled properly
- f) That good public relations are established
- g) That appropriate plans for future expansions are drafted.

Some other additional tasks that the supervisory units may handle could be briefly stated as under:

- a) The entire work of the organisation could be grouped into logical tasks or functions. Each function may be assigned to a group of workers
- b) Wherever found necessary and in the interest of work, powers could be delegated to subordinates
- c) The organisation could be flexible in order to enable it to respond to changing work load and work conditions
- d) Organisation manual and charts could be developed containing (i) Role of organisation, (ii) Job descriptions, (iii) Statements etc.
- e) O & M. schedules could be prepared assigning works to individuals
- f) Works could be checked to see that these are being done as required/expected
- g) O & M. manual could be developed to include (i) Description of system (ii) System operation (iii) Special items to be considered (iv) Lubrication and Maintenance (v) Repairs etc.
- h) Office operations include answering telephone calls, handling correspondence, records, typing letters/ statements, standardising work forms for transmission of information etc.
- i) Number and nature of complaints received
- j) Compilation of statistical information and producing necessary reports
- k) Documentation of how specific problems in implementation and O & M were overcome and dissemination of the same to other agencies.

2.2.1.2 OPERATING STAFF

The establishment required at operating level of a wastewater disposal system is determined on the basis of physical work output to be expected from each individual. The requirements are expected to vary according to individual circumstances, geographical locations and the like.

For optimum output from each of the operating staff certain modern business principles could be introduced such as:

- a) Unity of Command - Each worker should report to only one person incharge. One person incharge may not have more than 8 to 10 persons for direct control
- b) Each worker must have a clear understanding as to the expectations of the job from him by the supervisory units
- c) The worker should be given the relevant extract of the operating manual
- d) Regular work forms should be maintained by each worker and submitted to controlling person incharge
- e) Service records of each worker should be kept upto date by supervisory section and all dues paid to him on time
- f) All possible service facilities should be provided to the operating staff so that they can devote their full attention to work entrusted to them
- g) Personal grievances of workers should be attended to promptly.

2.2.2 Personnel Administration

The personnel administration can be classified into four categories namely:

- a) Describing and classifying work by developing job descriptions, establishing qualifications and goals for each position and developing wage and salary structure
- b) Recruiting and selecting employees by evaluation
- c) Evaluating the work of the employee by a system of evaluation norms such as confidential reports etc. The tasks should be identified and achievements mentioned against each task. General assessment made on these basis and report prepared. The evaluation may inter alia refer to (i) Knowledge and skill (ii) Punctuality (iii) Quality of work (iv) Dependability (v) Initiative and (vi) Tolerance of criticism
- d) Inservice training of employee (described separately hereafter).

2.2.3 Inventory Control

Inventory control is the process of managing supplies required for day to day management of wastewater works. It involves (a) deciding what supplies to stock (b) keeping a record of supplies and their locations and (c) accounting for all receipts and issues of supplies.

Many of the failures in the system require spare parts or supplies available instantly to put the system back in working order. These supplies have got to be ready at hand any time the failure occurs for repairs to be carried out. Materials of stock would pertain to items which have frequent usage and items of emergency repairs.

Inventory control cards are vital documents to serve the purpose of accountability and stock demand by reflecting usage pattern. They enable stock control and record purchasing information.

Inventory control would include tools required for O. & M. of the system, although new purchases for these may not be as frequent as for stock materials for repairs and replacement. Requirements have to be checked at intervals.

2.2.4 Financial Control

2.2.4.1 ACCOUNTING

Accounting is the process of recording and summarising business transactions that affect the financial status of the organisation of the wastewater disposal system. It is an important tool for monitoring revenues and expenditure activities and for interpreting the financial results of the organisation.

Accounting system would involve the following functions:

- a) A basic chart of accounts for the organisation
- b) Accounting reports such as income and expenditure statements, balance sheets and cash flow statements, debt servicing etc.
- c) Annual O. & M. budget
- d) A frequent review, say quarterly, of income analysis is desirable.

