Preparation of Sewerage Project for Urban Areas

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ABSTRACT

Sewerage system is an important part of Nation's infrastructure and plays an essential part in maintaining public health. While planning for development of a place the sewerage is remains to be out of focus, the due negligence leads to flooding, pollution, collapse and blockage. The current rate of development in par with planning without forecasting the needs of the society pose to be challenge for implementing planning strategies. The remedial measure is to stop littering the waste in the open environment like roads, water bodies pollutes hence pollution can be brought under control. In order to maximize the efficiency of water and waste water systems by proper techno-economic designs, execution, O&M & Conservation of water bodies would reduce the ground water pollution and by and large the environment. Water & Waste water schemes should be executed simultaneously and connectivity of individual households should be included in project itself as both the components are hand-in-hand, Government of India & State Government, need to enforce water Departments/agencies to sanction schemes simultaneously with sewerage projects and not in isolation.

Key words: Sewerage System, Infrastructure, Sustainable development, Sewerage Project, O&M, Techno-economic design, Waste water

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INTRODUCTION

Need for Sewerage System

The basic reason for need of sewerage system is because **it stinks**. If you release waste water directly into the environment, the odur spreads very fast it **contains harmful bacteria**. Human waste contains coliform bacteria (for example, E. coli) and other bacteria that may cause disease.

Secondly, it contains suspended solids and chemicals that affect the environment.

Waste water contains nitrogen and phosphates, encourages the growth of algae. Excessive algae growth can block sunlight and foul the water and thirdly Wastewater contains organic material i.e. bacteria in the environment and it will start decomposing. While proposing to have proper sewage disposal technique the British Columbia catalogue (1994) state that sewage wastes can attract insects and rodents, encourage the growth of disease causing bacteria and pollute the environment. According to www.who.int/ the hazardous effect of release of untreated sewerage water into the environment would lead to pollution of natural environment. Further the untreated wastewater discharged into aquatic ecosystem is detrimental threat affect on marine life (Wilson, 2000)

The underground conduit for the collection of sewage is called sewer. A network of sewers and appurtenances for the collection and conveyance of sewage generated from each of the properties to sewage pumping station for pumping to sewage treatment and disposal is called Sewage system. There are two types of sewerage system.

1. Separate Sewerage System
2. Combined Sewerage System

Separate sewerage system

In separate system of sewerage there are two collection systems or pipe network; one for collecting domestic sewage as sanitary sewerage system and another for collecting storm water as storm water drainage system. The sanitary sewerage systems for domestic sewage and industrial waste water are designed for peak sewage flow expected at ultimate stage at the end of design period. The storm water drainage systems are designed to carry the maximum storm runoff expected during the critical duration of rainfall.

Advantages of Separate Sewerage System

The capacity of the water treatment plant will be smaller since only domestic and industrial sewage is to be treated. Operational problems are less.

Disadvantage of separate sewerage system are

Storm water may always find its way into the domestic sewerage system either through wrong house sewer connections or through manholes and may overload the sewage treatment plant. In Combined system of sewerage both sewage discharge and the storm runoff are collected and conveyed through a common collection system. The ratio of the maximum storm runoff to sewage flow works out to be 20 to 30. Hence, during non-monsoon period only 1/20th or 1/30th of the design flow, i.e., only the sewage flow is passing through the combined system with very small velocity, resulting in clogging of the systems. Combined sewers are of special types such as egg shaped etc. Combined sewers are, therefore not recommended

for Indian conditions since the rainfall occurs for a period of 3 months or less and there are poor water supplies. In India, only separate sewerage systems are adopted.

Advantage of Combined sewerage system

Only one system is provided and therefore there will not be any confusion in giving connection, and less expensive to install the system.

Disadvantage of Combined sewerage system

During non-rainy days the flow will be very meager causing, salivation requiring frequent cleaning.

Aim

Preparing design model for sewerage system in the developing and under-develop urban and semi-urban areas

Objective

To study existing sewerage system design implemented in Urban Local Bodies (ULB) and propose a sustainable sewerage model.

