However, a table of conversion factors has been appended to facilitate the verification of any of the parameters by conversion to the units he is accustomed to.

This Manual also contains a set of appendices furnishing useful information helpful in solving day to day problems which the practicing engineer is likely to encounter. Model problems have been worked out which have a relevance in design. Useful references of the Bureau of Indian Standards, are also listed in a separate appendix. Charts for Hazen Williams formula as well as Manning's formula, which are frequently used, are presented in the metric system in separate appendices.

A companion Manual on Sewerage and Sewage Treatment has been brought out by the erstwhile Union Ministry of Works and Housing (Central Public Health and Environmental Engineering Organization) which has been revised and published in 1993. The recommendations of this Manual and the provisions of the Water (Prevention and Control of Pollution) Act, 1974 should be followed wherever applicable.

CHAPTER 2
PLANNING

2.1 OBJECTIVE

The objective of a public protected water supply system is to supply safe and clean water in adequate quantity, conveniently and as economically as possible. The planning may be required at national level for the country as a whole, or for the state or region or community. Though the responsibility of the various organizations incharge of planning of water supply systems in each of these cases is different, they still have to function within the priorities fixed by the national and state governments, taking into consideration, the areas to be provided with water supply and the most economical way of doing it, keeping in view the overall requirements of the entire region.

The water supply projects formulated by the various state authorities and local bodies at present do not contain all the essential elements for appraisal and when projects are assessed for their cost benefit ratio and for institutional or other funding, they are not amenable for comparative study and appraisal. Also, different guidelines and norms are adopted by the central and state agencies; for example, assumptions regarding per capita water supply, design period, population forecast, measurement of flow, water treatment, specifications of materials, etc. Therefore, there is a need to specify appropriate standards, planning, and design criteria to avoid empirical approach.

2.2 BASIC DESIGN CONSIDERATIONS

Engineering decisions are required to specify the area and population to be served, the design period, the per capita rate of water supply, other water needs in the area, the nature and location of facilities to be provided, the utilization of centralized or multiple points of treatment facilities and points of water supply intake and waste water disposal. Projects have to be identified and prepared in adequate detail in order to enable timely and proper implementation. Optimization may call for planning for a number of phases relating to plant capacity and the degree of treatment to be provided by determining the capacities for several units, working out capital cost required, interest charges, period of repayment of loan, water tax and water rate. Uncertainties in such studies are many, such as the difficulties in anticipating new technology and changes in the investment pattern, the latter being characterized by increasing financing costs.

2.2.1 WATER QUALITY AND QUANTITY

The waters to be handled may vary both in quantity and quality and in the degree of treatment required, seasonally, monthly, daily and sometimes even hourly. The public health engineer may use his ingenuity to mitigate the variations in quantity by provision of storage, which may be drawn upon during peak demand. Variations in quality can be managed by provision for the introduction of suitable process adjustments in the water treatment plant.

2.2.1.1 Water Conservation

Rising demand for water in urban communities due to population increase, commercial and industrial development and improvement in living standards is putting enormous stress on easily and economically exploitable water resources. Not only the quantity of extractable fresh water resources is being depleted but also the quality is deteriorating. Ground waters may be chemically contaminated, for example, due to excessive fluorides, total dissolved solids, iron and manganese and even arsenic in some cases. Due to over abstraction of ground waters for agricultural and industrial uses, this problem is further aggravated. Surface water bodies, being indiscriminately used for discharge of municipal and industrial wastewaters, may have quality parameters which may require application of advanced water treatment processes. It has therefore, become essential to initiate measures for effective and integrated approach for water conservation.

Water conservation may be possible through optimal use of available water resources; prevention and control of wastage of water and effective demand management.

2.2.1.2 Increasing The Water Availability And Supply& Demand Management

The measures required to increase the water availability involve augmentation of water resources by storing rainwater on the surface or below the surface. Surface storage is usually contemplated either in natural ponds, reservoirs and lakes or artificially created depressions, ponds, impounding reservoirs or tanks. Subsurface storage of water is effected by constructing subsurface dykes, artificial recharge wells, etc. For storing subsurface water in rocky areas, several techniques have been developed indigenously like Jacket Well Technique, Bore Blast Techniques, Fracture Seal Cementation etc. These techniques have been deployed to improve porosity, storage volume as well as interconnectivity between fractures/fissures and other types of pores. Artificial recharge of ground water may be contemplated in some areas.

