Wastewater Treatment and Recycling
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Lecture - 60
Wastewater Reuse and Recycling: Global Practices and Case Studies

Hello everyone and welcome to this last lecture of this course Wastewater Treatment and Recycling. So, progressively our journey has come towards this sixth lecture which is actually the final lecture for this course. We will have couple of lectures on summary later on. But this is where we are going to basically conclude the discussions about the course.

So, this since last couple of weeks we have been talking about the Wastewater Reuse and Recycling. And we discussed various aspects related to reuse and recycling starting from it is the basic concepts, what are the advantages, the sectors in which we can reuse or recycle the water, what are the risk associated with that.

Then really talk about what are the current trends and kind of the research work which is going on in this area. And in the last couple of lectures, we did talk about the concept of decision making and decision support system which can be used for kind of making decisions in the reuse, or recycling projects and we did talk about the public perception as well.

So, in this final lecture, we are going to discuss on the global practices which is being adopted worldwide in some cities on the reuse, and recycling projects and we will take up that way some case studies. So, if we see the water reuse programs around the world, there are many cities across the globe, which are adopting this urban water reuse for various applications. And these applications range from irrigation to industrial uses to potable supplies ok.

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There are water scarcity and water kind of increasing water demand and particularly in the arid and semi arid regions where there is a higher level of scarcity. So, that scarcity or increasing demand drives this waste water reuse as an alternate water supply source. So, several water reuse programs have been kind of initiated across the world for considering water as an alternate water supply source.

However there are quite a few number of reuse programs particularly in the United States which has come in a response to the rigorous and costly requirement of the treatment. So, particularly because of the issues related to the Eutrophication, the discharge norms are getting more stringent and you need to remove the nutrients from the water if you want to discharge it.

So, many schemes have some that instead of going for the nutrient removal would not it be better to use that water for say irrigation purpose where this nutrient removal requirement is not there. So, many reused schemes comes towards like the objective of saving themselves from this rigorous and costly treatment for the nutrient removals.

So, there are that way like quite a few places like starting from Israel, Germany, Singapore, then various countries in the European Union USA, Namibia. So, there are many places such reuse and recycling programs are being adopted.

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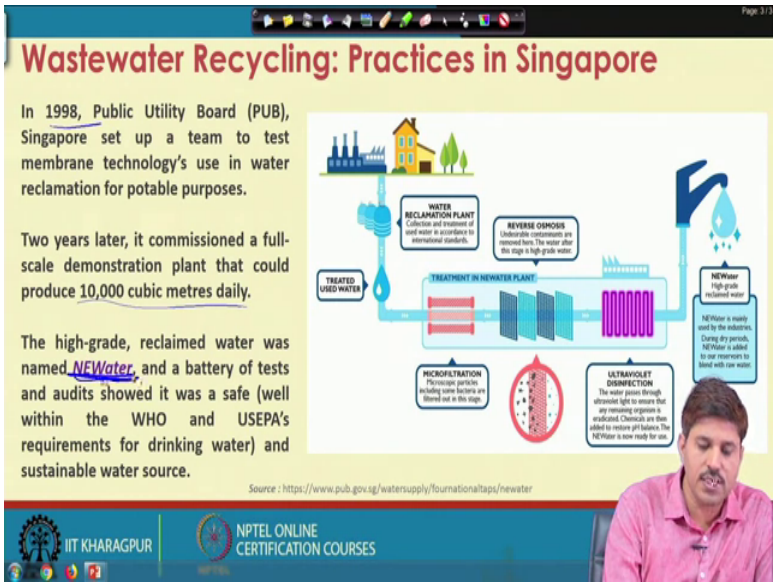

One of the most talked about and one of the most famous reuse program is in Singapore. So, in the Singapore the Public Utility Board which is PUB, so they kind of recycle the water, recycle the treated sewage for even up to augmenting domestic water supplies ok. So, they basically started it at as early as in 1998, there was discussions beforehand as well.

But in 1998 they basically set up a team to test the membrane technologies used, and two years later they produce the first they basically kind of put through a first plant to produce 10000 cubic meters water daily. This was a high grade reclaimed water and they did not call this as a say recycled or reclaimed water, but they gave it a new name saying this has a new water.

So, this new water is essentially the reclaimed water ok, and they performed several tests and several audits over some say like 5000 tests and different several 100 audits were done. And it was basically found that the water is completely safe well within the standards of WHO and USEPA for the drinking waters. And because wastewater is something which people will keep on generating, so it was perceived as a kind of sustainable source as well.

So, what they do? They take the treated wastewater and they pass it through a cycle of three treatment stages. So, there is a micro filtration, there is a reverse osmosis, and there

is the ultraviolet disinfection for the removal of pathogens and then that water which is produced is called new water ok.

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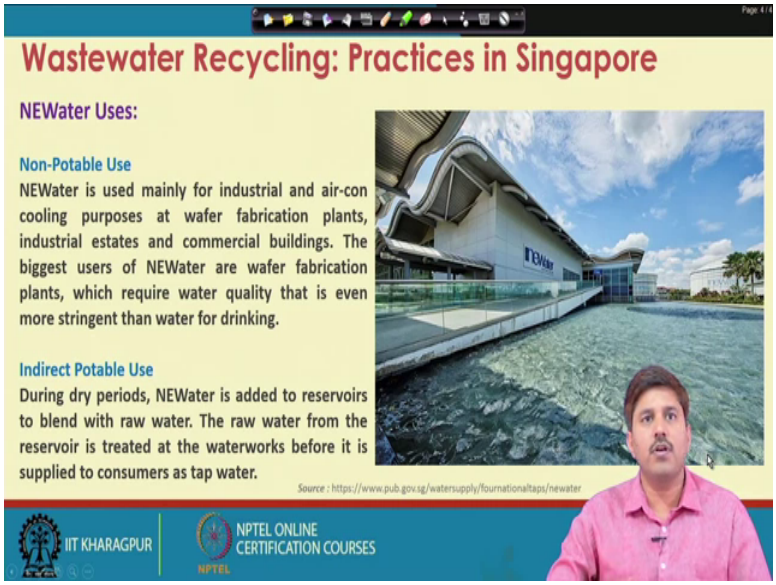

So, this new water is used for non potable as well as indirect potable uses. In non potable there is it is used mainly for industrial and Aircon cooling processes. So, the wafer fabrication industries particularly are the prime users of this ok, so they are the biggest user of new water that way where they use it for cooling purpose. And there are for wafer fabrication also, so this water is used.