Designing Sewerage System

(a) The out –fall point should be very carefully selected first and then adhered to strictly. While selecting the out fall points, the direction of wind should also be kept in view so that waft of bad odor are avoided. All town improvement and town planning schemes should be carefully considered so that shifting of out-fall point with the growth of town in that directions is avoided;

(b) The scheme should be started from out fall end so that sewers may be utilized from the beginning, thus ensuring that the functioning of scheme has not to wait for till the completion of the entire scheme;

(c) The scheme should be planned in progressive stages so that investment yield benefits from the beginning. To ensure that various stages fit in the main scheme, the scheme should be planned as a whole and various stages worked out thereafter;

(d) Method of treatment or disposal should be decided while preparing the project, in-stead of postponing it till the completion of the scheme and

(e) Sewerage should not be introduced without ensuring adequate water supply.

Solid waste is of great concern to our environment, especially sewerage systems. Collecting plastic bags from dumping ground, river side, ponds is a general scene everywhere in urban areas where pace of solid waste generation is very fast & quantum for handling is huge& poor. Flooding of all residential places in many of metro cities and cities surrounded by major rivers is common, due to unmanaged solid waste & sewage disposal systems.

Floods in Mumbai in last few years & recent in Patna gives warning. Indians buy more than 75 lakhs packed water bottles. India is urbanizing. At the present rate of increase of India's urban population will reach close to 600 million by 2031, more than double that in 2001. In the coming decades, the urban sector will play a critical role in the structural transformation of the Indian economy and in sustaining the high rates of economic growth. Cities and towns of India are visibly deficient in the quality of public services they provide, even to the existing population. Considering that the Indian economy is now one of the fastest growing economies in the world, and standards are rising, current service levels of needs of urban households are too low. For the first time since independence, the absolute increase in population is more in urban areas than in rural areas.

1. Rural – Urban distribution: 68.84 per cent and 31.16 per cent

2. Level of urbanization has increased from 27.81 per cent in 2001 to 31.16 per cent in 2011(http://censusindia.gov.in/)
3. The proportion of rural population declined from 72.19 per cent to 68.84 per cent

In India, today about 18 per cent of urban households do not have access to any form of latrine facility and defecate in the open. Only 21 per cent of the waste water generated is treated, compared with 57 per cent in South Africa.

India's sanitation coverage is of 38 per cent of which 58 per cent in urban areas and 18 per cent in rural areas Sewerage system is an intricate civil engineering work, which is designed for two extreme conditions of minimum flow in the initial range of population and maximum flow for design period loads with conditions of extreme velocities and depth of flow in the conduit.

Sewerage scheme is designed only for DWF i.e. designed as separate system and not as combined system for techno- economic reasons as practiced in India following guidelines of CPHEEO. In case of combined system we shall have to spend 3.5 times more for collection and transmission of sewage and then also due to dilution of sewage, functioning of STP becomes inefficient. A Sewerage System is technically viable if per capita water supply in the area is at list 135 lpcd and water is supplied through house connections. Sewerage System is financially viable if the area has reasonable population density. In case sewer connections are not done for a longer period without any flow, the assets created for it may become nonfunctional. Therefore most important component of the system is sewer connections to ensure proper functioning of the total sewerage system.

SURVEY AND INVESTIGATION FOR SEWERAGE PROJECT

Success of any sewerage project depends on proper survey & investigations works before actual work execution. Local Master plan provisions, population load based on population increase in the area, governing levels and slope patters, soil and strata details, water table details and proper grab sampling of present sewage generated in the town/area.

These aspects are usually neglected in preparation of Project report and then number complications affect the progress of work & then success of assets created also becomes problem. Work Breakdown structure for each & every item of work be planned & followed to ensure success story of any project.

PREPARATION OF SEWERAGE PROJECT

Preparation of concept report for works to be under taken on priority basis, following to that based on design parameters understand and Prepare final detailed Survey and investigation works.

Detailed Project Report including detailed design and good for construction drawing and specifications are to be drawn carefully studying all options and befitting our requirements that to allowing our techno-economic decisions. Bid documents should be prepared carefully and every line and clause of bid document should be kept clear and no ambiguous point be kept open for claims & disputes by the contractor.

The length of time up to which the capacity of a sewer will be adequate is referred as design period. In the sewer system the flow is largely a function of population density and water consumption. Manual gives design period for different components of sewerage system and sewage treatment plant. STP should be designed in phases, first phase of STP should be for about 10-15 years but land of STP should be taken for 30 years period. Population existing and anticipated in various zones to be served by a particular sewer is arrived at and designs will be carried for it.

