Urban Services Planning
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Lecture 31
SWM 2016 Specifications for Sanitary Landfills

Welcome back. In module 7, we will talk about waste disposal planning for urban area, and in lecture 31, we will be talking about solid waste management rules 2016. And within that, specifications for sanitary landfills.

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The different concepts that we will cover are on waste disposal at sanitary landfills, landfill and sanitary landfill definitions. The software management rules 2016 and it is, and what it talks about, sanitary landfills, then software management rules 2016, criteria for site selection for landfills. Then criteria for development of facilities at the sanitary landfills. Criteria for specifications for landfilling operations and closure, criteria for pollution prevention, criteria for environmental monitoring and also other criteria.

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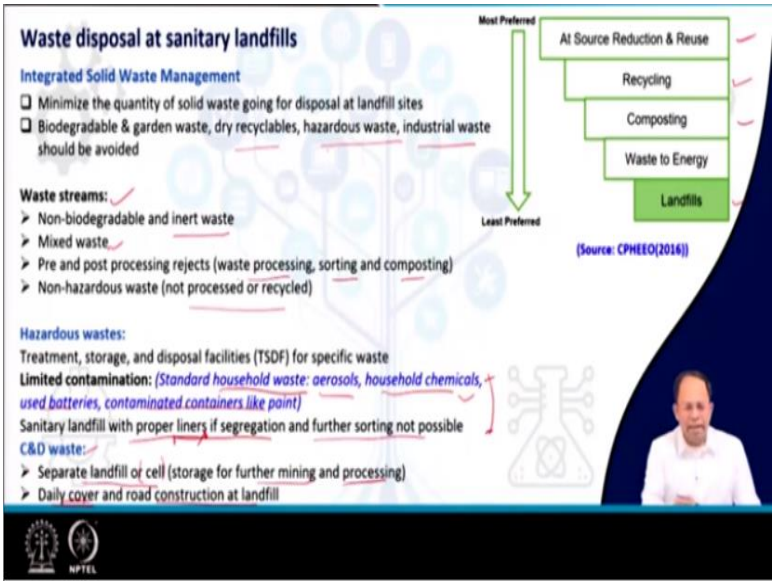

So, as we have learned earlier that when we talk about integrated solid waste, our idea is to reduce the total quantity of waste that finally reaches the landfill. So, of course, we should try to reduce at source and of course, and reuse as much as possible. Then recycle some of the waste that is generated or some of the, like for example, we can, recycle certain materials, certain glass, certain metals can be recycled, some paper can be recycled.

Similarly, composting for the biodegradable part, for organic part, we can do composting. And then some of the rest could be also converted into energy. Some waste can be also converted to energy. And finally, whatever remains goes to the landfill. So, our goal is to reduce in each of these phases. And finally, when we reach the landfill site, it should be as less as possible because landfill requires land at, in certain areas, there is absolutely no land area available where we can, permanently put our waste or dump our waste.

And as you know that, if I design a landfill site, the site life is for a long period, and that means that that particular area would be engaged. And so, we cannot have other alternative users for that area for a long period of time. So, areas which do not have land, there of course, the target should be to reduce as much as waste that goes into the landfill, that reduces the overall area for the landfill site.

So, usually, we should avoid sending biodegradable and garden waste, dried recyclables, hazards waste and industrial waste directly to the municipal land. Of course, hazard waste and industrial waste has to be taken care of by other facilities, but and eventually some of that goes back to the landfill. But for that, we can also specialize landfills as well. But the normal standard municipal landfill, we should avoid this kind of waste.

Now, what should go into the landfill then? So, which waste stream should we considered going into the landfill? Non-biodegradable and inert waste. We have learned the definitions of this earlier. Mixed waste, the waste which cannot be segregated, that has to go into the landfill. Pre and post-processing rejects at waste processing, sorting and composting plants. So, in waste processing and sorting centers and composting, there are a lot of rejects which are generated, which cannot be recycled or reused. So, that rejects goes into the landfill site.

Sometimes all this we call the residual also. Then non-hazardous waste, which is not processed or recycled, that also may go into the landfill site. What about the hazard as waste then? So, hazardous waste, usually for hazard as waste, we have TSDF facilities that is treatment, storage and disposal facilities. And we have specific kind of a facilities for specific kind of waste. For battery, we will have a specific facilities. Similarly, for plastic bottles, we will have a separate facility.

So, for each of these different kinds of waste, we will generate different kinds of facilities, specialized facilities. And for areas, this is possible because we have a adequate quantity of waste of each of these kind, but for small areas, we can create regional facilities as well. Then normal household waste sometimes it is like in most earlier when we have discussed collection, you have seen that usually the collection is dry, come in form of wet waste and dry waste.

So, in dry waste in certain municipalities, if they do not have a (())(4:57) processing and a sorting centre, in that case, some hazardous waste remains in the waste. For example, standard, like aerosols, aerosol can like sprays and all, household chemicals, use batteries, contaminated containers like paints and all this remain in the standard household waste. So, what to do about them.

So, in that case also, even though these are hazardous waste, we put them in a landfill site and it goes into the municipal landfill. But we have to really take care that the landfill is designed in such a way so that it does not allows further creation of leachate, which leachate is the water when it comes in contact with the material in the landfill site, it actually acquires all the different pollutants from that, and then goes down downwards and mixes with the groundwater. So, that is leachate. So, sanitary landfill with proper liners if segregation and partnering is not possible.