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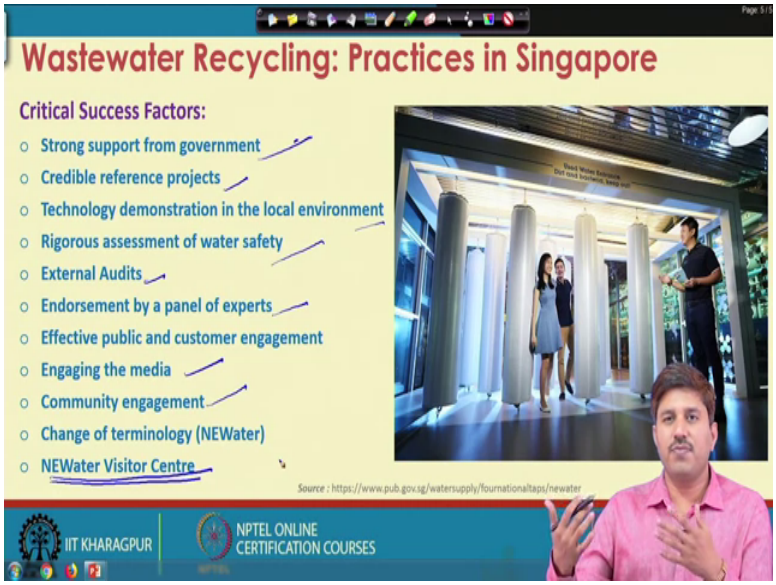

Now, the requirement of the basically water the water quality that is required for wafer fabrication is actually more stringent than the water for drinking and still this water is being used because it is of that higher quality. Then there are indirect potable uses, so during the dry weather periods when there is not enough water available in the reservoirs.

So, this new water is added to the reservoir and it is blended with raw water and this raw water from the reservoir is then further treated for drinking water at their waterworks and then it is supplies to the consumer along with as a tap water. So, basically this is used for augmenting the domestic water supplies as well in the form of indirect potable uses. So, that is what is the basically the two major uses.

Now if we see their critical success factor because when we are discussing the public perception, so it there has been several plants say in Australia, in US which has been stopped for which targeted toilet to tap campaigns. So, but Singapore successfully managed it and there were several factors for this success.

So, there was strong support from the government, then there was kind of credible reference point. So, they took the reference of orange city in the orange city council in the California, where this reclaimed water is being used for the augmenting domestic water supplies although not in the open reservoir form, but still. Then there are technology demonstration in the local environment there are rigorous assessment for water safety, they conducted several external audits, so that basically puts the faith in the utility these external audits they were endorsement by the panel of experts.

So, several experts reviewed the process and said that yes it is safe, so that kind of endorsement also help then there was effective public and customer engagement. So, they made it sure that the end users or the consumers of the water are on the same platform knowing about all the process the details and this they, in fact, achieved through a new water visitor centre as well.

So, this is a kind of centre where everybody can visit and this museum also. So, this basically talks about the process of the generation of the new water, its quality there is demonstration on to that. So, those things are open to public, they engage the media, they engage the community ok.

Community engagement essentially means they basically the senators and politicians from different regions who are invited were briefed about what is being done? How it is advantageous? So, all those things were done and they also changed the terminology. So, because that disgust which comes from a say oh I am going to use sewage. So, they got to some extent read out of that by renaming that water as a new water. So, these are some of the factors which are believed to be kind of acted in favour of the acceptance of the new water.

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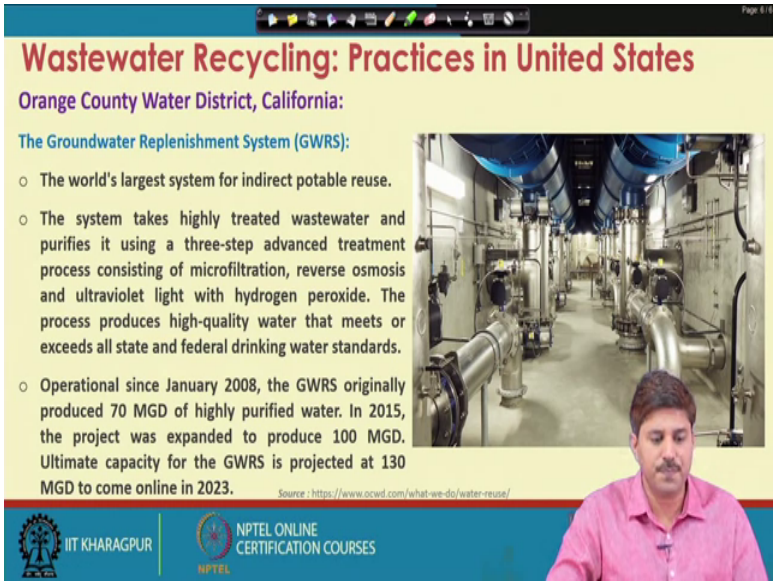

There are practices in United States if we see so the couple of popular schemes are from orange county water districts of California, where there is a groundwater replenishment system. So, this is again an indirect potable use kind of system. So, this is the world's largest system for indirect potable reuse the system takes kind of highly treated water.

So, the treatment here is also the micro filtration, reverse osmosis followed by ultraviolet light with hydrogen peroxide for the disinfection purpose. So, that way they produce high quality water that meets and kind of exceeds the state and federal drinking water standards and then this they inject in the groundwater so which is again being pumped for the domestic water supplies.