It would be desirable to keep financial records of the system on commercial lines to include:

- a) Updated valuation of the system
- b) Depreciation
- c) Operating expenses
- d) Investments in new capital improvements
- e) Long term debts, their servicing
- f) Appropriate schedules of taxes.

2.2.4.2 BUDGETING

Budgeting is the art of interpreting the goal of O. & M. Organisation in meaningful monetary terms. It should be used to control the financial activities of the organisation.

2.2.5 Public Relations

The object of public relations is to develop

- a) Satisfaction of the community served
- b) Opportunity for the community to know how works are planned, executed and managed
- c) Frequent dialogue between the community owner and management
- d) Art of keeping owners informed about day to day working of the system, shortfalls if any and assistance required
- e) Objective interpretation of articles in the news papers about O. & M. situation, deficiencies, deviations etc., based on facts and figures.

Sufficient publicity needs to be given to the work being done by the management, difficulties experienced and cooperation required from public to make good the deficiencies, if any. Information could be given in newspapers. Appropriate talks could be given on T.V., A.I.R.etc., All criticism in the press about O & M. of the system could be promptly attended to and appropriate replies published, preferably in the same newspapers in which criticism appeared.

In addition to the above activities publicity of O & M. work is automatically enhanced if,

- a) every employee of the management who makes public contacts adopts a helpful and courteous attitude towards consumers and public
- b) Personal attention is paid to complaints and problems and these are dealt with promptly with courtesy and commonsense
- c) Community is encouraged to visit wastewater disposal works which should be kept clean, tidy and in good repairs
- d) Good relations are established with the media by providing fullest possible information on the system
- e) Contacts are established with benevolent, social,health and educational bodies
- f) Pamphlets on the wastewater disposal works are periodically published and distributed.

2.3 OTHER ASPECTS OF MANAGEMENT

2.3.1 Inservice Training

The object of well founded short term in-service training for the employees of wastewater disposal undertaking is

- i) To improve group level operational efficiency
- ii) To acquaint the group with the new developments
- iii) To develop amongst the members of the group a better understanding of human relations and concept of their individual responsibility to the community
- iv) To bring about an increased community appreciation in the operation of wastewater disposal works

The training could include

- a) Orientation courses to describe duties and responsibilities of individuals in the organisation
 - b) Providing an employee with a hand book
 - c) On the job training to work with an experienced employee for some time
 - d) Work shops, short courses and seminars on concerned subjects.
- The subjects to be included in the training could be
- a) How to perform a number of specific jobs well

- b) Lectures on practical aspects of subjects covered under wastewater disposal work including O & M
- c) Laboratory control tests
- d) Physical, chemical and bacteriological examination of sewage and interpretation of results
- e) Disinfection
- f) Design of component works of scheme
- g) Supervisory control
- h) Systems management and administration
- i) Accounting, budgeting and financial management.

2.3.2 Long Term Planning

One of the important functions of a wastewater disposal system management is to develop technical and financial plans for future expansion. For this purpose, the management should review periodically, present adequacy and future requirements. Some of the aspects to be reviewed could be:

- a) Analyse the ability of the system to cater, without causing problems to the needs of the community
- b) Forecast future requirements, determine the areas and the population to be covered and the likely future contribution
- c) Co-ordinate construction and financing
 - It is much better to keep up and improve the system through small construction programmes undertaken yearly than to allow deficiencies to accumulate. The yearly improvement should be planned to fit in with the prospective objectives and requirements
- d) The planning for future expansions require knowledge of original designs and basis for present system
- e) Local bodies may solicit assistance from external agencies such as Governments, Boards, Academic Institutions and Consultants for development of future plans and implementation programmes as required.

2.4 LEGAL ASPECTS

Municipal wastewaters contain organic/inorganic and other toxic matter which are injurious to the general health of man apart from being of immense nuisance value. It is therefore obligatory that the wastewater is properly treated and safely disposed off.

