Sustainable and Affordable Sanitation Solutions for Small Towns

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Lecture - 17
Introduction to liquid waste treatment technologies

Hello everybody hope the course is going on well. As you have seen until now this is not a normal academic course we are actually learning by doing through some interventions in a specific context. Last week we focused on the problem of sanitation in Alappuzha. In general the lectures focused on situational analysis of wastewater management in the city and followed a stepwise approach to understand the problem at the town level.

Also last week we introduced something called fecal sludge management, fecal sludge is the slurry that accumulates in your onsite sanitation systems like this septic tanks. If it is not removed periodically it can potentially contaminate the soil and groundwater. Having understood the problem this week we will look at the solution space, particularly we will explore the different alternatives to tackle the problem of liquid waste management. We will start with different wastewater treatment technologies, this will be taken by Professor Pradip Kalbar of IIT Bombay and it is a very technical presentation.

He will be explaining the conventional model of wastewater treatment, the various processes involved in treatment of wastewater and different types of collection systems. Since our interest is in more sustainable and participatory models we will be looking at decentralized models, for that we move on to a practitioner architect Latha Jayagopal, she will explain the concept of decentralized wastewater treatment and how she has deployed it in one canal in Alapura.

Good afternoon I have been told that you have been already expert of decentralization I will not spend my time on why decentralization or why it different approaches. But how to achieve decentralization and what are the different technology technological options we have that I will cover in this presentation and wherever you have questions you can ask.

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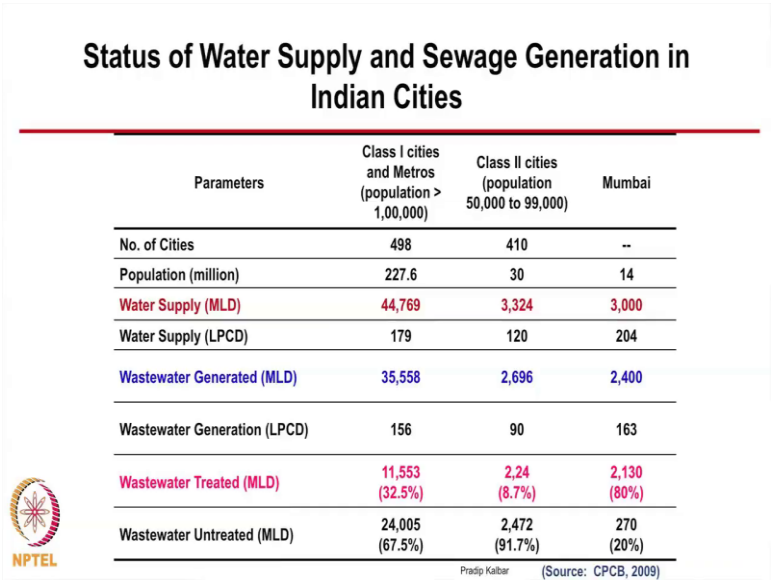

If you see this particular slide where I have put a status of water supply and waste water treatment in India and as you can see there is huge gap between water supply infrastructure that has been created in India and how much waste water treatment is required. So, there is a tremendous gap between generated waste water or here in this particular session we talk about sewage which is domestic waste water.

So, there is a gap between sewage generated and sewage treated ok. So, and these newer funding schemes from central government or state governments are focusing on matching this gap between the sewage generation and sewage treatment. So, there is a huge amount of funding going to come still it is already it has come and but we are like and there are so many technologies available for wastewater treatment and which one to go from when and those kind of guidelines are still not there.

But overall as expert when you grow in this field you will understand what kind of technology choice will make in given situations. So, I have this all classifications of technologies and I just touch upon the basic principles of how these technologies works and some case studies where those have been applied that is the overall frame of this particular representation ok.

So, waste water is basically defined by 2 aspects, it is quality and the flow and both needs to be considered in the design. It is not only the quality that will govern the size of

a treatment plant, but it is also the flow and flow has a different aspect that I will cover. So, it is quality and flow both needs to be taken in to account.

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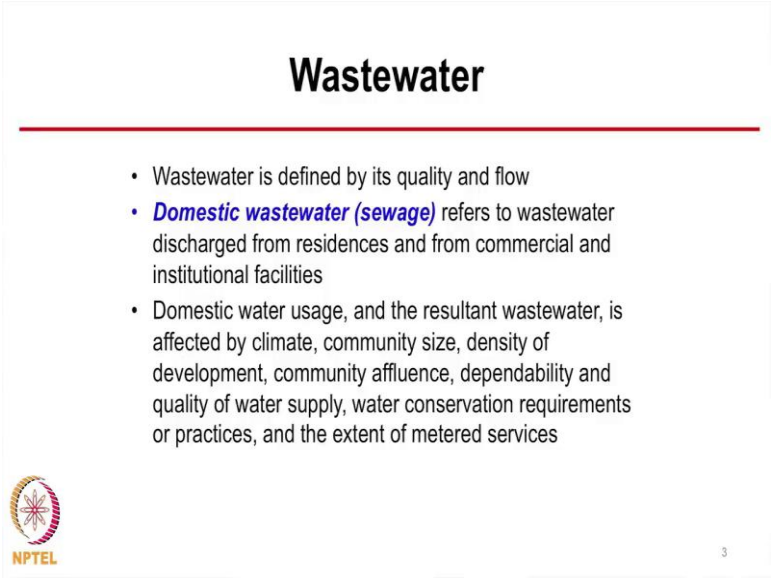

And basically we are dealing with domestic wastewater which is sewage from the urban areas or rural areas from the housing societies, the houses and sometimes we have some small commercial facility that also discharged their wastewater and that is accommodated into sewage ok. Or institutional like this institutions, colleges or some of the institutes that also needs accounted in to domestic waste water.

And how the domestic water basically varies is basically on the use and the resultant waste water is affected by climate, community size, density of development, community affluence, dependability, quality of water supplies and water conservation practices. So, these are all; these are all practice that will affect the quality or quantity of waste water generated.

For example, a city such as Mumbai we will have very different kind of waste water characteristics than cities such as Kochi or Jaipur because these have very different climatic conditions very different water culture and that affects the waste water quality and the quantity. So, we will discuss that I think you have been exposed to the this terminology.

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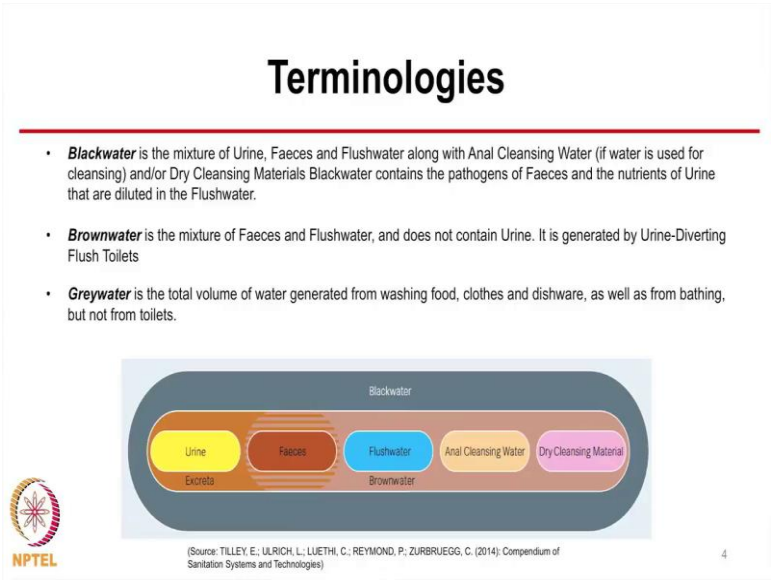

Sewage is the mix of everything and if you just decipher in to what is how sewage forms is basically forms from the black water, from the brown water and the grey water. Black water is the mixture of urine, faeces and the washing water that we use. Brown water is the mixture of the faeces plus fresh water, but when you have the urine separate in urine separated toilet you get a brown water. And the grey is from kitchens and bathrooms that we gave and in a city scale we mix all these free flows and we get the sewage typically.

