Wastewater Treatment and Recycling
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Lecture – 54
Wastewater Reuse and Recycling
Potential and Requirements

Hello everyone, so welcome back we have been discussing about the Reuse and Recycling aspects this week and in the last 2 lectures we did talk about the basic concept of the recycling and what are the various types of the recycling. So, this class we are going to discuss about the potential of the recycling and then what are the various requirements or some of the considerations which are taken or which must be taken up when we go for a recycling project or when we decide to recycle or reuse the wastewater.

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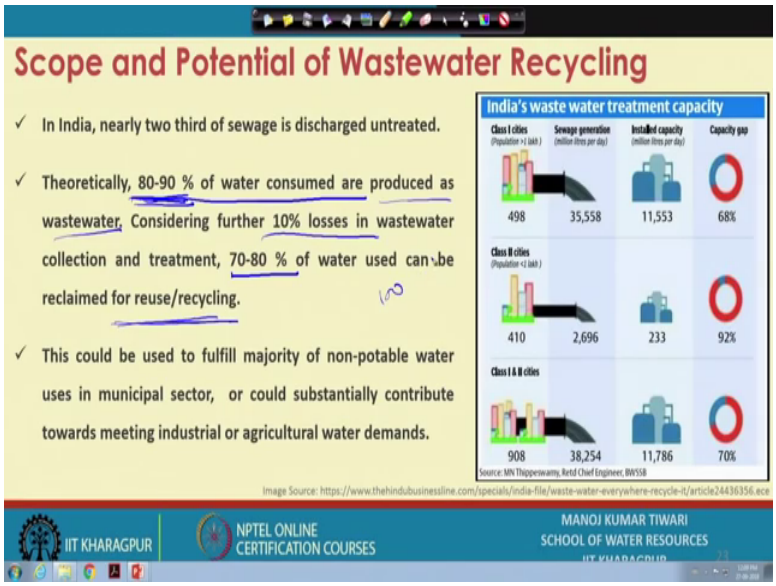

So, to begin with there is a enormous amount of wastewater which is generated, so there has been basically ample discussion on this that the water demand is increasing from all the sectors. So, increasing demand essentially means increasing the water consumption. So, when the water consumption is increasing obviously, the wastewater the amount of wastewater which is being generated or the used water which is being generated that will also increase in the same proportion ok.

So, that way there is a huge or enormous quantity of wastewater which is being generated from the primary uses of water ok, primary uses could be anything like could be basically there are direct uses. So, direct uses in the industrial sector direct uses in the agricultural sector or direct uses in the domestic sector or municipal sector.

So, the amount of water which is being used is almost 80 to 90 percent of that water is produced in the form of wastewater. And then we can say it if it is being produced from industry we can call that as a industrial effluent, if it is from the municipal we call that as domestic wastewater or sewage typically or agricultural wastewater if it is coming out of the agricultural activities.

So, tapping agricultural wastewater is quite difficult. So we will kind of more focus on the domestic wastewater and industrial wastewater industrial effluent which is being generated. So, at generation perspective there is around 80 to 90 percent of the wastewater 80 to 90 percent of the water which is consumed comes back in the form of wastewater.

Now, if we further consider let us say 10 percent loss, for say just assume that around 10 percent further losses in the collection and treatment of wastewater. We still we can recover or we can reclaim a substantial amount some 70 to 80 percent of the water which has been used can be reclaimed for the purpose of use and recycling ok.

So, if consider a demand of water is say 100 by one person so out of that, that means around 70 to 80 percent water can be reclaimed. That means, 70 to 80 liters water per day per person can be reclaimed and if we put that reclaimed water back into the cycle back into the basically supply back to the user, so that means around 70 to 80 percent demand of the user can be met from the recycled wastewater ok.

So, that way it could actually fulfill the majority of the non portable water uses in the municipal sector ok. So, almost like major portion because the portable water uses is very little for drinking purpose how much water one person drinks may be 3 liter 4 liter 5 liter and then for cooking purpose again requirement is very limited.