So, we will learn about what are liners, liners are barriers that we create below the landfill site so that water cannot pass through it. So, these barriers are made of many materials. It

could be compacted clay, it could be normal soil mixed with some amount of cement as material, or there could be some sort of geo membrane as well. So, we can create barriers in different ways. So, we call them liners.

And then coming to so some amount of, if we are designing a landfill site properly as sanitary landfill site, in that case, we can make, we can allow some amount of this hazardous waste to go into the landfill site. Then coming to C and D waste, construction and demolition waste, we require separate landfills or some part of the landfill. Here let us assume that water, we will learn about this again in later. So, some separate landfill or within the existing landfill, one part of it, or some specific cells can be, can be reserved for this kind of construction and demolition waste.

Now, why separate cells, so that we can know where we have put that kind of waste and later on we can mine it and process it. Mine, it means I will take it this kind of waste out and then process it. So, right now I may not have a facility for processing, construction and demolition waste, but in future I may have a facility for construction and demolition waste and I, that is why I need to mine it out of the of the waste. And then again, further work on it. We can also use this construction and demolition waste for creating daily covers and road construction at the landfill sites.

Now, road construction is pretty obvious, but what is daily cover? That means every day when soil, when waste comes to the landfill at the end of each day's operation, we also cover that waste using a layer of soil. So, instead of soil, we can use this C and D waste as also cover as well. So, that is how we can use C and D waste. So, these are the different kinds of waste in that goes into the landfill site. And our target is to of course, minimize the quantity of solid waste that comes into the landfill site.

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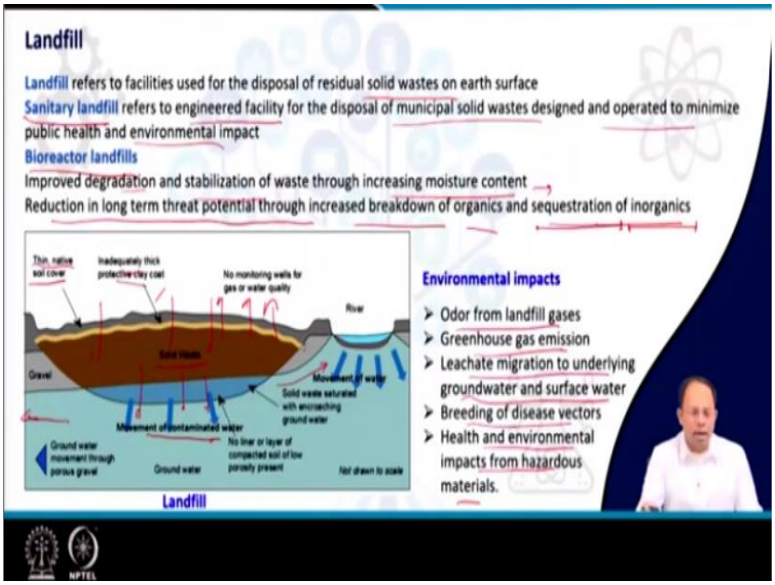

So, coming to the definitions, usually, landfill refers to facilities used for disposal of residual solid waste on earth. In other words, we also call them as dumpsite. Now the problem with dumpsite is, as you can see in this particular image, this is a standard dump site. We, you can see that this is where the solid waste is being stored.

And some amount the leachate moves from the solid waste because of more and more waste that is being dumped on the, on each layer, it presses on it, and that takes the and so the, and also, moisture keeps on coming in from rainfall and all, some amount of obviously infiltrates and that this all water moves downwards and then mixes with the groundwater and contaminate it. So, that is what is being shown over here.

Similarly, in case of solid waste, you can see that this groundwater can actually move and mix with the surface water sources as well. And, it can spread to other areas, like it can flow as per the hydraulic gradient. And, and then it will mix with other aquifers and all. So, all this is a problem. And then in this kind of landfill, you will see a little bit of cover given at the top. So, a thin native cover using local soil is given at the top. And this is inadequate and it is, it is, it does not prevent water to get inside. So, water will continuously get inside and it will keep on creating leachate and further contaminating the entire sources of water.

Now, because we have not done proper covers and all, obviously the landfill gases which results from decomposition comes out and they will go into start going into the atmosphere. So, all these problems will happen. Now, usually we find lot of odour coming out of landfill gas in this kind of facilities where there is no proper engineering design, greenhouse gas emissions, CH_4 and CO_2, leachate migration to underlying groundwater and surface water,

breeding of disease vectors. Lot of animals or lot of this insects and other disease vectors are, they are produced as well as they continue to grow over here.

Then health and environmental impacts from this hazard materials in the surrounding area because of contamination. So, all these problems happen. So, that is why a standard dumpsite is obviously not a solution. We have to develop better facilities. So, that is where sanitary landfills come in. So, sanitary landfill refers to engineered facility for the disposal of municipal solid waste designed and operated to minimize public health and environmental impact.

So, it is the engineered facility and the design is such so that the overall health and the environment is protected in for this particular area. And finally, we have further developments of landfills, like from sanitary landfill nowadays we construct bio landfills, which is of course a engineered facility as well. But the only difference is, we can achieve further degradation of the waste and stabilization of the waste through increasing the moisture content.