So, operational since January 2008, this originally produced 70 MGD of highly purified water. In 2015, it was expended to produce 100 MGD, and they target to produce 130 Million Gallons per Day of water by 2023, so that is what their plan. This practice was

even before the augmentation, so before this GWRS they were doing it at other name at a much smaller scale. But from 2008 onwards they made this under GWRS with a bigger scale.

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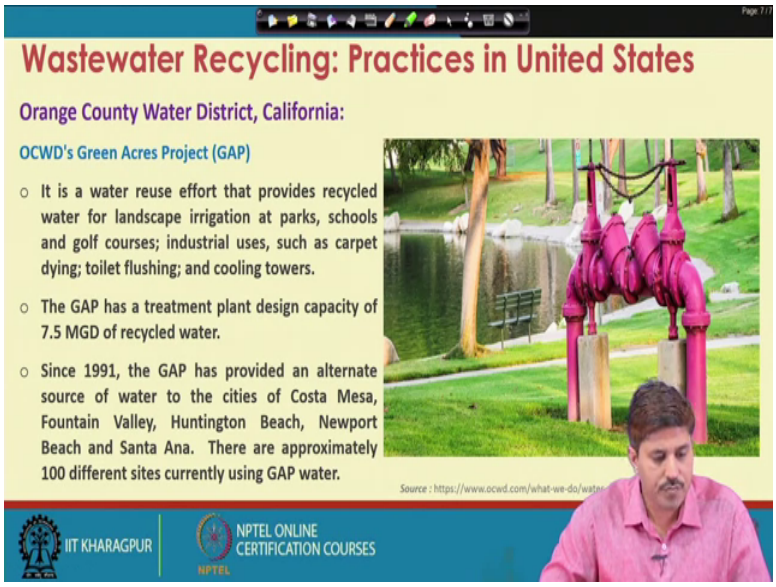

This also uses as a green area project which kind of recycles for landscape irrigation at parks, schools, golf courses, and also for industrial uses such as carpet drying, toilet flushing, and cooling towers. So, this gap which is also called green area project is another reuse from the orange county where part of that is used for augmenting say groundwater ok.

And so, this gap has a capacity of 7.5 MGD of the recycled water. In 1991 the gap has provided an alternate source of water to various cities including Costa Mesa, Fountain Valley all those things Newport Beach, Santana. There are approximately 100 different sites currently which used the gap water for these different purposes.

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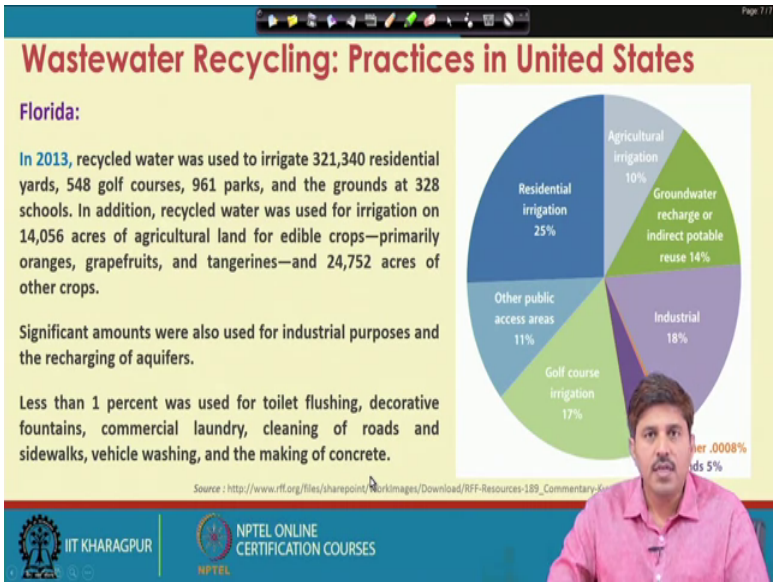

So, then another popular program of wastewater recycling in the United States is of Florida. So, in Florida the in 19 in 2030 the recycled water was used to irrigate over kind of 3 lakhs residential yards over 500 golf courses, close to 1000 parks, so that there are different parks ground schools. So, this is typically used for irrigation there are various other uses. So, if you see the industrial sector it goes to around 18 percent, so that is significant amount ok.

Then different form of irrigation, so residential irrigation, golf course irrigation, then agricultural irrigation that was the major reused. Then significant part was going for the groundwater recharge or indirect potable reuse and some other public access ok. Very little part was used for other uses such as toilet flushing, decorative fountains, commercial laundry all those things. So, just less than 1 percent of water was being reused for those. The primary uses basically was groundwater recharge, different form of irrigation, and the industrial uses to some extent.

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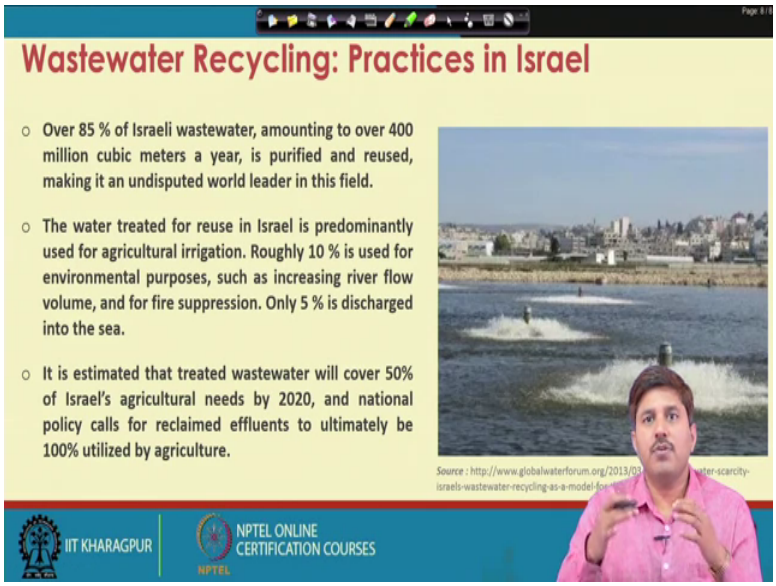

Then if we talk about the extent of recycling, so Israel is kind of the world leader in this. So, Israel claims to use over 85 percent of the waste water which is generated across the nation and which kind of amount over 400 million cubic meters of water in a year that is purified and reused ok.