So, we remember this particular classification and I guess you already have been exposed and these are the typical characteristics per which environmental engineers classify the sewage.

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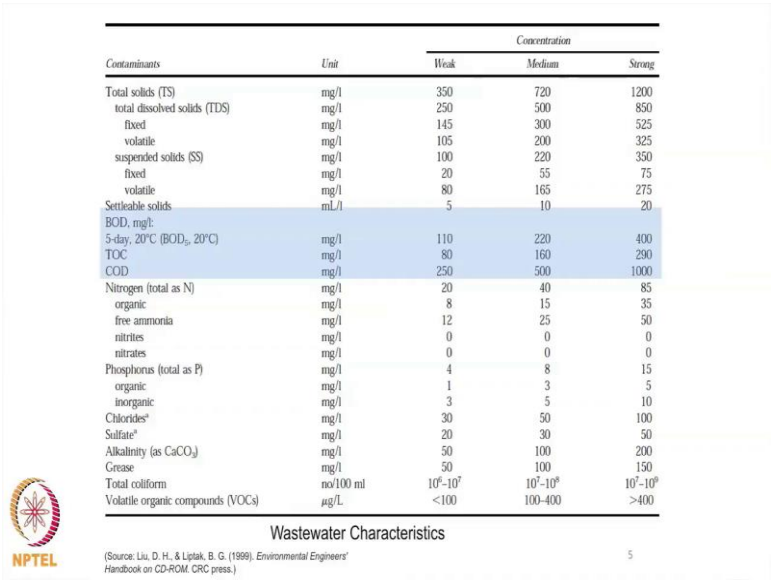

Basically we call weak, medium or a strong waste water depending on the type of its characteristics. The main concern in this particular characteristics which is this particular value which is this biochemical oxygen demand and chemical oxygen demand ok. These two this particular parameter you see this varies, here it is about 100 here, it is about 200 here, it is about 400 here. So, more the strength of the BOD a more the basically we classified as a more strength or more intense sewage. And BOD everybody understands? Clear.

Student: Yes sir.

Anybody needs any explanation of BOD? Yes so, basically yeah any other so, people who understand BOD, what is BOD?

Student: Biological or Biochemical Oxygen Demand.

Do not tell me the long form tell me the, what is it means, quickly?

Student: Oxygen required.

Oxygen required for what?

Student: To biodegrade.

To biodegrade right, but why we do why we measure BOD? What is the reason we measure BOD?

Student:

Organic to know the?

Student: Organic matter.

Organic matter and?

Student:

It is requirement, oxygen requirement. So, basically BOD is a not a direct parameter, it is proxy parameter ok, remember BOD COD are proxy parameter for organic pollution ok. So, because measuring the total organic carbon is difficult and it is costly and hence to avoid that we have this measurements called as BOD and COD which are proxy for TOC. So, more the basically oxygen demand of a particular organic compound it will exert more BOD, it will exert more COD ok.

So, and the basically COD accounts for both bio degradable and non - bio degradable component of the oxygen demand. So, basically for this classification we have the weak, medium and strength as 3 sewage classification and depending on that the technology choice differs, whichever flow you get in this particular concentration your technology choice will defer ok, that is the first principle you should remember.

First of all check the BOD according the BOD your classification or the technology choice will change. This these are the; these are the main spectrum there you should do look into and what we want to achieve from this is basically we have to treat, but treatment up to what level is also question that we should not we should have some goal that at what level we should treat our waste water.

So, we have the minimum discharge standards set up by the central pollution control board and those gets keep updated. So, we can just go on center pollution control board website and get those different discharge standards.

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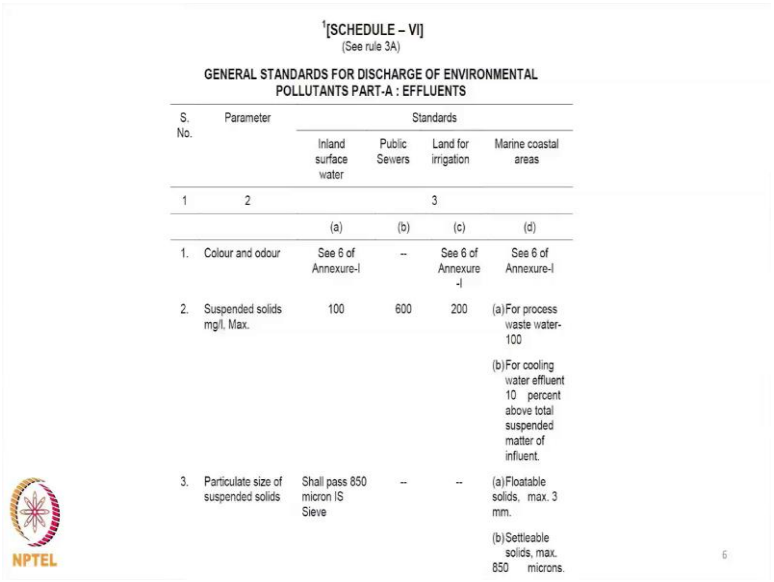

[1][SCHEDULE – VI]
(See rule 3A)

GENERAL STANDARDS FOR DISCHARGE OF ENVIRONMENTAL POLLUTANTS PART-A : EFFLUENTS

S. No.	Parameter	Standards			
		Inland surface water	Public Sewers	Land for irrigation	Marine coastal areas
1	2	3			
		(a)	(b)	(c)	(d)
1.	Colour and odour	See 6 of Annexure-I	--	See 6 of Annexure -I	See 6 of Annexure-I
2.	Suspended solids mg/l, Max.	100	600	200	(a)For process waste water- 100 (b)For cooling water effluent 10 percent above total suspended matter of influent.
3.	Particulate size of suspended solids	Shall pass 850 micron IS Sieve	--	--	(a)Floatable solids, max. 3 mm. (b)Settleable solids, max. 850 microns.

So, these are the typical discharge standard which is under this particular environmental protection act Schedule 6 under that we have this particular environmental.