2.4.1 Municipal Bylaws

Most municipal bylaws provide for the owner of any property to dispose off his wastewater in a proper manner without causing any nuisance to others. Wherever municipal sewers exist within some specified distance, it is obligatory that the wastewater of the property is discharged into it. The bylaws provide for action against defaulting owners. However in the case of areas not originally served with

sewerage facilities, the owners may have to be persuaded to avail of the facilities provided to dispose off their wastewaters and in some cases it may even become necessary for the local body to show some incentive like loan/subsidy for getting the works necessary to dispose the wastewater into such municipal sewers.

2.4.2 Prevention of Pollution

The early law regulating pollution was enforced almost entirely through the process of individual suits for what was termed a private nuisance. The concept of public nuisance has also been used to some degree to control pollution. A public nuisance is an act which causes inconvenience or damage to the public as distinguished from one or a few individuals and includes any interference with the public health, safety, or inconvenience. A public nuisance is subject to abatement at the behest of state officials. It may also constitute a crime.

In our country until recently the pollution was regulated through state factory acts and rules and also by some sections (section 28) of the Indian Easement Act. As the scope of these acts is limited in its extent and does not provide much guidance in respect of water pollution prevention, the Union Government enacted the Water (Prevention and Control of Pollution) Act, in 1974, which is applicable to all Union Territories and has been adopted by all the States, by resolution passed in that behalf under clause (i) of Article 252 of the Constitution. Under the provision of this Act, no discharge of wastewater can be made in the environment without obtaining consent from the State Pollution Control Board (from the Central Pollution Control Board, in respect of Union Territories). A consent prescribes the volume and quality of wastewater in terms of concentration of various pollutants which can be permitted for discharge in the environment.

In 1986, the Union Government enacted the Environment (Protection) Act 1986, for protection and improvement of environment and the prevention of hazards to human beings, other living creatures, plants and property. The Act empowers the Union Government to make rules providing standards in excess of which environmental pollutants shall not be discharged or emitted in the environment and to take direct action against defaulters.

2.5 FINANCIAL ASPECTS

2.5.1 General

The aim of any wastewater disposal project should be to provide the lowest cost wastewater collection, transportation, treatment and disposal facility to the community. This demands, in addition to the knowledge of wastewater works planning, design, construction and administration, a sound understanding of the elements of financial policy, viz.,

- i) The equitable spreading of the cost of wastewater disposal system by means of appropriate scales of taxes/cess and
- ii) The economic aspects of development and execution of the schemes, the methods of providing the capital needed to finance such schemes and the manner of providing for the redemption of such capital outlay.

Apart from the above, financing in the wastewater disposal sector requires consideration of expanding requirements due to increase in population, changes in living habits and also increasing discharge of wastewater due to emphasis on industrialisation.

2.5.2 Scope

The salient features of wastewater disposal financing are:

- a) methods of raising capital for the installation of the system and provision for redemption of loans where needed
- b) methods of raising revenue to meet the annual expenses of wastewater disposal including the determination of tax/cess as well as their collection/recovery
- c) the formation and use of reserve and contingency funds
- d) accounting in connection with income and expenditure
- e) wages, store and cost accounting
- f) financial organisation and control such as ordering of goods, budgeting, insurance etc.

2.5.3 Sources for Raising Capital

The various sources available for raising capital are:

- i) accumulated funds with the local body
- ii) grant from government, donations from individuals/agencies
- iii) internal borrowing, which means investing the surplus funds of the authority itself from its various accumulations which is the cheapest source as the rate of interest would be the lowest and
 - iv) external borrowings from
 - a) Government with stipulated terms of repayment
 - b) Open market borrowings through bonds
 - c) National Financing institutions like Life Insurance Corporation, HUDDCO, Nationalised Banks etc.
 - d) Direct beneficiaries
 - e) Bilateral assistance
 - f) International agencies such as the World Bank, International Development Authority (IDA), Asian Development Bank.