Now, this is very odd because earlier I was saying that if more moisture gets inside the waste, it will create more pollution, but here we are proposing to increase moisture. Now, when I increase moisture in the waste, the decomposition processes occur, it increases decomposition of the waste and so, but that also means that we will capture this moisture or this leachate and will not allow to go down and mix with the groundwater and use this captured leachate and some of it we could be and we can treat it, and some of it could be, again, pumped inside the landfill and it will keep on increasing the moisture content.

So, moisture along with bacteria that comes along with that particular leachate also gets mixed and that will keep on increasing the decomposition of the waste. And that results in a more stabilized solid waste and, more stabilized landfill. Stabilize means that the overall size of the landfill requirement and all those things will gradually go down and it is a more compact, more stabilized regional surface, which we can use even later.

Now, this reduces the long-term threat potential through increased breakdown of organics. Of course, we say composition increases and sequestration of some amount of inorganic. So, inorganic material takes a long time to break down in the environment. And so, this actually also helps to fast degrade. So, this is the benefits of a bioreactor landfill.

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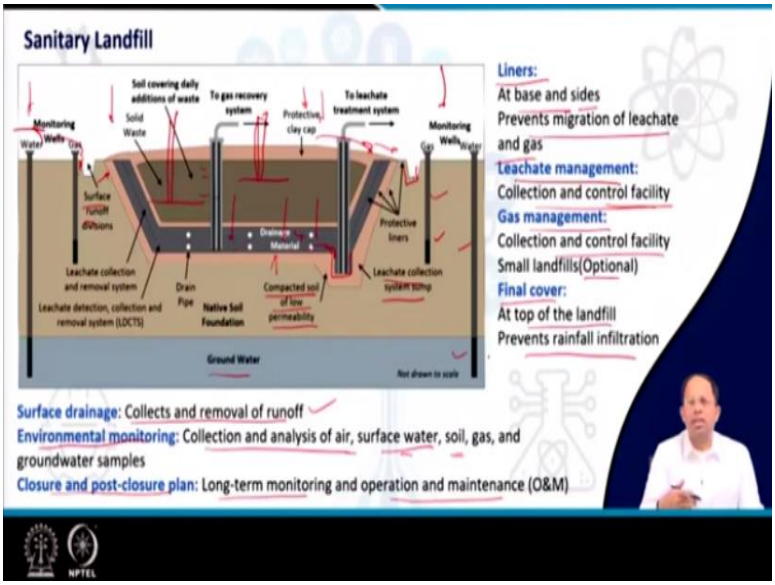

Now coming to a standard sanitary landfill, which is an engineered facility, as you can see in this particular image, it shows the typical sanitary landfill. And here you can see that we have groundwater over here and, and here we are not allowing the leachate to come down and mix with the groundwater, how we have done that. So, you can see here a compacted soil of low permeability is given. So, this is called the liner.

So, liners are provided at the base and at the sites to prevent migration of leachate and gas. So, basically this liner, as you can see, it is at the side as well as the bottom. It prevents movement of both the landfill gases as well as water to the surrounding areas and also below. Then management system is installed. What is that? Collection and control facility for leachate. So, here you can see that above the liner we have created a drainage layer. Drainage layer is a layer which is made of gravel and other materials so that the leachate that comes directly from the top to this particular layer is captured in this drainage layer.

And we have this open jointed pipes, porous pipes you can say inside this particular layer, which captures that leachate and of course we give a slope to this particular drainage there. And because of this pipe network, this leachate could be captured and then they could be brought to a particular area, for example, it or some amount of leachate also flows to this area which is created like a sum over here. So, leachate collection sum and we can pump the leachate up from this particular sum.

Or sometimes these pipes also lead to, some outside as well. From there also, we can pump it up. So, that means we are allowing the leachate to pass through, but capture it in the drainage

layer and then, we can pump that leachate out, which could be further treated, so that is why a collection and control facility for leachate is required.

Then gas management system; collection and control facility. For small landfills, gas management is optional, but for large landfills we have to design a gas collection system. So, we want to recover the gas, now it is done in different ways. We will discuss it later in detail, but as you can see from the drainage layer, also, we can have some certain pipes installed. And this has got some amount of material given inside this pipe so that it allows gases to enter. And then gas collection could be done at the perimeter, it could be done at different layers.

So, from different layers we can install gas collection system. And, using this gas collection system, we can through passive and active measures suck out the gas and then use it for our purposes. Then finally, the final cover, which is the top cover. This is the top of the landfill, which prevents rainfall infiltration. So, that means we are giving a protective cover at the top, which prevents water to get, get inside the landfill. So, this is how it looks.

Now, surface drainage also needs to be collected and we need to remove the runoff. So, whatever water rainfall falls in this surrounding area, we should not prevent, we should prevent it to move into the landfill site. So, there are, so that means we have to create the surface drains over here. So, here the water that will flow from this side, it gets strapped inside the surface drain, and we can divert it from the landfill side.

And similarly, the water that is falling on the landfill side, most of it will flow down, but because we give a slope to the landfill surface, in most cases, the landfill, this mount surface, and it will also flow back and then be captured into this, into this surface drainage. So, surface drainage is a big thing that means, we have to properly do a drainage network planning in this particular area, collect all this runoff, and then if this gets somehow contaminated, we have to treat that runoff. Or if its we can prevent contamination, we can actually, collect it and then gradually let it go without flooding other areas.