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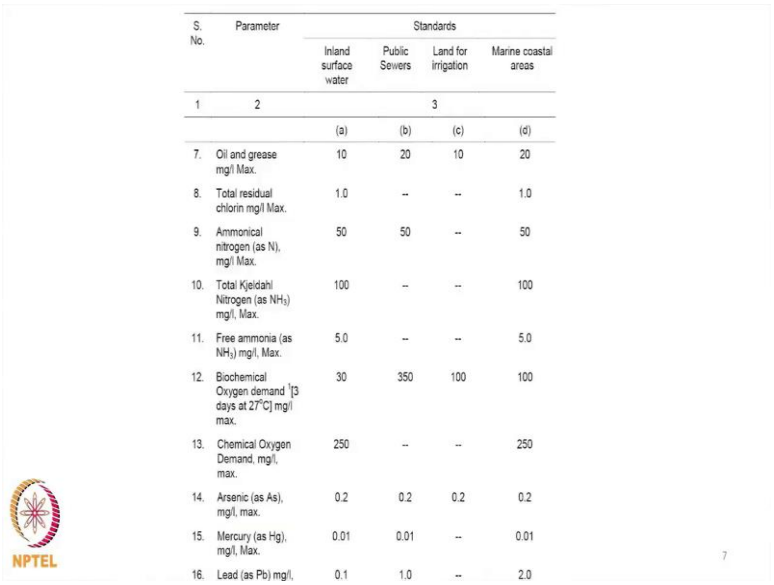

S. No.	Parameter	Standards			
		Inland surface water	Public Sewers	Land for irrigation	Marine coastal areas
1	2	3			
		(a)	(b)	(c)	(d)
7.	Oil and grease mg/l Max.	10	20	10	20
8.	Total residual chlorin mg/l Max.	1.0	--	--	1.0
9.	Ammonical nitrogen (as N), mg/l Max.	50	50	--	50
10.	Total Kjeldahl Nitrogen (as NH_3) mg/l, Max.	100	--	--	100
11.	Free ammonia (as NH_3) mg/l, Max.	5.0	--	--	5.0
12.	Biochemical Oxygen demand [1][3 days at 27°C] mg/l max.	30	350	100	100
13.	Chemical Oxygen Demand, mg/l, max.	250	--	--	250
14.	Arsenic (as As), mg/l, max.	0.2	0.2	0.2	0.2
15.	Mercury (as Hg), mg/l, Max.	0.01	0.01	--	0.01
16.	Lead (as Pb) mg/l,	0.1	1.0	--	2.0

Discharge standards what we need is how much basically BOD and COD and nitrogen is allowed to discharge in a given treated if you are treated waste water for different classes such as inland surface water, such as public sewer this is for irrigation and this is for marine coastal areas ok.

So, as per this, whether to treat or whether not to treat, if city has it is own sewage treatment plant and if you have access to public sewer then you can really do not have to worry about your sewage ; that IIT goes to the sewer and municipal waste water treatment plant should take care, that is the ideal situation based on that these guidelines are basically fixed.

So, and but when you when you do not have that particular facility and when you have when you have a have to dispose your sewage into such kind of canal or such kind of river or a lake you have to meet BOD standard of 30 and those are becoming more seriously with the new regulations ah, but this has some logic why 30 because that much carrying capacity our particular this rivers and lakes has ok.

So, there is lot of modeling goes into to fix this particular discharge standard, assuming there is some carrying capacity available in the natural body and as we push ourselves from 30 to 20 to 20 to 10 to 10 to 5 the cost of the treatment goes tremendous. So, up to 30 all technology spectrum has some comparison ok, but as we push below that your costing becomes very different very different, hence the basically 30 is a very safe number 30 to 20 cost will be tremendous.

And then you have trend now and you know this the second thing you should take of centralized and decentralized systems and I think you have trade what is the advantages and disadvantages.

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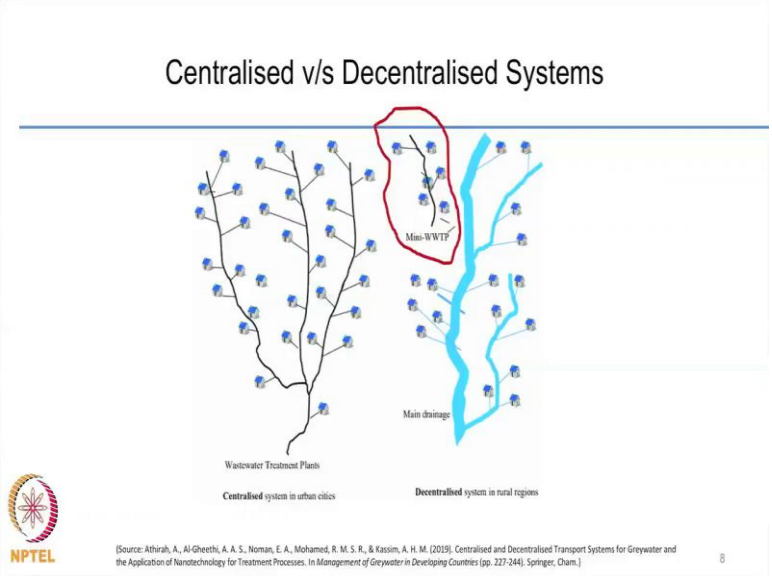

And such kind of small scale treatments, cluster treatment or house level those goes into the decentralized system discussion. And if you talk about the approaches for waste water management I call the term not the treatment, but the management, because it is a strategy it is not the one technology if you can solve the problem you cannot be doing that, but that is not the solution. We have to look at the how what kind of management approach we should have for solving this problem.

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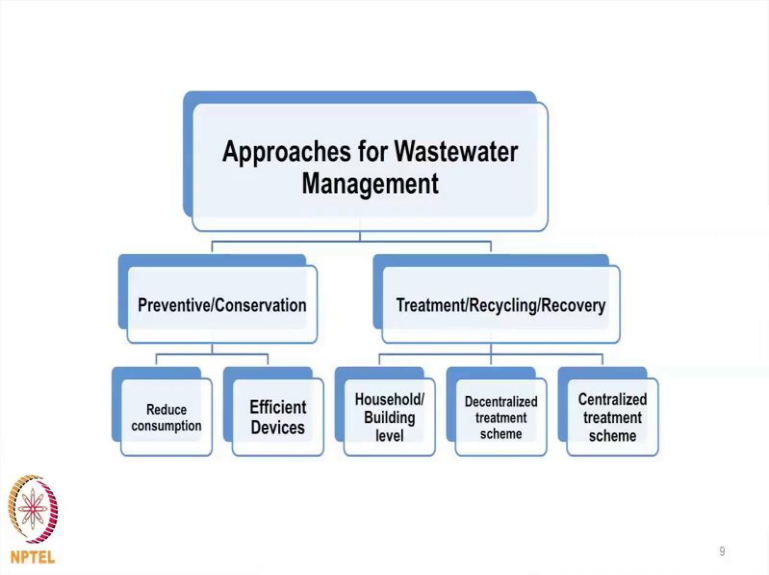

So, first is the prevention and conservation. So, before creating the sewage we should try to minimize it is quantity ok. So, how we can do is, that is the reduce consumption with this public awareness such as you have right Canalpy other such initiatives. So, reduction in the water consumption will give you the most basically less, lesser flow, but whether your organic load will deplete? your BOD will go down or go up? If you reduce the consumption, let us say in all of we decide from tomorrow we cut off 50 percent of water supply everybody agrees and what happens to your BOD then?

Student: More .

More?

Student: More.

Or less?

Student: More.

Because I have cutting down 50 percent of the water supply.

Student:

So, water will be more concentrated right. So, whether it is good or bad?

Student: Bad.

Bad, bad for whom; bad for whom?

Student:

These all question needs to be answered and then we can say something about it right, hence forth as a human being I like it is not bad for me because more strength be honest handling more strong sewage with less volume is more easy than having a sewage with the diluted BOD and the more volume. So, if for example, Jaipur sewage is more easy to treat than Mumbai sewage, because Mumbai is a huge flow and BOD a lesser than Jaipur because if Jaipur has a very concentrated BOD of about 500 400 whereas, Mumbai BOD will be of 250 ok.