So, out of like if we remove that drinking and cooking requirement which are may be direct portable consumptions. So, majority of the water usually like rest of the water or

the majority of the total water that way goes for the non portable user uses and this recycled or reclaimed water can fulfill that substantial portion of that demand ok.

Alternatively, it could be basically taken away and then it can contribute towards meeting the industrial demand or some of the agricultural water demands, of course agricultural water demand is huge ok. So, and the water that we reclaim out of say municipal sector or industrial sector is very little. So, in India if you say the water consumption pattern, so almost like somewhere between 85 to 90 percent different agencies claim different number. But, it is somewhere 85 to 90 percent of the water is consumed in the agricultural sector, while the contribution from industrial and municipal sector is of the order of 7 8 percent that way ok.

So, if it is like that so basically we are trying to recover the wastewater generated from these say margin of 10 to 15 percent water which has been used actually. So, that could fulfill the major demands from this sector only from larger agricultural sector it cannot from urban agricultural sector it can because, if there are like say horticulture gardening those kind of requirements. So, it can like be helpful there it cans serve agricultural demand for nearby villages or towns which are surrounding the cities that way and if sufficient amount of wastewater is being produced or is being collected properly because collection of waste water is another major challenge ok, we will talk about that.

So, that way the major demand that is being kind of that your treated or reclaimed water can fulfill will be from industrial and municipal sector. Of course the majority of water is used in the agricultural sector, but that does not contributes substantially or you cannot say that it can actually meet almost all the agricultural demands. Like it can serve it can be basically meet quite a few or more than half of the domestic demand or the industrial demand.

Same way it is difficult to say that it can meet more than half of the agricultural demand because, agricultural requirements are huge. And if we are just trying to use sewage recycled sewage for that purpose it could be possible in the developed world, where the like consumption form the consumption in the industries and municipal sectors are significant and requirement for the agricultural sectors are low.

But, in a country like India or in other developing countries or agricultural based economies if since the requirement for agricultural sector is huge, so this recycled

wastewater should be used for agriculture that is fine. But, it cannot sort of like say contribute to the major portion of the agricultural demand, it can just fulfill our minor fraction of the agricultural demand that way. So, if we see in like in our country, so there is nearly two third of the sewage is discharged untreated ok. So, we have seen these numbers in the early stages of this course as well so just kind of quick recap.

So, in class one cities almost 70 percent water 68 percent water go untreated, so is in the class like 2 cities it is almost class 2 cities it is over 92 percent water which goes untreated and if we combine so almost 70 percent of the water goes untreated. So, that way more than two third or at least two third of the water which is being produced the waste water which is being produced goes untreated in the nature creating huge environmental burdens environmental problems.

So, if we can put treatment systems for all these and the existing treatment system the pores and which is being treated if we combine and couple all these systems then probably we will be able to achieve or we will be able to produce good enough amount of treated wastewater or reclaimed water which can be used for different purpose. So, that way there is enormous scope and a huge potential for this wastewater treatment and recycling ok.

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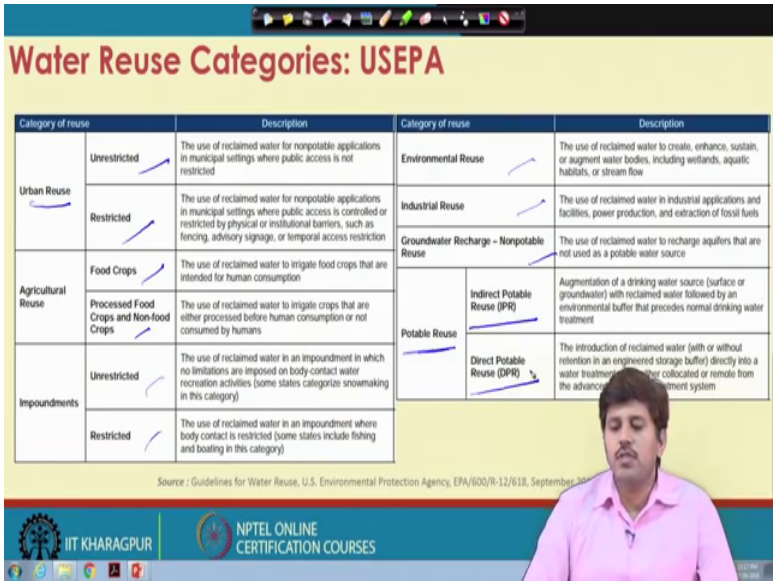

So, if we see the reuse categories of as recommended by USEPA, we did discuss about different types of reuse in the earlier class, but the EPA has far more detailed

classification of these different reuse categories so where this water can be reused. So, there are urban reuses categories there are unrestricted and restricted uses are there. So, unrestricted uses means we can use reclaimed water for non portable applications where public access is not restricted means public.