S. No	Design Component	Design Period	Remarks
1.	Land Acquisition for STP, SPS, sewers etc.	30 Years	Land acquisition in future become difficult
2.	Sewer network laterals, Trunk mains, Outfall etc.,)	30 Years	Replacement difficult and costly
3.	Force mains	30 Years	Cost may be economical
4.	Pumping Stations-Civil Work	30 Years	
5.	Pumping Machinery	15 Years	Life of pumping machinery is 15 years

6.	Sewage Treatment Plants	30 Years	The construction shall be modular (15 years)in phased manner as actual population less than design population and in Indian cities initially flows are much less due to connectivity problems.
7.	Effluent disposal and utilization	30 Years	Provision of design capacities in the initial stages itself is economical

CPHEEO Manual stipulates that generally 80% of the water supply may be expected to reach the sewers. However sewers should be designed to minimum waste water flow of 100 to 135 liters per capita per day for urban, as per the rate of water supply. Industries, commercial buildings etc., which often use water other than the municipal supply may discharge their liquid waste into the sanitary sewers. Such quantities should be worked out separately.

Population Change

Fertility, mortality, and migration are the three components that determine the growth of the Region, these components enables for estimating population projection to be calculated by different methods considering: Floor Area Ratio (FAR), Fixtures load of the contributory area, Trend of population density, Type of activity in the area, Population based on NBC Norms.

Forecast population for design period by using standard methods and check the same for its validity. Where population details are not available, the Manual on sewerage, government of India recommends following densities of population:

Density of Population

Size of town	Population Density of (population per hectare)
• Up to 5,000	75-150
• 5,000-20,000	150-250
• 20,000-50,000	250-300
• 50,000-100,000	300-350
• Above 100,000	350-1000

The carrying capacity of the sewers is designed on the basis of prospective population and taking into consideration that 80% of water supply (manual of sewerage) will reach the sewer, multiplied by the peak factor. Peak factor is the ratio of maximum flow at any time to average flow and depends on contributory population. Para 3.2.5 of Manual stipulate peak factor for different contributory population. The minimum flow may vary from 1/2 to 1/3 of average flow. Flow in gravity sewer varies from hour to hour and seasonally.

Some quantity of ground water or subsoil water may infiltrate into sewers through defective joints, broken pipes etc. This is significant when water table is high and head of ground water is more than the head of sewage in sewers. Some quantity of sewage may leak out from defective joints and defective pipes when head of sewage is more in sewers than head of ground water outside. Infiltration and leakage mainly depends on quality of construction and water table levels.

Infiltration can be considered, vide Para 3.2.7 Manual stipulation: minimum-maximum- 5000-50000 liters per day per hectare, or 500-5000 liters per day per km length of sewers, or 250-500 liters per day per manhole of sewers laid below ground water level. Sewage contains organic and inorganic matter. Therefore, if the velocity of flow in sewer is low, this solid matter is likely to settle down and deposited, thus blocking the flow. The minimum velocity required to prevent silting in sewer is called self-cleansing velocity. The velocity should be attained once a day or preferably twice a day to keep the sewer free from trouble of blocking. Sewers have to be designed such that self-cleansing velocity is developed with minimum discharge. A velocity of 0.6 mps would be required to transport sand particles of 0.09 mm size having a specific gravity of 2.65. Vide Para 3.4.3 Manual recommends a minimum velocity (self- cleansing velocity of 0.6 mps, for present peak flow and 0.8 mps at design peak flow for sanitary sewers. Thus the sewers are designed on the assumption that although silting might occur at minimum flow, it would be flushed out during peak flows.

Erosion of sewer (bottom surface) is caused by sand and other gritty material deposited in the sewer accompanied by excessive Velocity. Velocity in a sewer desirably should not exceed 3m/sec. for RCC pipes and 1.5 m/sec. for SW pipes at any time else it will cause erosion of bottom of pipe. The closed sewers should not run full, otherwise the pressure will rise above or fall below the atmospheric pressure and condition of open channel flow will cease to exist. Also from consideration of ventilation sewers should not be designed to run full. In case of circular sewers, as per table 3.6 of Manual (Hydraulic properties of Circular sections), the velocity is maximum at 0.8 full and is 1.14 times the velocity at full flow. The discharge at 0.8 full is 0.98 times the discharge at full flow. Therefore the maximum flow depth should be 0.8 (0.8d) full at ultimate peak flow for all pipe diameters. When pipe is not flowing full and it is desirable to calculate the discharge, velocity and depth of flow. This can be accomplished readily by the use of partial flow diagram. The maximum velocity occurs when the ratio of depth to dia. is about 0.8. At half depth, the velocity is the same as at full depth, but the flow is then half of the full flow. The velocity diminishes rapidly as the depth of flow decreases below half the diameter.

