

Chapter – 8

Domestic Waste Management

Every human being on this earth generates waste, which includes large quantities of tin cans, packing material, waste papers, glass, wood, etc. As seen in the previous chapters, waste is something that is not required, hence, discarded. Over population and industrialization has increased the amount of waste on the earth. Newer products are being manufactured and so also the number of consumers is increasing day by day. In the last twenty years or so, the use of plastic increased by leaps and bounds. Right from packaging up to the micro chips in computers, plastics are used. These plastics once used and later discarded, accumulate in heaps in cities. Not only do they spoil the landscape but cause ecological disasters, as was seen in the recent deluge on 26th July 2005 in Mumbai. Plastics clogged the drainage system and caused flooding all over Mumbai city. Plastics, metal, glass can be recycled and help to prevent such disasters in future. In India per Capita 0.3 - 0.6 kg per day and 30,000 tons waste from 23 metro cities is generated (Visvanathan et al, 2009). The collection rates are 50 – 90% where 15% is disposed as landfill, 60% in open dumping, 5% is incinerated and only 10% is composted. Even biological waste, if allowed to accumulate can spread diseases. Solid waste management strategies are according to municipal solid waste handling rules 2000 and National Environment Policy 2004. Hence, it becomes extremely important to manage the waste and treat it in such a way that it is not detrimental to the environment.

In 2001, the population of Kanpur was 25.51 lacs. According to the estimate given by NEERI 350 gm waste per capita per day is disposed. The waste generation of Kanpur in future will go as 1015 MT in 2011 by 29 lakh population, 1155 MT in 2016 by 32.97 lakh population, 1315MT in 2021 by 37.49 lakh population and 1696 MT in 2031 by 48.46 lakh population. In 2012, the waste generated is 1200- 1500 MT which is much more than projected waste. That shows, the statistics of waste management is getting affected by increasing income, urbanization and modernization. As per media reports on urbanization, expansion of urbanization is

taking place at fast rate and metro cities are turning into mega cities. Indian economy is becoming industrial from agrarian. This is clear indication that Government has to take mega leaps to fight against increasing waste. It is observed from our study that actually waste produced is just double of the estimate given by National Environmental Engineering Research Institute and Central Pollution Control Board.

This chapter deals with the various option of solid waste management and options practiced in Kanpur Metropolis which include open dumping, landfills, sanitary landfills, composting, recycling and incineration. All these management methods are discussed and analyzed separately. Before discussing these methods separately zone wise total waste generation should be analyzed comprehensively for the study area. Therefore, this chapter is divided into three sub section. The overall waste generation, collection & left out is dealt in section 8.1, whereas section 8.2 represents solid waste management and in section 8.3 management of domestic effluent in Kanpur Metropolis is discussed.

8.1 Waste Generation, Collection and Ignored :

In fact, waste of one could be others wealth but it becomes a problem with crossing the limit of carrying capacity, improper management and mass awareness. The population boom along with unplanned growth of urban areas, has given rise to the problem of waste accumulation. Collection and treatment of municipal waste in the towns and cities is one of them many the services that local authorities have to organize for their population. The collection, treatment & disposal facilities are highly inadequate and proper facilities are almost non-existent in majority of the study area. Costly and complex technical investments are bound to run at loss. Therefore to manage exponentially increasing amount of garbage, cheap and more appropriate solutions are to be found for proper planning and execution and hence the present scenario of waste generation is to be studied in detail. Therefore Solid waste and Kitchen waste generated in all the zones is thus summarized in a Table No. 8.1 along with the collection and ignored quantity. Fig. No. 8.1A represents total waste generated in the city, collection by A to Z Infrastructure Ltd and scrap dealers along with ignored waste. We have analyzed the per person per day quantity

of waste generation in the city and recorded that total 2508394 kg waste is generated daily in Kanpur city which comprises of 1154217.44 kg (46.01%) kitchen waste and 1354176.70 kg (53.99%) solid waste. We have also noticed that only 627033 kg. (25%) kitchen waste and 1221734 kg (49%) solid waste is collected and rest 659626.81 kg (26%) waste remains ignored that accumulates and takes the shape of dump in short time.

**Table No. 8.1
Zone-wise Generation, Collection and Ignored Waste (kg)**

Municipal's Zone	Zone wise population	Kitchen Waste			Solid Waste			Total collected waste	Total Ignored Waste
		Generation	Collection	Ignored	Generation	Collection	Ignored		
1	415038	199633.27	121332	78301.27	405907.16	381552.74	243544.42	502884.74	102655.69
2	431821	190433.06	90319	100114.06	151137.35	128466.75	2267.60	218785.75	122784.66
3	425401	183347.83	95202	88145.83	164204.78	142037.14	22167.64	237239.14	110313.47
4	390203	188858.25	106361	82497.25	367961.42	340364.32	27597.10	446725.32	110044.35
5	438499	196813	126895	69918	120699.96	103801.97	16897.99	230696.97	86815.99
6	436499	195132.05	86924	108208.05	144266.17	125511.57	18754.60	212435.57	126962.65
Total	2551335	1154217.44	627033	527184.46	1354176.7	1221734	132442.35	1848767.46	659626.81

8.1.1 Zone-wise Waste Generation :

Ideally, with sincere efforts of city administration only 74 % waste is collected and 26% waste is ignored, but in reality the collection rates differ day to day due to multiple reasons and the proportion of ignored waste increases and take the shape of littered heaps. After the commencement of A 2 Z functioning in the city, the dumping points allotted by Nagar Nigam have been discarded. In our study we have calculated that per capita per day disposal of solid waste is 0.542 kg and kitchen waste disposal is 0.453 kg in Kanpur metropolis. Total waste generation in Kanpur metropolis is 2508394 kg by 2551337 people per day which consists of 46.01% kitchen waste and 53.99% solid waste. Maximum kitchen waste generation

is observed in zone 1 (199633.27 kg) and minimum kitchen waste generation is observed in zone 3 is (183347.83 kg) whereas, in case of solid waste maximum generation is observed in zone 1 (405907.16 kg) and minimum solid waste generation is observed in zone 5 (120699.96 kg).