Water supply management aims at improving the supply by minimizing losses and wastage and unaccounted for water (UFW) in the transmission mains and distribution system (Reference may also be made to section 10.10.) The unaccounted-for-water constitutes a significantly higher fraction of total water supplied in poorly managed water transmission and distribution systems. Measures like detection, control and prevention of leakage, metering of water supply, installation of properly designed waste-not-taps and prompt action to repair and maintain distribution system components should be adopted.

Water demand management involves measures which aim at reducing water demand by optimal utilization of water supplies for all essential and desirable needs. It focuses on identification of all practices and uses of water in excess of functional requirement. Use of plumbing fixtures, such as low volume and dual flushing cisterns in place of conventional 12.5 litre capacity cisterns which conserve water may be encouraged. Practices like reuse and recycling of treated wastewater may be promoted for which references may be made to chapter 19 & 20 of the Manual on Sewerage and Sewage Treatment.

2.2.2 Plant Siting

Though the distribution lay out and the sources of supply and their development methods are important in siting the different units for optimal and economical utilization, factors like topography, soil conditions, and physical hazards should also be taken into consideration. Hillside construction may have an advantage in accommodating the headloss in the plant without excessive excavation and may permit ground level entrance to several floors in service buildings. Wet sites must be dewatered and structures may have to be designed to overcome the hydrostatic uplift. On soils having low bearing capacities, structures may need to be placed on piles or rafts. Rocky sites may require costly excavation.

Flooding is a common hazard for the treatment plants and pumping stations located near rivers. The highest flood level observed at the site selected should be taken into account and the treatment plant and pumping station structures may be built above the high water mark, or may be surrounded by dykes, to prevent damage due to flooding. Contact should be maintained with the Irrigation Department for the use of the flood warning system.

2.2.3 Mechanization

Mechanization, instrumentation, and automation are becoming more and more common in water works and this should also be taken into account in planning the system, subject to local availability and maintenance facilities.

Mechanization replaces and serves the functions that cannot be performed efficiently by manual operations such as the removal of the sludge from sedimentation tanks. Instrumentation involves installation of various kinds of devices and gauges for monitoring and recording of plant flows and performance. Automation combines instrumentation and mechanization to effect head loss control for back washing and specific control for turbidity, colour, dissolved oxygen, pH, chlorine residual, conductivity and float controls for pumping.

2.2.4 Service Building

Considerable attention is to be given to the service building required at treatment works and pumping stations such as houses, offices and laboratories, washing room and store rooms, chemical house, pump house etc.. In mild climates operating structures need to be protected against rain and sun while in adverse climates complete protection against such weather is advisable.

2.2.5 Other Utilities

Provision needs to be made for facilities such as electricity, water supply and drainage, roadways, parking areas, walkways, fencing, telephone facilities and other welfare services such as housing for operation and maintenance personnel.

2.2.6 Design Period

Water Supply projects may be designed normally to meet the requirements over a thirty-year period after their completion. The time lag between design and completion of the project should also be taken into account which should not exceed two years to five years depending on the size of the project. The thirty year period may however be modified in regard to certain components of the project depending on their useful life or the facility for carrying out extensions when required and rate of interest so that expenditure far ahead of utility is avoided. Necessary land for future expansion/duplication of components should be acquired in the beginning itself. Where expensive tunnels and large aqueducts are involved entailing large capital outlay for duplication, they may be designed for ultimate project requirements. Where failure such as collapse of steel pipes under vacuum put the pipe line out of commission for a long time or the pipe location presents special hazards such as floods, ice, and mining etc., duplicate lines may be necessary.

Project components may be designed to meet the requirements of the following design periods:

Sl. No.	Items	Design period in years
1.	Storage by dams	50
2.	Infiltration works	30
3.	Pumping:	
	i. Pump house (civil works)	30
	ii. Electric motors and pumps	15
4.	Water treatment units	15
5.	Pipe connection to several treatment units and other small appurtenances	30
6.	Raw water and clear water conveying mains	30
7.	Clear water reservoirs at the head works, balancing tanks and service reservoirs (overhead or ground level)	15
8.	Distribution system	30

2.2.7 POPULATION FORECAST

2.2.7.1 General Considerations

The design population will have to be estimated with due regard to all the factors governing the future growth and development of the project area in the industrial, commercial, educational, social and administrative spheres. Special factors causing sudden emigration or influx of population should also be foreseen to the extent possible.