Flow – Friction formula

Manning's formula: V = 1/n X(r ^2/3) x (S^1/2)

For circular sewers the formula takes the following form: Q= 1/n x 3.118 x 10^-6 x d^8/3 x S^1/2

V= 1/n x 3.968 x 10^-3 x d^2/3 x S^1/2

Where V=velocity in pipe in m/sec, Q=discharge in lps, d=Diameter of pipe in mm, S=slope of hydraulic gradient, R=Hydraulic radius in meters, n=Manning's coefficient.

TABLE - 2

The relation between flow ratio and velocity ratio with depth ratio:

Constant (n)				Variable (n)	
d/D	v/V	q/Q	nd/n	v/V	q/Q
1	1	1	1	1	1
0.9	1.124	1.066	1.07	1.056	1.02
0.8	1.14	0.968	1.44	1.03	0.89
0.7	1.12	0.838	1.18	0.952	0.712
0.6	1.072	0.671	1.21	0.89	0.557
0.5	1	0.5	1.24	0.81	0.45
0.4	0.902	0.337	1.27	0.713	0.266
0.3	0.776	0.196	1.28	0.605	0.153
0.2	0.615	0.088	1.27	0.486	0.07
0.1	0.401	0.021	1.22	0.329	0.017

Where: D = Full Depth of flow (internal dia), d Actual Depth of flow, V = Velocity at full depth, v = Velocity at depth'd', n = Manning's coefficient at full depth, nd = Manning's coefficient at depth 'd', Q = Discharge at full depth, q = Discharge at depth 'd'

Velocity of flow is equal to full flow velocity when the flow is half full, Velocity of flow is more than full flow velocity when the flow is **more than** half full, Velocity of flow is rapidly decreasing when the flow is less than half full, Velocity of flow has to be checked for minimum self-cleansing velocity whenever the sewer is flowing less than half full; Velocity of flow is the maximum when the depth of flow is 0.82 D. The carrying capacity of the sewer is the maximum when the depth of flow is approximately equal to 0.9D. The starting sewer should be laid at such a depth that the sewer connection from the house is possible. Minimum depth should be on the criteria of the stress on the pipe due to external load is negligible. The minimum depth of cushion over the top of the sewer should be at least 0.9 m. Pipes laid under main roads should have a cushion of 1.20 m over the top of the pipe. For initial laterals in small housing colonies depth may be considered as 0.3 m, where vehicular loads are considered negligible. The maximum depth of cutting for trenches for construction of sewers is decided based on the depth of groundwater table and sub-soil conditions.

Normally a depth of 5.0 to 6.0m may be the upper limit considering the difficulty in implementation and economy. However, greater depths for short lengths for negotiating a hump or avoiding a lift station are permitted if the site condition permits. The minimum cover without protection has been proposed 1.00 m above the pipe. With adequate cement concrete encasing the cover can be suitably reduced. The maximum depth of sewer pipe can be kept as per site conditions to minimize the number of pumping stations. Normally the same may be kept as 8-10 m. in big cities. Brickwork was used in past for large diameter sewers. Concrete pipes are commonly used now as these can be manufactured to any reasonable strength and lying is easy and jointing is leak proof. However these pipes are subject to corrosion where acid discharges are carried or where velocities are not sufficient to prevent septic conditions or where the soil is highly acidic or contains excessive sulphates. Only high alumina cement concrete should be used for pipes when it is exposed to corrosive sewage or industrial wastes.