So, it is from of kind of contact uses the contacts could be there public contact could be there and then there are restricted uses. So, restricted uses means that public assess has to be restricted means there should not be any contact there, so those kind of things and there has to be proper advisory science signals. So, that it public is aware that this is the restricted area restricted use kind of things and we should not interfere go touch in that way.

Then agricultural use there are food crops and there are processed food crops and non food crops there are impoundments, so unrestricted and restricted impoundments there are environmental reuse, which we discussed industrial reuse and then there are ground water recharge for which is kind of a non portable reuse. And then there are portable reuses which is indirect portable reuse and direct portable reuse. So, IPR and DPR are the 2 different kind of uses which are recommended by the USEPA for portable purpose.

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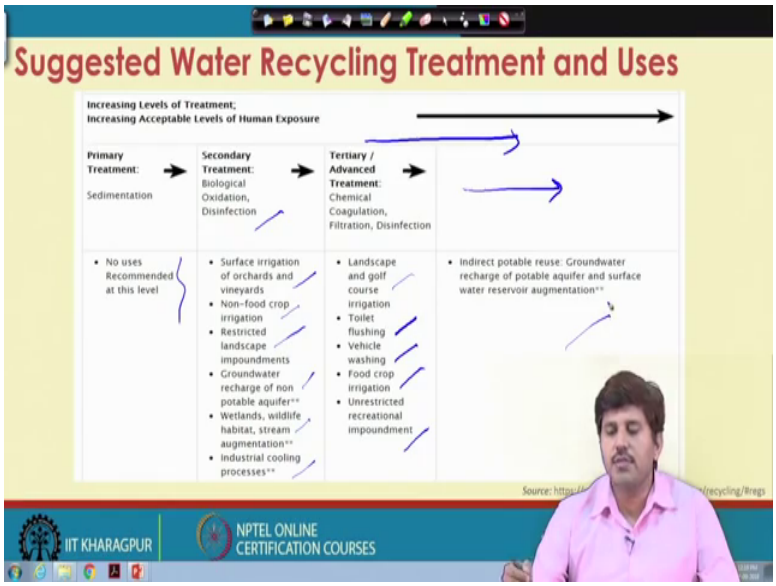

So, if we see that the recycling treatment and uses so what kind of treatment, if we provide let us say wastewater certain kind of treatment. So, how much recycling is possible or in what way we can recycle the water that way. So, it is if we move towards

the increased level of treatment as this way. So, with primary treatment just basic sedimentation there is no use recommended at this level, so just like particularly in the US with just primary treatment they do not recommend to reuse the water. So, the for reuse purpose the water or the wastewater generated must undergo at least secondary level of treatment.

So, secondary treatment which is biological oxidation and disinfection, so that it can be used for surface irrigation orchard and vineyards it can be used for non food crop irrigation, for restricted landscape impoundments, for ground water recharge on non portable aquifers, for wet land and white life habitat purpose for industrial cooling processes where the requirements are low. Then with tertiary and advanced treatment where like chemical coagulation filtration and disinfection is also added after the secondary treatment we can go for landscape and golf course irrigation where human touch is inevitable.

So, it is kind of a non restricted uses that way it could be used for toilet flushing, vehicle washing, food crop irrigation and unrestricted recreational impoundments and we need next level of treatment like RO or those kind of further advanced treatment for indirect portable reuse like ground water recharge or portable aquifer or surface water reservoir augmentation purposes. So, that way we have like the different level or different grade of treatment is needed for type of reuse options.