A judgement based on these factors would help in selecting the most suitable method of deriving the probable trend of the population growth in the area or areas of the project from out of the following mathematical methods, graphically interpreted where necessary.

a) Demographic Method of Population Projection

Population change can occur only in three ways (i) by births (population gain) (ii) by deaths (population loss) or (iii) migration (population loss or gain depending on whether movement out or movement in occurs in excess). Annexation of an area may be considered as a special form of migration. Population forecasts are frequently obtained by preparing and summing up of separate but related projections of natural increases and of net migration and is expressed as below.

The net effect of births and deaths on population is termed natural increase (natural decrease, if deaths exceed births).

Migration also affects the number of births and deaths in an area and so, projections of net migration are prepared before projections for natural increase.

This method thus takes into account the prevailing and anticipated birth rates and death rates of the region or city for the period under consideration. An estimate is also made of the emigration from and immigration to the city, growth of city area wise, and the net increase of population is calculated accordingly considering all these factors, by arithmetical balancing.

b) Arithmetical Increase Method

This method is generally applicable to large and old cities. In this method the average increase of population per decade is calculated from the past records and added to the present population to find out population in the next decade. This method gives a low value and is suitable for well-settled and established communities.

c) Incremental Increase Method

In this method the increment in arithmetical increase is determined from the past decades and the average of that increment is added to the average increase. This method increases the figures obtained by the arithmetical increase method.

d) Geometrical Increase Method

In this method percentage increase is assumed to be the rate of growth and the average of the percentage increases is used to find out future increment in population. This method gives much higher value and mostly applicable for growing towns and cities having vast scope for expansion.

e) Decreasing Rate Of Growth Method

In this method it is assumed that rate of percentage increase decreases and the average decrease in the rate of growth is calculated. Then the percentage increase is modified by deducting the decrease in rate of growth. This method is applicable only in such cases where the rate of growth of population shows a downward trend.

f) Graphical Method

In this approach there are two methods. In one, only the city in question is considered and in the second, other similar cities are also taken into account.

(i) Graphical Method Based On Single City

In this method the population curve of the city (i.e. the Population vs. Past Decades) is smoothly extended for getting future value. This extension has to be done carefully and it requires vast experience and good judgement. The line of best fit may be obtained by the method of least squares.

(ii) Graphical Method Based On Cities With Similar Growth Pattern

In this method the city in question is compared with other cities which have already undergone the same phases of development which the city in question is likely to undergo and based on this comparison, a graph between population and decades is plotted.

g) Logistic Method

The 'S' shaped logistic curve for any city gives complete trend of growth of the city right from beginning to saturation limit of population of the city.

h) Method of Density

In this approach, trend in rate of density increase of population for each sector of a city is found out and population forecast is done for each sector based on above approach. Addition of sector-wise population gives the population of the city.

2.2.7.2 Final Forecast

While the forecast of the prospective population of a projected area at any given time during the period of design can be derived by any one of the foregoing methods appropriate to each case, the density and distribution of such population within the several areas, zones or districts will again have to be made with a discerning judgement on the relative probabilities of expansion within each zone or district, according to its nature of development and based on existing and contemplated town planning regulations.

Wherever population growth forecast or master plans prepared by town planning or other appropriate authorities are available, the decision regarding the design population should take into account their figures. Worked out examples for estimation of the future population by some of the methods are given in Appendix 2.1.

2.2.8 PER CAPITA SUPPLY

2.2.8.1 Basic Needs

Piped water supplies for communities should provide adequately for the following as applicable:

(a) Domestic needs such as drinking, cooking, bathing, washing, flushing of toilets, gardening and individual air conditioning

(b) Institutional needs

(c) Public purposes such as street washing or street watering, flushing of sewers, watering of public parks

(d) Industrial and commercial uses including central air conditioning

(e) Fire fighting

(f) Requirement for livestock; and

(g) Minimum permissible UFW(Ref. Table. 2.1)

2.2.8.2 Factors Affecting Consumption

a) Size of City

Larger the size, more the consumption.

b) Characteristics of Population and Standard of Living

In the high value residential area of the city or in a suburban community, per capita consumption is high. Slum areas of large cities have low per capita consumption. A person staying in an independent bungalow consumes more water compared to a person staying in a flat. Habit of person also affects consumption; the type of bath i.e. tub bath or otherwise and material used for ablution etc. also affect per capita consumption.

c) Industries and Commerce

The type and number of different industries also affect consumption. Commercial consumption is that of the retail and wholesale mercantile houses and office buildings.

d) Climatic Conditions

In hot weather, the consumption of water is more compared to that during cold weather.

e) Metering

The consumption of water when supply is metered is less compared to that when the water charges are on flat rate basis.