2.5.4 Financial Appraisal

Financial appraisal of wastewater disposal scheme is necessary:

- i) to ensure that the project is financially viable - whether the project will meet all its financial obligations including Operation and Maintenance, debt servicing, whether there will be adequate working capital, whether the project along with any cross financing from water supply scheme can generate funds from internal resources to make the scheme self supporting

- ii) to adjust the level and structure of taxes/cess charged, when need arises
- iii) to ensure recovery of investment and operating costs from the project beneficiaries.

The finances of a project are closely reviewed through projections of the balance sheet, income/expenditure statement, and cash flow. Where financial accounts are inadequate a new accounting system has to be established.

2.5.5 Statutory Water and Sanitation Boards

Most of the local bodies at present face serious handicaps in the promotional stages of a project, in its prefinancing stage and in the fund raising stage as well. Saddled as they are with responsibilities beyond their capacity and circumscribed by limitation of finance and procedures, any attempts by them individually to raise loans in the open market to finance a local wastewater disposal project may not attract encouraging response. This problem may be solved by the creation of autonomous water and sanitation Boards.

These boards are devices by which State Government will be able to establish corporate public entities to construct, manage and operate water and sanitary services on a fully commercial basis in large metropolitan areas as well as in smaller urban communities. These Boards should be empowered and equipped to raise such capital from local resources and the open market borrowings to supplement the resources provided by the Government at the State and Central level. Such Boards may have the advantage of:

- i) an increased efficiency resulting from financial autonomy
- ii) improved ability to raise capital with confidence
- iii) affording better opportunities for small municipalities grouped together to finance and operate their schemes as a business proposition
- iv) the economies implicit in a common authority which may be made to serve several undertakings
- v) a better and fuller realisation of Taxes/Cess when this duty is divorced from local politics
- vi) the economies possible by pooling technical and administrative staff to serve a number of municipalities and
- vii) the opportunities for equalising the rates in every region.

A statutory Water and Sanitation Board may be set up at State level with regional boards if and to the extent necessary within the State, to provide water and sanitation services and to collect revenues to meet such services, to raise the capital needed to provide the facilities and to exercise all other corporate powers necessary to act on behalf of the local bodies within their jurisdiction. Normally, such boards would encompass all activities including production, conveyance and distribution of water within their statutory areas and also for the collection, treatment and disposal of sewage from that area as well as other sanitation services. It is, however, possible that some local bodies may prefer to purchase water in bulk from the statutory boards and arrange for the internal distribution themselves and may also prefer to have the statutory Board take over sewage in bulk from the local area and arrange for its treatment and disposal. This should be avoided as far possible as the supply and distribution of water as also collection and disposal of sewage are two interdependent functions and the divisions of such functions amongst two independent agencies might lead to inefficiency and avoidable difficulties for both parties. Any local body managing its systems satisfactorily need not necessarily come under such a Board.

CHAPTER 3

DESIGN OF SEWERS

3.1 INTRODUCTION

Sewerage systems may be classified as sanitary sewers designed to receive domestic sewage and industrial wastes excluding storm water, storm sewers designed to carry off storm water and ground water but excluding domestic sewage and industrial wastes and combined sewers designed to receive domestic sewage, industrial wastes and storm water. These systems may also be part storm sewers and part combined sewers.

The combined system of sewerage though may be economical initially, suffers from several disadvantages such as sluggish flow during non stormy days, leading to deposition of sewage solids causing foul odours and increased cost of eventual sewage treatment or pumping costs, associated with disposal of sewage. In view of this, the combined system is normally not recommended.

Anticipation of future growth in any community in terms of population or commercial and industrial expansion should be based on a long-range Master Plan, which shall form the basis for preparation of plan for providing the amenities including installation of sewers in the area to be served. A plan of this type will permit the orderly and timely expansion of the facilities on a sound technical and financial basis, without resorting to costly crash programmes. The provision for future should not however be much in excess of the actual discharge in the early years of its use to avoid deposition in sewers.