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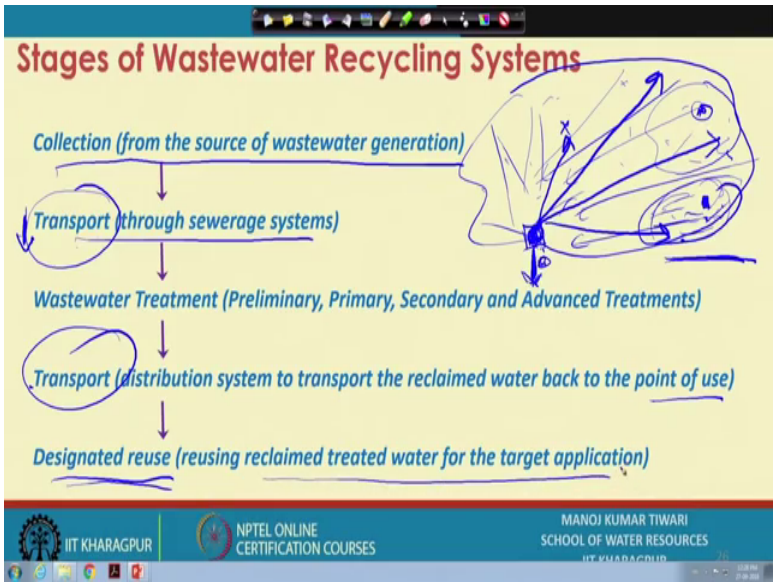

Now, if we see that what are the various stages that are involved in a wastewater recycling system, so again it will although depend on what kind of like what kind of reuse application is being planned. So, what is the target reuse application and what is the source of wastewater it where it is being generated how distributed it is or it is concentrated. So, let us say if it is being generated at a industrial scale, so it is far easy for industry to tap that water and then process it in some purpose and recycle back to the processes over here. But, for sewage system for domestic wastewater so the first major challenge comes in form of the collection ok.

So, the wastewater which is being generated has to be collected ok. So, from source of the wastewater generation the where the waste water is being generated from that point forwards starting from that point we must collect that wastewater ok. Now, the collection system is again a very big challenge because, we have to have those proper sanitary systems those proper sewer system for collecting that wastewater. What happens that majority of the towns are particularly the smaller towns lack this basics like sewerage facility, so if you are not able to collect this wastewater how you are going to say reuse or recycle it.

So, for the purpose of reusing and recycling the first and a very important aspect is collecting that sewage. So and sewage collection needs a sewage collection system, proper sewage collection system which is which needs to be kind of put in place in the reason from where we want to collect the sewage and we are actually planning a reuse or recycling project ok.

The sewer collection system should ensure minimum losses so they has to be properly lined because, many places we see that there are unlined drains which carry the sewage. So, what happens that sewage starts from generation point or from household scales and as actually it moves. So, because it is unlined system so lot of water loss through percolation through infiltration takes place and by the time it will reach to your process facility whether treatment or whatever.

So, by the time it reaches the process facility the majority of the volume has already been lost ok, has been sort of infiltrated evaporated permitted to the subsurface that we are evaporated to the atmosphere and evaporation is still ok. But, if it leaches if it goes to the

subsurface, so there is a lot of pollutant which can actually leach through it and can contaminate the vadose zone water or your aquifer ok.

So, those kind of problems could arise ok, so it is like quite important to have a proper sewer system for collecting proper line sewer system with like with the ideal design or the pro necessary slope. So, that it can transport the sewerage it can transport the sewage to the point of the process facility. So, after collection next thing comes the transport ok, so as we were just discussing we will need those proper sewer network system.

So, it is being collected from households being put through one point or in a colony or through a main hole and then it has to be transported to the process facility. So, this transport is through this sewerage system and again for the as we are discussing that transport has to be a like this.

The transport system or whatever like channel or pipe we are providing we must ensure there is no leakage they are properly lined all those things must be taken care of, so that it can transport that sewage effectively to the point of treatment. Then comes the wastewater treatment which is the next stage.