Salt Glazed Stoneware Pipes are mostly manufactured in sizes 80-1000 mm but sizes greater than 80 mm are generally not used due to economic considerations. The length of these pipes is 60 cm, 75 cm and 90 cm. These pipes are good for corrosion resistance and erosion resistance. However due to less length, more joints, difficulty in jointing, requirement of special bedding and less compressive strength of pipes manufactured in India; use of these pipes is reducing in India. AC pipes cannot stand high superimposed loads, subject to corrosion from acids in sewage and high sulphate soils, require special bedding and weak against erosion where high velocities are encountered; as such use of AC pipe is not prevalent. Cast iron, DI and steel pipes are not used due to high cost. uPVC pipes are manufactured in sizes 75, 90,110, 140, 160,200,250,290 and 315 mm outer dia. uPVC pipes are smooth, light, easy to join and leak proof joint. Rates are also low. These days these pipes are used for making connection from house to sewer but not prevalent in street sewers. HDPE pipes are available up to 630 mm dia. The manufacturing of these pipes have started in India but are costlier than RCC pipes and uPVC pipes. The welded joints are leak proof and as such some people have started using these pipes. GRP pipes are widely used in other countries where corrosion resistant pipes are required at reasonable rates. Generally bedding shall be provided to withstand overburden and to an extent possible from locally available materials. Bedding shall be designed corresponding to laying condition of sewer in trench, embankment or tunnel as per CPHEEO manual.

Generally sewers are laid in trenches by excavation in natural soil and then covered by refilling the trench to the original ground level. Four classes of beddings of A, B, C, and D are used for laying of sewers. Class A bedding may be either concrete cradle or concrete arch. Class B is bedding having a shaped bottom or compacted granular bedding with a carefully compacted backfill. Class C is an ordinary bedding having a shaped bottom or compacted granular bedding but with a lightly compacted backfill. Class D is one with flat bottom trench with no care being taken to secure compaction of backfill at the sides and immediately over the pipe and hence is not recommended. Class B or C bedding with compacted granular bedding is generally recommended. Shaped bottom is difficult and costly and hence notrecommended. The pipe bedding material must be firm and not permit displacement of pipe. Minimum pipe diameter recommended in CPHEEO manual is 150 mm except that in hilly areas, where extreme slopes are prevalent, 100 mm can be used. Some states and ULBs have started adopting minimum diameter as 200 mm or even 250 mm. The logic is (i) Maintenance of sewer system is generally not good and 150 mm dia sewer will block frequently and remain un attended for some time. (ii) Quality of construction in smaller size RCC main such as 150 mm is not good. (iii) The sewerage system is not totally closed one and undesired waste such as solid waste and drains finds way in sewerage, making smaller size sewer lines more prone to frequent blocking (iv) The cost of pipe line element is only about 15 percent of total project cost and increase in pipe size from minimum of 150 mm to minimum of 200 mm size will increase cost of project by 2 percent whereas flow capacity increases by more than 80 percent.

After detailed survey is completed line diagram (flow diagram) for each sub basin (sump well) drawn. Flow line with arrow head towards direction of flow of sewage to be marked. Node numbers are given at every change of direction ,(road direction)or 30,60 120 meters in straight reaches , at every change of slope, Node numbers are given starting from sump well (grit chamber)as “0” node. Next higher numbers to be given on upstream side as1,2,3,4...At a particular node 3-4 lines are joining next higher number be given in clockwise direction. Follow only; higher number is given on upstream side and lower number on downstream side. The size of manholes shall be such that there should be a clear opening of not less than 0.56m dia for entry. Steel Fiber Reinforced Concrete Covers (SFRC) conforming to IS 12592 (heavy duty HD- 20 Grade designation) or cast iron manhole covers and frames conforming to IS 1726 (part 1 -7) be considered. For HSC, 150 mm diameter sewer with minimum slope 1 in 40 is to be provided for giving public sewer connections. Property Connections shall be direct to the street manhole subject to maximum 6 number of connections to a particular manhole when road width is less. Property Connections shall be through Road side Chamber to the street manhole when width of road is more.

Safe distance between two water supply and sewer lines: Location of Water mains: For roads wider than 25 meters, the water distribution pipes should be provided on both sides of the road, by running rider mains suitably linked with trunk mains.

Laying and Jointing of Water pipes: As a rule, trenching should not be carried out too far ahead of pipe laying. The trench should be as narrow as practicable. This may be kept from 0.30 meter over the outside diameter of pipe and depth may be kept at 0.60 - 1.0 meter depending upon traffic conditions. If trucks, Lorries, or other heavy traffic will pass across the pipeline, concrete tiles 600 x 600 mm of suitable thickness and reinforcement should be laid about 2m above the pipe to distribute the load. If the pipeline crosses a river, the pipe should be buried at least 2m below bed level to protect the pipe.