Then environmental monitoring. This is collection of analysis, collection and analysis of air, surface water, soil, gas, and groundwater samples from the surrounding area. So, we have to continuously keep on monitoring. Are we, is contamination happening? Is there is some contamination of the groundwater? If the surrounding, atmosphere there is lot of methane in it because if there is too much methane, it may explode. So, this will keep on monitoring.

And finally, once our plan period is over, that means the landfill has reached its end of design life, then in that case we do a closure and a post closure plan. And that means that how do I complete the landfill process and it is a long, and we also keep on monitoring all these parameters, the air surface, soil, gas, and all this.

And we also have a operation and maintenance strategy so that it does not, certain, that clay layer at the top does not get damaged. And all this has to be continuously monitored. So, we keep on monitoring for roughly 15, 20, 15 years. And by that time, the landfill more or less stabilizes, the decomposition is more or less complete and we can further think of utilizing this particular landfill. So, this is how a sanitary landfill looks like.

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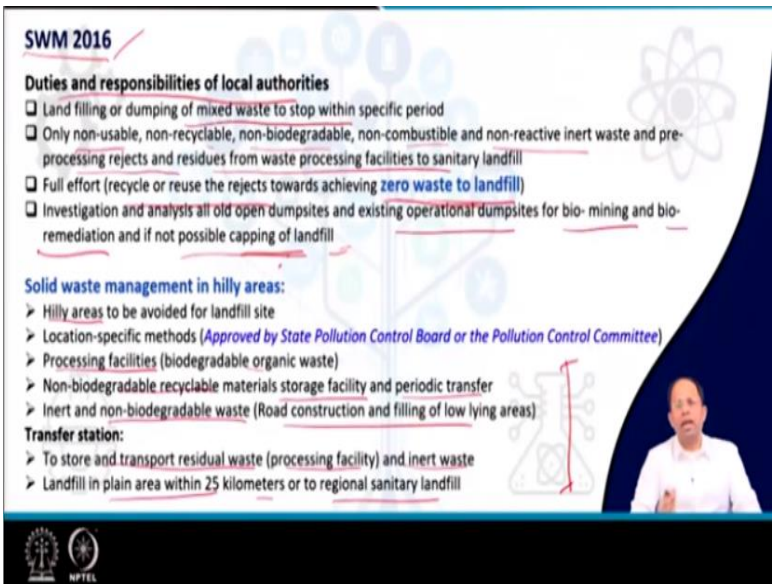

Now, coming to the solid waste management rule 2016, we have already discussed this in one of our lectures, but we have not talked specifically about landfills. So, we will just take you through the point so that you can actually go through this particular point and see that these are the things that needs to be done.

And like for example, the duties and responsibilities of local authorities. That means, we as per rules, that is solid waste management 2016, you can say as per law also that landfilling or dumping of mixed waste has to stop within a specific period. That means we cannot take mixed waste to the landfill and we have to keep on reducing that quantity of waste that goes into the landfill.

So, only non-usable, non-recyclable, non-biodegradable, non-stable and non-reactive inert waste and pre-processing rejects and residues from waste processing facilities goes into the

landfill site. So, our effort should be towards a zero-waste landfill. That means we should invest a lot of money in recycle and reuse of rejects so that we can achieve eventually a zero waste that goes into the landfill, but it will take time. It cannot happen over one day. So, we have to give that time, but gradually the municipality should try to achieve this.

So, in addition to that, the solid waste management rule talks about existing dump sites or old dump sites and existing operational dump sites, and say that if possible we have to improve them. How we can do that, we can bio mine them. That means we have to take away certain garbage from there, we have to treat it and then we have to do bio-remediations.

So, we have to treat it and process it and so on. And if possible, also, if the, if and if we cannot do this kind of bio mining or bio-remediation, the waste is too mixed, which is not possible in that case, we have to give a proper cap or a proper cover to the landfill so that it does not allows further infiltration of leachate or moisture into the landfill. And we give as much as protective measures as possible. And also, this will allow us if we a proper capping, some amount of gas to be also collected, methane could be also collected from landfill.

Now, in hilly areas, everything is more or less same, but in addition, there are certain additional considerations. And the hilly area, because of the terrain, we cannot have landfill in a slope, definitely for obvious reason. But, that means that our target should be to have, again, as much as processing facilities for biodegradable waste and recycling and all these other centres can be also centre set up and for non-degradable waste, if recycle centres are not able to be, set up over there or we do not have land in that case, there has to be a storage facility. And from there periodically this waste has to be transferred to regional this material recovery centres or (())(21:23) centres.

And inert n non-degradable waste could, could be used for road construction and filling up low line areas in this hilly region. And this transfer station, as we were talking about earlier, to store and transport residual waste to a processing facility and inert waste of course, so this goes to, finally to the landfill site. And the landfill could be located around within a 25 kilometre radius, but it should be in a plain area.

And if it is not available, then the regional sanitary landfill facility also could be considered. So, this is that what it, this particular, after SWM, every waste should be segregated and we should only take the relevant waste, waste streams to the landfill site. So, earlier every week mixed waste used to go to the landfill. So, that has to be prevented.