8.1.2 Zone-wise Waste Collection :

A2Z infrastructure limited started collecting household waste by door to door service with the help of *Safai Mitra* from October 2010 in some wards of zone 1 and zone 4 and from January 2012 onwards collection started from the whole city. But the system and the efforts put forth seems to be insufficient and waste collection is not cent percent. Instead the community bins are found over flow and littered here and there. Household do not follow segregation at all and all together entire waste is thrown outside in open space on vacant land. So the composition of city waste is highly heterogeneous. Zone wise collection of kitchen waste is maximum in zone 5 (126895 kg) and minimum in zone 6 (86924 kg) and maximum solid waste collection is from zone 1 (381552.74 kg) and minimum solid waste collection is from zone 5 (103801.97 kg) but it is to be noticed that solid waste generation per person per day is also lowest in zone 5. Otherwise minimum collection is recorded by zone 2 (128466.75 kg.). We observed that ratio of kitchen waste disposal is much more than solid waste. Multiple reasons which are responsible have been discussed in solid waste management. On the other hand solid waste like plastic, paper, metal are very well collected and sold to scrap dealers and vendors. If anything is thrown under forced circumstances that also is picked by rag pickers and sold. So the ratio of solid waste disposal sounds better and gives major contribution in recycling trade. Maximum waste is sold to scrap dealers in zone 1 and followed by zone 4. Even in zone 2 people are cautiously selling waste to scrap vendors where maximum negligence is observed in this case also. Role of scrap dealers and vendors in city's waste management become very important as they collect 49% of the total city waste and give strong contribution in city's waste management. Their organized working is observed in whole city but perform best in zone 1 and zone 4 as the quality and quantity of disposal waste in these zones are much better than the waste disposed from other zones. Total waste collected in the city is just 74% in which

25% is collected by A to Z waste management company 49% by waste vendors from the waste generated daily in the city.

8.1.3 Zone-wise Ignored Waste :

As discussed earlier in our studies kitchen waste disposal is ignored more than solid waste disposal for a simple reason that solid waste if sold gives monetary benefit but kitchen waste does not give such benefit rather is a cause of concerns if not collected and degraded as organic waste produces foul order and contaminates surroundings on fermentation. Not only this, lot of efforts and time is required in the processing of kitchen waste which is actually a challenge for one's patience and available space. As per our observation in zone 1 only 16.96% waste is ignored in which 76.27 % is kitchen waste and 23.72 % is solid waste which is minimum out of all the zones and in zone 4 only 19.77% waste is ignored in which kitchen waste is 74.93% and solid waste is 25.07% because civic administration is very alert and ideally work along with the alertness of the residents. The areas of these zones are business centers so well maintained because of high class people but the living conditions in other zones are point of concern where in zone 2, left out waste is 35.94% of which 81.54% is kitchen waste and 18.64% is solid waste. In zone 3, left out waste is 31.74% of which 79.90% is kitchen waste and 20.10 % is solid waste. In zone 5, 27.34% waste is left out, in which 85.18 % is kitchen waste and 19.47 % is solid waste. In zone 6, 37.29% waste is left out in which 85.18 % is kitchen waste and 14.82 % is solid waste. In the whole city 26% waste is left ignored. It is also tried to consider that the 100 percent Kanpur's garbage is not collected and disposed. The probable reasons include that there are no special provisions made in the budget of municipality for the waste collection, money given by state government remains inadequate, revenue collected through taxes on waste removal is not sufficient and the fleet of trucks and other machinery like loaders tippers remain badly maintained with over half the fleet lying in operable due to breakdown and repair.

8.2 Solid Waste Management :

The explosion in the world population is changing the nature of solid waste management from mainly a low priority, localized issue to an internationally pervasive social problem. As expected with such a massive population and rapid urbanization the country is currently facing some serious environmental challenges. The majority of waste is still disposed in open and unsanitary open dumps, making for serious environmental degradation and unhygienic and often dangerous situation for waste pickers and workers. Another major impediment to the Solid Waste Management situation in India is the lack of civic awareness and the disparity of various Non Government Organization and other community driven efforts. Risk to public health and the environment due to solid waste in large metropolitan areas are becoming intolerable. There is a real need in the country for a coordination of efforts and for an increase in public participation in Solid Waste Management. Reducing waste in the very place it originates (source point) will support in solving problems of energy, pollution and refuse disposal. We as individuals hand in hand with government can play vital role in our own small ways to minimize waste thus helping to preserve and conserve the only natural resource we have. In the study salient features of the current scenario of domestic solid waste in Kanpur metropolis and the directions for improving the situation has been summarized. The reasons for the non participation of public are lack of accessibility to disposal resources, user charges, and the use of kitchen waste as cattle food. Negligence of authorities is due to vast area, unsystematic and non coordination of city cleaning department. In spite of a stringent legislation in place open dumping is most widespread form of waste disposal. The possible reasons for poor implementation could be a combination of social, technical, institutional and financial issues. Public awareness, political will and public participation is essential for the successful implementation of the legal provisions and to have an integrated approach towards sustainable management of municipal solid waste in Kanpur.

In the present study the total quantity of waste generated by Kanpur metropolis and its management options are discussed. Rapid population growth accompanied by proliferation of culture of consumerism, industrialization and

urbanization gave birth to large amount of solid waste and hence future waste generation is expected to grow at fast rate. One's waste could be others wealth. It is the need of the hour to see waste as a resource at a wrong place rather than something to be swept under the carpet until it explodes. As a matter of fact there is nothing that goes waste in nature so, economics that utilize waste in most efficient way possible needs to be created. Table No 8.1 clearly shows the waste generation in every zone, collection by waste vendors or scrap dealers and ignored waste. Figure No 8.2 shows the ratio of waste generation, collection and ignored waste every day in the city which indicates that the amount of ignored waste is really a point of concern while the Fig No 8.3 indicates the zone wise waste generation, collection and disposal quantities. Therefore the prevailing management methods as well as some ideal methods are discussed which could be sustainable options for the waste management in the city.

8.2.1 Prevailing Management Methods :

Waste management is important in number of ways like it helps to reduce the impact of waste substances on the environment i.e. it helps to reduce pollution of air, water and soil, and prevents the spread of infectious diseases. Help to conserve our natural resources by applying the method of reusing and recycling the waste substances. Most of the components of solid waste may be valuable as a source of raw material for industry, for production of fuel, etc. Hence, processing the solid waste helps to recover materials that can be put to further use. Processing the solid waste helps to recover large proportions of glass, paper, metal, plastics and wood. Metal and glass as well as plastic are recycled whereas the other lighter portions of paper and wood are used for energy production. For recovery of resources as much as possible and avoid deterioration of environment various methods of disposal is in practice from low cost to high technology. The methods in common practice are discussed and out of which only land filling, recycling and composting is practiced in the study region Kanpur.

8.2.1.1 Open Dumping :

Open dumping is the most common practice. The process of throwing the waste in open ground is known as open dumping. Households use to throw the daily disposal just outside their house in any such vacant and open area. From where Nagar Nigam trucks collect all the waste and carry it to the disposal sites or dumping grounds designated by Nagar Nigam. There were 5 dumping grounds in Kanpur namely Panki, Krishna Nagar, Bhinagawan, Bhauti and Rooma. The city doesn't have even controlled dumps. Waste was simply dumped at designated sites, with or without compaction where no soil cover was used, no visual or environmental barriers and no provision for leachate checking was available. Besides the official dump sites there are numerous unofficial dump sites till date. Burning of waste in container, on roadsides and small dumps is often practiced by the residents and also by municipal sweepers till date. Identification of sites for dumping depends upon easy availability of open spaces. The practice of open dumping often leads to a number of problems like air, water and ground pollution, spread of diseases through rodents and other vector carriers, increased risks of respiratory diseases, increased emission of green house gases, loss of real estate value of adjacent land, poor aesthetics and environment. One of the most important aspects of solid waste pollution is the nuisance caused by the leachates. Water flowing through or percolating the piles of partially decomposed or un-decomposed solid dissolves away plenty of harmful substances, organic remain and carry down associated microbes. Water carrying these leachates may percolate down the soil strata and spoil sub surface water as well. This could render wells, tube wells, hand pumps etc. useless and contaminate surface water as well. All these problems pertaining to open dumping is still observed in the study area even after A 2 Z's working in the city because of irregular collection by workers and distantly placed community bins.