3.2 ESTIMATION OF SANITARY SEWAGE

Separate sanitary sewers are provided, primarily to carry the spent water of a community with some ground water and a fraction of storm run off and the community's industrial wastes to the point of treatment and disposal. The sewer capacity to be provided must be determined from an analysis of the present and probable quantities expected at the end of design period. The estimation of flow is based upon the contributory population and the per capita flow of sewage, both the factors being guided by the design period. The connection of roof, back yard, and foundation drains to the sanitary sewers should be avoided and hence shall not be considered for the estimation of sanitary sewage.

3.2.1 Design Period

The length of time upto which the capacity of a sewer will be adequate is referred to as the design period. In fixing a period of design, consideration must be given for the useful life of structures and equipment employed, taking into account obsolescence as well as wear and tear, the ease or difficulty of extending or increasing or addition of the works including a consideration of their location, design constraints, the anticipated rate of growth of the population with due regard to increase in industrial and commercial needs and the economic justification linked to the rate of interest and inflation.

Because the flow is largely a function of population served, population density and water consumption, lateral and sub-main sewers are usually designed for peak flows of the population at saturation density as set forth in the Master Plan. Trunk sewers, interceptors, and outfalls are difficult and uneconomical to be enlarged or duplicated and hence are designed for longer design periods. In the case of trunk sewers serving relatively undeveloped areas adjacent to metropolitan areas, it is advisable to construct initial facilities for more than a limited period. Nevertheless right of way for future larger size trunk sewers can be acquired or reserved. Thus, the population estimate is guided by the anticipated ultimate

growth rates of each community. These may differ in different zones of the same town. A design period of 30 years (excluding construction period) is recommended for all types of sewers.

3.2.2 Population Forecast

Methods of estimation of population for arriving at the design population have been discussed in 1.5. Where a Master Plan containing land use pattern and zoning regulations is available for the town, the anticipated population can be based on the ultimate densities and permitted floor space Index provided for in the Master Plan. In the absence of such information on population the following densities are suggested for adoption.

Size of town (Population)	Density of population per hectare.
Upto 5,000	75 - 150
5,000 to 20,000	150 - 250
20,000 to 50,000	250 - 300
50,000 to 1,00,000	300 - 350
Above 1,00,000	350 - 1000

In cities where Floor Space Index (FSI) or Floor Area Ratio (FAR) limits are fixed by the local authority this approach may be used for working out the population density. FSI or FAR is the ratio of total floor area (of all the floors) to the plot area. The densities of population on this concept may be worked out as in the following example:

Assume that a particular development plan rules provide for the following reservations for different land uses.

Roads	20%
Gardens	15%
Schools (including playgrounds)	5%
Markets	2%
Hospital and Dispensary	2%
Total	44%

Area available for Residential Development (100 - 44) = 56%

Actual total floor area = Area for residential development x FSI.

Assuming an FSI of 0.5 and floor area of 9 m²/person.

Number of persons or density = $\frac{0.56 \times 10,000 \times 0.5}{9}$ = 311 per hectare.

3.2.3 Tributary Area

The natural topography, layout of buildings, political boundaries, economic factors etc., determine the tributary area. For larger drainage areas, though it is desirable that the sewer capacities to be designed for the total tributary area, some time, political boundaries and legal restrictions prevent the sewers to be constructed beyond the limits of the local authority. However in designing sewers for larger areas, there is usually an economic advantage in providing adequate capacity initially for a certain period of time and adding additional sewers, when the pattern of growth becomes established. The need to finance projects within the available resources may necessitate the design to be restricted to political boundaries. The tributary area for any section under consideration has to be marked on a key plan and the area can be measured from the map.