So, that is how like Israel is considered as the world leader in reusing the wastewater no other country goes to that extent. I think Spain comes second at say range of 20 to 25 percent of the wastewater which is generated is reused. So, the water treated in for reuse in Israel is primarily through conventional process and it is mostly used for agricultural irrigation.

So, there are risk associated with that but still it is being reused, so roughly 10 percent of water is goes to the environmental purposes such as increasing river flow and volume or some for fire suppression, very little is discharged in the sea.

So, most of the uses are in agricultural and it is basically targeting, or they have estimate that this wastewater will cover fifty percent of their total agricultural needs by 2020 ok. So, that national policy calls for reclaimed affluent to kind of ultimately like 100 percent utilization of the reclaimed waste water for agricultural purpose which can cover up almost 50 percent of their total agricultural demand.

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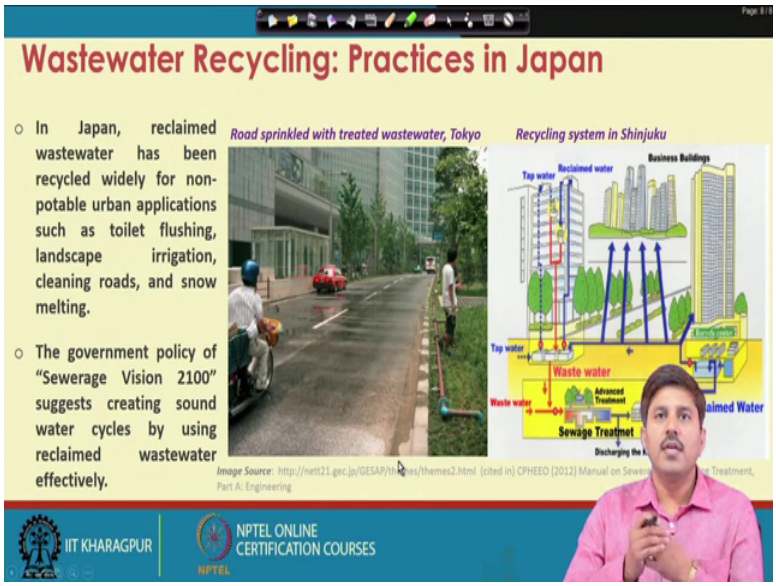

Japan is also feeding pretty good in terms of wastewater recycling. So, in Japan wastewater reclaim reclaimed wastewater is used for various non potable urban applications like toilet flushing, landscaping irrigation, cleaning road, and snow melting.

The government has come up with a policy "Sewerage Vision 2100" that suggests creating sound water cycles by using the reclaimed waste water effectively. So, there are popular reclaimed uses are road sprinkling. So, like there is an example of road sprinkled with the waste water in Tokyo.

They have a toilet supply with the reclaimed water ok, again in several areas of Tokyo. And in fact, in Tokyo they have made it mandatory for larger complexes to have a recycling system ok. Particularly for the toilet grey water recycling system those kind of system has been made mandatory over there.

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Now, if you see the wastewater like wastewater recycling practices. So, they in Tokyo metropolitan government is using wastewater for toilet flushing in an area wide water recycling system. So, they treat it to the tertiary level and then use it for toilet flushing.

There are another very effective and popular case study is of the Tokyo metropolitan government is that they uses this highly treated water from their which I water reclamation centre to restore the abundant Meguro river.

So, the initially river used to basically look like this and it passes through the residential area of the some of the residential areas of the city of the Tokyo and it was in a very pathetic situation. So, they started putting the treated wastewater, reclaimed wastewater in this and the condition of the river has kind of been improved drastically. So, this has effectively converted to this after this strategy implementation of this strategy.

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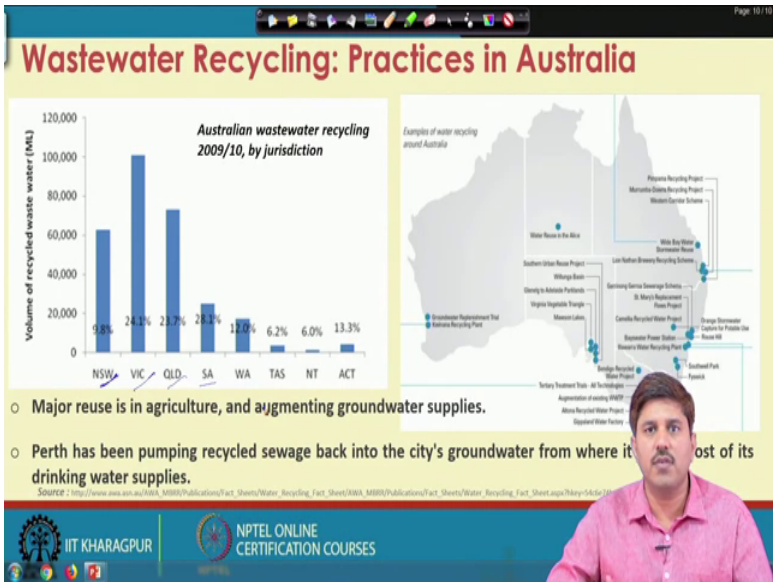

There are recycling systems placed in the different cities, or different states in the Australia. So their waste water recycling if we see by jurisdiction so the different states of the Australia this data is little older of 910, but that is what is available. So, new south wells was used almost recycling 10 percent of their affluent, Victoria was doing fairly good of like one-fourth of the total wastewater generated was getting recycled. Queensland again like almost one-fourth, then South Australia was again quite good that in sense, so they are like the different state has different systems.