Horizontal separation: A Water pipe line should be laid such that there **is at least 3 meters** separation, horizontally from any existing or proposed drain or sewer line. If local conditions prevent this lateral separation, a water main may be laid closer to a storm or sanitation sewer, provided that the main is laid in a separate trench, or on an undisturbed earth shelf located on one side of sewer at such an elevation that the bottom of the water main is at least 0.5 meters above the top of the sewer .If water table rises above the bottom of the leach pit ,the safe distance should be kept as 8m.If this cannot be achieved then the pipe should be completely encased to a length at least 3m.on either side of leach pit.

Vertical Separation: In situations where mains have to cross house sewer, storm drain, or sanitary sewer, it should be laid at such an elevation that the bottom of the water main is **0.5 meter above the top of the drain or sewer** with the joints as remote from the sewer as possible. This vertical separation should be maintained for a distance of 3 meter on both sides measured normal to the sewer or drain it crosses.

While designing sewer following factors may be considered

(1) Higher velocities are usually be adopted 0.6/0.8 m/ sec. i.e. for initial and ultimate (design) peak sewage flows. Slopes for present (initial year) peak flows be given and diameter for ultimate peak flows to be checked.

(2) Ground slopes are flatter than the slope required is only for self-cleansing velocity. If possible slopes to be adopted are the same as ground slope. Pipes are laid to steeper slopes with the condition that non-scouring velocity i.e. maximum permissible velocities are not exceeded for SW pipes as1.5 m/sec. and for RCC. pipes as 3m/sec.

(3) A Minimum depth of earth cushion of backfill is to be

ensured over the pipe to avoid physical damage to the pipe (minimum 0.6 to 0.9m).This is ensured by lowering the depth of upstream manholes or by laying the pipe at steeper slopes such that permissible non- scouring velocity is attained. Minimum self-cleansing velocity to be developed as 0.6m/sec for present peak flow while self-cleansing velocity is to be developed for the ultimate peak flow i.e. 0.8m/sec to 0.75m/sec.

(4) Higher depth of flow calls for smaller dia. of pipes resulting in economy in cost of pipes and trench excavation width. However this should be limited to maximum of 0.8 full depths. Hydraulic flow formula and the value of roughness co-efficient :- Manning's formula is the most widely used formula and co-efficient of roughness (n) is assumed as constant for all depths. Thus sewers are to be designed fixing slope and diameter of pipes to meet the above stipulations, taking into consideration of ground topographical conditions.

Steps involved

(1) Determine the present peak flow in Lps=Qip =Present (Initial) population load

(2) Determine the ultimate peak flow in Lps=Qup Ultimate (designed) population load on the pipe section.

(3) Determine the slope of pipe for present peak flow and minimum velocity of 0.6m/second

(4) Determine the slope of pipe to ultimate peak flow as to achieve velocity of 0.8m/sec (max.).

(5) Critical of above two slopes is the slope of pipe to be laid, If Ground slope is flatter than the critical slope is to be provided. If Ground slope is steeper follow ground slope subject to condition of velocity with in Min. 0.6m/sec (Initial) to Max. 1.5m/sec for SW. and Min. 0.8m/sec (Ultimate) to 3m/sec for RCC pipes. Determine the nearest commercial diameter of pipe such that depth of flow is close to the specified values (maximum 0.8 full flow) for the ultimate peak flows. Choose nearest smaller commercial diameter pipe than theoretical diameter will give slightly more depth of flow, but will be economical. A commercial bigger diameter pipe is chosen than theoretical dia. of pipe will give slightly lesser depths of flow than specified, but will be costlier.

(6) Fix the crown levels of pipe considering the cushion depths required, slope and length of sewer.

Sewage Pumping Station: Earlier Pumping stations used to be rectangular with dry and wet wells adjacent to each other or circular with central dry well and peripheral wet well or circular with a dividing wall to separate the dry and wet wells and with centrifugal pumping sets.