Because it gives me advantage in terms of cost because it my reactor will be very getting a continuous flow that will come in to when we talk about the how the reactor works. Hence our particular this reduction in consumption will give me 2 advantages; one is direct saving in terms of water consumption and second is I will get a more strong BOD in the sewage and that will be more easy to treat in a effective manner that having a very diluted sewage in that kind of thing ok.

And for that second strategy the efficient devices and fixtures and fittings and there can be many more things that you can have efficient devices for reducing the water consumption. So, this two particular approach is one is prevention conservation and then the basically recovery, recycling and treatment. So, read it from right to left such as recovery, recycling and treatment ok.

So, recovery in terms of we cannot have a nowadays treatment only for the sake of treatment, because of the cost involved because of the kind of operations and maintenances that these treatment technology is required, spending so much money is

not possible for government bodies. Hence we should have such a plan such that we can recover the energy, nitrogen, phosphorous and resources and then whatever treated effluents we should recycle and hence the treatment, not the only for the sake of disposal ok.

That is the whole paradigms of waste water management we are going into and in terms of how we enable these 3 things is, one is household or building level treatment that is the where the starting point of the discharge is. Second is decentralized treatment schemes and third is the centralized, when you have collected everything together and when to when to call something decentralized and centralized they are not fixed guidelines those we are basically they have been depend upon the population density depending on the city scale.

So, but as soon as you decide that I do not want to create only one single treatment plant at for given location you are thinking in decentralized manner.

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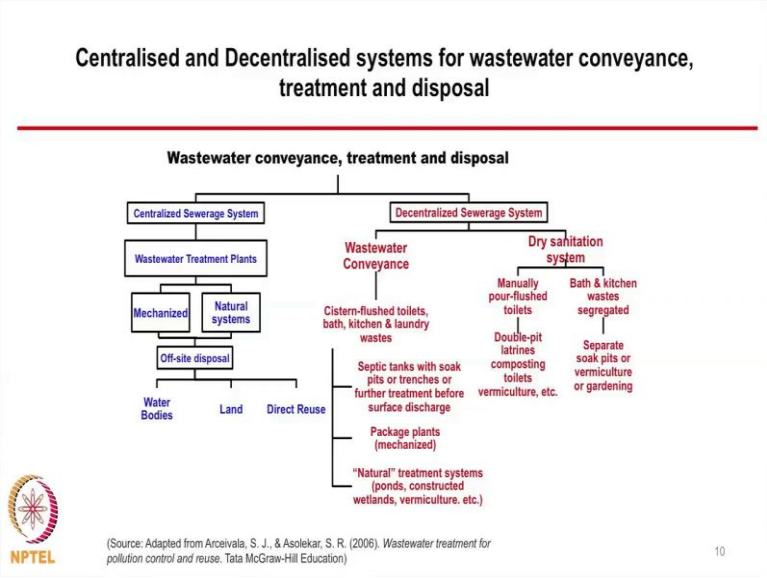

So, basically the classification for this centralized decentralized system is given in this particular book by Professor Arceivala and Professor Asolekar, where you have this centralized sewerage system which basically have the wastewater treatment plants which can be mechanized or which can be based on natural treatment system in it is centralized manner ah. And basically you can have the off site disposal or to water bodies to land or we can reuse for irrigation purposes ok.

So, that is the centralized scheme of the and then in the decentralized sewerage system you have the waste water conveyance locally, system flushed toilets, septic tanks with soak pits or trenches or further treatment before surface discharge and package treatment plans, natural treatment systems, ponds constructed wetland, vermiculture etcetera and then dry sanitation systems which are like not much commonly used and basically this is the classification of centralized waste water treatment schemes ok.

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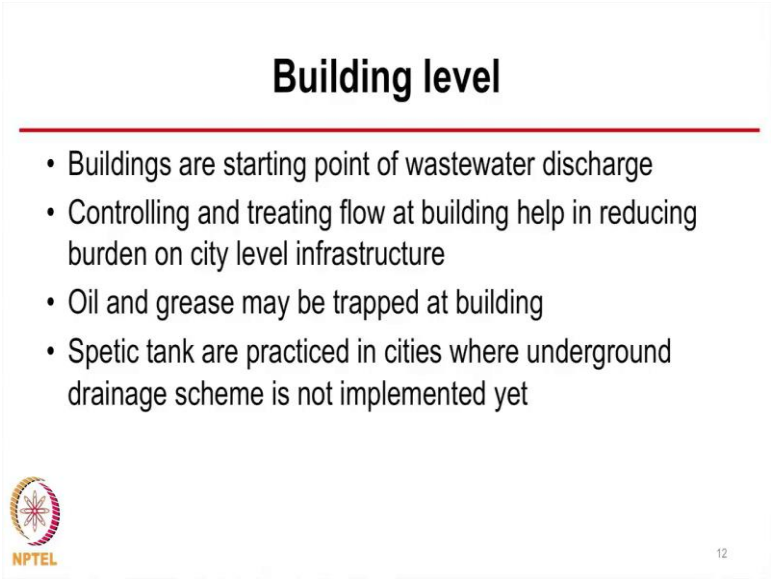

So, coming to the now treatment part ok, one by one we will go from building level to the community level to the centralized systems ok. Any questions until here? So, buildings have the start, building or houses are the starting point of waste water discharges and controlling and treating flow at building help in reducing burden on city level infrastructure ok.

So, you may have some intervention at the building level which can be helpful to reduce the organic load on the city scale, whatever treatment plan that municipality may be planning and oil and grease may be trapped at the building level or if you have a big kitchens or restaurants in this general huge kind of oil and grease. For example, in all of you have so many spas where they use lot of oil for therapies. So, those have very high organic matter. So, it will be basically giving you lot of load.

So, you can have basically this spa should be having some oil and gas strap for their that is the first level of intervention and then septic tanks are have practice in cities where

underground drainage schemes is not get implemented because underground scheme cost a lot. So, cities in India have immerged like having septic tank and then open drain and in that whatever reductions happens that is going into rivers, but that was fine 30 - 40 years before population was not that much, now the urbanization has grown a lot and that much intervention is not enough ok. So, this plus something additional has to be there such as decartelization treatment plan or centralized.

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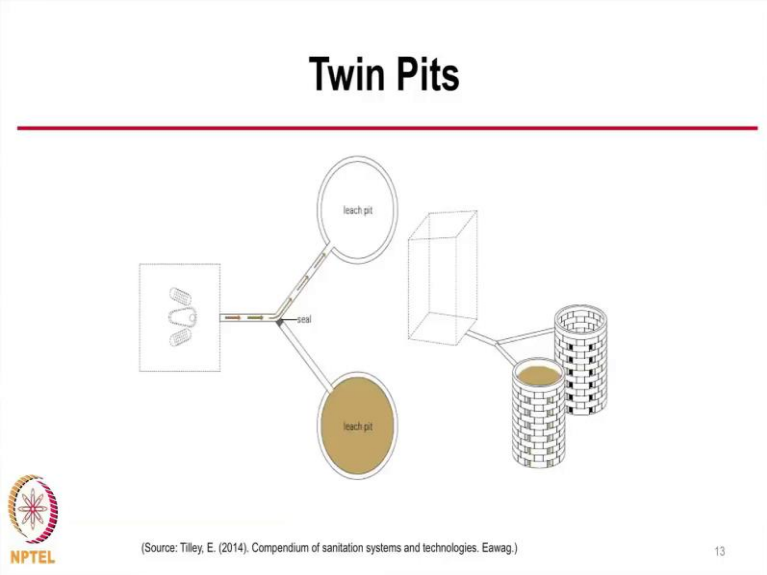

And in the building level you have the twin pits and there is very nice find book by Eawag which is sewage agency for water and it gives very nice classification of sanitation technologies, it is a very good book at your level when you start to understand concepts of sanitation technologies. So, it is got compendium of sanitation systems and technologies ok.