So, major reusing agriculture and augmenting ground water supplies. In Australia there has been in Tamaki, there has been a basically case of public opposition for reusing water for drinking water supplies. So, they are very cautious about that, but still have started planned.

So, Perth is been basically pumping recycled sewage back to the cities groundwater from where it draws most of it is drinking water supplies. So, there are various plants recycling systems across these nation, so that is what is the status in Australia.

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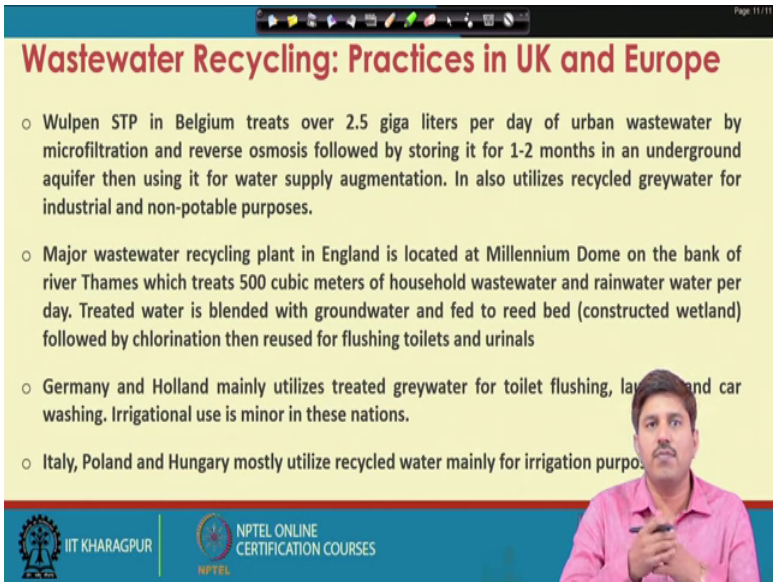

There are if we see the practices in UK and Europe. So, particularly Wulpen STP in the Belgium that treats over 2.5 Giga litres water per day, and then kind of it treats with the micro filtration and reverse osmosis followed by storing it for 1 to 2 months in an underground aquifer and then using it for water supply augmentation, so that is again an indirect potable reuse kind of system. It also utilized this recycled grey water for industrial and non potable purposes.

There are major wastewater recycling plants in England is located at this Millennium Dome which is on the bank of the river Thames and that treats all around 500 cubic meters of household waste water, and rain water per day. This treated water is blended with the ground water and fed to the reed bed which is the constructed wetland and then it is followed by the chlorination and reused for flushing toilets and urinals.

Germany and Holland mainly utilized treated wastewater for toilet flushing, laundry, car washing those kinds of things. Irrigation uses are fairly minor in these nations whereas, Italy, Poland, Hungary mostly utilized recycled wastewater for irrigation purpose.

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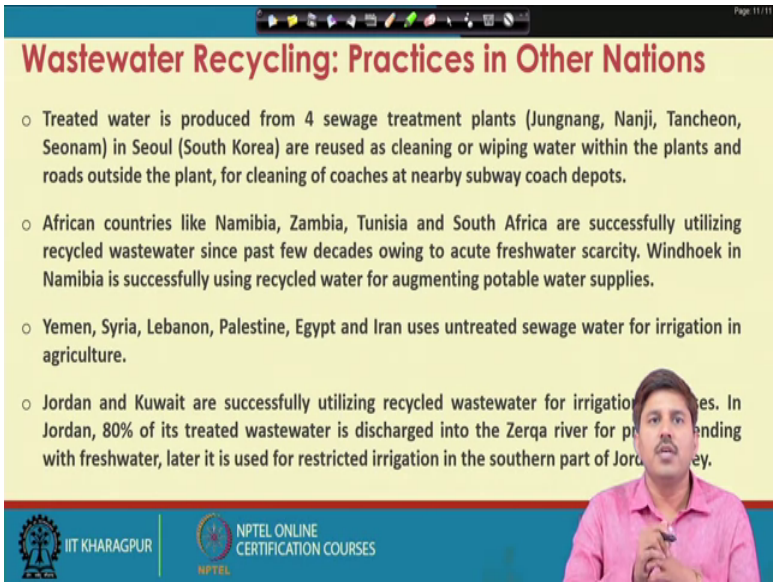

If we see the other nations, so treated wastewater from 4 sewage treatment plants in the South Korea Seoul; so they are used for cleaning and wiping kind of structures infrastructures within the plant; the roads outside the plant. And particularly from this joint STP, the water is basically drained for cleaning of the coaches at this nearby subway coach depots. So, that is what the reuse in the Korea.

Then various African countries like Namibia, Zambia, Tunisia, South Africa they have been utilizing recycled wastewater since some quite some time now. And they are forced to also because there is a queued fresh water scarcity we heard with the case of South Africa that there is an out of the water balance run out of zero.

So, that kind of situations is there in the African countries and that is how they are motivated to recycle the water. A particularly wind hawk treatment system in Namibia is fairly successful which is recycling water for augmenting potable water supplies. The Yemen, Syria, Lebanon, Palestine, Egypt and Iran are using untreated sewage for irrigation in agriculture. Jordan and Kuwait are utilizing the recycled wastewater for irrigation purpose.

So, treated wastewater is being uses in these countries. Particularly in Jordan 80 percent of its treated wastewater is discharged into the Zerqa River for proper blending with the fresh water and later it is used for the restricted irrigation in the southern part of the Jordan valley. So, that is about the things happening across the world.