- Now a days wet well (no dry well) with submersible pumps are more prevalent.The construction is of RCC. Sulphate resistant cement is used in corrosive soils.
- Provision of flow measurement, adequate ventilation, safety equipment's, pump lifting arrangements shall be made.
- At places, where depth of sewer becomes too deep and it is difficult to lay sewer at such depths, sewage-pumping station is required to lift the sewage to nearby manhole or to the STP, from where it will flow by gravity.

Screens and Overflow

• All SPS or SPH are to be provided with coarse **screens** before the wet well with clear opening of 40-50 mm between the bars for the manually cleaned type and 25 mm for the mechanical type.

The screening units shall always be provided in duplicate. It is also provided with a **bye bass** on the upstream side, to avoid overflow of the screen channel in case of sudden power failure. Drainage facility shall also be provided in the individual screen channels to empty these channels formaintenance purposes.

- **Wet Well:** The sewer line will discharge the sewage into a wet well. The capacity of wet well/sump should be such that deposition of solids is avoided and sewage does not turn septic.
- The capacity should not be too low to require frequent on-off of pumping sets. Pump start/stop shall be restricted to 6nos/hour.
- The capacity of the wet well is to be so kept that with any combination of inflow and pumping, the cycle of operation for each pump will not be less than 5 minutes and the maximum detention time in the wet well will not exceed 30 minutes of average flow.
- The high water level in sump well will not exceed invert level of lowest incoming pipe.
- All the pipes within the pump house should be cast iron double flanged. Velocity in suction pipe should be less than 1.5m/sec. and in delivery pipe it should be within 2.5 m/sec.
- The shape & size of dry well (SPH) is considered on-number of pumps to be housed, to accommodate piping, valves, handling equipment, space for maintenance of pumps and other equipment's.

Types of Sewage Pumps and Configuration

Non clog submersible pumps are proposed in all Pumping stations as per availability in the Indian market. Pumping units are designed to handle suitably **peak, average and low-flow** from connected sewers. The capacity of pumps shall be adequate to meet the peak rate of flow with 50% standby. Pumps of varying discharge capacity are desirable to handle the variation in flows (lean/average/peak flows)

- The general practice is to provide 3 pumps for a small capacity pumping station comprising 1 pump of 1 DWF, 1 of 2 DWF and third of 3 DWF capacity.

- For large capacity pumping station, 5 pumps are usually provided, comprising 2 of ½ DWF, 2 of 1 DWF and 1 of 3 DWF capacities, including standby.

Rising mains (pressure mains or force mains) are provided to carry sewage to higher elevations. It is generally provided to convey sewage from Sewage Pumping Stations to a higher level inlet chamber of nearby sewer or Sewage Treatment Plants. Characteristics of different pipes for pumping main help to choose between pipe options for particular site. The size of the main should be determined considering initial cost and capitalized O & M cost for different sizes as per method given in Water Supply Manual. It is designed according to the following considerations:

- Force main should be designed for a minimum velocity of 0.60m/sec for low duty pump in operation to avoid deposition. Force main should be designed for a minimum velocity of 0.80m/sec for high duty pump in operation. The maximum velocity of 2.5 to 3.0 m/s at ultimate peak flow and usually economic pipe diameter is obtained at velocity of 1.1 m/sec.
- Each pumping station should be provided with an on line flow meter.
  - Sewage average residence time in pumping mainshould be restricted to 2 hours to avoid septic condition of sewage, but it should not exceed 4 hours in any case.
- **Pumping Hours:** Find out the actual availability of power in the city and based on it adopt pumping hours. More pumping hours give lower pipe size and hence cost saving. Future expected improvement in power supply may also be considered.

- Hydraulic design is done using Hazen-Williams formula as given below:
- **V** = 4.567 X 10-3 CD^0.63 * S^0.54 and
- **Q** = 1.292 X 10-5 CD^2.63 *S^0.54
- Where, Q - Discharge in m3/hr, **V** - Velocity of flow in m/sec, **d** - diameter of pipe in mm;
- **C** - Hazen-Williams Co-efficient, **S** - Slope of

  Hydraulic Gradient;
- **'C' Hazen-William Coefficients** Value adopted used in the hydraulic design is taken 140 for DI pipes with cement mortar lining inside.