And that is the representation I have take from that is the twin pit toilet and I think you must have been exposed for twin pit how it works right, anybody not knowing twin pit system?

Student:

One person that I have to explain, 2 person, yes. So, basically twin pit is you have this particular toilet and which is the flush water toilet ok. So, basically people use this flash

water and twin pit is because one people be active at one time and once this is filled this will be close and this remains say for years.

So, that it may be composed a decomposed bacterial activity will be there and you will be just humus and humus after years. So, that can be use for agriculture applications and then the second pit will be active in that time. So, by that time this pit fills you empty of this pits and this system work, this very good system for rural areas or urban areas where there is land or there is a practice of having this particular leach pit.

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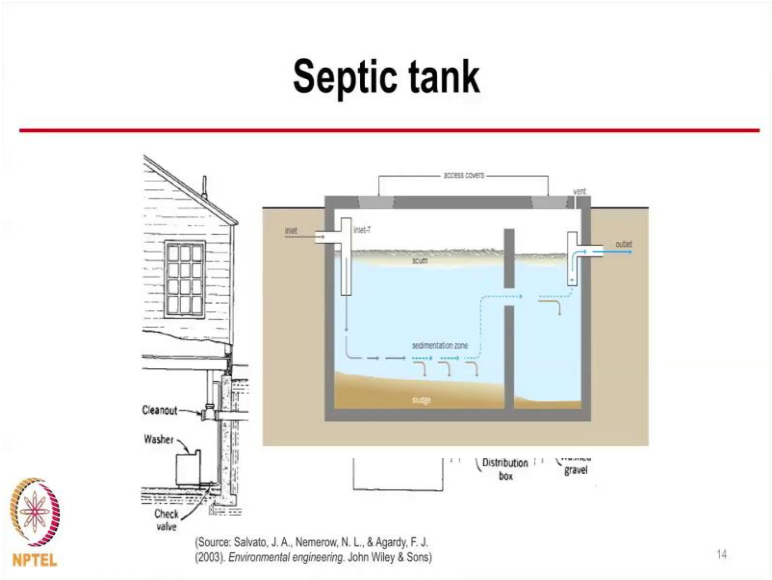

And then you have the septic tank that is second level building second building level intervention and septic tanks are basically again a tank for which basically do not have any design treatment. But because of the nature of bacteria in anaerobic condition they live there and start decomposing the organic matter in the black water and septic tanks are typically designed for handling the this particular you know black water only. And we have the is code for used design guidelines for septic tanks.

And there are many of the books and this particular compendium that I showed which also covers this particular septic tank details and with the baffle it improves the efficiency in terms of all the solids are collected in one baffle before. So, that the outlet will not be having any solids. So, basically septic tank is based on a simple principle that you retain the sludge and that will start decomposing anaerobically and that is the main purpose of septic tank.

And in precise basically is governed by how much solid how much solids per day per person generates typically it is assumed that about 30 to 40 liters per year per person is required for holding this sludge for one person and then you need additional amount per day for whatever flush water that generates ok. So, that is basically some detention time of that, detention time means basically whatever volume is has divided by the flow, v by q is your detention time in terms of minutes or hours ok.

So, all this treatment plants has a basic parameter of detention time which is v by q volume divided by discharge that is whatever input you are applying to the this particular any unit. Whether it is septic tank or whether it is a complicated waste water treatment plant it has a simple with basic one of the parameter is detention time or it is hydraulic detention time. And then if you want to go for a more complicated systems in at a building scale for a very urbanized cities or hotels or multi storing buildings we have a set of array of technologies I mean explain the details later.

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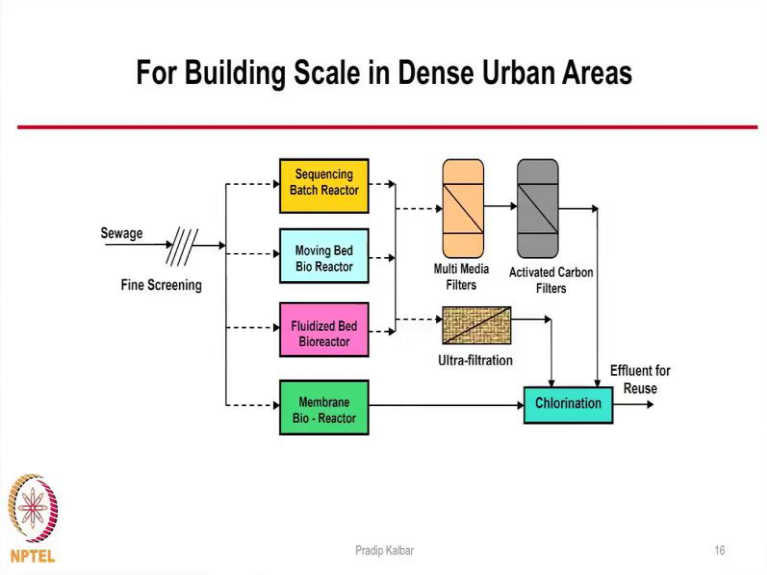

But this scheme I am explaining here at the building level, you can have the Sequencing Batch Reactor, Moving Bed Bio Reactor, Fluidized Bed Bioreactor, Membrane Bio - Reactor and which will basically take care of organic load of the sewage ok. So, first is organic load, but that will not be enough for if you want to reuse because if you are making so much of investment I said our objective should be to reuse re cycle the waste

water. We can see here the multimedia filters, the activated carbon this kind of additional systems we can placed for removing the 100 percent solids.

So, that you are at least the treated effluent looks pure and then you have the ultra filtration modules also and I will show you one of this examples and you have a disinfect and then may be recycle for secondary purposes like air conditioning, gardening, car washing, those kind of things.

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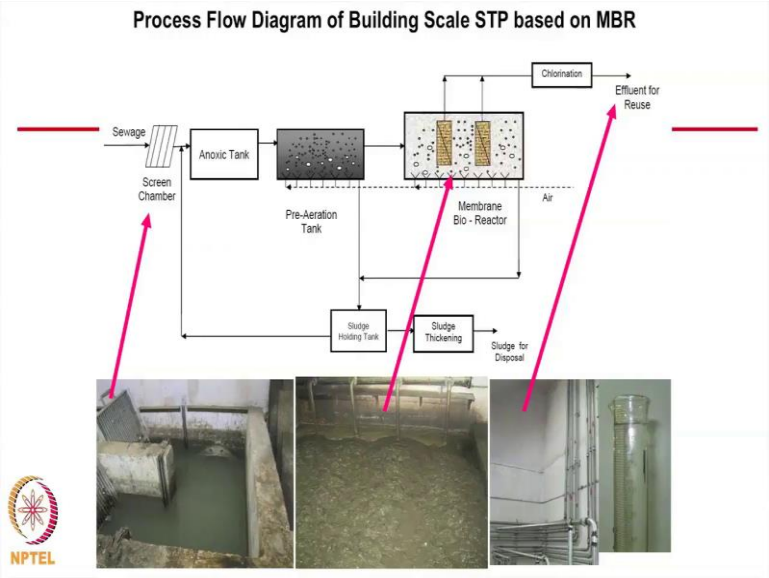

And this is one of the treatment plant for one high rise building at the basement where you have this particular screening of the sewage, it is in the basement and this is called Membrane Bio - Reactor. So, basically it is a combination of the biological activity and membrane force both are placed together I will explain how it works later, just look at the scheme and then you have this particular plumbing system, twin plumbing twin plumbing system or double plumbing system which take cares of recycle water will be used for toilet flushing and this plants can be design and operate.