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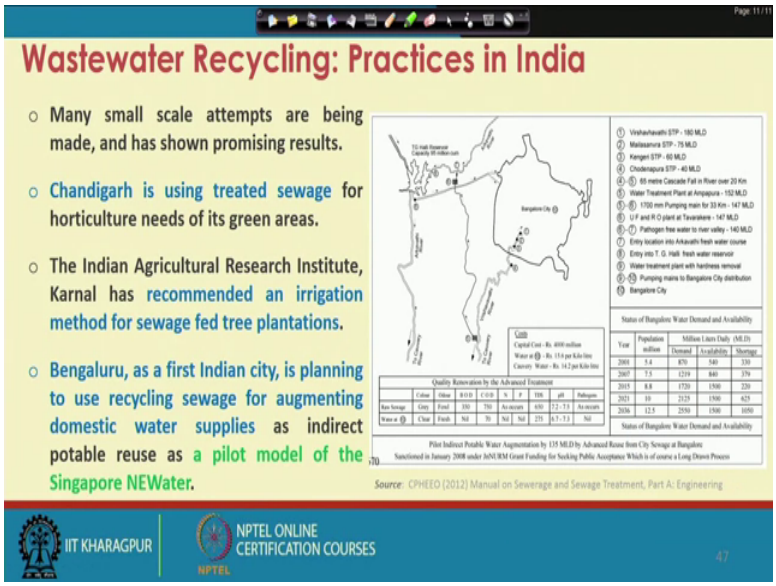

Now if we see about India the, what are the practices that are basically under operation in India? So, there are many small scale attempts which are being made and they have shown quite promising results as well. Like Chandigarh is using treated sewage for horticultural needs of it is green area.

The ARI IARI in the Karnal; Indian agricultural research centre; so, they have done some research and come up with a recommended irrigation method for sewage fed, tree plantation for kind of sewage forming systems. In Calcutta the sewage and is used in a kind of for fish farming purpose. Bangalore is the first Indian city which is planning to use recycled sewage for augmenting domestic water supplies as I indirect potable reuse.

So, they are actually have an idea of essentially put a pilot model of the Singapore's new water. So, like Singapore's new water is achieving these indirect potable reuse options, so Bangalore is also trying to come up with a system like that. This is actually the plan for that scheme. So, this is the indirect potable augmentation by 135 MLD, of the advanced reuse sewage in the city of Bangalore, so that is what is the plan and the details of the plan like this.

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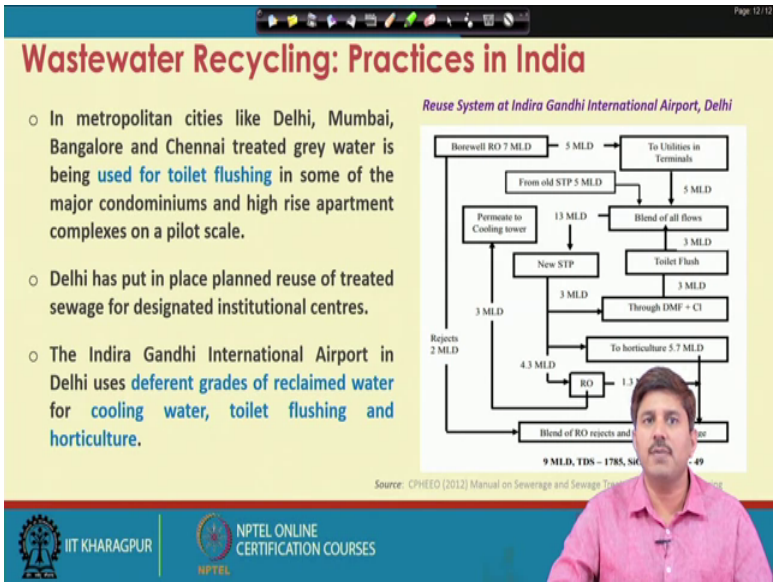

If we see the other uses so, in metropolitan cities like Delhi, Mumbai, Bangalore, Chennai, Hyderabad, Madabad, there are systems for particularly the grey water which is being recycled and reused for toilet flushing, in the major high rise apartment complexes ok. So, that is being done on a pilot scale in several apartments.

Delhi has put in place in a plant reuse of treated sewage for various designated institutional centres. The one of the prime example is Indira Gandhi international airport in Delhi which uses the different grades of reclaimed water for cooling purpose, for toilet flushing purpose, and for horticultural purpose. So, this is the kind of plant for that Indira Gandhi international airport water reuse system.

So, they get 5 MLD sewage from the urinals, they get 3 MLD from the toilet flushes and from older STP they get 5 MLD. So, that 5, 5; 10 plus 3 total 13 MLD water they take they treaty with the newer STP through different degrees, out of this 13 MLD; 3 MLD. They finally, after the STP they put it through the kind of filter and they chlorinate it, and put it for the toilet flushing which again goes here. So, that is your one cycle.

Then out of that the 5.7 MLD they bring it for horticultural uses. So, for irrigation or horticultural purpose at the IGI airport itself, and the remaining 4.3 they treat it to RO level. So, when they treat it to R O level they get 3 MLD permit and 1.3 MLD as a reject. So, reject they again put it with this horticultural water that is coming blend the RO

reject, and the STP treated sewage. And the permit or the R O treated water is basically goes for the cooling tower ok, so that is how kind of the reuse it for different purposes.

So, the they treat it through DMF, and C L, and then for chlorine,and then put for toilet flush. The STP sewage treated is used for horticulture and they further put additional step of R O and use it for the cooling tower, so that is what is happening at IGI airport. The reuse system the concept of using treated wastewater for industrial activities is also gaining quite popularity ok.