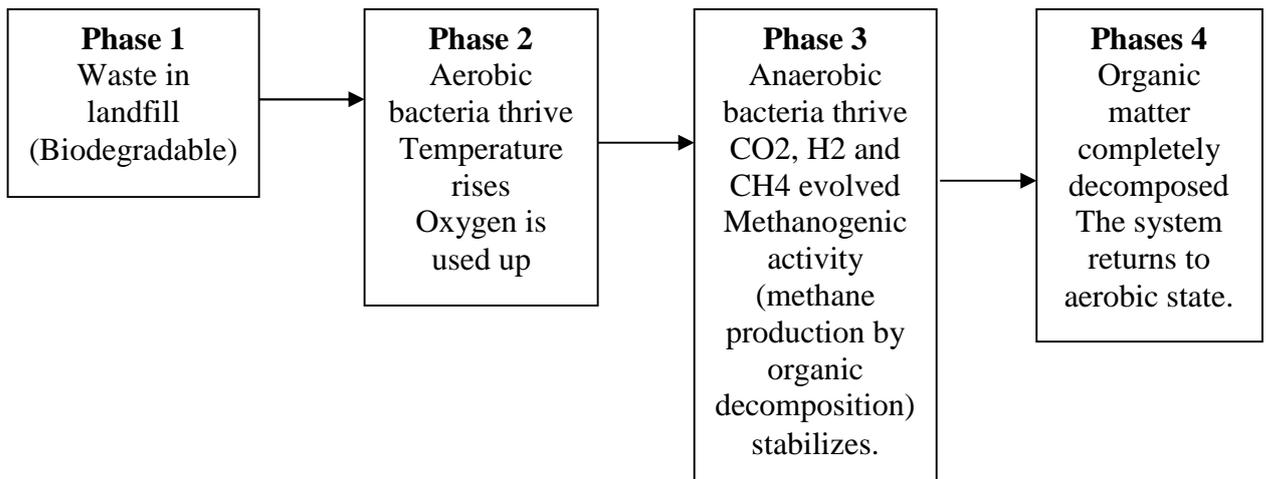
8.2.1.2 Landfills :

The process of throwing garbage in open, low land areas is called as landfills. It is of two types. Scientifically designed landfills are called as sanitary landfills. Land filling is the technical term used to describe filling holes in the ground with waste. These holes may be specially excavated for the purpose of filling

waste or may be old quarries, mine shafts and even railway cuttings. More recently, the term has been expanded to cover the creation of waste mountains even though there is no filling as such, this process also known as land rising. Landfill site produce 55% methane and 45% carbon dioxide which can be partly captured for energy production. Friends of the earth opposes landfill for the 80% of municipal solid waste that can be recycled or composted for the reasons that waste is a valuable resources, it exacerbates climate change because when materials are buried, more fossils fuel energy is used to replace the products through mining manufacturing and transportation around the world, it produce Methane, a greenhouse gas which contributes to climate change, it creates water pollution through leaching, it can lead to the contamination of land, it gives rise to various nuisances including increased traffic, noise, odors, smoke, dust, litter and pests. It occupies large space. Organic waste are dumped into one pit and topped with soil. Improperly planned landfills have the potential to create environmental damage primarily through leaching of waste by products in to the surrounding environment. Landfill leachat often contains dissolved solids, organic materials and heavy metals of which lead and cadmium are the main concerns, sources are lead acid batteries, plastics, cans, used oil and light bulbs while cadmium is generated from disposal of nickel- cadmium batteries, plastics, non-food packaging and electronic appliances. Leachates can have negative impacts upon terrestrial eco system, ground water sources and surface water. A second harmful byproduct of landfills are gases mainly methane and carbon dioxide. The Solid wastes are dumped into low-lying areas on the land and covered with good earth of at least 20 cm thickness. This ensures that insects and rodents do not enter the landfill and the refuse is not directly exposed. Each layer is then left for at least 7 days and it is compacted by bulldozers. Insecticides are sprayed on top to prevent breeding of mosquitoes and flies.

8.1.4.2.3 Land usage on the Landfills :

The solid wastes eventually stabilize and within 2 to 12 months the waste settles down by 20% to 40% of its original height. For the first few years there may be some odor but after that the land can be used for developing parks, etc. The waste deposited in a landfill undergoes biological decomposition in the following phases :



Sanitary landfills are very economical method if land is available. The initial investment is low compared to other disposal methods, no additional treatment is required. A landfill can receive all kinds of wastes; the land can be reclaimed for use as playground, parking lot, golf courses, etc. But as there is always the other side of the coin, there are some disadvantages of Sanitary landfills as in highly populated areas, suitable land may not be available and transport to a suitable place will add to the expense, Proper methods need to be employed or the result may just form an open dump and periodic maintenance will be required for many years. Decomposition of the waste may produce gases like methane, etc., which may become a nuisance. Over the landfills, plantation can be done and as suggested the land can be converted in to park, playground, parking. And so the types of vegetation over the landfill should be such that Plants should be drought resistant, and the roots do not penetrate more than 30 cm. They have the ability to thrive in low nutrients i.e. they should be of a hard variety.

8.2.1.3 Composting :

Composting is a process by which bacterial decomposition of the organic fraction of solid wastes is carried out. The end product left after bacterial decomposition is called humus. Decomposition of the organic matter can be done by aerobic or anaerobic bacteria depending on the amount of oxygen available. By bacterial decomposition, the Volume of the waste gets reduced considerably. Pathogens (disease causing organisms) are destroyed and the compost of humus can be safely handled. The process of composting is one of the biological decomposition

under aerobic (open air) and hemophilic (at or above 70c) condition, which break down organic material to leave a humus rich residue, the compost. Compost is a valuable soil conditioner for agriculture, gardening and forestry. Compost consists of many minerals like nitrogen, phosphorus and potassium and hence is an important natural fertilizer for crops. Composting is excellent method of managing solid waste with a high organic content (biodegradable waste) such as garden waste, kitchen waste that can be composted. Home composting can be made at home using a traditional compost heap, purposely designed for composting. Composting can also be done at large scale with huge amount of organic waste collected in rows. Such a method of composting is called as community composting. It can be done by various ways as given below -