2.2.8.3 Recommendations

The Environmental Hygiene Committee suggested certain optimum service levels for communities based on population groups. In the Code of Basic Requirements of Water Supply, Drainage and Sanitation (IS: 1172-1983) as well as the National Building Code, a minimum of 135 lpcd has been recommended for all residences provided with full flushing system for excreta disposal. Though the Manual on Sewerage and Sewage Treatment recommends a supply of 150 lpcd wherever sewerage is existing/contemplated, with a view to conserve water, a minimum of 135 lpcd is now recommended.

It is well recognised that the minimum water requirements for domestic and other essential beneficial uses should be met through public water supply. Other needs for water including industries etc. may have to be supplemented from other systems depending upon the constraints imposed by the availability of capital finances and the proximity of water sources having adequate quantities of acceptable quality which can be economically utilised for public water supplies.

Based on the objectives of full coverage of urban communities with easy access to potable drinking water in quantities recommended to meet the domestic and other essential non-domestic needs, the following recommendations are made:

a) Domestic and non-domestic needs

The recommended values for domestic and non-domestic purposes are given in Table 2.1

TABLE 2.1

RECOMMENDED PER CAPITA WATER SUPPLY LEVELS FOR DESIGNING SCHEMES

Sl. No.	Classification of towns/cities	Recommended Maximum Water Supply Levels (lpcd)
1.	Towns provided with piped water supply but without sewerage system	70
2.	Cities provided with piped water supply where sewerage system is existing/contemplated	135
3.	Metropolitan and Mega cities provided with piped water supply where sewerage system is existing/ contemplated	150

Note:

(i) In urban areas, where water is provided through public standposts, 40 lpcd should be considered;

(ii) Figures exclude "Unaccounted for Water(UFW)" which should be limited to 15%

(iii) Figures include requirements of water for commercial, institutional and minor industries. However, the bulk supply to such establishments should be assessed separately with proper justification.

b) Institutional Needs

The water requirements for institutions should be provided in addition to the provisions indicated in (a) above, where required, if they are of considerable magnitude and not covered in the provisions already made. The individual requirements would be as follows:

Sl.No.	Institutions	Litres per head per day
1.	Hospital (including laundry)	
	(a) No. of beds exceeding 100	450 (per bed)
	(b) No. of beds not exceeding 100	340 (per bed)
2.	Hotels	180(per bed)
3.	Hostels	135
4.	Nurses' homes and medical quarters	135
5.	Boarding schools / colleges	135
6.	Restaurants	70(per seat)
7.	Air ports and sea ports	70

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Sl.No.	Institutions	Litres per head per day
8.	Junction Stations and intermediate stations where mail or express stoppage (both railways and bus stations) is provided	70
9.	Terminal stations	45
10.	Intermediate stations (excluding mail and express stops)	45 (could be reduced to 25 where bathing facilities are not provided)
11.	Day schools / colleges	45
12.	Offices	45
13.	Factories	45 (could be reduced to 30 where no bathrooms are provided)
14.	Cinema, concert halls and theatre	15

c) Fire Fighting Demand

It is usual to provide for fire fighting demand as a coincident draft on the distribution system along with the normal supply to the consumers as assumed. A provision in kilolitres per day based on the formula of $100\sqrt{p}$ where, p = population in thousands may be adopted for communities larger than 50,000. It is desirable that one third of the fire-fighting requirements form part of the service storage. The balance requirement may be distributed in several static tanks at strategic points. These static tanks may be filled from the nearby ponds, streams or canals by water tankers wherever feasible. The high rise buildings should be provided with adequate fire storage from the protected water supply distribution as indicated in 10.3.2.

d) Industrial Needs

While the per capita rates of supply recommended will ordinarily include the requirement of small industries (other than factories) distributed within a town, separate provisions will have to be included for meeting the demands likely to be made by specific industries within the urban areas. The forecast of this demand will be based on the nature and magnitude of each such industry and the quantity of water required per unit of production. The potential for industrial expansion should be carefully investigated, so that the availability of adequate water supply may attract such industries and add to the economic prosperity of the community. As can be seen from the tabulation, the quantities of water used by industry vary widely. They are also affected by many factors such as cost and availability of water, waste disposal problems, management and the types of processes involved. Individual studies of the water requirement of a specific industry should, therefore, be made for each location, the values given below serving only as guidelines. In the context of reuse of water in several industries, the requirement of fresh water is getting reduced considerably.