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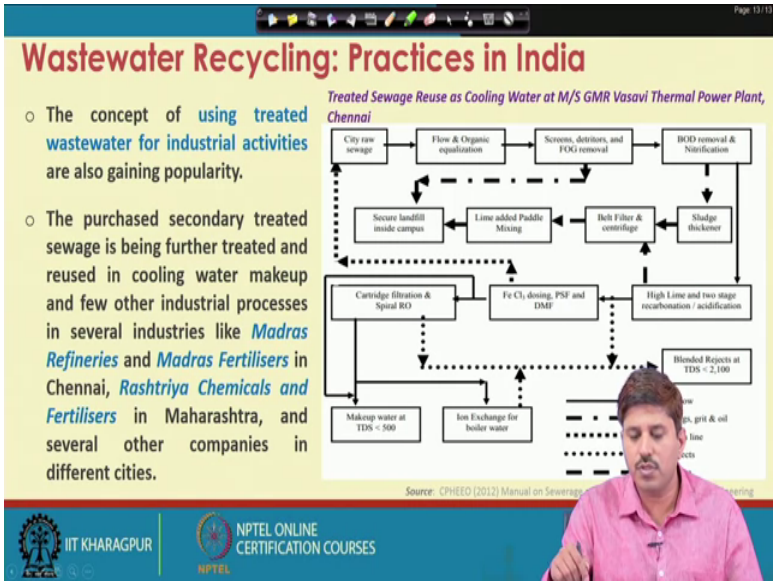

So, there are like various industries who purchase the secondary treated sewage and then further treat it, and reuse it in cooling water makeup, or few other industrial processes in several industries. So, some of the examples are like Madras refineries, or Madras fertilizers which are situated in or placed in Chennai. Then Rashtriya chemicals, and fertilizers of Maharashtra, and there are several other companies in different cities some are in sutra, also that way there are quite a few companies.

So, this is kind of an treated sewage reuse example as a cooling water at Vasai thermal power plant in Chennai. So, this is a kind of thermal power plant reuse options. So, they take the city sewage, then flow and they do equalization screening all those standard treatment, BOD removal, nutrient removal, then sludge thickness, then they do lime dosing, and all these different type of dosing.

And finally, they sent if you they basically do a cartridge filtration and spiral reverse osmosis processes and put it as makeup water at TDS less than 500, then that is how kind of they reuse it.

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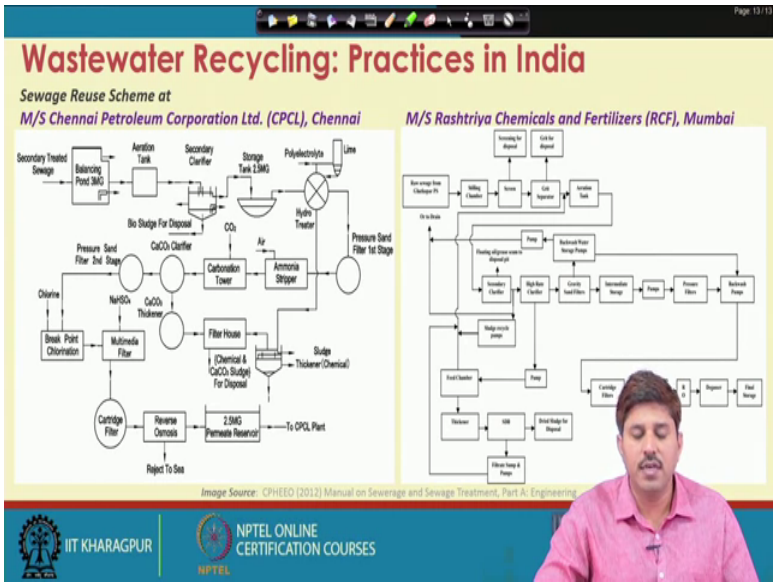

So, this is a reunion scheme at say Chennai Petroleum Corporation limited which is CPCL in the Chennai, the right side one this one is for the Rashtriya chemical and fertilizers RCF Mumbai. So, that way there are different systems are actually in place.

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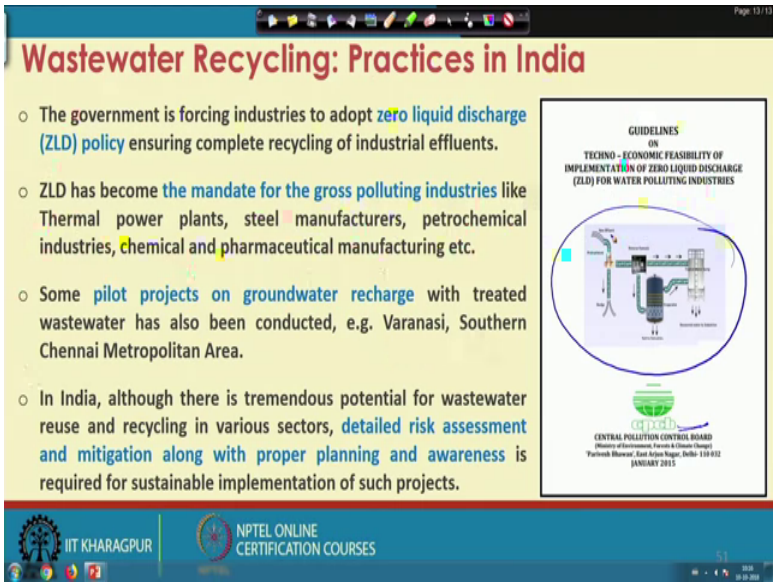

So, if we see the kind of overall practices of the industrial industries are using reclaimed water, but what is happening to the water that is being generated by the industry. So, that also the government is kind of forcing through this zero liquid discharge policy which is typically known as ZLD. So, this government is making a mandate particularly for the gross polluting industries like your thermal power plants, steel manufacturers, petrochemical industries, various chemical and fertilizer manufacturing industries.

So, there are kind of 12 specific industries specific type of industries which has been bought under the umbrella of ZLD, that they have to opt for zero liquid discharge systems including distilleries or those so high grossly polluting industries that way. So, they are the government has come up with a mandate that they have to adopt the ZLD practices.