- Open/open air windrow- compostable are gathered in large elongated pipe (the windrow) and every so often the compost is turned over. An open windrow design offers advantages of flexibility and maximization of space or the other exposure to the elements means that leaching, moisture and potential animal vectors must be intensively managed to avoid and maximize compost throughout.
- Enclosed/covered windrow- compostable is put into a covered ventilated container and leaching material is collected. Covered windrows offer advantages in eliminating environmental influences and enable increased composting rates in severe winter weather.
- In vessels: In vessels composting takes place in specially designed vessel that control moisture, temperature and aeration of the composting process. They can maintain a rapid decomposition throughout the year regardless of the external ambient condition.
- Composting alone has the potential of reducing waste generated. The resource requirement is minimal and it should be easy to implement. The reward is fertile soil which can help vegetable, fruit production.
- Recent strides taken in the field of biotechnology has become to be of great help in this direction. It was only an Indian born American Scientist

Chakravarty A.N. who has patented for the first time a genetically engineered strain of bacteria *Pseudomonas* which decomposes a number of complex and toxic hydrocarbons.

8.2.1.4 Recycling :

Recycling is a collection of separated materials from waste and subsequent processing to produce marketable. Recycling basic materials in order to make new products has several benefits like it reduces the demand for raw materials by extending their life and maximizing it. It reduces transport costs and the pollution caused from transporting of raw material for manufacturing new products. It saves energy in the production process when compared with the energy consumed in raw materials, It reduces disposable impact (if more waste is recycled less waste goes to landfill or incinerators, it promotes personal responsibility for the waste that we create. It offers enormous potential for job creation. A recent study suggests that upto 45,000 jobs could be created in recycling and composting if the government was just to meet its recycling target of 30% by 2010. Recycling trade is thriving very well even in our own city total solid waste of 1221734 kg from Kanpur Metropolis goes for recycling per day. Incredible contribution is given by scrap vendors and rag pickers. Waste goes to recycling by selling the goods to scrap dealers but rag pickers pick up any thing recyclable even from lane to lane. A large informal sector is working in very efficient and systematic manner in which around 15000-20000 people are involved in this method of recycling. In our city Kanpur metropolis recycling rate is incredible in each and every household. Solid waste collected and disposal is kept safely till it is sold to scrap dealers as it gives monetary benefit in turn. The mineral water bottles, which are crushed and thrown after use or thrown after few uses, are collected by scrap vendors and rag pickers and are sent for recycling. To the level of surprise this is used in making cheap synthetic sarees and blankets. Although this trade is not regulated by Govt. terms and regulations but it occupies major role and has a big market.

However, the products derived from recycling operations are often not of same quality as original ones, paper derived from recycling is stiff and of a rough quality and has to be used as packing material, in cartons and in corrugated boards

etc. Similarly recycling of trash consisting of polyvinyl chloride (PVC) after retrieval from waste dumps does not yield good quality products. The thin polythene bags and containers made can be reused but the result is hard and brittle material which has to be discarded soon. The material of the transparent plastic bottles consists of polyethylene tetra phthalate (PET) which is capable of picking up poisonous substances from waste dump and it may persist in final product after recycling. It may be released slowly in the material stored in the container made of recyclable material. The problem is thus not solved but only delayed. We need to develop sustainable technologies that sustains longer. Ahmad khan is producing plastic sacks for 20 years in Bangalore. About 8 years ago, his company developed a polyblend, a fine powder of recycled modified plastic. This mixture is mixed with bitumen and is used to lay roads which he says enhances the water repellent properties of bitumen and helped to increase road life. A2Z infrastructure in our city is making RDF (Refuse derived fuel) from discarded plastic which is used in maximum quantity in day to day life.

8.2.1.5 Incineration :

Incineration means burning of the solid waste in proper furnaces, this method is generally used when land is not available for dumping and disposal into the oceans or seas is not possible. Combustible and non-combustible materials from the solid waste are separated so as to reduce the load on the furnace. Combustible components of garbage, rubbish and dead animals are burnt. Proper temperature in the incineration plant, incinerate all the organic matter and oxidize all the foul smelling gases. Incineration is the combustion of waste at high temperature. It uses a wide variety of combustion systems developed from boiler plant technology and also more novel techniques such as molten salt and fluidized bed incinerators. It is burning of waste at a very high temperature so that bulk of waste can be reduced to small volume of ash to be dumped in economically cheaper and ecologically safer way. Also the heat produced during incineration can be tapped to raise steam for turbines generating electricity. Pollution due to incineration is less and very often the heat generated is used to produce electricity. (Incineration is a very important method of disposing bio-medical waste as many infectious organisms are killed).

Friends of the earth opposes incineration for the 80% of municipal solid waste that can be recycled or composted for the some important reasons like it destroys valuable resources, it exacerbates climate change because when materials are burned, more fossil fuel energy is used to replace the products through mining, manufacturing and transportation around the world. Energy from burning waste is not renewable, It determines councils recycling schemes by demanding long term waste delivery because it takes 15-25 years for a waste management company to make a return on their capital investment, the contract between a council and a waste management company requires the council to provide an agreed amount of waste for at least 25 years. It produces emission of nitrogen oxides, particulates, heavy metals and dioxins, all of which are potentially dangerous to human health. It produces bottom ash which may contain heavy metals and dioxins present in the waste burnt, such as batteries. Bottom ash represents one third, by weight of the original waste and still has to be land filled, it also produces fly ash (the fine particles and gases caught in the chimney by filter system) which is undisputedly toxic, containing pollutants such as heavy metals and dioxins. Fly ash is classified as special waste (i.e. hazardous waste) and has to be land filled in very careful circumstances. It is a much more capital intensive and costly approach than recycling. It creates more noise and also regarded as eyesores. It creates very few jobs. The recycling Industry however offers enormous potential for substantial job creation.

Those waste materials not suitable for recycling or composting and not containing plastics or hazardous waste should be considered for incineration (i.e. paper, non compostable kitchen waste etc.) Incineration can reduce waste volume from 80-95% (with an average of 90%) while at the same time reducing the net pollution potential of waste. The ash produced by incineration can be highly toxic and more susceptible to leaching into the environment than the original waste. As a result it is recommended that incineration should only be considered when, well trained staff with proper protective gear to ensure their health and safety are available. No plastic, compostable or hazardous waste material should be burned. Ash must be covered while in temporary storage and during transit. Ash must be disposed off in a properly lined landfill or made stable through mixing with lime and water to produce cement like substance that is relatively leach resistance prior to

disposal. To ensure complete combustion, materials must be burnt between 45-70⁰C min. Optimal temperature for burning waste is 1100⁰C as when burned below 800⁰C produce odorous problem and proper incineration requires constant supply and circulation. However, the bye-products of incineration are toxic ash and certain gaseous products. Burning of plastic produces toxic substances like dioxins. Hence, before burning, the waste should be properly segregated. Ashes are generally dispersed by dumping them in low-lying areas while the solid, residual particles can be used for road construction. Since our theme of the study is Domestic waste only general and theoretical approach has been done and not studied in detail about its working in Kanpur Metropolis.