So, when we receive the wastewater and we intend to say reuse it or recycle it, so we will have to go for the basic prime preliminary treatment, primary treatment, secondary treatment and then advanced treatment to produce a water quality which is acceptable ok, which meets the water quality criteria for the reuse and which can be reused for the designated purpose or the target reuse application that we have in mind. So, that becomes the next step, then after this again there comes a step of transport ok, so in the first transport stage we bring the; we bring the sewage or we bring this wastewater to the process facility and there we process it and in the second transport stage.

So, this is actually bringing it here and in the second transport stage this the processed water or the treated water is transported back to the point of application to the point of use. So, if it is to be used an industry, so we have to basically put a pipeline or channel system which can take this wastewater to the industry. If it is to be used in a agricultural or gardening purpose we have to make arrangements for taking that water to that area where it is to be kind of applied.

If it is to be used back in the household systems, so we will need those kind of transport system that it can actually take that water back to the household system. And then this kind of makes it tricky because we are first so, as we discussed earlier there are centralized system and decentralized system. So, in centralized system what happens that let us say you have a large city somewhere here and your wastewater treatment plant is here ok.

Now, you are collecting water from the entire city, entire sewerage network bringing it here treating it, if you have to say disposed to some point then it does make some sense fine because eventually your disposal point is this. So, all the water has to come at this point that is that become somewhat ok, but if you are planning the recycling or reuse of this water so if your reuse site it here again you will have to transport it to this point.

If your reuse site it here again you have to transport at this point, again you might need to transport the treated water to this side you may need to transport the treated water to this side. So, then collecting this water from here and bringing it here processing it and again basically putting it here requires huge amount of kind of requires huge amount of energy as well as cost for the purpose of transportation only.

So, there if we plan a decentralized system so instead of having a treatment plant big treatment plant over here, we may go for a small treatment plant here which collects from this reason process it and supplies back to this reason we can have another treatment plant say here which collects from this reason and supplies back to this reason. So, instead of one big plant we may go for say 5 6 smaller plants which can collect the water locally process it and supply it. So, this becomes your decentralized system and for wastewater purpose if we have a decentralized system so we save on this and this front ok.

Of course, we are splitting one big plant into the several small systems, so there is going to be cost involved for that as well ok. But, then we save lot of cost and energy in the recurring cost and energy in the form of transport ok. So, that way that is one advantage of these decentralized systems particularly for the recycling applications. So, once it is basically transported back at the point of use and then we can use that water for the designated reuse options, so this is just be using the reclaim treated water for the target

application that we have decided or that we have thought about ok. So, that is what is the kind of stages various stages of wastewater recycling system.

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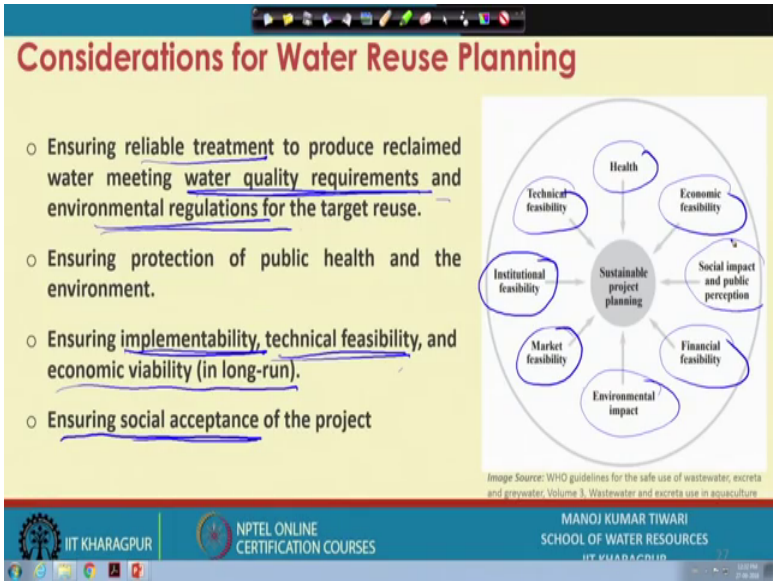

Now, if we see the consideration for water reuse planning, so a water reuse planning system should make sure that the treatment is reliable and it is producing the reclaimed water which is meeting the water quality requirements ok. So, that is one of the as we discussed earlier this becomes one of the major objective of the kind of treating water to meet the water quality requirements ok.