Because and how this can be effective because it will reduce the flush water demand of the entire building because toilet flush is about 40 to 50 liters per person in such kind of life style. So, that much amount of fresh water consumption will reduce ok. So, this is for a long term sustainability of the city, this kind of things are available that these are like more mechanized solutions and more high tech oriented solutions.

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And if there is a space we can have a simple natural treatment system also, which is called constructed wetlands in a scientific language where you have the septic tank at the bottom of the building, again this is a high rise building and this is the basically a septic tank and it can be baffled, multi baffled septic tank also.

And then you have the wet lands these are designed for particular flow and particular BOD and this you not realized that treatment is occurring there itself ok. So, you have 2 sets of solutions, one is completely mechanized completely high tech. This is also high tech, this is not low tech, it look low tech, but it is not low tech by the way ok. It requires lot of scientific principles to design and maintain this particular facility ok, but it gives a very different basically appearance that you are using making the use of nature and treating the waste.

So, any questions here? We will see we will come to the actual principles by which this treatments occur. And then coming to the community scale solutions and you can basically club this natural treatment systems and make a community level treatment system such as.

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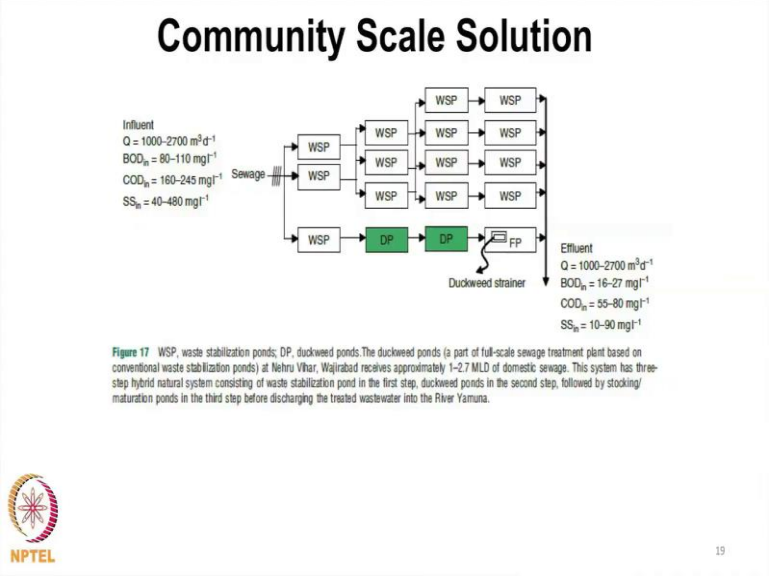

This is the waste this is the system from Nehru Vihar Wajirabad we have to check whether it is working or not, but when we documented this particular system, that was that time it was working, where you have the multiple waste stabilizations ponds. Waste stabilization ponds are natural treatment basically natural system when you have the pond there is a herbal activity and there is a symbiosis between algae and bacteria ok.

So, this is a very well system very works with very good in natural condition and to improve the like basically the nutrient removal, you can have 1 or 2 duckweed ponds the fish are again some already specific species for that can grow on the this particular pond and there you have the facultative ponds for basically for further treatment.

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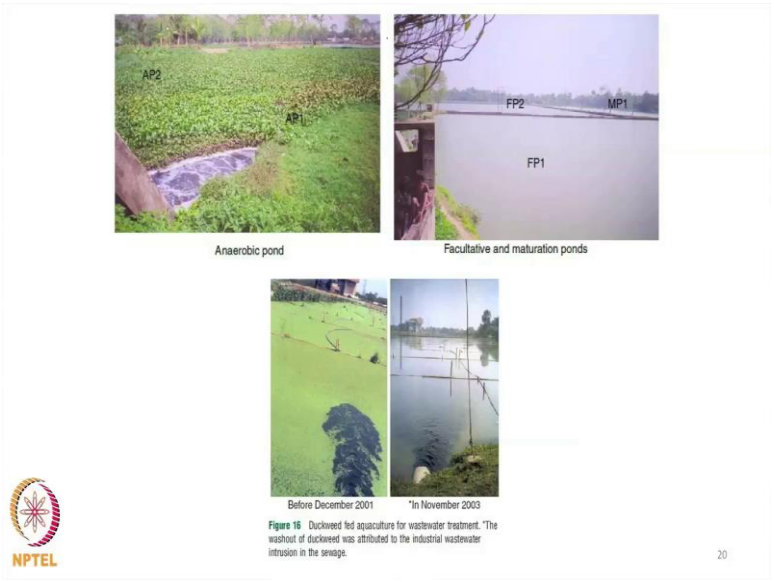

So, these are the pictures from that particular site and we have a book chapter which documents all this sorts of treatment approaches which is anaerobic pond ah, facultative and maturation pond and basically this is the pit pond ok. So, this is based on use of nature, but you can see the land requirement because, but this if we plan I guess assume some of your plans. So, if you are plan if you while you while you plan the city or while you plan the expansion of the city if you leave this spaces for having this kind of treatments this will basically help city sustain in more environment friendly manner.

Because if we do not have land we have to go to those machines and then machines will work to. The basic difference between these two systems is this particular systems have low rate of basically pollutant removal whereas, the mechanized systems will basically accelerate the rate of removal and hence compact the area required area requirement ok.

So, that is the basic difference one here both of the systems will give the same reason at the end of the day one will have slower rate natural treatment systems whereas, in engineered system mechanized systems will have high higher degradation rate because of we are doing something artificially there and that is why your land requirement is coming down. And then we come to the centralized collection and treatment ok.

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So, I will explain the building level, I will explain the community level.

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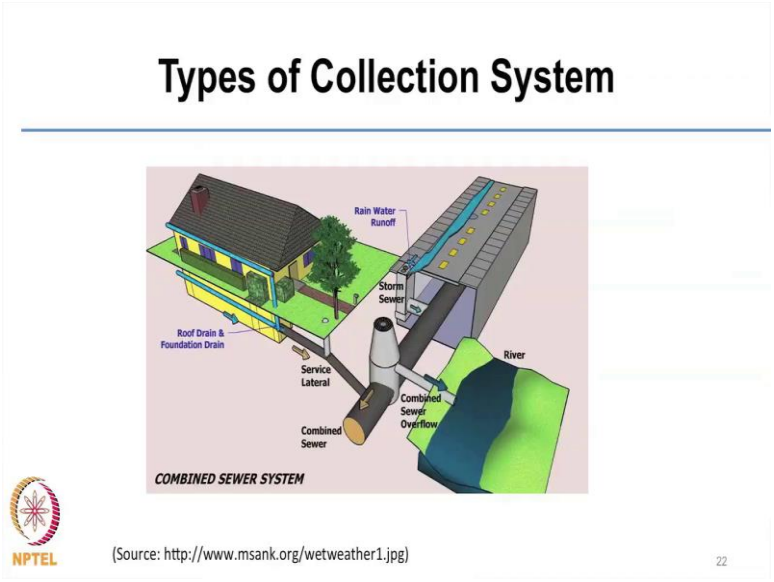

And now, this is centralized collection and treatment, where the 2 different types of collection system one is called combined sewer system where we put together the storm water. You see here storm water is connected here and mostly in Indian cities except metros city metros we have the combined sewer system because it is more economical. So, one only sewer taking the and we have very only 2 - 3 months rain fall and also some finite number of days. So, this kind of system was in India.