8.2.2 Suggestive Management Methods :

The prevailing management methods and local authorities efforts prove to be insufficient Municipal refuse dumps overflowing with garbage in many parts of the city are often a sign of inefficiency of services of civic authorities whereas households waste can be easily managed at household level. Some of such methods are suggested below :

8.2.2.1 Sanitary Landfills :

Many of the problems associated with landfills can be controlled through proper planning and design. It is recommended that some points should be considered in redeveloping a landfill as a top cover or cap must be used to insulate landfill from environment. An impermeable bottom liner (HDPE – High density polythene liner) must be used to control leachate. Monitoring of the land fill and surrounding environment - ground water, surface water, landfill gas, atmospheric gas, settlement, leachate should be pumped and re-circulated into landfill to promote decomposition and the collection and extraction of landfill gases should be considered, perimeter trenches may be dug to capture gases. Methane capture can be used to provide energy as 1 kg of dry waste produce 262 L of methane gas.

There were no landfills in Kanpur till the commencement of A2Z in the city for domestic waste management. A 2 Z Infrastructure Ltd. developed a sanitary landfill in plant premises with a prospective of its usage for 30 years in one acre land

area. But in fact that Sanitary Land fill is being used only by A2Z Infrastructure Ltd. to throw debris left out after waste processing. The actual use of it is neglected and recycles still facing with problem of landfills.

8.2.2.2 Individual Contribution to Recycling :

Recycling in Kanpur city is mainly carried out by scrap vendors and dealers. A large group of people is engaged in recycling trade. There is no alliance between formal and informal sectors dealing with waste collection. Hence, there is no accountability of total solid waste generated and recycled. Therefore it is suggested to establish solid waste collection centre in every ward with easy accessibility from households, so that every type of waste from small broken parts to intact items can be sold out at the collection centers of respective wards. From the collection centers different types of waste like plastic, paper, metal, glass, linen etc. can go to recycling units as per requirement. Waste from households are not segregated and disposed in a heterogeneous state. Therefore the concept of saving time, money and resource by recycling fails, so the households must dispose the waste separately so that time, money and man power utilized in segregation can be saved. An individual can contribute to recycling by segregating waste at house. The different types of waste generated at home should be segregated in different categories like bio degradable and non degradable with sub categories of recyclables and non recyclables. Recyclable waste like plastic, paper, glass, metal, linen etc. should be separately collected. And the different types of metals like copper, tin, aluminum, iron etc should further be kept separately. All these segregated waste separately and properly should be brought to the collection centers of waste disposal mandis designated by Nagar Nigam. Depending upon the prevailing situation we recommend the development of collection centers in every ward with easy accessibility to household or waste disposal mandi. And the common mass should be made well aware of these centers. As of now even if the people keep different waste separately at homes due to lack of disposal points it is finally thrown randomly and only such waste are kept which give lucrative returns. Such waste given to scrap vendors has no accountability till date. If disposal of recyclables is done systematically it gives better returns and helps to achieve the concept of

recycling that further helps to save time, money and resources. Even the discarded packing material which is the menace of the modern society if thrown after use, we see heaps and litters of polythenes everywhere in the city, is commonly used in making RDF (refuse derived fuel) pellets that are consumed in boilers of industries. So it is strongly recommended that all packing material should be collected and sent to disposal sites of mandis or RDF making plants. Vendors or helpers (Safai Mitra of Nagar Nigam) can also be employed in collection. Hence all types of segregated waste from households should be properly disposed on collection centers of waste disposal mandis designated by Nagar Nigam in every ward. As discussed there should be waste disposal mandi like we have the facilities of Sabji mandi, Fal mandi, galla mandi etc from where a purchaser, owners of recycling factory purchase segregated waste like copper, aluminium, tin, iron separately and the waste quickly gets recycled under monitored state. The whole guidelines and supervision for the process would be of Nagar Nigam and State Pollution Control Board.

8.2.2.3 Composting at Individual Level :

Composting can even be done by individuals in their home gardens or backyard of buildings. During composting, kitchen waste containing fruit and vegetable peels, leaves, left over food, etc., are buried in a small pit and left for over a month. Bacterial decay converts all this waste into manure.

8.2.2.3.1 Domestic Composting:

Since Organic waste is generated daily in households, composting can also be done at home, it is very simple, easily handled. It helps to reduce organic waste at source point and also avoids the side effects of degradation till processing.

1. Dig a compost pit or use old, large 200 litre drums.
2. Remove the top and bottom of the drum.
3. Bore 3-4 holes on the side of the drum about 25 cm from the base and some more holes about 50 cm from the bottom.
4. Spread a layer of sugarcane bagasse at the bottom, about 5 cm thick.
5. On this keep spreading kitchen waste daily.

6. Sprinkle water on it daily.
7. When the garbage reaches the level of the first holes, plants a sapling or some seeds.
8. Spread another layer of bagasse and continue putting the garbage in layers.

In about a month's time, the garbage will get converted to compost and manure, which can be used as a fertilizer.

8.2.2.3.2 Advantage of Composting:

Farmers use natural fertilizers like manure and compost containing many nutrients and add to the crops. These do not pollute and excess does not harm the crops. Organic farming reduces pollution and ensures self-sufficiency. Fruits and vegetables grown organically are easier on the digestive system and even taste better. It provides nutrients to the soil, as it is rich in nitrogen, phosphorus and potassium. It improves the water holding capacity of the soil and provides trace elements like copper, molybdenum, manganese, magnesium, etc. also it helps to bind the soil and reduces soil erosion. Hence manure is considered as a soil conditioner.

8.2.3 Managing Agents :

The statistics of waste management is getting affected by increasing per capita income, urbanization, modernization, industrialization and in the last but not the least common man's careless attitude and city's waste increasing by leaps and bounds. As per waste handling and management rules 2000 the collection and treatment of municipal waste is one of the basic facility that has to be given by local civic authorities, but in Kanpur metropolis it is highly uneven, inadequate and inefficient. Along with it the required process are not genuinely followed and needs to be monitored at every step. Waste management is not only government's responsibility but in fact is a collective effort. Civic Authorities are unable to combat the menace of increasing quantity of the city waste. Thus as per the waste handling and management rules 2000, Municipal authorities further give it to private agencies. Therefore it is done with the support of private agencies. In Kanpur, Kanpur Municipal Corporation (Kanpur Nagar Nigam) has given the liability of

waste collection and treatment to A2Z Infrastructure Ltd in 2010, on contract basis for 30 years. An NGO named Kanpur Parivartan Forum is also working in the city for the objective of waste management at source point (Households level). But all these prevailing methods of waste management in the city prove to be inadequate. Therefore for total resource recovery every citizen also needs to be the part of proper waste handling and management. Thus in the sub section of managing agents waste management at organizational level is discussed in one hand and on the other hand waste management at individual level is also discussed as it has been given importance due to its sustainability.