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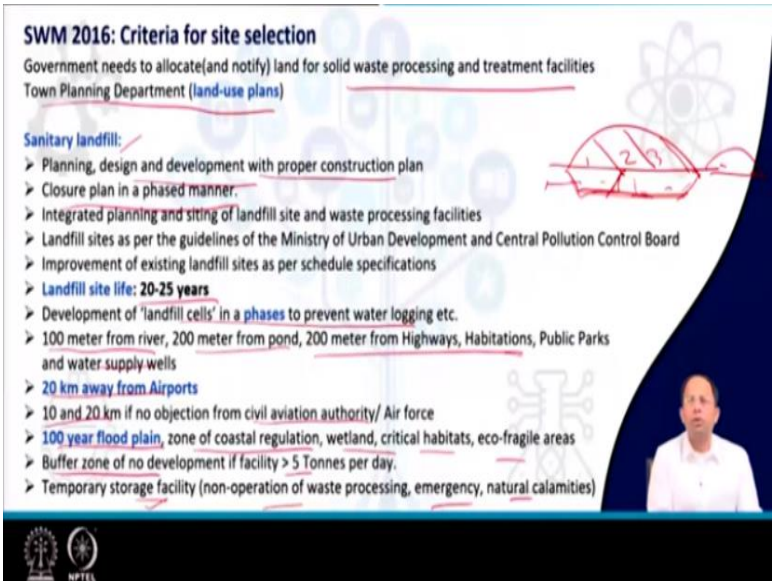

So, these are some of the criteria for site selection of landfill as given by the, notified by the government. First of all, the land should be made available for allocation of a landfill site and also the site for waste processing and treatment facilities. And the, usually it is a responsibility of the town planning department to produce, create land use plans and reserve land for land sites.

So, the town planning department also, when they create the land use plan, they should also consider a few aspects when they create this, when they find the location for this land. So, these are some of the rules which are given, landfill site life should be 22, 25 years, proper construction plan. And a and the design development should be done as per plan. A closure plan should be done in a phase manner. That means we gradually, we develop the landfill in phases, part by part because the landfill life is 20 to 25 years.

So, I cannot just create the engineered facility for 25 years at one go. Because it will be very costly. So, we create phases, we create certain zones, we create the engineering design for that, and then we do it, and then we cap it, and then we move on the next phase, but within the same landfill site. And the design itself, so that at the end it is all it will look like an integrated mark.

For example, I have a landfill site like this. So, maybe in the first phase I will do this is phase 1. In the second phase I will do this. In the third phase I will do this and so on. So, actually this is how we should create the phases. And, then landfill cells in phases to prevent water logging. And because what happens when I do a landfill, I will dig up a certain part of the landfill, so, we use this soil as soil cover. Whenever garbage comes in, we have to put our

soil in every daily cover, intermediate cover, we have to put this soil covers and on where do I get this soil?

So, I get this soil by digging in the same landfill. So, if I dig the entire area and create a dump of soil over here, obviously there will be water sum. So, it is better to do it in phases so that only this zone is considered and this zone is not, dug up the entire zone is not totally dug up. And, in addition to that, the landfill should be 100 meters away from a river, 200 meters from surface water bodies like ponds and all, 200 meters for highway, habitation, public park and water wells and so on.

So, this is given as per the SWM 2016 and landfill should be also 20 kilometres away from land airport. But if I get special permission, if land is not available, I can get special permission from civil aviation authority or air force. And using that, I can create a landfill within 10 to 20 kilometre. And in addition, hundred years flood plane zone of coastal regulation, wetlands, critical habitats eco-fragile, these are absolute no for creation of landfill sites. So, this kind of land areas should be prevented.

So, finally, we have to create buffer zones. If the amount of waste that we deal per day is more than 5 tons per day and temporary storage facility is also required in the landfill site, so that in case of stoppage of operation because of many reasons, like emergency, natural calamities, non-operation of waste processing centres, then in that case this facility has to be there, which can temporarily store the waste before it moves into the landfill site.

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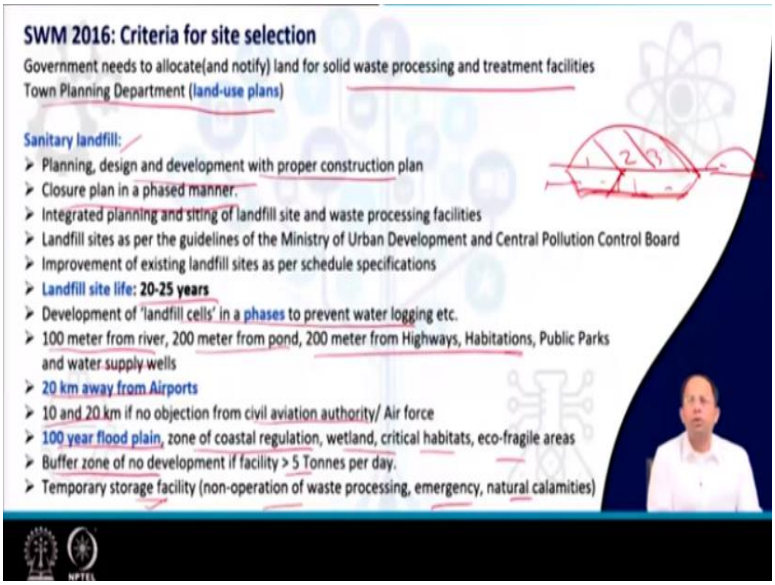

So, what are the different kinds of facilities that should be provided in the landfill site? First of all, entry should be monitored and entry should be controlled. We do not allow unauthorized access or movement of stray animals inside that landfill site. Similarly, all records should be maintain. Waste received, process and disposed all these records should be maintained and we should have office for that.