So ZLD practices essentially that you recycle your entire waste that way do not leave anything outside the plant periphery. There has been kind of this techno economic feasibility report from central pollution control board, so that talks about the ZLD systems. How this can be implemented? So that is what is one development which is taking place.

So, preventing the industrial effluents to going into the river and ensuring the complete reuse and recycling of the industrial effluents, there are pilot projects on groundwater recharge as well in some places particularly like in the Varanasi or southern Chennai metropolitan areas. But they have not been to a very large scale small pilot projects, there are tremendous potential for wastewater reuse, and recycling in the various sectors in India of course, there are associated risk also.

So, a detailed risk assessment and mitigation policy should be prepared and along with the proper planning and awareness is needed is basically very much required for sustainable implementation of these recycling projects in the country.

So, there are enough potential only thing is that we should be able to harness that. So, we need the technical skills for that, we need the social acceptability for that, we need adequate fund for that, we need adequate technologies for that, that ensures that there is like minimal risk ok.

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And what are the adequate risk assessment measures? So, if we look for the future, so water reuse for future supplies and reliabilities is a must ok. We should have to have water reuse systems where we can use water for factory, streams, agricultural purpose the different purpose.

So we can bring it into the basically system or into the water cycle the wastewater should also come into the water cycle that way. And if we look at a utility or future, so ideally a water a wastewater utility particularly should be a kind of resource recovery factory ok.

So what we can recover? We can recover once we receive the wastewater through the basic primary treatment and all that. So, we can recover the energy out of this treatment ok. So, the like we discussed the anaerobic digestion, or incineration or those processes. So, there is a possibility of recovering energy. So, we should try to use this as energy factory, there is a possibility of recovering nutrients after secondary treatment.

So, we should try to use as a nutrient factory nutrient or other elements metal. So, we can use that as a recovery factory for those things. And eventually we should be able to get reclaimed water of usable quality. So, that is basically we should try to treat it as a water factory which produces water from the wastewater ok. So, the wastewater have all the pollutants with all it is the politics in it can actually be still used for production of energy, for recovery of nutrients, and for reclaiming water out of it and that is what we should aim as a future. So, this is where we are conclude the discussions ok.

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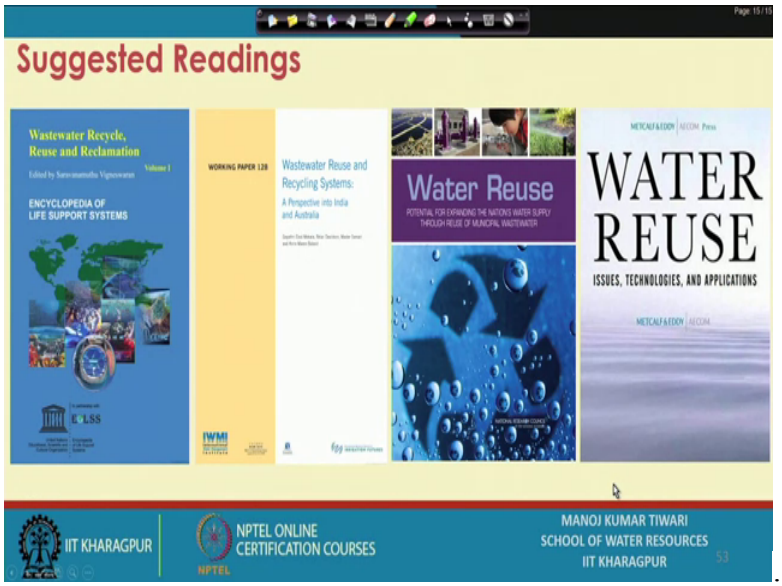

There are quite a few literatures available. So, somebody wants to explore in the more deeper. So, there are these are some of the recommended books or these are more so in fact, the manuals ok.

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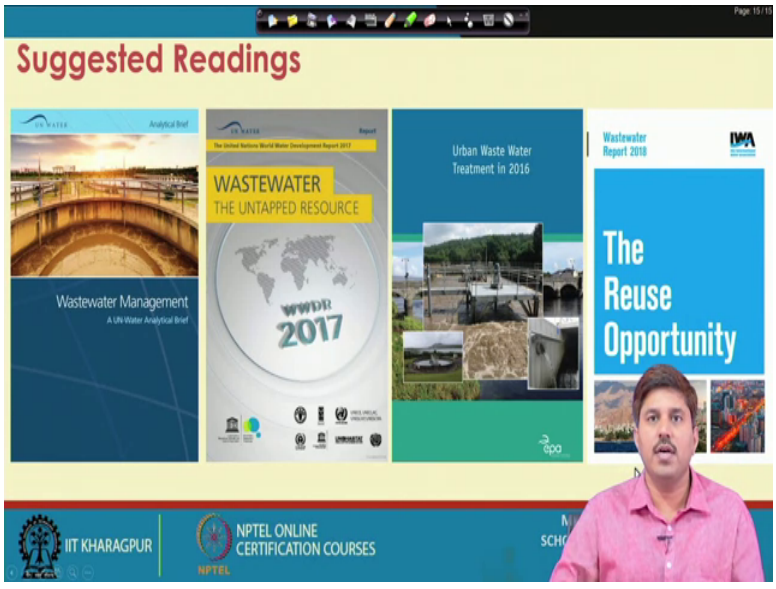

So, various manuals and books which can be which can be basically read through for getting more detailed knowledge on the reuse recycling aspect ok, and water treatment aspects. So, with this we conclude the discussions here, we have completed this journey of the 12 week and have come towards the end of the discussions. Of course, we will

have we will try to basically get to a summary of this entire discussion that we had in the 12 weeks.

But content wise so this is where we conclude our discussions thank you thank you all for being with us for this period of 12 weeks. And I look forward to your feedback, your suggestions, and any comments, or queries that you may have. So, please feel free to post that in the forum we will be happy to answer those and we welcome your feedback and comments also. So, thanks again for being with us for this entire period, and wish you a good time I had.

Thank you.