8.2.3.1 Organizational Level :

According to the guidelines of Supreme Court for handling and management of waste which is increasing by leaps and bounds Municipal Corporation can take help of private agencies to handle it in a better and efficient way. In Kanpur Metropolis Kanpur Municipal corporation gave a 30 years contract to A to Z Infrastructure Ltd for an integrated solution to city waste. A large fleet of vehicles, skilled and efficient staff of Nagar Nigam and A2Z Infrastructure Ltd is working in collaboration since year 2010. Prior to that, Kanpur Nagar Nigam was simply collecting and disposing the waste till designated dump site. Waste disposal conditions improved with the working of A to Z Infrastructure Ltd. Besides that an NGO named Kanpur Parivartan Forum is also working since 2008 and its efforts are at small scale, but the objective of awareness and waste management at source point i.e. at the household level is very strong with lasting effects. To accomplish its objective the forum provides composting unit to families. Hence, we observed that at organizational level public, private entities as well as NGO's are working for smooth and efficient management of solid waste in the city which have been discussed as below:

8.2.3.1.1 Role of Public/Private Agencies :

A2Z Infrastructure Ltd is playing very important role in city waste management with an approach of integrated waste management. Although its efforts are not sufficient till now but collection rate has improved rather doubled from 400-500 MT to 1000-1200 MT. Scattered heaps of garbage everywhere in the city is the

synonym of city's name. Under MSW rules 2000 Solid Waste Management is the responsibility of city administration and so door to door collection of waste was given to A2Z Infrastructure Ltd till its disposal to Panki Bhausingh dumping ground and management. According to strict order of honorable Supreme Court, MSW Rules 2000 is to be implemented in the city. The city municipal corporation, have to implement the standard process either by itself or by taking help from private agency. Keeping this in view 30 years contract was given to A2Z infrastructure Ltd. A very well planned, organized collection of waste from every house hold by door to door collection covering even narrow lanes of city and sending it to dumping ground for processing was the ideal implementation of supreme court order in context to municipal waste management to get rid of huge mounds of waste dumped here and there. Garbage after processing gets converted into manure and the residue is used for making interlocking tiles. Along with 100 tones of manure daily 250 tones green coal is also produced. In this manner 90-92 % of the city waste is utilized in making commercially and environmentally useful products leaving behind only 8-10% inert material which is dumped in sanitary landfill. The complete process helps to get rid of littered garbage along with 100% resource recovery. Production of 15 mw electricity is also planned using the RDF, produced in the plant out of plastic pouches and polythenes. A2Z company with collaboration of Nagar Nigam although collecting waste door to door still proves to be insufficient and the city is covered with numerous heaps of garbage. Waste that was supposed to be collected properly is scattered everywhere. Initially with collection of waste from door to door by blowing whistle, streets were also cleaned. Later the company got involved in making manure from waste, interlocking tiles and green coal (RDF-refuse derived fuel) and fully concentrated on it. Now A2Z Company is concentrating more on processing of collected waste, only earning and making plant shine to get contract from Municipal Corporations in other cities. The situation of the city is deteriorating due to heaps of garbage, littered waste everywhere. Initially the entire process started with the trained and efficient staff and big fleet of vehicles but gradually the system started failing due to financial, institutional, social and political issues. Education training and mass awareness governs waste collection and processing. Lacking focus on social, environmental and awareness issues A2Z at

present has almost failed. Moreover rate of waste generation is much more than the rate of waste processing. Due to which heaps in and around Plant is increasing, causing inconvenience to local residents with numerous uncontrolled illegal garbage heaps in the city making the city worst than hell.

8.2.3.1.2 Kanpur Parivartan Forum :

Kanpur Parivartan Forum is an initiative of informed and concerned citizens of Kanpur who believe in working together towards making continuous holistic improvements in the city. The silent working of the Forum is incredible. Founder member Mr. Ganesh Tewari incepted the Forum in the year 2008 with a mission to make people of Kanpur environmentally aware and responsible for the greenery and cleanliness of the whole city. Kanpur Parivartan Forum is a NGO group of 1700 members under the administration of Mr. Amit Tiwari and Mr. Anil Gupta. Objective of the forum is to provide a platform for like minded citizens of Kanpur to share and discuss their ideas, identify the problems of the city and search for a possible solution. The forum also helps to seek people's participation and co-operation in implementing sustainable solutions for making Kanpur a clean and green city. Forum also encourages developing a sense of belongingness towards the city, motivating citizens to take ownership of the city and feel proud of being a resident of Kanpur. In the year 2008 door to door collection of domestic waste in Swaroop nagar and its proper disposal to designated dumping sites was initiated by Kanpur Parivartan Forum. The Forum is concerned for the present state of air and water which are the basic needs for living hence putting forth the concept of organic waste management at source point. Kanpur Parivartan Forum also promotes composting on house to house basis. Forum helps to get three tier terra cotta composting unit in which all kitchen waste and dry leaves are utilized in turning into compost. The kit is beautifully made of pots and easy to use with an affordable cost of Rs. 4000/-.The composting unit is also called as "Khamba Composter". Members in the forum contribute in clean up, removing of weeds, pruning of shrubs and plant new plantations. Forum encourages citizens to adopt composting and turn surroundings clean and green. Forum is against the burning of waste as it produces Dioxins and adds to air pollution in the city. The commendable tasks taken up by the

Forum is showing colors now and the day is not far when it will gain attention of civic authorities as well as common mass of the city.

8.2.3.2 Individual Level :

Individual level means waste management at household. Households are the bottom unit of management hierarchy, where disposal of waste will be managed at micro level. We can say at residence level or waste management at individual level. The major problem for managing the disposed waste is that the domestic waste is not segregated at the source which is more essential than the disposal because if the segregation will take place properly then segregated waste will be utilized properly for further uses which is our main objective. Hence role of individual is most important and basic requirement of waste management strategy because households are responsible for the generation of heterogeneous waste. Then a costly and complex technical process is required for separation, transportation and processing. Approximately 1000-1200 MT heterogeneous waste is generated everyday in the city which fails the concepts of recycling. Complete resource recovery target can be achieved only with individuals participation by considering segregation as the first and foremost step of waste management which should be done at household level. Waste should be segregated in broadly two categories – biodegradable and non-biodegradable. The bio degradable or organic waste should be composted with the help of small composting units made at home or by readymade composting units which is not popular but available in market now a days. The non biodegradable should further be differentiated into recyclables and non recyclables. The recyclable waste like plastic, paper, glass, metal linen etc. should be kept separately and when a desirable quantity gets collected it should be sent to or disposed off on the collection centers of waste disposal mandis designated by Nagar Nigam in every ward as discussed in sub section 8.2.2.2 individual contribution to recycling. And the non recyclable mainly packing materials like milk and oil pouches, polythenes etc. should be collected. On sufficient collection it should also be disposed on the collection centers from where the plants making RDF (Refuse derived fuels) pellets can further purchase for it making RDF pellets to be used in boilers of industries. So that even packing materials, nuisance of the present society can be utilized.