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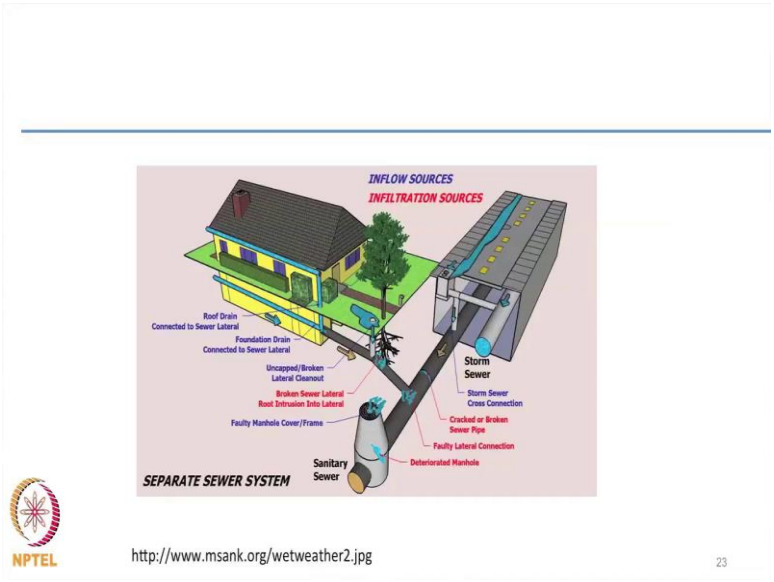

And then you have the second is a separate sewer system which were the sewer is sewage is taken separately and storm is taken separately ok. So, these two kind of systems are increased and depending on your design you have to make a choice for when you say decide a collection system. So, assuming that for centralized or even decentralized with some good scale you need some kind of collection system. And for that you have to keep in mind centralized or this basically combines sewer system or separate sewer system.

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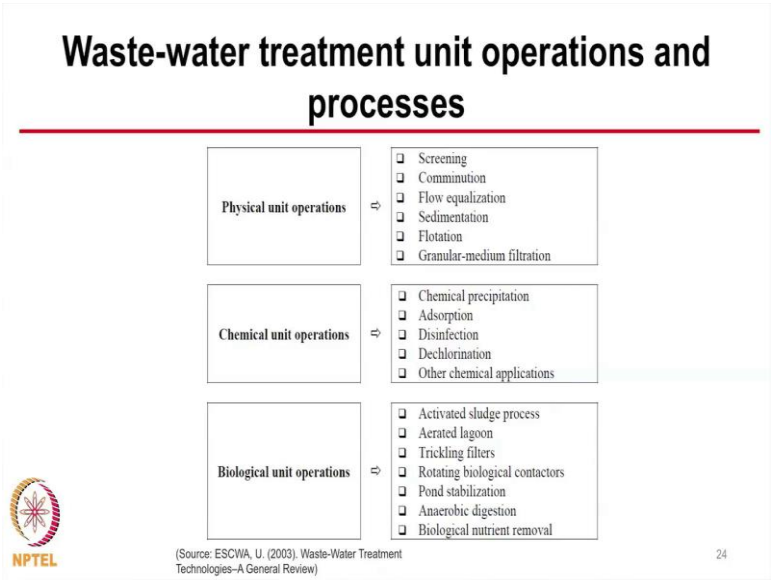

And these are some waste water treatment unit operations and processes ah. So, basically there are some physical unit operations that we used for waste water treatment, such as screening, flow equalization, sedimentation, flotation or granular filtration and those are used at various stages ok. It is it does not mean that I started with these; that means, it comes at the start of the plan it just classification from the physical unit operation point of view.

And then there are chemical unit operations which are like chemical precipitation, adsorption, disinfection and other chemical applications. And then we take use of bacteria and algae and other microorganisms which are biological unit operations. So, we make use of 3 principles physical force, chemicals and biology this combination of these 3 works in waste water treatment plant ok. And in biological treatment you have activated sludge process, aerated lagoon, trickling filters, pond stabilization, all this things ok. So, we will cover that good and what are the types of collective system?

Student: Combined.

Combined and?

Student: Separate.

Separate and which is more feasible in India or more commonly used in India?

Student: Combined.

Combined, what are the commonly used unit operations and process in waste water treatment? First the 3 classification.

Student: Physical, chemical and biological.

Physical, chemical?

Student: Biological.

Biological, 2 in physical, 2 names in physical?

Student:

2 in chemical.

Student: Pollination, adsorption.

Pollination, adsorption.

And 2 processes from biological.

Student:

Where is it lagoons?

Student: Trickling filters.

Trickling filters, activated sludge process good. So, any questions until now? Clear. Now we come to the how all this 3 physical, chemical and biological unit processes or operations there is a difference between operation and the process are put together to have the treatment.

And as per our guidelines central with we have Central Public Health Environmental Engineering Organization which we call CPHEEO which is a agency to develop guidelines for sanitation and sewage treatment and this is I am referring from this 2013 CPHEEO guideline which basically talks about, conventional waste water treatment plant ok.

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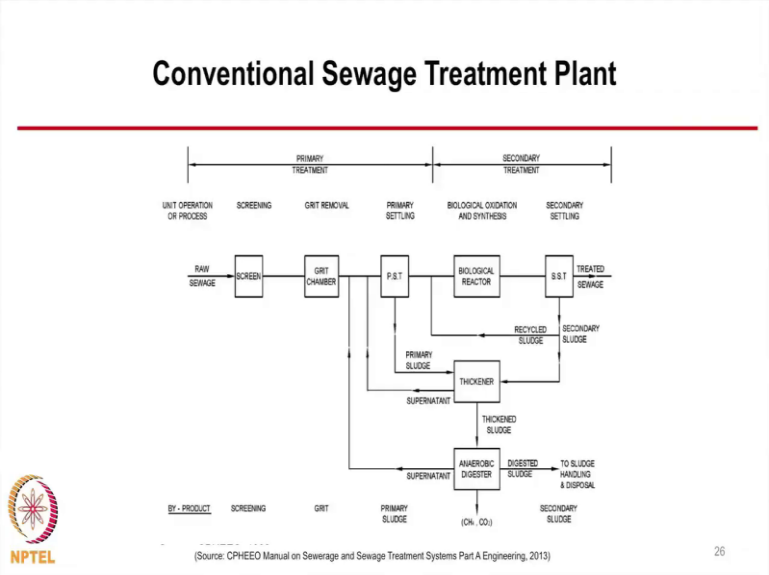

Conventional meaning it is most commonly conventionally we have to treating sewage in this manner. So, conventional treatment goes in these two primary and secondary and this particular in primary treatment we have the unit operation or process screening, grit removal and primary settling. So, in the primary treatment we take care of mostly suspended load of the particles ok. So, suspended load meaning will it remove some BOD?

Student:

Will it remove some BOD?

Student: Yes.

How come?

Student: some portion.