If we are even it is for disposal say so disposal like the discharge requirement has to be made, but we are not discussing the disposal part here. So, for reuse purpose whatever is the reuse of water quality criteria as for the designated reuse purpose so, the treated water must meet those quality requirements for the purpose then only it will be allowed to use that way.

So, that like it must meet those requirements and if there are environmental regulations related to the for the target reuse purpose it should actually fulfill those things. It should also ensure the protection of public health and the environment that is one of the other major aspects it should ensure that the system which is being put through is implementable ok.

So, the kind of treatment or recycling system we are proposing is in practical in field implementable it is technically feasible to do that and it is economically viable particularly in the long run, in the short run it may not be because it requires huge amount of investment. But, we must ensure that over the period of the project or in a longer run it is economically viable solution ok.

So, it should not happen that we end up spending too much of money without generating any kind of benefits ok, either financial or social benefits at least some type of benefit should be coming out. So, it if the project has to be a net positive worth project and one of the other very important aspects is it should actually ensure the social acceptance of the project ok. So, social acceptance in a way that particularly like the because, many places with the recycled water people have reservations for using it for at least for domestic purpose or those kind of thing.

So, it should be publicly be acceptable the public should be open to use that water and how to achieve that is also a consideration must be thought about when we go for the planning the wastewater reuse. And this sustainable project planning that way will involve various aspects will involve health aspect, will involve economic feasibility, will involve technical feasibility.

As we have been discussing there has to be institutional feasibility means there has to be kind of the institutional arrangement proper institutional arrangement has to be there with the assigned responsibility in order to kind of conduct these projects. In order to oversee the implementation of these projects there has to be market feasibility. So, if you are let us say producing reclaiming water is there any market for that, are there any user domain for that. So, who is going to potentially buy that water is it going to be brought by farmers it is going to bought by industrialist or it is going to be basically bought by the end users other end users, what are the environmental impact and then the financial feasibility of the project and social impact and public perception ok.

So, the point that we were just discussing that socially it should be socially acceptable that way, so these are the kind of points which should be thinks upon while then while sort of planning the water reuse project ok.

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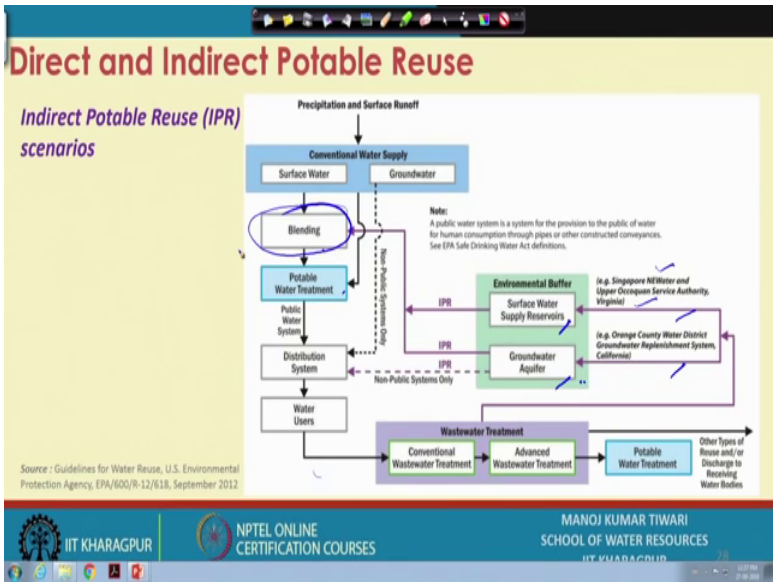

So, there are as we say that major sectors if you see the different sectors that we discussed in the last class also. So, there are environmental sector, there are industrial sector, agricultural sector and domestic sector so, the most crucial of these is actually the domestic sector and particularly if we are trying to sell that water for portable purpose ok.