8.3 Liquid Waste Management :

Water consumption in the city is commonly very high due to easy availability of underground water which is available at 90 ft and drinking water available at 150 ft and water from river Ganga. On an average, 400 L water is required per person per day and hence disposed in large quantities. With increasing population a lot of stress is being laid on city sewerage system. Old and inefficient drains are clogged and remain flooded. The sewage treatment capacity is also too less than the daily disposal in the city. In our study we have given an option that reduces the stress on sewage treatment plants as well as consumption also. The water that is disposed from kitchen and bathroom can be collected in a storage tank. After a normal process of sedimentation and microbial action it can be reused in various activities like gardening, house cleaning, vehicle washing, etc. 27 lakh population of the city disposes approximately 10 crore litre water per day, but on the same hand if recycling of water is practiced only drinking water would be required and all other necessities would be completed by self treated water available at home. Disposal of kitchen water can be used in gardens or watering plants, disposal of bathroom can be reused in flushing and other activities like vehicle washing but leakage should be completely avoided. In 2001, the government officially instructed all departments to set up rain-water-harvesting system; however the orders were incautiously overlooked. Till date the rain-water-harvesting systems have worked out only in the medical college commissioner's resident, the office and resident of the *Vice President* (Kanpur Development Authority), Hartcourt Butler Technical Institute (HBTI), Gandhi Bhawan, Phool Bagh, and the Polytechnic Institute. Besides this the Underground Water Department has planted the rain-water-harvesting system in Sanjay Van and Vikas Nagar. The government has made it mandatory for the rain-water-harvesting system to be planted in 200 square meters of residential area; however, only a hundred houses have been privileged.

8.3.1 Composition of Domestic Effluent :

Domestic sewage consists of decomposable organic matter, besides several pathogenic organisms, these wastes contain putrescible materials which are responsible for obnoxious conditions and irreparable damage to aesthetics of our

water environment. The sewage contains large amounts of domestic wastes including human and animal excreta, washing water, microbes (many of which are causative agents of diseases) and everything enters sewerage system.

Chemically the sewage consists of approximately 99% water and 1% solid waste including inorganic and organic matter. The micro organism present in sewage include bacteria (coli-forms, streptococci, clostridia, lactobacilli etc.), micro fungi, protozoa and micro algae. These micro organisms carry out natural treatment of sewage. Detergents are used to wash clothes and to clean utensils particularly in every house. Phosphates, nitrates, ammonium compounds and alkyl benzene sulphonate (Abs) etc are accumulated in water due to the use of detergents.

8.3.2 Disposal of Domestic Effluent :

It is surprising to know that about 800 million gallons of sewage is produced in our country per day. About 30% of it comes from urban areas and only 20% of one day sewage production is disposed off properly after proper treatment and rest remain untreated. When domestic effluent poured into water bodies like river, pond or in some open space untreated causes algal blooms and leads to oxygen depletion. The rich amount of carbon, organic phosphorus and nitrogenous compounds in domestic sewage also favour algal bloom. This reduces oxygen in the water which results in decaying of plant species and clean water turns into stinking water. Besides, sewage results in epidemics of fatal diseases as cholera, typhoid, dysentery etc. So common man need to extend his contribution by adopting some measures to control water pollution and related issues.

The kitchen out flow system for grey water is not presently functioning in an environmentally sustainable. It employs a typical “drain out back” approach with soils capacity for purification over loaded as a result of high discharge. This leads to ineffective filtering of pollutants that is organic waste, soap etc from kitchen grey water being released into the environment. An improved bio filtration system should be developed with potential application to grey water out flow system. The kitchen system deserves priority as it releases the most water into environment from single source. A strain of *Pseudomonas Aeruginosa* has been developed capable of reducing viscosity and surface tension of the oil water interface.

Some recommendations are advised to improve the existing situations like, Pre filter screens should be used on drains to prevent larger particles from entering the bio filtration system. A grease trap should be bought or built to collect animal fat and vegetable oil. Grease trap work by trapping grease/ oils which float in water. Passive grease traps must be maintained and cleaned out regularly. Construction of the branch drains system which splits out flows from kitchen into several covered and more manageable flows.

- Uses T shaped pipes to divide large flow over a greater area increasing the infiltration potential of grey water.
- Uses a series of mulch basin filled with wood chips from hard wood trees species which function as excellent pollution absorber.
- Native wet land vegetation could be used in a series of artificial wet land to further cleanse and absorb grey water.

8.3.3 Management of Liquid Waste :

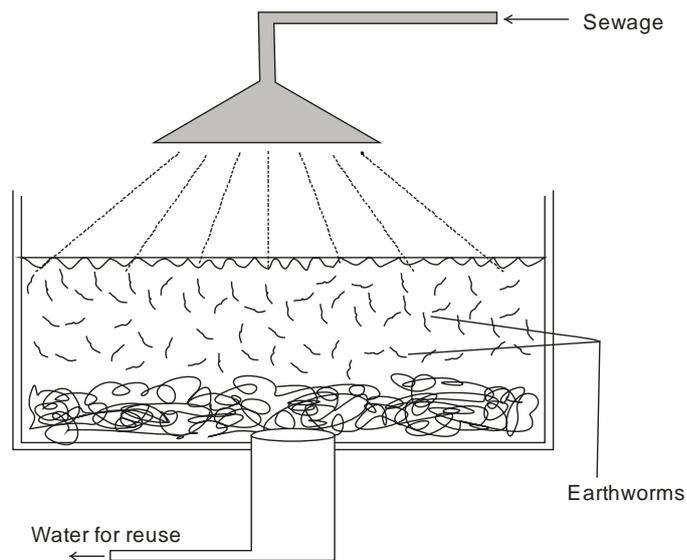
The pollutants present in the domestic effluent are biodegradable and can be effectively treated with microorganism and decomposed to simple harmless constituents. The biological treatment is rather an inexpensive treatment. It not only eliminates the pollutions but also provides economically useful products. The excellent microbial agencies of nature can efficiently degrade the waste. Problems arise when large amount of organic waste are produced. The microbial machinery is unable to handle such huge quantities in given space, time and conditions. Human skill has tamed nature's microbial machinery to work at its maximum efficiency within a contained space. This has enabled man to dispose of large quantities of biodegradable waste quickly, efficiently and with little expenditure. The microbial populations grow and multiply in between the sand and gravel particles. These include various bacteria, green and blue green algae and diatoms in the upper zones where plenty of light is available. In the lower zone various fungi, bacteria, protozoans and other small animals which live on the dead and decaying organic matter are found. Passing through biologically active layers oxidize much of the organic matter present in the waste water. These microbes rapidly decompose most

of the organic matter present in water. Water treatment can be done at small domestic level as well as sewage treatment by city water treatment plants.