Then in addition, we should have provision for weigh bridge, fire protection equipment, drinking water, sanitary facilities, night time working should be allowed and that is why there should be adequate lighting. Then safety and provisions for the, and the health inspection provisions for the workers. So, there has to be certain centres for that. And finally, provision for parking, cleaning and washing of transport vehicles and treatment of the water that is generated from this particular activity. So, these are some of the facilities that provided for landfill site.

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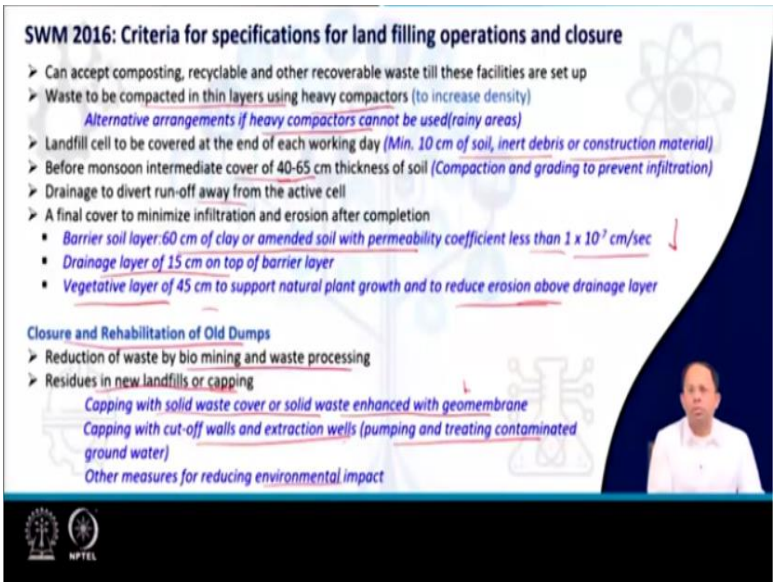

Finally, criteria for specification of landfill operations and closure. That means how do I operate and how do I close the landfill? So, we have more or less discussed all this, like, we have to compact the waste, before I put it inside the landfill, so it done by some heavy compacting equipment like bulldozers and all the press garbage into this particular site. But problem is if in case of rainy areas, this kind of compactors will not be able to work. So, we have to make alternative array, maybe I do the compaction earlier using the compactor vehicle and then bring the compactors to the landfill site.

So, landfills should be covered at the end of each day, 10 centimetre soil or inert C and D waste as we have discussed earlier, among before after before monsoon, we should put a

intermediate cover. A more thicker cover is provided so that water does not get inside the waste and it is around 40 to 65 centimetre thickness. And the other things we have discussed, like drainage to divert runoff. And finally, a barrier cover at the top.

Now, we have discussed about the reason for providing barrier, cover. But here some specifications are given in the rules. For example, it should be a 60 centimetre clay or amend clay, amended soil. Amended soil means soil mixes cement material with permeability coefficients less than 1 into 10 to the power 7 centimetre per second. That means, it should not allow water to pass. Plus, a drainage layer on the top 15 centimetre of the barrier layer. Why this drainage layer? Because at the top there is a vegetative layer of 45 centimetre.

Now, this vegetative layer is given so that we can allow plants to grow. And this plant actually keeps the soil held by the roots, which prevents erosion. And that is why we have to put a top soil layer. Now because we are putting a top soil layer, there has to be a drainage layer below it so that the water that passes this soil has to be drained out via the drainage layer and below the drainage layer, there is the barrier there. So, that part, the water does not goes down.

Similarly, for old dump sites or old dump sites, we also have to have certain considerations. So, we have to do bio mining and waste processing as we have discussed that means wherever possible we should have to do that. And in case, if in that case, whatever is after processing the waste, again, some waste will go into some waste, will recycled some waste will go in the fertilizer on the composting plant, but whatever remains goes into the new landfill site. Or in the same we can have a new facility design, which is engineered and the rest would be capped or we should put on that particular remaining waste that is there.

The capping could be done with or solid waste cover or solid waste enhanced with a geomembrane. We will learn about this design later on. Geomembrane is a plastic layer sort of, which along with the soil clay layer, we also put this plastic layer, which prevents water to pass through. Capping with cut-off walls and extraction wells and so that, and also, we may need to pump and treat the contaminated groundwater because there is no bottom liner in this particular case. And finally, other measures for reducing environmental impact also should be considered.