3.2.4 Per capita Sewage Flow

The entire spent water of a community should normally contribute to the total flow in a sanitary sewer. However, the observed Dry Weather Flow quantities usually are slightly less than the per capita water consumption, since some water is lost in evaporation, seepage into ground, leakage etc. In arid regions, mean sewage flows may be as little as 40 percent of water consumption. In well developed areas, flows may be as high as 90% due to industrial wastes, changed water use habits etc. Generally 80% of the water supply may be expected to reach the sewers unless there is data available to the contrary. However, the sewers should be designed for a minimum waste water flow of 100 litres per capita per day. Industries and commercial buildings often use water other than the municipal supply and may discharge their liquid wastes into the sanitary sewers. Estimates of such flows have to be made separately. The details of requirements of water for Institutions and Industries is discussed in Chapter 2 of Manual on Water Supply and Treatment. Industrial wastes have to be treated to the standards prescribed by the regulatory authorities before being discharged into sewers. For some areas, it is safe to assume that the future density of population for design purpose to be equal to the saturation density. It is desirable that all sewers serving a small area be designed on the basis of saturation density.

Infiltration into sewer may occur through pipes, pipe joints and structures. The probable amount has to be evaluated carefully.

3.2.5 Flow Assumptions

The flow in sewers varies considerably from hour to hour and also seasonally, but for the purposes of hydraulic design it is the estimated peak flow that is adopted.

The peak factor or the ratio of maximum to average flows, depends upon contributory population and the following values are recommended.

Contributory population	Peak Factor
Upto 20,000	3.0
20,000 to 50,000	2.5
50,000 to 7,50,000	2.25
Above 7,50,000	2.00

The peak factors also depend upon the density of population, topography of the site, hours of water supply and therefore it is desirable to estimate the same in individual cases, if required. The minimum flow may vary from 1/3 to 1/2 of average flow.

3.2.6 Storm Runoff

Sanitary sewers are not expected to receive storm water. Strict inspection and vigilance and proper design and construction of sewers and manholes should eliminate this flow or bring it down to a very insignificant quantity.

3.2.7 Ground Water Infiltration

Estimate of flow in sanitary sewers may include certain flows due to infiltration of ground water through joints. The quantity will depend on workmanship in laying of sewers and level of the ground water table. Since sewers are designed for peak discharges, allowance for ground water infiltration for the worst condition in the area should be made. Suggested estimates for ground water infiltration for sewers laid below ground water table are as follows:

	Minimum	Maximum
liters/Ha.d	5,000	50,000
liters/Km. d	500	5,000
lpd/manhole	250	500

With improved standards of workmanship and quality and availability of various construction aids, these values should tend to the minimum, rather than the maximum. These values should not mean any relaxation on the water tightness test requirements in 7.1.5 (Hydraulic testing of pipe sewers).

3.3 ESTIMATION OF STORM RUNOFF

Storm runoff is that portion of the precipitation which drains over the ground surface. Estimation of such runoff reaching the storm sewers therefore is dependent on intensity and duration of precipitation, characteristics of the tributary area and the time required for such flow to reach the sewer. The storm water flow for this purpose may be determined by using the rational method, hydrograph method, rainfall-runoff correlation studies, digital computer models, inlet method or empirical formulae.

The empirical formulae that are available for estimating the storm water runoff can be used only when comparable conditions to those for which the equations were derived initially can be assured.

A rational approach, therefore, demands a study of the existing precipitation data of the area concerned to permit a suitable forecast. Storm sewers are not designed for the peak flow of rare occurrence such as once in 10 years or more but, it is necessary to provide sufficient capacity to avoid too frequent flooding of the drainage area. There may be some flooding when the precipitation exceeds the design value, which has to be permitted. The frequency of such permissible flooding may vary from place to place, depending on the importance of the area. Though such flooding causes inconvenience, it may have to be accepted once in a while considering the economy effected in storm drainage costs.

The maximum runoff, which has to be carried in a sewer section should be computed for a condition when the entire basin draining at that point becomes contributory to the flow and the time needed for this is known as the time of concentration (t_c) with reference to the concerned section. Thus, for