So, for portable purpose there are direct and indirect portable reuses of the wastewater which is possible and USEPA has which is united state environmental protection agency has proposed a framework for looking after these different portable reuse options ok. So, in the indirect portable reuse scenarios if we see which is kind of known as IPR indirect portable reuse.

So, we are let us say getting the water through precipitation and surface runoff in the ground waters and in the surface waters, so these are over conventional water supply sources of water supply resources ok. Then we usually take this water directly and treat it for potable water purpose, so this is a portable water treatment and then we through public water systems we put it through distribution system and it reaches to the users where users consume this water.

So, after users consume this water it goes to waste water treatment systems where there are conventional waste water treatment systems and advanced wastewater treatment systems ok. So, through this advanced wastewater treatment systems we end up

producing portable water by giving further portable water treatment ok, we need to generate that for if we are willing for direct portable supply otherwise this waste water can be used for other type of reuse and discharge purposes.

For IPR Indirect Portable Reuse options, so this treated wastewater is to be taken away and then from this point forwards it can actually be put through a environmental buffer system ok. Now, environmental buffer system means we can put it into the groundwater, so we can sort of put it we can recharge groundwater which is being used for portable purpose.

So, this water can be used for recharging the groundwater aquifer and from this groundwater aquifer again the water could be withdrawn and could be taken here and then blend with the water which is being received and after this blending it actually goes to the your treatment system. So, that is one aspect the other way is to basically store this water in a water supply reservoir ok, so in a surface water supply reservoir we store this water.

So, the water which is basically coming in is a stored in the surface water reservoirs and then from reservoirs it is again taken up and blend with the typical surface water sources and after this blending. So, instead of like if we do not have any reuse or recycling purpose we will not have this blending step, so we are just taking water directly for potable water treatment and doing all this thing.

But, with the indirect portable reuse option we will blend this water with the treated water, now this treated water can actually be stored in a surface reservoirs or aquifer system both intend to kind of supply the portable water quality water for the end users ok. So, if you see here there are like Singapore's new water system or upper Occoquan service authority of Virginia uses the recycled water in a surface water reservoir from where they pump and blend it for the portable water supplies.

Whereas, orange county water district of the California is an example that actually kind of produce this water and then put it to the groundwater aquifer systems from where it pumps and then blend water and supplies. So, that is the 2 approaches either storing in the groundwater aquifers or storing in the subsurface in the surface reservoirs and then blending it with the natural water for the water supply purpose and that is what is basically the indirect portable reuse of the water.

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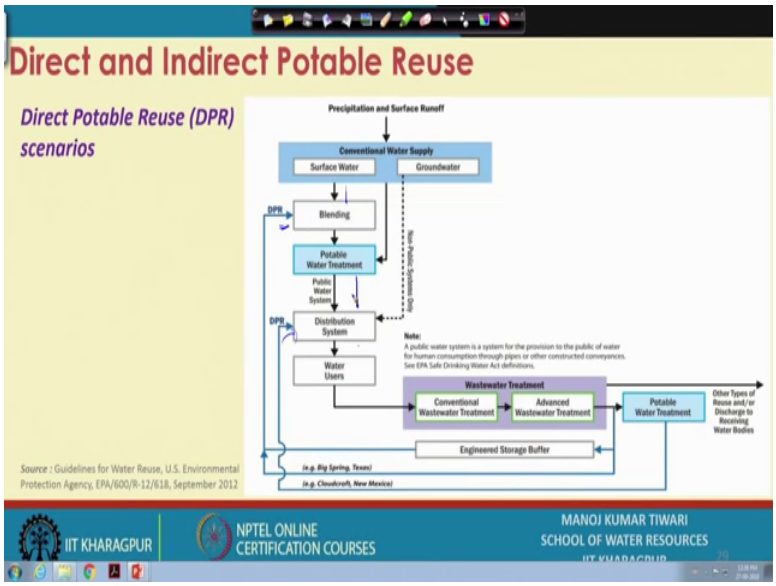

Similarly, we have direct portable reuse so, as like this major steps remains the same from treatment points, so the portable water treatment is given. And this portable water treatment is taken and directly put to the distribution system or this water can actually be taken away to the like the secondary tertiary treated water without giving portable water treatment can be taken away and with blend with the surface water and then provide the treatment and put into the distribution system.