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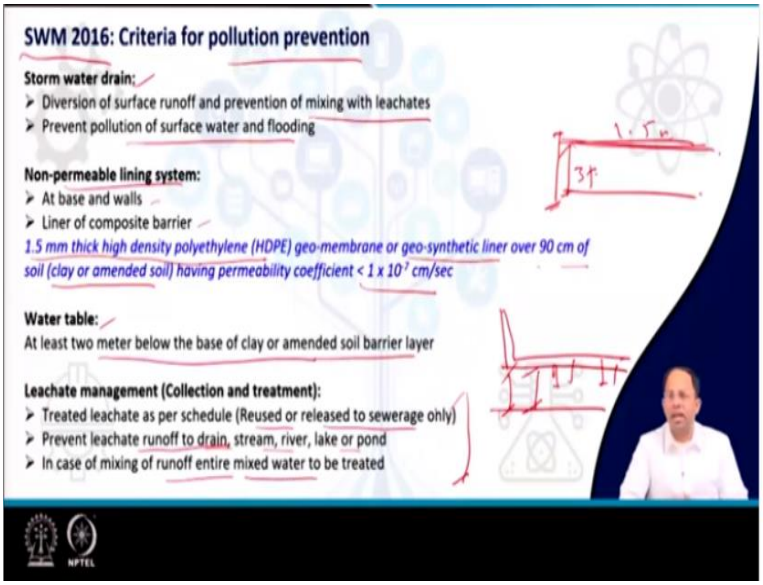

Now, in general, the new landfill design specified by solid waste management rules 2016 talks about prevention of all sorts of pollution. So, first we have to create a proper drainage system for draining the storm water so that, it, we have to prevent it to mix with the leachate. And of course, this will prevent pollution of surface waters and it will allow and during certain rainfall event, there may some amount of flood that happens, so this should be prevented.

And we have to create nonpermeable lining system at basin walls. Liner of composite barrier as we discussed, a 1.5 millimetre thick density polyethylene HDPE, this is a geomembrane and we can call them geomembrane, so geosynthetic liners. And this is above another 3 feet or 90 centimetre of soil, which is clay or amended soil, having low permeability of 1 into 10 to the power 7 centimetre per second. So, I have got a soil layer and then a geomembrane. So, this is 3 feet and this is that geomembrane of 51.5 mm. So, this is the design of the cover, design of this liner. So, there are different designs, we will discuss that in detail later.

We should be very careful about the water table, at least 2 meter below the base of clear amended soil barrier layer. So, below the bottom most liner, there could be multiple liners below. So, later they allow there is one liner. So, at least a 2 meter distance to maintain with the groundwater table. So, otherwise what happens there is some leachate whatever liners you give, there will be some amount of leachate which goes down. So, we create an additional paper.

Then leachate management collection has to be done, which is nothing but collection and treatment of leachate and some could be reused and otherwise it has to be released to the

network after treatment of course. But it cannot be directly laid out as runoff to drain, streams, lakes, or pond and in, but in case it somehow gets mixed with the runoff, the entire mixed water needs to be treated. So, that means we have to very, very careful about what did as well as those surface runoff in site area so that they do not get mixed together. And if they get mixed together, we have to make provisions for treating them.

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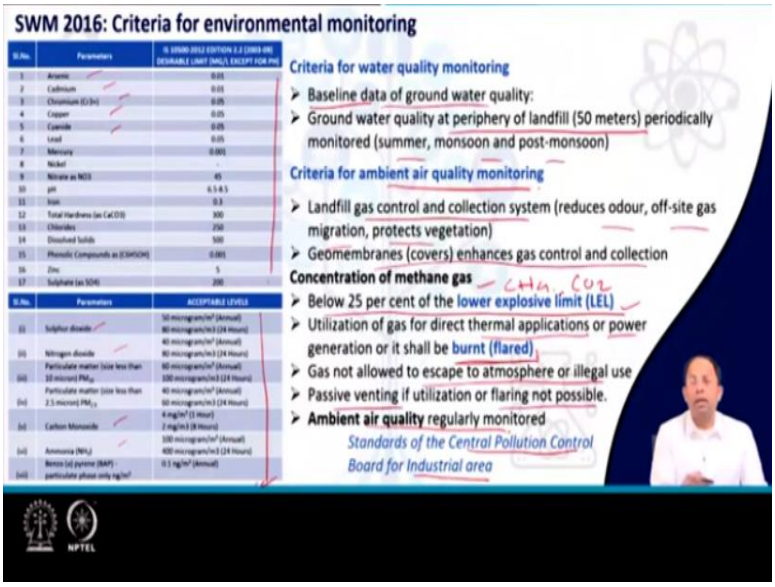

Finally, these are the criteria for water quality monitoring and ambient air quality monitoring. Water quality of course, groundwater quality at periphery of the landfill to a distance of 50 meters has to be monitored and particularly in summer, monsoon seasons. And we have to have a baseline data on groundwater quality so that we can understand what kind of contamination is happening. If I get the baseline, then I can compare the current observation with the baseline.

And these are some of the standards. As you can see, we measure for arsenic, cadmium, chromium, copper cyanide and so on. Similarly, for landfill gas or air quality monitoring, we have to have a landfill gas control and collection system. This reduces odour, off-site gas migration, protect vegetation and geomembrane enhances gas control and collection.

And we have to make sure that the total concentration of methane gas, which is CH 4, this is a result of the decomposition process. Methane and CO 2, these are both greenhouse gases. And below 20, it should be below 25 percent of the lower exclusive limit. Why? Because methane gas is highly inflammable, and in case you are not taking care of that, it may get accumulated and it is also heavy, so it will remain there, it will get accumulate and actually

create an explosion and that may lead to lot of human lives. So, that is why we have to be careful.