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Industry	Unit of production	Water requirement in Kilolitres per unit
Automobile	Vehicle	40
Distillery	(Kilolitre Alcohol)	122-170
Fertilizer	Tonne	80-200
Leather	100 Kg (tanned)	4
Paper	Tonne	200-400
Special quality paper	Tonne	400-1000
Straw board	Tonne	75-100
Petroleum Refinery	Tonne(crude)	1-2
Steel	Tonne	200-250
Sugar	Tonne (Cane crushed)	1-2
Textile	100 Kg (goods)	8-14

e) Pressure Requirements

Piped water supplies should be designed on continuous 24 hours basis to distribute water to consumers at adequate pressure at all points. Intermittent supplies are neither desirable from the public health point of view nor economical. For towns where one-storeyed buildings are common and for supply to the ground level storage tanks in multi-storeyed buildings, the minimum residual pressure at ferrule point should be 7m for direct supply. Where two-storeyed buildings are common, it may be 12m and where three-storeyed buildings are prevalent 17 m or as stipulated by local byelaws. The pressure required for fire fighting would have to be boosted by the fire engines.

2.2.9 Quality Standards

The objective of Water Works Management is to ensure that the water supplied is free from pathogenic organisms, clear, palatable and free from undesirable taste and odour, of reasonable temperature, neither corrosive nor scale forming and free from minerals which could produce undesirable physiological effects. The establishment of minimum standards of quality for public water supply is of fundamental importance in achieving this objective. Standards of quality form the yardstick within which the quality control of any public water supply has to be assessed.

Sanitary inspections are intended to provide a range of information and to locate potential problems. The inspections allow for an overall appraisal of many factors associated with a water supply system, including the water works and the distribution system. Moreover such an appraisal may later be verified and confirmed by microbiological analysis, which will indicate the severity of the problem. Sanitary inspections thus provide a direct method of pinpointing possible problems and sources of contamination. They are also important in the prevention and control of potentially hazardous conditions, including epidemics of water borne diseases. The data obtained may identify failures, anomalies, operator errors and any deviations from normal that may affect the production and distribution of safe drinking water. When the inspections are properly carried out at appropriate regular intervals and where the inspector has the knowledge necessary to detect problems and suggest technical solutions, the production of good quality water is ensured.

The evolution of standards for the quality control of public water supplies has to take into account the limitations imposed by local factors in the several regions of the country. The Environmental Hygiene Committee (1949) recommended that the objective of a public water supply should be to supply water "that is absolutely free from risks of transmitting diseases, is pleasing to the senses and is suitable for culinary and laundering purposes" and added that "freedom from risks is comparatively more important than physical appearance or hardness" and that safety is an obligatory standard and physical and chemical qualities are optional within a range. These observations are relevant in the development of a country-wide programs of protected water supply systems for communities big and small, making use of the available water resources in the different regions, with a wide variation in their physical, chemical and aesthetic qualities, that can be achieved by communities in due course within the limits of their financial resources. The immediate need is for minimum standards, consistent with the safety of public water supplies. Considering the standards prescribed in the earlier Manual and further development in the international standardization and the conditions in the country, the following guidelines are recommended.

a) Physical And Chemical Quality Of Drinking Water

The physical and chemical quality of drinking water should be in accordance with the recommended guidelines presented in Table 2.2.

TABLE 2.2

RECOMMENDED GUIDELINES FOR PHYSICAL AND CHEMICAL PARAMETERS

Sl. No.	Characteristics	*Acceptable	**Cause for Rejection
1.	Turbidity (NTU)	1	10
2.	Colour (Units on Platinum Cobalt scale)	5	25
3.	Taste and Odour	Unobjectionable	Objectionable
4.	pH	7. 0 to 8.5	<6.5 or > 9.2
5.	Total dissolved solids (mg/l)	500	2000
6.	Total hardness (as $CaCO_3$) (mg/l)	200	600
7.	Chlorides (as Cl) (mg/l)	200	1000
8.	Sulphates (as SO_4) (mg/l)	200	400
9.	Fluorides (as F) (mg/l)	1.0	1.5
10.	Nitrates (as NO_3) (mg/l)	45	45
11.	Calcium (as Ca) (mg/l)	75	200
12.	Magnesium (as Mg) (mg/l)	≤ 30	150