8.3.3.1 Domestic Management of Liquid Waste :

As we are aware that the total disposal per day is 10 crore lt. and treatment capacity is only 371 mld per day. A major contribution of citizen can be forwarded by collecting, storing and reusing after basic microbial action. Household detergents liberate phosphates, nitrates, ammonium compounds and alkyl benzene sulphonates in water. Proper collection and disposal of domestic sewage is most important step for preventing water pollution. Phosphates can be precipitated and further removed from the water reservoirs with the help of lime, ferric chloride, calcium hydroxide alum etc. This can be achieved by using septic tanks, oxidative ponds and filter beds. In rural and semi urban areas sanitary latrines should be provided for the public. For Indian condition pour flush latrine is the best suited. The system provides safe collection of excreta without exposure to flies and scavengers and free from foul odors. In this systems excreta is digested and converted into innocuous humus material which can be used as manure. There are certain algae and bacteria used for natural purification of water. Bacteria consume the organic matter. Algae produce oxygen for bacteria. The components are allowed to collect and then shifted to settling tank. The effluent which is now almost clean of organic matter is removed from the upper side of settling tank. It is then chlorinated to kill micro organism.

Several institutions like Sanjeevan Vidyalaya at Panchgani use vermi culture technology to solve the problems of sewage disposal and water shortage. The sewage from the Sanjeevan Vidyalaya hostel is fed into a vermin processing plant where earthworms convert it to vermi castings, releasing clean water in the process.



8.3.3.2 Natural Depollution :

In large lakes and rivers pollutants are disposed to some extent by nature. Some solid organic pollutants settle down to the bottom others are pushed ashore by wind, still others are decomposed by micro organism. Night, cool water, sunlight disinfects water.

8.3.3.3 Municipal Management of Liquid Waste :

The Central Pollution Control Board is taking effective steps to promote this cost effective method of sewage treatment. In Kanpur Metropolis the existing sewage treatment facility with 5 mld, 36 mld and 130 mld treatment plant is operated and maintained by Jal Nigam and Jal Sansthan located at Wajidpur, Jajmau. Municipal sewage treatment is carried out in the following two stages –

1. Primary Treatment :

Primary treatment of sewage is mostly mechanical and concerned mainly with the removal of coarse solid materials through filtration and sedimentation. First of all the sewage, diluted with water, is passed through a series of filters of sequentially small pore sizes to remove large floating objects like polythene bags. Then the filtered sewage is passed into the grit chamber where coarse solid materials (sand, small pebbles, etc.) settle down by gravity. After this the sewage is allowed to pass into a sedimentation tank where most of the suspended material settles down.

This concentrated solid material that settles down forms the primary sludge. The effluent is then taken for secondary treatment.

2. Secondary Treatment :

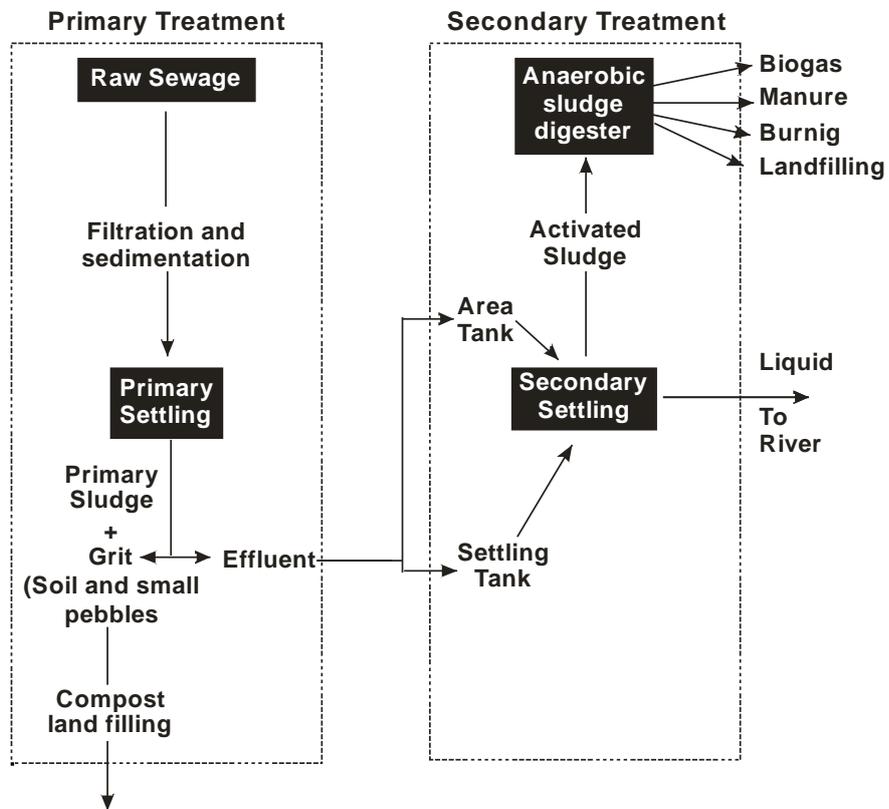
Secondary treatment of the liquid effluent from the primary settling tank is purely a biological treatment involving microbial activity. First of all, the effluent is passed into large aeration tanks where it is constantly agitated mechanically. The air is allowed to pass through agitating mixture in sewage. The aerobic microbes consist of micro algae (*Chlorella pyrenoidosa*), micro-fungi, bacteria and protozoa. These aerobes grow in “flocs” and consume a major part of organic matter so that the Biological Oxygen Demand of sewage is reduced. Now the effluent is passed through a sedimentation tank where microbial ‘flocks’ are allowed to settle down. The settled material is called ‘activated sludge’.

The activated sludge is collected and subjected to anaerobic digestion in separate tank. This tank has oxygen free atmosphere where anaerobic microorganism start digesting the bacteria and fungi in the sludge. The anaerobic micro organism digests the organic matter into soluble substances and gaseous products (a mixture of methane, carbon dioxide and hydrogen sulphide). This gas is highly inflammable and can be used as biogas. Finally the treated sewage effluent is subjected to chemical treatment for disinfection before releasing it into natural water bodies like rivers and streams.

Importance of microbial treatment of sewage :

Prior to year 1985, only few cities and towns had sewage treatment plants. Most of the sewage water of urban as well as rural areas was discharged directly into rivers resulting in their pollution. Importance of microbial treatment of sewage was then realized and more sewage treatment plants were established. Still, they are not sufficient due to increasing urbanization and production of much larger quantities of sewage as compared to earlier days. Realizing the importance of microbes in pollution control, the ministry of environment and forests has initiated development of sewage treatment plants under the National River Conservation Authority e.g.

Ganga Action Plan and Yamuna Action Plan to save these major rivers of our country from pollution.



Flow chart of sewage treatment