So, some portion right we call even if it is the suspended, but it can be organic right. So, if it will exert some BOD on the system. So, primary treatment is very essential and one and same because primary treatment in primary treatment we make use of gravity that gravity will be used to settle the particle ok. Now something that can be settled by gravity it is not wise to put it into reactor right for the further treatment, because for the further treatment we are making use of basically additional artificial air to supply the oxygen which may increase the cost of a system because it will required more energy.

So, basic principle you should remember is something that can be settled by gravity should be used in should be settled in primary treatment itself. You should not take in to the secondary treatment, because secondary treatment is a part of the system which is made to only convert the biological of the dissolve BOD into suspended BOD ok. So, basically that conversion happens in the this reactor and there are different types of reactors ok.

The basic treatment if you want to remember first principle is to remove the screens it will help it is to remove the floating material as plastic or something will come that will be abstracted with the screens. Then you have the grit basically sand silt particles are more large diameter which will settle which are mostly in organic in nature those will be removed and then in the primary sedimentation tank PST primary sedimentation tank

and it is also known as clarifier primary clarifier ok, because that is the settling of the solids ok. And then this all vey now everything you have removed that is subjected to the this particular biological reactor.

The most commonly used biological reactor is called as activated sludge process. So, activated sludge process is where you see here some part of the sludge is taken back to the reactor, because that particular bacteria available in the reactor are active and you do not have to basically always put new bacterial culture to maintain the system, you can just part of the system can be recycle part of the biomass is recycled to maintain the given concentration of the biomass in the system ok.

So, this particular activated sludge processes use the biomass to get remove the this particular BOD from the system and whatever excess. So, basically this particular reactor will convert the BOD to the suspended form and to that needs to be settle down that is by secondly, settling tank or secondary clarifier and that will settle down that will be taken part of the sludge will be taken to the reactor and part will be wasted that is the excess sludge that system cannot hold or we should not keep that in the system.

So, that is thickener and this will go back to the whatever the supernatant after thickening the sludge because this particular sludge will be very having lot of moisture lot of water in to it and solid should be low. So, handling and transporting such a volume less sludge will be costly. So, typically we use this particular thickener and take takeout whatever possible water from the sludge, make sludge more drains and again put it for the anaerobic digester because anaerobic digester will basically whatever remaining organic matter is there which is in concentrated form now and we subjected to the anaerobic bacteria, basically those bacteria which do not require oxygen for their metabolism ok.

So, these are the bacteria which are survive on basically other form of sources than oxygen. So, here in activated sludge process, here we use of anaerobic bacteria in anaerobic digester we use anaerobic bacteria and which provides basically methane bio gas and hence if the energy can be recovered ok. And then you have the basically digested sludge and also supernatant is recycle plant that is a conventional treatment plant.

If you understand this all other treatments are to variant of this particular scheme most of the systems require this nobody wants basically this solids in to the biological reactor ok. So, and this biological reactor varies, but basic principle of recycling this biomass active bio mass remains the same. Any questions here, as the most important part of understanding waste water treatment.

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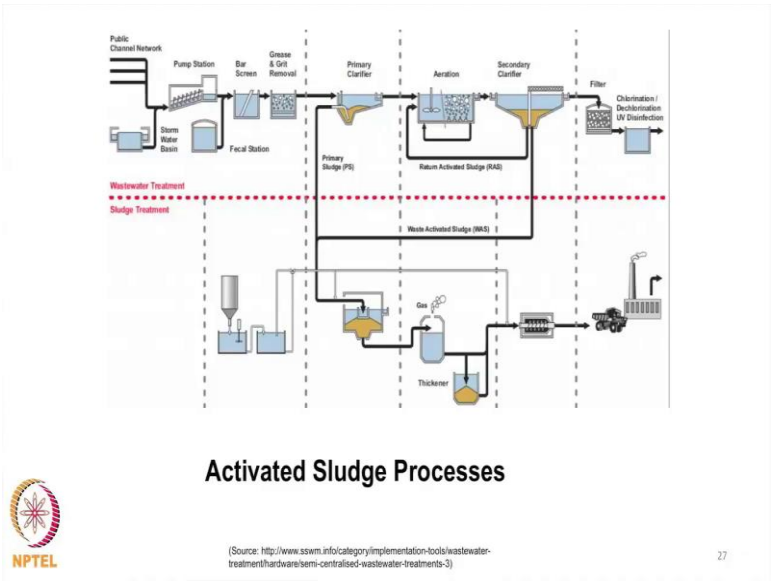

And this looks like in graphical representation this screening is happening here, bar screens are placed, then this is the grit removal ah, this is primary clarifier, you see the oxygen supply here on some external source ok. Because we have to maintain the bacteria in anaerobic mode hence we have to supply some air from the outside. And that sludge is settled and taken down for sludge processing, coming to the variants of this particular treatment systems.

One of the conventional treatment plant works on principle of basically this biological reactor activated sludge and bacterial mass is in suspension. So, it is completely suspension classifier those are classifier on the suspended basically treatment methods, but we can attach the bio mass to some area so, that is another classification. So, waste water treatment methods or techniques that if you want to call one is physicochemical.

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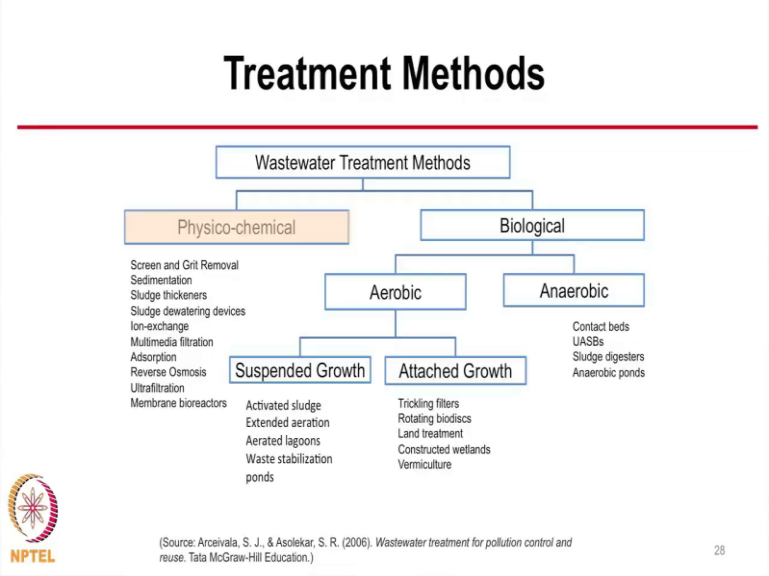

Which are like this using the physical and chemical actions or physical forces and chemical using the chemicals, which are screening, sedimentation, ion exchange, multimedia filter, adsorption, some membranes reverse osmosis and this all have has it is own particular unique purpose and when to use and when not to use.

And then you have the biological system that classifies under first aerobic and anaerobic. Aerobic where oxygen is supplied and bacteria are aerobic bacteria and anaerobic are where the bacteria are survived without oxygen. And under them you have the contact beds up flow anaerobic sludge blanket UASB up flow anaerobic sludge blanket, when you have the sludge digesters, anaerobic ponds those are there.

Then you have the in aerobic you have the suspended growth and under suspended growth you have the activated sludge process, extended aeration, aerated lagoons, waste stabilization, ponds ok. And then you have the attached growth where you have the bacterial mass is attached to some area in all this technologies bacterial mass is in a suspension and then you have the trickling filters, rotating biodiscs, land treatment, constructed wetlands and vermiculture these are the attached growth processes. Any questions here? This is the basic classification you should remember for any waste water treatment.