Sl. No.	Characteristics	*Acceptable	**Cause for Rejection
If there are 250 mg/l of sulphates, Mg content can be increased to a maximum of 125 mg/l with the reduction of sulphates at the rate of 1 unit per every 2.5 units of sulphates			
13.	Iron (as Fe) (mg/l)	0.1	1.0
14.	Manganese (as Mn) (mg/l)	0.05	0.5
15.	Copper (as Cu) (mg/l)	0.05	1.5
16.	Aluminium (as Al) (mg/l)	0.03	0.2
17.	Alkalinity (mg/l)	200	600
18.	Residual Chlorine (mg/l)	0.2	>1.0
19.	Zinc (as Zn) (mg/l)	5.0	15.0
20.	Phenolic compounds (as Phenol) (mg/l)	0.001	0.002
21.	Anionic detergents (mg/l) (as MBAS)	0.2	1.0
22.	Mineral Oil (mg/l)	0.01	0.03
	TOXIC MATERIALS		
23.	Arsenic (as As) (mg/l)	0.01	0.05
24.	Cadmium (as Cd) (mg/l)	0.01	0.01
25.	Chromium (as hexavalent Cr) (mg/l)	0.05	0.05
26.	Cyanides (as CN) (mg/l)	0.05	0.05
27.	Lead (as Pb) (mg/l)	0.05	0.05
28.	Selenium (as Se) (mg/l)	0.01	0.01
29.	Mercury (total as Hg) (mg/l)	0.001	0.001
30.	Polynuclear aromatic hydrocarbons (PAH) (µg/l)	0. 2	0. 2
31.	Pesticides (total, mg/l)	Absent	Refer to WHO guidelines for drinking water quality Vol I. – 1993
	RADIO ACTIVITY+		
32.	Gross Alpha activity (Bq/l)	0.1	0.1
33.	Gross Beta activity (Bq/l)	1.0	1.0

NOTES

* The figures indicated under the column 'Acceptable' are the limits upto which water is generally acceptable to the consumers.

** Figures in excess of those mentioned under 'Acceptable' render the water not acceptable, but still may be tolerated in the absence of an alternative and better source but upto the limits indicated under column "Cause for Rejection" above which the sources will have to be rejected.

\+ It is possible that some mine and spring waters may exceed these radio activity limits and in such cases it is necessary to analyze the individual radio-nuclides in order to assess the acceptability or otherwise for public consumption.

b) Bacteriological Guidelines

The recommended guidelines for bacteriological quality are given in Table 2.3.

TABLE 2.3
BACTERIOLOGICAL QUALITY OF DRINKING WATER[a]

Organisms	Guideline value
All water intended for drinking	
E.coli or thermotolerant coliform bacteria[b,c]	Must not be detectable in any 100-ml sample
Treated water entering the distribution system	
E.coli or thermotolerant coliform bacteria[b]	Must not be detectable in any 100-ml sample
Total coliform bacteria	Must not be detectable in any 100-ml sample
Treated water in the distribution system	
E.coli or thermotolerant coliform bacteria[b]	Must not be detectable in any 100-ml sample
Total coliform bacteria	Must not be detectable in any 100-ml sample. In case of large supplies, where sufficient samples are examined, must not be present in 95% of samples taken throughout any 12 month period.

Source : WHO guidelines for Drinking Water Quality Vol.1 – 1993.

[a] Immediate investigative action must be taken if either *E.coli* or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause must be determined by immediate further investigation.

[b] Although *E.coli* is the more precise indicator of faecal pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory test must be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

[c] It is recognized that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium term targets for progressive improvement of water supplies, as recommended in volume 3 of W.H.O. *guidelines for drinking-water quality1993.*

c) Virological Quality

Drinking water must essentially be free of human enteroviruses to ensure negligible risk of transmitting viral infection. Any drinking-water supply subject to faecal contamination presents a risk of a viral disease to consumers. Two approaches can be used to ensure that the risk of viral infection is kept to a minimum: providing drinking water from a source verified free of faecal contamination, or adequately treating faecally contaminated water to reduce enteroviruses to a negligible level.

Virological studies have shown that drinking water treatment can considerably reduce the levels of viruses but may not eliminate them completely from very large volumes of water. Virological, epidemiological, and risk analysis are providing important information, although it is still insufficient for deriving quantitative and direct virological criteria. Such criteria can not be recommended for routine use because of the cost, complexity, and lengthy nature of virological analysis, and the fact that they can-not detect the most relevant viruses.

The guideline criteria shown in Table 2.4 are based upon the likely viral content of source waters and the degree of treatment necessary to ensure that even very large volumes of drinking water have negligible risk of containing viruses.

Ground water obtained from a protected source and documented to be free from faecal contamination from its zone of influence, the well, pumps, and delivery system can be assumed to be virus-free. However, when such water is distributed, it is desirable that it is disinfected, and that a residual level of disinfectant is maintained in the distribution system to guard against contamination.