So, this like here instead of just storing it somewhere in the surface reservoir or groundwater aquifers and then blending it and then treating it and for supply purpose, so that is the indirect or IPR system indirect portable reuse system. But, in direct portable reuse systems we do not store that way this treated water is directly blended, directly put through either distribution system like it is done in the New Mexico cloud croft or it can actually be taken to the direct blending with the surface water as is done in the big spring of the taxes facilities. So, these are the example of direct portable reuse scenarios ok.

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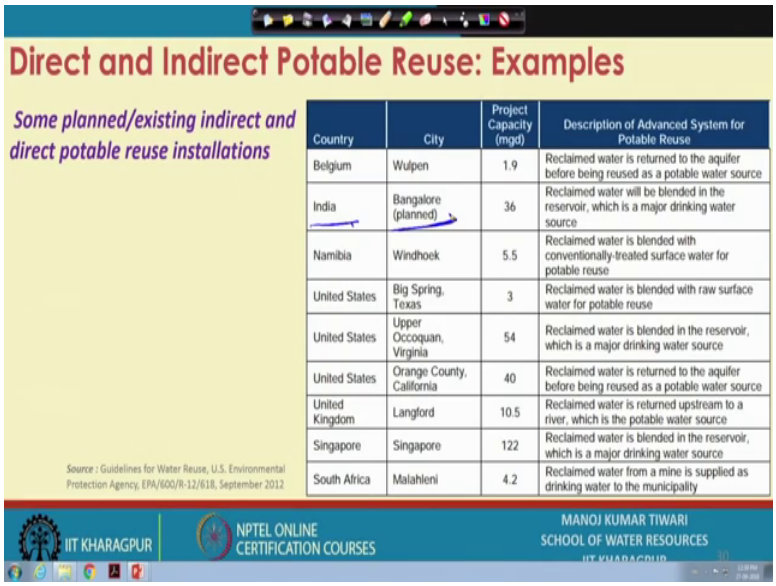

Country	City	Project Capacity (mgd)	Description of Advanced System for Potable Reuse
Belgium	Wulpen	1.9	Reclaimed water is returned to the aquifer before being reused as a potable water source
India	Bangalore (planned)	36	Reclaimed water will be blended in the reservoir, which is a major drinking water source
Namibia	Windhoek	5.5	Reclaimed water is blended with conventionally-treated surface water for potable reuse
United States	Big Spring, Texas	3	Reclaimed water is blended with raw surface water for potable reuse
United States	Upper Occoquan, Virginia	54	Reclaimed water is blended in the reservoir, which is a major drinking water source
United States	Orange County, California	40	Reclaimed water is returned to the aquifer before being reused as a potable water source
United Kingdom	Langford	10.5	Reclaimed water is returned upstream to a river, which is the potable water source
Singapore	Singapore	122	Reclaimed water is blended in the reservoir, which is a major drinking water source
South Africa	Malahleni	4.2	Reclaimed water from a mine is supplied as drinking water to the municipality

Now, if we see so some of the existing direct and indirect portable reuse installations that we have are kind of this, if we see them the India also we have a plant reuse scenario for the Bangalore where the project capacity is 36 million gallons per day. So, here the idea is that 10 percent treated water or reclaimed water is to be blend means, it will serve the 10 percent of the total water supply. So, 10 percent of the total water supply will be come in the form of reclaimed water which will be blended with the reservoir which is a major drinking water source for the city.

Of course there are many other plants which are existing which are working, so in Belgium we have at Wulpen in Namibia we have at Windhock. Then United States we have a few facilities like big spring orange county city of the California, Singapore new water is one of the most popular system for using reclaimed water which is blended in the reservoir and there is a major drinking source ok.

So, that way we have several options, several examples of using the reclaimed water directly or indirectly for portable purpose as well. So, we will conclude this class here and in the next class then we are going to talk about the different aspects of the different regulatory aspects or the regulatory requirement the kind of standards and criteria's for water reuse which are adopted in the different parts of the world. So, see you in the next class.

Thank you.