TABLE-3

SELECTION OF SEWAGE *TREATMENT PROCESS*

The selection of a particular type of treatment technology will depend upon the techno-economic feasibility of the process selected for treatment. The tech-economic feasibility can be attributed to the following parameters:

- ☐ *Degree of treatment required*
- ☐ Capital cost of the project
- ☐ Operation & Maintenance cost
- ☐ Power Requirement
- ☐ Land Requirement
- ☐ Ease of construction, Operation & Maintenance
- ☐ Simplicity of system
- ☐ Trouble free service
- ☐ Proven process
- ☐ Ability to absorb shock loads (Hydraulic / Organic)
- ☐ Need for skilled / unskilled staff O&M
- ☐ Presence / absence of nuisance potential from mosquito / fly / odor
- ☐ Ease of access to components of the system for repairs and maintenance
- ☐ Safety / Hazardous conditions at the plant

CLASSIFICATION OF SEWAGE TREATMENT PLANTS

When characteristics of raw wastewater, the intended use and quality of receiving waters and their assimilative capacity are known, extent or degree of treatment needed for the wastewaters (sewage) can be determined. Different types of treatment provide different percentage removal of BOD, suspended solids, and total coli forms the general yardstick for evaluating the performance of sewage treatment plants.

In general, the treatment plants are classified as: Preliminary treatments, Primary treatments, Intermediate treatments, Secondary treatments & Tertiary treatments. Construction Activities: Issues:

• Depth and section for execution and it's implicitly. Working in densely populated areas and heavy traffic conditions need to be explored & Safety and security at works. Working in night be allowed and in built in bid doc. Realistic period of work be given and proportionate completion, if not done be panelized. Water &waste water should get status of business. Like work suffering during rains time lag due to festivals in India like Sankranti, Holi, Ganesh, Durga Dashera and Diwali Mohram, Ed,Crismas are also need to be considered. Effect of this time loss should also reflect in our bid documents as considered for rainy season. Public criticism and complaints during execution of work need to be addressed immediately. The process of road development after sewer deployment is to be introduced separately to avoid public criticism.

ISSUES OF CONCERN TODAY

- We have to bring the new concepts to work in difficult situations and not to neglect in tackling the safe disposal of liquid waste coming out from communities. We must conserve water bodies, natural water flows and aquifers at any cost.
- Need to change mindset of Engineers and community that services need money and cannot be given free, taken for granted.
- Expenses on water are important but sanitation conditions cannot be neglected by reasoning of paucity of funds. Need to think of sanitation in totality of waste water disposal, safe disposal of industrial effluent and solid waste management
- Rehabilitation of sewerage systems must be taken up in all the cities where the sewerage system exists but has become non-functional. Wastewater treatment must be made mandatory for all sizes of urban centers. Pollution of land or water body with untreated wastewater should be made punishable with fine & enforced with commitment.

Recycling/ reuse of wastewater must be encouraged. Technical and financial assistance must be provided for this, if required. All agencies dealing with wastewater must prepare plans for cost recovery from this service. Private sector participation could be encouraged in managing this service to reduce public expenditure. Successful examples of people's

- Participation in contributing to the cost of construction of sewerage system must be examined and adopted in other urban centers of the country.

CONCLUSION

1. There are technological solutions to the crisis, but they demand political action. Together they comprise the committed efforts to resolve by WE ALL WATER and ENVIRONMENTAL ENGINEERS for a sustainable world. Nothing is unknown or new but to act with commitment.
2. Water & Sewerage schemes should be executed simultaneously. Government of India and State Governments need to enforce water Departments/agencies to sanction schemes. Simultaneously with sewerage projects and not in isolation neglecting to tackle 80% of water generated as waste water. Need to see this issue as Social crime by us. Regulations & Laws for this act should be punishable for deciding authorities. These words do not sound good but these practices enlarging environmental problems in all water bodies in India.
3. Municipal Service Regulator should be assigned the responsibility of revising user charges regularly. Even when different segments of the population are charged differently, the cross- subsidization should be such that the overall O&M cost is recovered and a minimal surplus generated. ii. User charges to be so structured as to meet O&M cost, debt servicing, and depreciation towards the cost of the project. In addition, they must also generate some surplus to enable building the equity base of ULBs, supported where appropriate, with viability gap funding (VGF) iii. Levy water and sewerage charges separately rather than built into the property tax. Government of India OR body like IWWA should create a Regulatory Guidelines' for Water &Waste Water.

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