TABLE 2.4

RECOMMENDED TREATMENT FOR DIFFERENT WATER SOURCES TO PRODUCE WATER WITH NEGLIGIBLE VIRUS RISK[a]

Type of Source	Recommended Treatment
Ground water	
Protected, deep wells; essentially free of faecal contamination	Disinfection[b]
Unprotected, shallow wells; faecally contaminated	Filtration and disinfection
Surface water	
Protected, impounded upland water; essentially free of faecal contamination	Disinfection
Unprotected impounded water or upland river; faecal contamination	Filtration and disinfection

Type of Source	Recommended Treatment
Unprotected lowland rivers; faecal contamination	Pre-disinfection or storage, filtration, disinfection
Unprotected watershed; heavy faecal contamination	Pre-disinfection or storage, filtration, additional treatment and disinfection
Unprotected watershed; gross faecal contamination	Not recommended for drinking water supply

[a] For all sources, the median value of turbidity before terminal disinfection must not exceed 1 nephelometric turbidity unit(NTU) and must not exceed 5 NTU in single sample.

Terminal disinfection must produce a residual concentration of free chlorine of ≥0.5 mg/litre after atleast 30 minutes of contact in water at pH < 8.0, or must be shown to be an equivalent disinfection process in terms of the degree of enterovirus inactivation(>99.99%).

Filtration must be either slow sand filtration or rapid filtration (sand, dual, or mixed media) preceded by adequate coagulation-flocculation (with sedimentation or floatation). Diatomaceous earth filtration or filtration process demonstrated to be equivalent for virus reduction can also be used. The degree of virus reduction must be >90%.

Additional treatment may consist of slow sand filtration, ozonation with granular activated carbon adsorption, or any other process demonstrated to achieve > 99% enterovirus reduction.

[b] Disinfection should be used if monitoring has shown the presence of *E. coli* or thermo-tolerant coliform bacteria.

SOURCE : W.H.O. guidelines for Drinking Water Quality – 1993.

CHAPTER 3
PROJECT REPORT

3.1 GENERAL

All projects have to follow distinct stages between the period they are conceived and completed. These various stages are:

- Pre-Investment Planning
  - Identification of a project
  - Preparation of project
- Appraisal and sanction
- Construction of facilities and carrying out support activities
- Operation and Maintenance
- Monitoring and feed back

3.1.1 PROJECT REPORTS

Project reports deal with all the aspects of pre-investment planning and establishes the need as well as the feasibility of projects technically, financially, socially, culturally, environmentally, legally and institutionally. For big projects economical feasibility may also have to be examined. Project reports should be prepared in three stages viz. (i) identification report; (ii) pre-feasibility report and (iii) feasibility report. Projects for small towns or those forming parts of a programme may not require preparation of feasibility reports. Detailed engineering, and preparation of technical specifications and tender documents are not necessary for taking investment decisions, since these activities can be carried out during the implementation phase of projects. For small projects, however, it may be convenient to include detailed engineering in the project report, if standard design and drawings can be adopted.

Since project preparation is quite expensive and time consuming, all projects should normally proceed through three stages; and at the end of each stage a decision should be taken whether to proceed to the next planning stage, and commit the necessary manpower and financial resources for the next stage. Report at the end of each stage should include a time table and cost estimate for undertaking the next stage activity, and a realistic schedule for all future stages of project development, taking into consideration time required for review and approval of the report, providing funding for the next stage, mobilising personnel or fixing agency (for the next stage of project preparation), data gathering, physical surveys, site investigations etc.

The basic design of a project is influenced by the authorities/organizations who are involved in approving, implementing and operating and maintaining the project. Therefore, the institutional arrangements through which a project will be brought into operation, must be considered at the project preparation stage. Similarly responsibility for project preparation may change at various stages. Arrangements in this respect should be finalized for each stage of project preparation. Sometimes more than one organisation may have a role to play in the various stages of preparation of a project. It is, therefore, necessary to identify a single entity to be responsible for overall management and coordination of each stage of project preparation. It is desirable that the implementing authority and those responsible for operation of a project are consulted at the project preparation stage.