Utilization of, so either I can use this for creating power, we can burn it in our power plant. We can create power out this gas. Or if, if we are not able to the, if the quantity is not adequate to set up our power plant, in that case we need to pair it or burn it. We have discussed this earlier as well. Gas is not allowed to escape to the atmosphere or any other illegal use. The in case pairing is not possible for some reason, then we allow (())(34:38)

So, in addition, ambient air quality standards are monitored. As you can see, these are the ambient air quality standards. These are standards created by the Central Pollution Control Board. And this, because it is considered as an industrial idea, these are the standards that we consider, sulphur dioxide, nitrogen dioxide, particulate matter pm 2.5 and pm 10, and carbon monoxide, amonia and benzopyrene. So, the standards are given and it, our, the levels monitored should be within acceptable level.

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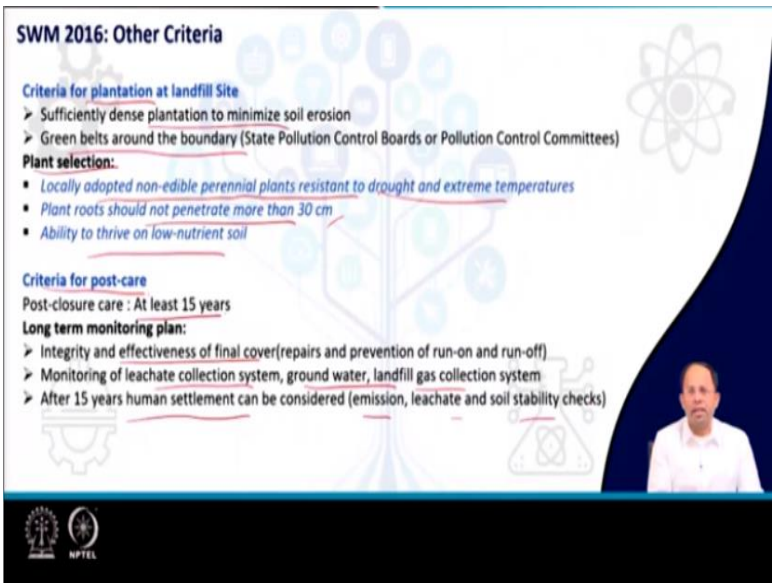

So, some other criteria, criteria for pollution at landfill site, plant, sorry, plantation at landfill site. So, we, as we discussed, the top cover should be, done. And after that we can have a vegetative layer at the top. And the plant selection should be done so that locally adopted non-edible perennial plants resistant to drought temperature.

Plant root should not penetrate more than 30 centimetre. Because if it, it will create holes in that top barrier layer and because holes are there, then water will percolate. So, we have to

make sure that the root have, trees has very shallow root systems and ability to thrive low nutrient soil.

So, these are the criteria for selecting these plants. And usually in addition to the plantation, which helps in prevention of erosion and all at the top cover, we also have green belts around the boundary of. And finally, for post care, that is post care, once the landfill operations are done, then we have to cover it, the, the final cover, the vegetation layer, all those things are put, but at least we have to keep on monitoring this for the next 15 years.

Because this is the time when the decomposition will gradually happen, there is subsidence of the landfill and because subsidence may crack may appear, which may allow water to get inside, that will create further leachate and so integrity and effectiveness of the final cover needs to be checked from time to time.

Monitoring of the collection system. Groundwater, landfill, gas collection system has to be done. And after 15 years, we can consider human settlements or for any kind use, like it could be made into a park or something. And, but obviously we have to first check for emission, leachate and soil stability of this particular site. And according we have to take a decision, we should allow other in this area or not.

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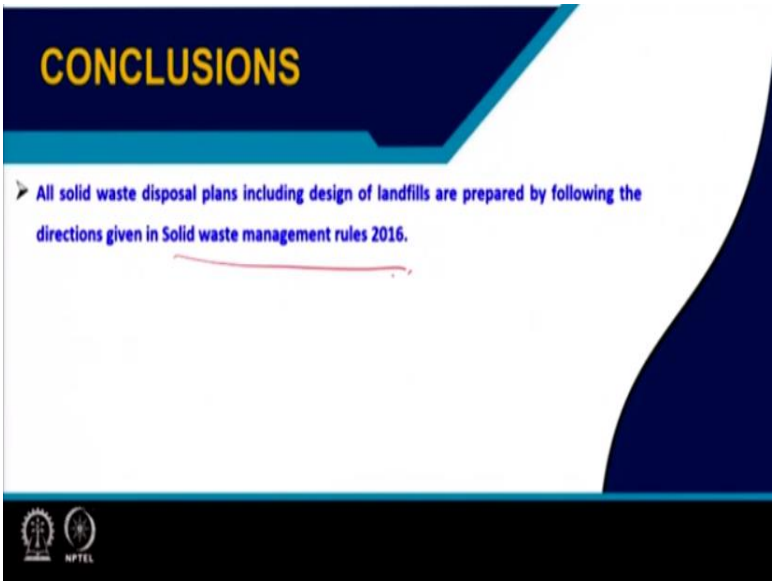

So, these are the references that you can consider. And all solid waste to conclude, all solid waste disposal plants, including designs of landfills are prepared by following the directions given in the solid waste management 2016. And as you have, we have discussed the rules today. So, these are rules, so every area has to follow this kind of rules which are given. So, thank you for this and we will discuss this in detail later.