3.2 IDENTIFICATION REPORT

Identification report is basically a "desk study", to be carried out relying primarily on the existing information. It can be prepared reasonably quickly by those who are familiar with the project area and needs of project components. This report is essentially meant for establishing the need for a project, indicating likely alternatives, which would meet the requirements. It also provides an idea of the magnitude of cost estimates of a project to facilitate bringing the project in the planning and budgetary cycle, and makes out a case for obtaining sanction to incur expenditure for carrying out the next stages of project preparation. The report should be brief and include the following information:

- Identification of project area and its physical environment
- Commercial, industrial, educational, cultural and religious importance and activities in and around the project area (also point out special activities or establishment like defence or others of national importance)
- Existing population, its physical distribution and socio-economic analysis
- Present water supply arrangements and quality of service in the project area, pointing out deficiencies, if any, in quality, quantity and delivery system
- Population projection for the planning period, according to existing and future land use plans, or master plans, if any
- Water requirements during planning period for domestic, industrial, commercial and any other uses
- Establish the need for taking up a project in the light of existing and future deficiencies in water supply services, pointing out adverse impacts of non-implementation of the project, on a time scale
- Bring out, how the project would fit in with the national/regional/sectoral strategies and with the general overall development in the project area
- Identify a strategic plan for long term development of water supply services in the project area, in the context of existing regional development plans, water resources studies and such other reports, indicating phases of development

- State the objectives of the short term project under consideration, in terms of population to be served, other consumers, if any, service standard to be provided, and the impact of the project after completion; clearly indicate the design period
- Identify project components, with alternatives if any; both physical facilities and supporting activities
- Preliminary estimates of costs (componentwise) of construction of physical facilities and supporting activities, cost of operation and maintenance, identify source for financing capital works, and operation and maintenance, work out annual burden (debt servicing + operational expenditure)
- Indicate institutions responsible for project approval, financing, implementation, operation and maintenance (e.g. National Government, State Government, Zilla Parishad, Local Body, Water Supply Boards)
- Indicate organisation responsible for preparing the project (pre-feasibility report, feasibility report), cost estimates for preparing project report, and sources of funds to finance preparation of project reports
- Indicate time table for carrying out all future stages of the project, and the earliest date by which the project might be operational
- Indicate personnel strength required for implementation of the project, indicate if any particular/peculiar difficulties of policy or other nature are likely to be encountered for implementing the project and how these could be resolved
- Recommend actions to be taken to proceed further.

The following plans may be enclosed with the report:

(a) An index plan to a scale of 1 cm = 2 km showing the project area, existing works, proposed works, location of community / township or institution to be served.

(b) A schematic diagram showing the salient levels of project components.

3.3 PRE-FEASIBILITY REPORT

After clearance is received, on the basis of identification report from the concerned authority and/or owner of the project, and commitments are made to finance further studies, the work of preparation of pre-feasibility report should be undertaken by an appropriate agency, which may be a central planning and designing cell of a Water Supply Department/ Board, Local Body, or professional consultants working in the water supply-sanitation-environmental areas. In the latter case, terms of references for the study and its scope should be carefully set out. Pre-feasibility study may be a separate and discrete stage of project preparation or it may be the first stage of a comprehensive feasibility study. In either case it is necessary that it proceeds with taking up of a feasibility study because the pre-feasibility study is essentially carried out for screening and ranking of all project alternatives, and to select an appropriate, alternative for carrying out detailed feasibility study. The pre-feasibility study helps in selecting a short-term project which will fit in the long term strategy for improving services in the context of overall perspective plan for development of the project area.

3.3.1 CONTENTS

A pre-feasibility report can be taken to be a preliminary Project Report, the structure and component of which are as follows:

- Executive summary
- Introduction
- The project area and the need for a project
- Long term plan for water supply
- Proposed water supply project
- Conclusions and recommendations
- Tables, figures/maps and annexes.

3.3.1.1 Executive Summary

It is a good practice to provide an Executive Summary at the beginning of the report, giving its essential features, basic strategy, approach adopted in developing the study project, and the salient features of financial and administrative aspects.

3.3.1.2 Introduction

This section explains the origin and concept of the project, how it was prepared and the scope and status of the report. These sub-sections may be detailed as under :

(a) Project Genesis

- Describe how the idea of the project originated, agency responsible for promoting the project, list and explain previous studies and reports on the project, including the project identification report, and agencies which prepared them,
- Describe how the project fits in the regional development plan, long term sector plan, land use plan, public health care, and water resources development etc.

(b) How Was The Study Organised

- Explain how the study was carried out, agencies responsible for carrying out the various elements of work, and their role in preparing the study,
- Time table followed for the study.

(c) Scope And Status Of The Report

- How the pre-feasibility report fits in the overall process of project preparation
- Describe data limitation.
- List interim reports prepared during the study,